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Basic problems of the Upper Volgian, Berriasian and Valanginian stratigraphy of the Boreal zone

ABSTRACT: The ammonite stratigraphy of the Upper Volgian, Berriasian and Valanginian of the Boreal zone of the USSR is presented and compared to other boreal zones of the world. The sediments of the above stages are chiefly silts, clays and siltstones sometimes hardly calcareous. The ammonite assemblages are unique in the Boreal zone and in more southerly peripheral zones some mixed assemblages with Tethyan forms occur. In the lack of ammonites the stratigraphy is based on pelecypods (*Buchia*). Attention is paid to the boundaries between the stages.

INTRODUCTION

It is a well known fact that a peculiar fauna and flora has developed during the Mesozoic Era in the middle and high latitudes of the Northern Hemisphere, circumspherically in relation to the pole. This fauna and flora characterizes the Boreal zone of our planet (Saks & *al.* 1971). Obviously the stratigraphic subdivision of sediments containing this fauna is entirely different than that of the Tethys zone which occupies lower latitudes of both hemispheres. In the Southern Hemisphere, as far as it is known, all areas belong to the Tethys except those which are dry land now (Basov & *al.* 1972).

The Jurassic/Cretaceous boundary is one of the main problems in the stratigraphy of the Upper Volgian, Berriasian and Valanginian of the Boreal zone. According to our views and the opinions of most of investigators this boundary should coincide with that between the Volgian and Berriasian stages. The data from the Boreal zone cannot solve the problem in planetary scale, nevertheless, they should be taken into account in its solution.

Delimitation of systems comes to the establishment of boundaries between the stages which in turn are defined by biostratigraphic zones: thus any stratigraphic boundary in point of fact should be that between the zones. Thus the zonal subdivision of stages *i.e.* definition of zonal complexes corresponding to a definite time span is another important problem of stratigraphy. It should be mentioned that the changes of the particular faunal groups of the Boreal zone were not strictly isochronous. The phases of development of the particular faunistic groups in various areas and provinces did not coincide. This pertains mostly to the benthic forms, which within the same area but in different facial conditions have developed in various speed which was proved by Dzakharov on the example of pelecypods. Ammonites are less dependent on facies as, in relation to other groups, their evolution was incomparably quicker and they expanded quickly over vast areas. Thus the establishment of zonal boundaries assemblages comes to changes of ammonite.

Tracing of zonal assemblages within various paleozoogeographic provinces and areas of the Boreal zone and their relation to the assemblages of stages known in the stratotypes is another important problem closely connected with the two preceding ones.

Zonal comparison of profiles from various paleozoogeographic areas assuming that the fauna in those profiles may slightly displace in time, can be done only approximately (Tab. 1). Consequently, establishment of stratigraphic boundaries over vast distances bears an element of convention. Nevertheless, we do not known so far other possibilities than faunistic criteria to correlate more precisely isochroneity of sediments in distanced areas.

Finally it is essential to point out the problem of names of stages. The authors are of opinion that naming of stages should be uniform. All our experience shows that the zonal scale elaborated for the Siberian profiles is more or less precisely comparable to that of Europe (Saks & Shulgina 1962). Even if it is impossible to correlate directly with the stratotype profiles there are some intermediate ones with mixed fauna with which it is possible to do that. We fully agree with Arkell (1956, p. 11) in this matter.

Acceptation of the Tithonian stage seems to be most advisable as the highest one in the Jurassic system on the world wide scale because the Portlandian and Volgian stages are less suitable in this respect. In the Russian Platform (in the lectostratotype) a regional outwash in the top of the Volgian makes its upper limit inexact and the English Portlandian in its range corresponds neither to the Volgian nor to the Tithonian stages. Nevertheless, so far the Volgian stage should be applied in the Boreal zone untill the substage and zonal comparison of the Volgian and Tithonian will be completed.

VOLGIAN, UPPER SUBSTAGE

Upper Volgian sediments are broadly exposed in the north of the USSR. They crop out along the eastern slope of the Northern Ural Mts in blocks at Novaya Zemlya, in boreholes in the Pechora basin, in western Siberia, in the lower reach of the Yenisey river, in the Taymyr, in basins of rivers Kheta, Anabar, Olenek and Lena. They occur as well in the North-East and in the Far East of the USSR. The most complete and most continuous profiles of the Upper Volgian with both lower and upper boundaries, abundant marine fauna among others with fine ammonites are to be found in the northern part of the Central Siberia in the Khatanga depression (Pahsa Peninsula and the Kheta basin). Two types of sediments prevail there; shallow-water glauconite-leptochlorite siltites with nodules of limy siltstones (the Kheta basin), and relatively deep water ones of the open basin — clays with calcareous and phosphoritic concretions (the Pahsa Peninsula). Thickness is 12—25 meters. Similar complete profiles with fauna consisting of East European and North Siberian forms developed as glauconite-leptochlorite sandstones, siltstones and clays up to 15 m thick occur in the eastern slope of the Northern Ural Mts (Helbert & *al.* 1972). In the North-East and Far East of the USSR the ammonite finds are almost unknown and the Upper Volgian sediments are subdivided not precisely by *Buchia*. Outside the USSR the sediments of that age are well developed in Spitsbergen. Those are siltstones up to 13 m thick with ammonites identical to the North Siberian ones. Probably fairly complete profiles of the Upper Volgian sediments occur in the East Greenland, but their fauna is still underscribed. In the Arctic Canada sediments of that age contain ammonites of the upper part of the substage, and *Buchia* which after Jeletzky (1966) correspond to all zones of the Upper Volgian substage. Marine sediments of the Upper Volgian are hardly known in western Europe. According to Casey (1971) the middle horizons of the Spilsby sandstone and the Sandringham sand of north-eastern England with *Subcraspedites, Craspedites* and *"Garniericeras"* (= *Oxynoticeras tolijense* Nikitin = *Toljaiceras* gen. nov. Shulgina) should be classified to the Upper Volgian. Lower horizons of those profiles containing *Paracraspedites* he ascribes to the Middle Volgian. Nevertheless, out of those ammonites only *Subcraspedites* and *Paracraspedites,* are connected with beds overlying the beds with *Virgatosphinctes* in Siberia thus being comparable to Berriasian in age. What concerns *Toli-jaiceras,* it comes probably from the Berriasian in the Ural Mts. The late Volgian ammonite fauna characterizes a definite phase in the development of the Late Jurassic faunas and sufficiently differs both from the Middle Volgian and from the Berriasian ones, the more so from the latter. Other groups undergo changes in other stages not always corresponding to those of the ammonite assemblages. The late Volgian belemnoid, pelecypods and foraminifers differ from the Middle Volgian ones mainly in impove-

rishment of their generic composition. At the Middle/Upper Volgian boundary the development of the Craspeditidae family took place as well as almost complete disappearance of the representatives of Dorsoplanitinae subfamily which were widely distributed in older Volgian horizons. Only one genus *Chetaites* persisted till the end of the Volgian and the beginning of the Berriasian times. Five genera of ammonites are characteristic for the Boreal zone during the late Volgian namely: *Craspedites, Kachpurites, Garniericeras, Tolijaiceras* and *Chetaites*. Few representatives of *Craspedites* have appeared already at the end of the Middle Volgian time but the full development of this genus took place during the late Volgian (29 species). *Craspedites* did not pass into the Berriasian. *Tolijaiceras* and *Chetaites* disappeared at the beginning of that stage. *Kachpurites* and *Garniericeras* are typically Upper Volgian genera and they do not pass the Jurassic/Cretaceous boundary. The representatives of Virgatosphinctinae disappear completely at the Volgian/Berriasian boundary both in the Arctic (northern Siberia, Northern Ural Mts, Spitsbergen) and in the Tethys.

Within the Boreal zone the ammonite fauna is most diversified in the North Siberian province where it is represented by 7 genera: *Craspedites, Garniericeras, Chetaites, Tolijaiceras, Virgatosphinctes, Aulacosphinctes* and *Berriasella (Lemencia)* (Shulgina, 1967). Presence of the three last mentioned genera allows to correlate the Volgian and Tithonian profiles. The ammonite assemblages reappeared several times during the late Volgian time which allows to distinguish three Zones within the substage: *Craspedites okensis, Craspedites taimyrensis, Chetaites chetae* and within the lower Zone three Subzones: *Virgatosphinctes exoticus, Craspedites okensis* s. s., *Craspedites originalis*. The lower Zone is comparable to the Zones with *Kachpurites fulgens* and *Craspedites subditus* of the Russian Platform and Northern Ural Mts, where in the two above mentioned zones *Craspedites okensis* (d'Orb.) occurs. The latter species was recently found in the West Spitsbergen as well. Ershova (1969) distinguishes also the Zone *Craspedites okensis* there. The *Craspedites taimyrensis* Zone (earlier *Taimyroceras taimyrense*) is well comparable to the *Craspedites nodiger* Zone of the Russian Platform and Spitsbergen. Beside that a form similar to *Craspedites nodiger* or to *C. taimyrense* Bodyl. has been found by Klimova in the Northern Ural Mts where the existence of the uppermost part of the Upper Volgian substage was not expected earlier. Common species are to be found in the above zones both in the Russian Platform and in the northern part of Siberia. *Craspedites pseudonodiger* Shulgina and *C. mosquensis* Geras. are to be found in the West Spitsbergen as well (Ershova 1969). In the Arctic Canada it is the Zone *Craspedites canadensis* Jel. (Jeletzky 1966) which corresponds to the *nodiger* and *taimyrensis* ones. This Canadian species belongs to the *nodiger* group. An unsolved problem remains

whether the uppermost Siberian Zone of *Chetaites chetae* corresponds to the upper part of the *Craspedites nodiger* Zone of the Russian Platform or to a younger one as there are no common ammonites. On the eastern slopes of the Northern Ural Mts Klimova has found some ammonites above the beds with ammonites of the *nodiger* group, which are close or even identical to *Chetaites* but they cannot be precisely determined because of bad preservation state. It was mentioned several times by the present authors that the *Chetaites chetae* Zone belongs to the Upper Jurassic and not to the Lower Cretaceous (Saks & *al.* 1972). It is worth of mention, however, that representatives of *Virgatosphinctes (V. tenuicostatus* Shulg.) and *Craspedites (C. singularis* Shulg.) are still preserved within that Zone but are extinct in the Lower Cretaceous.

Virgatosphinctinae occur throughout the profile of the Upper Volgian in the northern Siberia. Finds of single Berriasellas and Aulacosphinctids are limited to the *Craspedites okensis* Subzone. Beside that single Phylloceratids occur throughout the profile. It was presumed earlier that the migration of the southerly ammonites was from the east *i.e.* from the Pacific Basin (Shulgina 1967) as the Siberian Virgatosphinctids stand close to the Indian and Argentinian ones and because Virgatosphinctids and Berriasellids occur in the Far East. Judging from the palaeomagnetic data and from the position of the boundaries of the paleofloristic and paleozoogeographic provinces (Saks & *al.* 1971) the North Pole of the decline of the Jurassic was situated probably near the Bering Strait. Thus the North-East of the USSR, Alaska and northern Canada were within the Polar Circle of that time. Such pole position is supported also by the faunistic data. Late Jurassic and Neocomian faunas of the above mentioned areas are very poor in ammonites, belemnoids and foraminifers. *Buchia* form a peculiar background as they are found in immense quantities which proves somewhat specific most probably cold water conditions. Large biomasses are also to be found in recent Arctic seas with poor quantitative composition of faunas. Hence the representatives of southerly faunas (*Virgatosphinctes, Aulacosphinctes, Berriasella*) could have hardly penetrated northward to the Siberia through such as ecological barrier as Peripolar zone of the World Ocean. The North Atlantic path seems more probable in this respect. Passing northern Europe the ammonites followed a warm current from Central America. Such a migration path seems to be supported by new finds of Virgatosphinctinae on the eastern slopes of the Northern Ural Mts (Goldbert & *al.* 1972) in Spitsbergen and presumably in eastern Greenland.

The Upper Volgian Virgatosphinctids of Spitsbergen and Ural Mts are very close to those of northern Siberia. The Ural forms are badly preserved thus being indeterminable to specific range. The Spitsbergen forms are very similar or almost identical with the North Siberian *Virgatosphinctes tenuicostatus* Shulg.

Thus the correlation of the Upper Volgian sediments within the Boreal zone may be done at the zone level. The profiles of eastern Europe show many common species with the North Siberian and Spitsbergen profiles. The Ural assemblages have both East European (*Kachpurites, Craspedites subditus, C.* ex gr. *nodiger*), and Siberian elements (*Chetaites, Virgatosphinctes, Craspedites* ex gr. *taimyrensis*).

In the north-western and western Europe the sediments corresponding to the late Volgian times are developed as fresh-water or brackish facies of the Purbeck and Weald. The South European profiles of the Tithonian contain ammonite assemblages different from those of the Boreal ones. Nevertheless, the presence of *Berriasella (Lemencia)* aff. *richteri* (Oppel) in the Upper Volgian of Siberia, the species characteristic of the Upper Tithonian of Štramberk allows to presume a relative synchroneity of sediments containing it. Beside that, as it was already stated, Virgatosphinctids do not pass above the *Chetaites chetae* Zone in the Boreal zone. In the south-western France and in all other Tethyan profiles they are unknown in the Berriasian thus we may assume that they have disappeared more or less at the same time at the Jurassic/ /Cretaceous boundary all over the world. Hence the sediments of the Upper Volgian substage are an equivalent of the upper part of the Tithonian. Upper limit of both substages is well established but their lower limit and zonal subdivision need further elaboration.

BERRIASIAN

The present authors have pointed out many times their opinion about the differentiation of an independent Berriasian stage, within the Cretaceous period, as the fauna in the boundary beds of the Jurassic and Cretaceous of the Boreal zone and the ammonite assemblages in particular are so distinct that this phase may be regarded as fully different than the Late Jurassic and Valanginian (Saks & Shulgina 1962). That concerns the name, content of that stage and its relation to the Jurassic or Cretaceous periods there in no agreement now. The authors' opinion about the Berriasian has been expressed earlier (Saks & *al.* 1972). It is only to mention here that the inclusion of the Berriasian in the Cretaceous is justified by the priority principle. As an intermediate stage between the Jurassic and Cretaceous this stage inevitably contains Late Jurassic and Early Cretaceous elements. Various forms prevail in different faunistic groups thus the relations of both types of faunas in various zoogeographic provinces is not constant. Hence the classification of the Berriasian either to the Jurassic or to the Cretaceous on faunistic grounds cannot be solved univocally. The authors do not tend to distinguish provincial stages. The use of the Ryasan horizon or stage is not advisable first of all, because it

does not correspond to the whole Berriasian. The lower Zone of that horizon the *Riasanites rjasanensis* one corresponds to the *Berriasella boissieri* of the stratotype profile *i.e.* to the second (from bottom) Zone of the Berriasian. Both these zonal index species occur together in the Caucasus and Poland. Secondly, everywhere in the Russian Platform an erosion is marked at the base of the Lower Cretaceous. The upper boundary in the East European profiles is difficult to establish too? Either Valanginian strata rest on the Ryasan horizon with erosional break (the Oka and Volga rivers, the latter near Syzrani), or the beds are so reduced in thickness (Mena river) that the absence of gaps is hardly believable. The most complete profiles of the passage beds between the Jurassic and Cretaceous (Upper Volgian, Berriasian and Valanginian) of northern Siberia should be regarded as basic ones for the whole Boreal zone and could be stratotypes for the new regional stages which, in our opinion, should not be distinguished.

The sediments of the Berriasian embrace vast areas in the northern part of the USSR. They crop out at surface and were stated in many boreholes in the Pechora basin in the eastern slopes of the Northern Ural Mts, in boreholes in the western Siberian Lowland and in the lower course of the Yenisey river. Excellent sections occur in the Khatanga depression, in the northern Taimyr Peninsula, in the basins of rivers Anabar, Olenok and Lena. In the North-East and Far East of the USSR the Berriasian is not well faunistically proved although single finds of ammonites and mostly, of *Buchia* point to its presence there. Few Berriasian ammonites occur in the Novaya Zemlya.

The most complete and best characterized by ammonites Berriasian sediments crop out in the northern part of Central Siberia. In the coast of the Laptev Sea, in the eastern flank of the Khatanga depression (Pakhsa Peninsula) there is situated a unique trustworthy, complete section of the Upper Volgian, Berriasian, Valanginian and Lower Hauterivian sediments (Saks & *al.* 1972). We studied the Berriasian rocks and their fauna for many years at the southern flank of the Khatanga depression along the Kheta and Boyarka rivers, but we did not observed directly in outcrops the Jurassic/Cretaceous boundary (Saks & *al.* op. cit.). The faunistic assemblages and zones from the passage beds were also traced in the Pakhsa Peninsula. At the Kheta river the Berriasian is developed as silts and sands. In the Boyarka river those are moderately deep clayey--silty sediments and in the Pakhsa Peninsula — relatively deep-water clayey sediments of an open sea. Thickness of the Berriasian attains in the Pakhsa Peninsula — 52 m and at the Boyarka river — 77 m.

It became clear in recent times that probably a continuous section of the Upper Volgian and Berriasian sediments occurs in the eastern slopes of the Northern Ural Mts (Golbert & *al.* 1972). Nevertheless, the preservation of fauna is much poorer there than in the northern Siberia

thus it is not always possible to make specific and generic determinations. In practice, however, the same four zones as in Siberia are differentiated there, but the upper zone bears different name. In the Ural Mts the Berriasian sediments are developed as glauconitic-leptochlorite sandstones 25—26 m thick. Outside USSR the best continuous profiles of the Berriasian are probably those in eastern Greenland. In the Vollaston Island in the section of the Nisen Mt. thickness of the Berriasian sandstones, conglomerates and siltstones attains 150 m. Unfortunately the ammonite assemblages there were studied only in part, not from all horizons thus there is neither detailed zonal subdivision of the Berriasian nor its lower and upper boundaries are established.

A continuous profile of the Upper Jurassic — Lower Cretaceous sediments is to be encountered possibly in the West Spitsbergen as well. The Jurassic/Cretaceous boundary runs there within a series of claystones. The Upper Volgian Beds with ammonites were recently found there and two zones were distinguished. Berriasian ammonites are so rare in Spitsbergen that there is no possibility to make zonal subdivision of the latter stage.

In Alaska, Arctic and western Canada and in the western United States the subdivision of the Berriasian was based on. *Buchia* occurrences which makes correlation with other parts of the Boreal zone difficult.

The Berriasian ammonite assemblages distinctly differ from those of the Boreal Upper Volgian. Craspeditidae are in full development in the Berriasian and Perisphinctidae die out completely (only *Chetaites* still existed at the very beginning of that stage). Aside of the four late Volgian genera of Craspeditidae (*Craspedites, Kachpurites, Garniericeras* and *Tolijaiceras*) new nine ones have appeared in the Berriasian namely: *Paracraspedites, Surites, Subcraspedites, Praetollia, Hectoroceras, Esterniceras, Bojarkia, Tollia* and *Virgatoptychites*. The two last mentioned genera pass over to the Valanginian. *Chetaites* and *Tolijaiceras* pass from the Volgian up to the base of the Berriasian. Altogether there are eleven boreal ammonite genera in the Berriasian, out of which seven are entirely Berriasian forms. Ten genera are characteristic in northern Siberia and only *Externiceras* is unknown there. *Subcraspedites, Surites* and *Externiceras* occur in the Russian Platform together with such southern forms as *Riasanites, Euthymiceras* and *Neocomites*.

Good Berriasian profiles with boreal ammonites are known to occur in north-eastern England. The forms described from the Speeton Clay and Spilsby sandstone are strikingly similar to the Arctic ones. In the areas inbetween the Boreal and Tethyan zones mixed ammonite faunas are known in the Berriasian containing both boreal and Tethyan genera.

In Siberia and to a lesser extent in North America and Greenland the Volgian belemnoid assemblages are characterized by development of *Cylindroteuthis, Lagonibelus* and *Pachyteuthis*. These assemblages still

existed in the Berriasian in impoverished generic composition. Another assemblage with *Acroteuthis* and new species of the subgenus *Acroteuthis* has appeared at the end of the Berriasian and has developed in the Valanginian. The same belemnoid assemblage including the subgenus *Microbelus* appeared in Europe at the end of the Volgian times thus the lower time unit of the distribution of the assemblage with *Acroteuthis* characteristic in the Boreal Neocomian appears to be unstable.

The changes of assemblages of pelecypods and foraminifers are closely connected with facial conditions hence these groups cannot be decisive for establishment of time boundaries. Eurifacial *Buchia* and planctonic foraminifera are most suitable for the correlation and establishment of faunal development. The sharpest change of the specific composition of *Buchia* takes place at the Berriasian/Valanginian boundary. In the Berriasian there is partly preserved a late Volgian assemblage (*Buchia fischeriana* d'Orb., *B. trigonoides* Pavl., *B. terebratiloides* Lah., *B. lahuseni* Pavl.). There appear as well typical Berriasian forms like *B. volgensis* Lah., and *B. okensis* Pavl.

In the Arctic areas the ammonite assemblages reappeared several times during the Berriasian which allows to distinguish four Zones there: *Chetaites sibiricus, Hectoroceras kochi, Surites analogus* and *Bojarkia mesenzhnikovi* (Saks & *al.* 1972).

The lower Zone of *Chetaites sibiricus* within which appear the Berriasian forms like *Surites tzikvinianus* Bogosl., *Paracraspedites stenophaloides* Swinn., *Praetollia maynci* Spath, and lack the late Jurassic ones like *Craspedites, Garniericeras,* and *Virgatosphinctes* is ascribed to the Cretaceous. Its counterparts are probably to be found in the eastern slope of the Northern Ural Mts where over the beds with *Craspedites nodiger* and *Chetaites?* sp. were found *Chetaites* ex gr. *sibiricus* Shulg. The latter form occurs in the West Spitsbergen as well (*Perisphinctes* sp.), but it is not strictly connected with a profile. The beds with *Praetollia maynci* Spath of eastern Greenland and the underlying ones with *Suberaspedites* and *Surites* which lack *Hecteroceras,* may fully correspond to the *Chetaites sibiricus* Zone in which in the Pakhsa Peninsula the first mentioned form occurs as well. There is no counterparts of that Zone in the Russian Platform. Within the *Riasanites rjasanensis* Zone there occurs an ammonite assemblage similar to that of the higher Zone of Siberia. It is possible that the lower part of the Spilsby sandstone of England containing *Paracraspedites stenomphaloides* Swinn., *P. bifurcatus* Swinn., *Subcraspedites (Subcraspedites)* aff. *subpressulus* Bogosl. etc. corresponds to the *Chetaites sibiricus* Zone as the latter contains *Paracraspedites stenomphaloides* as well (Saks & *al.* 1972).

Next Zone of the Siberian Berriasian the *Hectoroceras kochi* one with *Surites (Surites) spasskensis* (Nik), *S. (Surites) subtzikvinianus* (Bogosl.), *Subcraspedites (Subcraspedites) plicomphalus* (Sow.), *S. (S.)*

anglicus Shulg., *S. (S.) pressulus* Bogosl., *S. (S.) subpressulus* (Bogosl.) etc. can be traced over many areas of the Boreal zone. Beds with *Hectoroceras kochi* and accompanying characteristic fauna crop out in the eastern slope of the Northern Ural Mts, in the eastern Greenland and in England. In the latter area they occur in the Sandringham sands, Norfolk over the beds with *Paracraspedites, Subcraspedites* and *Tolijaiceras* (Casey 1971). There are indications about existence of *Hectoroceras* aff. *kochi* Spath in the Arctic Canada (Wiedmann 1968). In the Russian Platform the *Riasanites rjasanensis* Zone corresponds partly or completely to that of the *Hectoroceras kochi.* Aside of the Tethyan forms like *Euthymiceras* and *Neocomites* and similar ones (*Riasanites*) there occurs a typical boreal Berriasian ammonite assemblage with *Surites, Subcraspedites* etc. (according to the authors' observations of 1972 done on the river Unzha the first representatives of that assemblage, *Surites* in particular, have appeared in the Rusian Platform already during the late Volgian times). In the *Surites analogus* Zone the characteristic forms in northern Siberia are: *Surites (Surites) analogus* Bogosl., *S. (S.) subanalogus* Shulg., *Subcraspedites (Subcraspedites) subpressulus* (Bogosl.). In the eastern slope of the Northern Ural Mts rare *Surites* cf. *spasskensis* (Nik.) and *Surites* sp. ind. occur in the *Surites analogus* Zone. In the Russian Platform the *Surites analogus* Zone should correspond fully or possibly only to the lower part of the *Surites spasskensis* Zone the latter containing similar assemblage of ammonites and *Buchia.*

Beds with *Surites spasskensis* (Nik.) of eastern Greenland are also parallelized with the *Surites analogus* Zone. It maybe presumed that an ammonite assemblage of western and Arctic Canada containing *Subcraspedites (Borealites) suprasubditus* (Bogosl.), *S. (S.)* ex gr. *plicomphalus* (Sow.), *Surites (Surites)* ex gr. *spasskensis* (Nik.), *S. (S.)* cf. *spasskensis* (Nik) [1] corresponds to the *Hectoroceras kochi* and *Surites analogus* Zones of northern Siberia.

The middle and upper parts of the Siberian Berriasian crop out in the Pechora basin along the river Izhma. According to Bodylevsky and the present authors the Jurassic/Berriasian contact does not crop out at surface there. Grey, argillaceous silts with phosphorites 11—15 m thick correspond to the middle and possibly to the upper horizons of the Siberian Berriasian. Below there is an assemblage with *Surites (Surites)* ex gr. *spasskensis* (Nik.), *S. (S.) kozakovianus* (Bogosl.), *Subcraspedites (Subcraspedites) pressulus* (Bogosl.), *S. (Borealites) suprasubditus* Bogosl., *Pachyteuthis (Simobelus) curvula* Sachs & Naln. and other forms. This assemblage corresponds first of all to the *Surites analogus* Zone. The overlying grey silts with *Tollia? (Bojarkia?)* sp. ind. should possibly be

[1] The ammonites, illustrated in papers by Jeletzky are partly redetermined by Shulgina (*see* Saks & *al.* 1972).

correlated with the upper zone of the Siberian Berriasian *i.e.* the *Bojarkia mesezhnikovi* Zone.

The *Bojarkia mesezhnikovi* Zone was established by the present authors instead of the lower part of the late *Tollia tolli* Zone, as the last mentioned species may occur in the Valanginian as well. The following forms are characteristic in that Zone: *Bojarkia mesezhnikovi* Shulg., *B. bodylevskii* Shulg., *B. payeri* Toula, and various species of *Tollia* and *Virgatoptychites.*

The counterparts of the *Bojarkia mesezhnikovi* Zone can be traced along the eastern slopes of the Northern Ural Mts (the *Bojarkia payeri* Zone) and in the Wollaston Peninsula in the eastern Greenland also with *Bojarkia payeri* Toula. In the Arctic Canada in the Deer Bay Formation the beds with *Tollia tolli* Pavl. may correspond to the above mentioned Zone of Siberia. *Tollia* cf. *payeri* Toula (Jeletzky 1964, Pl. 4, Fig. 8) belongs to *Surites (S.* cf. *spasskensis* Nik.).

In the Russian Platform it is impossible to show sediments which could correspond to the upper zone of the Siberian Berriasian. As there is a hiatus at top of the Berriasian in the Russian Platform thus the sediments corresponding in time to the *Bojarkia mesezhnikovi* Zone were eroded there. Another possibility is, as it was already mentioned, that the upper part of the *Surites spasskensis* Zone may correspond to the *Bojarkia mesezhnikovi* one. A mixed Berriasian-Valanginian fauna among others with *Bojarkia aff. bodylevskii* Shulg., occurs in the *Pseudogarnieria undulato-plicatilis* Zone which along the Mena river overlies the *Surites spasskensis* Zone (Saks & *al.* 1972). The presence of many typical Valanginian forms such as *Temnoptychites,* close to Platylenticeras, *Pseudogarnieria* and *Neotollia?* within the fauna of that Zone suggests to include it to the Valanginian after Sazanova (1971).

The upper beds of the Spilsby sandstone and beds D_6—D_8 of the Speeton Clay of England with *Paracraspedites stenomphaloides* Swinn., *Surites (Surites) subtzikvinianus* (Bogosl.), *S. (Bogoslavskia) stenomphalus* (Pavl.), *Tollia wrighti* Neale, *T. pseudotolli* Neale, *T.* cf. *tolmatschovi* Pavl. etc. possibly correspond to the upper half of the Siberian Berriasian.

A comparison with the Berriasian of Poland can be done only approximately as Tethyan ammonites predominate there. The boreal ammonites of Poland, as it can be judged from illustrations, are badly preserved as a rule and in many cases cannot be determined with certainty even to generic degree. Nevertheless, the presence of *Riasanites rjasanensis* together with *Berriasella* cf. *lorioli* Zitt., *B.* sp. cf. *pontiès* Ret., *B.* sp. cf. *boissieri* (Pict.) and boreal *Praetollia* cf. *maynci* Spath (the latter determination cannot be regarded as fully reliable) allows to presume that the Polish *Riasanites rjasanensis* Zone corresponds to the middle part of the Siberian Berriasian, more accurately to the *Hectoroceras kochi* Zone. The upper Zone named by Marek (1969) the *Surites stenomphalus*

Zone with ammonites *Surites (Surites)* cf. *spasskensis* (Nik.), *S. (S.)* cf. *subtzikvinianus* (Bogosl.), *S. (S.) kozakovianus* (Bogosl.), *Tollia*(?) sp. and Tethyan forms like *Neocosmoceras* aff. *sayni* Sim., *Euthymiceras* cf. *euthymi* Pict., *Berriasella* cf. *boissieri* Pict. corresponds to the upper part of the boreal Berriasian (*Surites spasskensis* Zone of the Russian Platform, *Surites analogus* and possibly *Bojarkia mesezhnikowi* Zones of Siberia).

A comparison with the Berriasian stratotype of the south-weastern France can be done only comparing indirectly some intermediate profiles from north to south. As it was already said the Berriasian assemblages of the northern Siberia, Russian Platform, Poland and Mangyshlak Peninsula have common genera and even species of ammonites. These are *Surites (Surites) kozakovianus* (Bogosl.), *Subcraspedites (Subcraspedites) subpressulus* (Bogosl.), *Surites (Surites) spasskensis* (Nik.) and many other forms. Some southerly ammonites corresponding in age to the *Berriasella boissieri* Zone of the south-eastern France occur together with the above mentioned ones. Thus we may assume that the sediments of the most part of the Siberian Berriasian correspond to the *Berriasella boisieri* Zone. The *Chetaites sibiricus* Zone appears to be older than the *Riasanites rjasanensis* one hence it maybe presumed that it corresponds to the *Berriasella grandis* Zone of the stratotype profile.

Out of the above review it is clear that the correlation of the Berriasian sediments within the Boreal zone as well as of the Upper Volgian ones may be accomplished inbetween many regions on the zone level. Correlation with the stratotype profile of the south-eastern France which includes two Zones namely the *Berriasella grandis* and *B. boissieri*, can be done only approximately. The lower boundary of the Berriasian which both in the Tethyan and Boreal zones coincides with the disappearance of Virgatosphinctidae can be traced with good accuracy. Its upper boundary coincides with the appearance of Valanginian genera both in the Tethyan and Boreal zones. These are: *Platylenticeras, Tolypeceras, Neotollia* (Saks & al. 1972), and slightly later — a new family Polyptychitidae.

VALANGINIAN

The Valanginian ammonites of the Boreal zone are poorly known in comparison to those of the Volgian and Berriasian. From the times of Koenen, Neumayr, Uhlig, Pavlov and Bogoslavsky nobody dealt seriously with the Polyptychitinae, and *Dichotomites* comprising a definite part of the Boreal assemblages. Their ontogeny is unknown and without it any taxonomy is impossible and zonal stratigraphy of the Valanginian has not reasonable frames. The situation is relatively better in the Lower Valanginian in which considerable distribution show Craspeditidae (*Platylenticeras, Tolypeceras, Pseudogarnieria, Proleopoldia, Menjaites, Neotoliia,*

Stchirovskiceras, Russanovia, Temnoptychites, Thornsteinssonoceras). The ammonites from the boundary beds of the Valanginian and Hauterivian, from the Upper Valanginian and from the Lower/Upper Valanginian boundary still need basic investigations. These are *Polyptychites, Euryptychites, Astieriptychites, Neocraspedites, Dichotomites.* Beside that there are some peculiar ammonites in the early Hauterivian of the Boreal areas which bear characters both of Polyptychitinae and Simbirskitinae and are still inadequately known. The genera *Subspeetoniceras, Pavlovites* and *Gorodzovia* (Aristov & Ivanov 1971) fill to some extent this gap, but outside the Russian Platform they were found almost nowhere. Thus our zonal subdivision of the Valanginian needs to be precised.

The Valanginian sediments occupy the same areas in the northern territories of the USSR as the Berriasian ones and are well exposed in the Pechora depression and in the Novaya Zemlya. Outside USSR rather complete Valanginian profiles occur in Spitsbergen and in western Canada. Ammonites are rare in the North-East and Far East of the USSR thus the Valanginian sediments of those areas are subdivided mainly on the basis of pelecypoda (*Buchia*).

Continuous profiles of this stage with its lower and upper boundaries are best exposed in northern Siberia, in the Pakhsa Peninsula. The Valanginian facies like clays, argillaceous silts and siltstones represent open sea conditions there.

In the Kheta river basin (profiles along rivers Kheta, Boyarka, Maymetch and Bolchaia, Romanikha) and along the rivers Anabar and Popigay the Valanginian is represented by near-shore siltstone and sands 128 m thick. A good profile is exposed along the Izhma river in the Pechora basin where on the upper part of the Berriasian rest silts with interbeds and concretions of siltstones up to 65 m thick. The upper substage consisting of silts and sands with thick nodules of calcareous siltstones and sandstones up to 80 m thick is less traceable. A complete section of the Valanginian crops out in the eastern slope of the Northern Ural Mts along the Yatra river. These are argillaceous siltstones 45 m thick with a faunal assemblage similar to that of the North Siberia.

Outside USSR in Spitsbergen, Canada and eastern Greenland the Valanginian profiles and their fauna still need additional studies. The zones distinguished in the northern Siberia maybe more or less precisely traced in the above mentioned areas.

The boreal ammonite assemblages of the Berriasian/Valanginian boundary have undergone considerable changes. Instead of 11 Berriasian genera there appear 15 Valanginian ones out of which 11 belong to the Craspeditidae (*Neotollia, Temnoptychites, Menjaites, Russanovia, Thornsteinssonoceras, Stchirovskiceras, Platylenticeras, Tolypeceras, Pseudogarnieria, Proleopoldia,* and *Neocraspedites).* Aside of that two other genera passed from the Berriasian into the Lower Valanginian. They

belong to Craspeditinae: *Tollia* and *Virgatoptychites*. Other four Valanginian genera belong to Polyptychitidae (*Polyptychites, Euryptychites, Astieriptychites,* and *Dichotomites).* Altogether there are 17 boreal genera in the boreal Valanginian. The total number of the ammonite genera including the Tethyan forms is 27 — out of those 10 are Tethyan. The latter are: *Bochianites* (northern Siberia), *Leopoldia* (Russian Platform, Greenland), *Endemoceras* (England, West Germany and Poland), *Olcostephanus* (England and West Germany), *Valanginites* (England and West Germany), *Kilianella* (England and West Germany), *Thurmanniceras* (western United States), *Neocomites* (western Canada, West Germany and Poland), *Saynoceras* (West Germany and Poland), *Sarasinella* (western United States) and *Homolsomites* (North America). This list does not include the representatives of *Lytoceratina* and *Phylloceratina* as they were not investigated.

Due to the presence of Tethyan forms together with the boreal ones we are able to correlate the Valanginian profiles of the Boreal zone with the stratotype of Switzerland.

Twelve ammonite genera are known to occur in the Valanginian of the Boreal zone namely *Tollia, Neotollia, Virgatoptychites, Temnoptychites, Russanovia, Thornsteinssonoceras, Neocraspedites, Euryptychites, Astieriptychites, Polyptychites, Dichotomites* and *Bochianites*. The *Neotollia klimovskiensis* Zone is distinguished at the base of the lower substage of the Valanginian which is characterized by the presence of various species of *Tollia* and *Virgatoptychites*. A new Valanginian assemblage of pelecypods (*Buchia*) appears at the base of that Zone. It does not occur in the Berriasian. It reaches the top of the Valanginian (*Buchia inflata* Toul., *B. crassa* Pavl., *B. bulloides* Lah., *B. keyserlingi* Lah. etc.). The belemnoid assemblage has changed as well and a typical Valanginian genus *Acroteuthis* has appeared.

The representatives of *Neotollia* occur also higher up but in association with such forms as *Temnoptychites, Russanovia, Astieriptychites, Euryptychites, Neocraspedites*. Out of Polyptychitinae the most characteristic are: *Polyptychites michalskii* (Bogosl.), *P. stubendorfii* (Schm.) and *P.* ex gr. *keyserlingi* Neum. & Uhl.

Still higher up in the section Temnoptychitinae and in general all Craspeditinae disappear and remains only the above mentioned assemblage of Polyptychitinae.

As far as the polyptychitid assemblage is of general character the present authors previously differentiated the *Polyptychites stubendorfii* Zone above the *Neotollia klimovskiensis* one in the Lower Valanginian (the former was named *P. michalskii* in earlier papers). This Zone is subdivided into two Subzones namely *Temnoptychites syzranicus* and *P. michalskii*. The ammonite assemblages of the two above Subzones

sufficiently differ one from another (after disappearance of Craspeditidae in the upper Subzone) and the Subzones are well traceable in the Boreal zone (Siberia, North America, western Europe, Spitsbergen and eastern Greenland). Thus it seems justifiable to regard these Subzones as independent Zones of the boreal Valanginian.

In the eastern slope of the Northern Ural Mts two Zones maybe distinctly differentiated. The lower Zone *Temnoptychites insolutus* with ammonites *Temnoptychites* spp., *Neotollia* spp., and rare Polyptychitinae should correspond to the *Neotollia klimovskiensis* and *Temnoptychites syzranicus* Zones of northern Siberia. The upper one — *Polyptychites michalskii* appears to be common with that one of North Siberia and is characterized by an assemblage with *Polyptychites* spp. and *Neocraspedites* spp.

In the Russian Platform along the rivers Mena and Oka Sazanova (1971) has distinguished at the base of the Valanginian the *Pseudogarnieria undulato-plicatilis* Zone with a peculiar endemic assemblage of ammonites: *Pseudogarnieria, Proleopoldia, Menjaites, Stchirovskiceras,* as well as *Surites, Bojarkia, Temnoptychites, Neotollia?* Judging from resemblance of *Pseudogarnieria* to *Platylenticeras* and abundance of *Neotollia?* this Zone corresponds mainly to the beds with *Platylenticeras* of Poland and of northern part of West Germany, and to the *Neotollia klimovskiensis* Zone of Siberia. The higher Zones of the Russian Lower Valanginian could correspond as follows: *Temnoptychites hoplitoides* — to the Siberian Zone of *T. syzranicus,* the *Polyptychites michalskii* is common with Siberia. In the Pechora basin the Upper Berriasian siltstones with *Tollia (Bojarkia?)* sp. ind. are overlaid by variegated silts with interbeds of siltstone with *Temnoptychites* spp., *Polyptychites* spp. They contain *Menjaites* and *Russanovia* as well. Higher horizons of the Lower Valanginian — counterparts of the *Polyptychites michalskii* Zone — are indistinctly pronounced in the Pechora basin.

Beds with *Neotollia* are widely distributed in the Boreal zone. Outside the USSR these beds occur in northern part of West Germany (*T. tolmatschovi* Kemper non Pavlov), in the western United States (*N. mutabilis* Stanton *in* Imlay & Jones 1970, Pl. 7, Figs 4, 7—8; Pl. 8, Figs 4—5), most probably in northern Canada (*N. ? anabarensis* Pavl.) and in eastern Greenland (*N. ? paucicostata* Donovan).

Beds with Temnoptychitinae crop out in western Spitsbergen and in eastern Greenland (Ershova 1969). Ammonites from those areas are illustrated by Donovan (1953) under other names. Their presence in Arctic Canada was stated by Jeletzky (1964). Nevertheless, their greatest distribution is noted in the Russian Platform, in the Pechora basin and in Novaya Zemlya.

Only one zone is distinguished in the upper substage of the Valanginian of the Boreal zone within the territory of the USSR. In the

northern Siberia it was named by the authors the *Dichotomites* spp. Zone. The species *D. bidichotomus* (Leym.) which occurs among other species there cannot be named an index species because it is an index form in the northern part of West Germany in a zone embracing only lower part of the Upper Valanginian. Hence an index species for the Upper Valanginian zone in Siberia can be established after monographic elaboration or Dichotomitidae will be done. Dichotomitidae are accompanied by some still not elaborated species of *Polyptychites* among which is *P.* ex gr. *polyptychus* (Keys) as well as *Neocraspedites* and *Bochianites*. In the eastern slope of the Northern Ural Mts Klimova has distinguished the *Dichotomites ramulosus* Zone containing *Dichotomites* spp. and *Neocraspedites* spp. which embraces the whole Upper Valanginian. In the Russian Platform including the Pechora basin there is the *Dichotomites petschorensis* Zone with *Dichotomites* spp., *Polyptychites* ex gr. *polyptychus* (Keys.) and other forms.

In Siberia, in the eastern slopes of the Northern Ural Mts and in the Russian Platform the beds with *Dichotomites* are overlaid by sediments containing *Homolsomites (Homolsomites bojarkensis* Zone) which in our opinion belong already to the Hauterivian. In the northern part of Central Siberia the sediments of the *Homolsomites bojarkensis* Zone terminate the marine sequence over which there are lagoonal and continental coal-bearing beds at the base of which only intercalations containing marine pelecypods (*Buchia crassicollis* Keys & *al.)* and foraminifers occur. In the foothills of the Ural Mts the beds with *Homolsomites* pass without any gap into the beds with *Speetoniceras* sp. (the *Speetoniceras versicolor* Zone of the upper part of the Lower Hauterivian). At Jaroslav in the Russian Platform Aristov and Ivanov (1971) have differentiated a *Pavlovites polyptychoides* Zone above the beds with *Homolsomites*. That Zone contains endemic ammonite genera namely *Subspeetoniceras, Gorodzovia, Pavlovites,* as well as *Buchia sublaevis* (Keys.). The ammonites are of intermediate character between Polyptychitidae and Simbirskitidae which supports the position of that Zone in the middle part of the Lower Hauterivian *i.e.* inbetween the Zones *Homolsomites bojarkensis* and *Speetoniceras versicolor*.

In North America the beds with *Homolsomites* are placed within the Upper Valanginian (Imlay & Jones 1970). The American *Homolsomites* stands close to *H. bojarkensis* Shulg. (*H. stantoni* McLell.). Some Lower Hauterivian ammonites classified by Jeletzky (1971) to *Homolsomites* have been ascribed earlier to *Wellsia* (*W. packardi* And., *W. oregonensis* And. This fact together with the occurrence of *Dichotomites* entirely in the lower part of the Upper Valanginian in western Europe leaves some doubts about the classification of the *Homolsomites bojarkensis* to the Hauterivian.

Table 1

Zonal subdivision of the Upper Volgian — Lower Hauterivian sediments of the Boreal zone

System	Stage	Substage	SE France and Switzerland	Northeastern England	Northern part of West Germany	Northern Poland /Kujawy/	Spitsbergen	Russian Platform	Northern Ural Mts	Northern Siberia	Northern Canada	Western Canada	Western United States	Eastern Greenland
Lower Cretaceous	Lower Hauterivian		Crioceratites duvali	Speetoniceras versicolor	Aegocrioceras capricorni		Speetoniceras versicolor	Speetoniceras versicolor	Speetoniceras versicolor	———		Hollisites lucasi. Speetoniceras agnessense	Hollisites dichotomus	
			Acanthodiscus radiatus	Acanthodiscus obergensis	Acanthodiscus aff. radiatus		?	Pavlovites polyptychoides	Homolsomites bojarkensis	Homolsomites bojarkensis	———	Homolsomites packardi	Homolsomites packardi	———
			Sarasinella ambigua	Endemoceras norioum	Endemoceras norioum	Endemoceras norioum		Homolsomites bojarkensis				Homolsomites oregonensis	Homolsomites oregonensis	Endemoceras sp.
			Himantoceras trinodosum											
	Valanginian	Upper	Saynoceras verrucosum	Dichotomites spp.	Olcostephanus psilostomus	Dichotomites bidichotomus Saynoceras verrucosum	Dichotomites petschorensis	Dichotomites petschorensis	Dichotomites ramulosus	Dichotomites spp.		Valanginites aff. nucleus	Olcostephanus peoki	Leopoldia spp. Dichotomites spp.
					Dichotomites bidichotomus						Homolsomites aff. quatsinoensis	Holmesomites quatsinoensis	Homolsomites quatsinoensis	
		Lower	Kilianella roubaudiana	Polyptychites spp.	Polyptychites spp.	———	Polyptychites spp.	Polyptychites michalskii	Polyptychites michalskii	Polyptychites michalskii	Buchia inflata, B. aff. B. keyserlingi — Polyptychites stubendorffi	?	Necoraspedites giganteus	Polyptychites spp.
			Kilianella lucensis	Tollia cf. tolmatschovi	Platylenticeras involutum Platylenticeras heteroplourum /with Tollia and Neotollia/ Tolypeceras marcouisianum	Platylenticeras sp. Neocomites neocomiensis premolica		Temnoptychites hoplitoides	Temnoptychites insolutus	Temnoptychites syzranicus				Temnoptychites spp.
											Neotollia/?/ anabarensis, Polyptychites	Buchia inflata Tollia sp.	Neotollia mutabilis	Neotollia /?/ paucicostata
											Thorsteinssonoceras ellesmerense	Buchia pacifica Neocomites cf. rota	Kilianella crassiplicata	
								Pseudogarnieria undulato-plicatilis		Neotollia klimovskiensis	Temnoptychites elegans Tollia tolli	Buchia tolmatschovi, Tollia sp., Surites cf. tzikvinianus	Thurmanniceras sp.	
	Berriasian		Berriasella boissieri	Bojarkia cf. payeri	Riasanites ?	Berriasella boissieri — Surites spp.	Tollia sp.	Surites spasskensis	Bojarkia payeri	Bojarkia meseshnikovi	Buchia sp. n. aff. volgensis Surites cf. spasskensis Suboraspedites sp.	Buchia uncitoides Spiticeras cf. scriptum Protacanthodiscus sp.	Negreliceras stonyense	Bojarkia payeri
				Surites stenemphalus			Surites sp. Suboraspedites sp.		Surites analogus	Surites analogus				Surites spp.
				Hectoroceras sp.		Riasanites rjasanensis		Riasanites rjasanensis	Hectoroceras kochi	Hectoroceras kochi	Hectoroceras aff. kochi			Hectoroceras kochi
			Berriasella grandis	Paraoraspedites stenomphaloides	Wealdian fauna	Wealdian fauna	Chetaites cf. sibiricus	———	Chetaites cf. sibiricus	Chetaites sibiricus	Buchia okensis, Suboraspedites cf. suprasubditus S. ex gr. plicomphalus	Buchia okensis, Pseudargentiniceras aff. gallicum, Suboraspedites cf. suprasubditus		Praetollia maynci
											Buchia ex gr. uncitoides Suboraspedites sp. n.			Suboraspedites aff. preplicomphalus
Upper Jurassic	Upper Tithonian /Volgian/		Berriasella chaperi	?			Chetaites? sp.		Chetaites cf. chetae	Chetaites chetae	Buchia unschensis B. terebratuloides Craspedites canadensis	Buchia terebratuloides Paradontoceras callistoides	Substeueroceras stantoni	Craspedites ferruginous Laugeites spp.
							Craspedites ex gr. nodiger	Craspedites nodiger	Craspedites cf. taimyrensis	Craspedites taimyrensis				
			Berriasella delphinensis				Craspedites Virgatosphinctes	Craspedites subditus	Craspedites subditus	Craspedites okensis — Craspedites originalis	Buchia fischeriana	Buchia fischeriana	Paradontoceras	
								Kachpurites fulgens	Kachpurites fulgens	Craspedites okensis — Craspedites okensis	Buchia richardsonensis	Buchia cf. blanfordiana ?Substeueroceras stantoni	Kossmatia	
										Craspedites okensis — Virgatosphinctes exoticus				

FINAL REMARKS

All the data mentioned above clearly show that the Upper Volgian sediments of the Boreal zone fully correspond to the Upper Tithonian of the Tethyan zone. They are characterized by occurrence of ammonite genera *Craspedites* and *Garniericeras*, and in the Arctic areas, also *Virgatosphinctes* and others.

Berriasian is distinguished on the basis of a unique ammonite assemblage of boreal forms such as *Surites, Paracraspedites, Subcraspedites, Hectoroceras* and others, and with *Bojarkia* in the upper part of the stage. In peripheral parts of the Boreal zone those ammonites occur together with some forms of the Tethyan Berriasian namely with *Berriasella, Euthymiceras, Riasanites* etc.

The Valanginian stage starts with the beds containing *Neotollia*. Then follow beds with *Temnoptychites* and *Polyptychites* ex gr. *keyserlingi* Neum. & Uhl. In the upper substage there occur *Dichotomites* and *Polyptychites* ex gr. *polyptychus* (Keys.). The Valanginian/Hauterivian boundary runs in Siberia and in eastern Europe at the base of the beds with *Homolsomites* which are overlaid by the ones with *Speetoniceras* or *Pavlovites* corresponding already to the upper part of the Lower Hauterivian.

The Volgian/Berriasian boundary *i.e.* that one of the Jurassic and Cretaceous systems and the Berriasian/Valanginian one seem to be fairly well pronounced in the Boreal zone. The Valanginian/Hauterivian boundary still needs farther studies.

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GŁÓWNE PROBLEMY STRATYGRAFII GÓRNEGO WOŁGU, BERIASU I WALANŻYNU STREFY BOREALNEJ

(Streszczenie)

Przedstawiono biostratygrafię i zespoły amonitowe górnego wołgu, beriasu i walanżynu borealnej strefy Związku Radzieckiego i dokonano porównań z analogicznymi strefami półkuli północnej. Osady strefy borealnej są wykształcone głównie jako muły, iły i mułowce, partiami słabo wapniste. Rozpatrywane zespoły amonitowe typowe są dla strefy borealnej, a jedynie w peryferycznych południowych regionach tej strefy napotyka się zespoły mieszane z formami Tetydy. W przypadku braku amonitów stratygrafię oparto na małżach (*Buchia*). Sprecyzowano także granice między piętrami.

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