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Late Jurassic ammonite evolution and paleoenvironment of the Russian Platform

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The stratigraphic record shows a considerable decrease in ammonoid taxonomic diversity and distinct changes of ammonite shell morphology toward end of the Jurassic in the Central Russian Basin. By the end-Volgian, ammonites were represented by only two genera, belonging to a single family Craspeditidae, which differ markedly from previous ammonite families in their shell form. The end-Jurassic decrease in ammonoid biodiversity started in the mid-Volgian and is mainly correlated with shallowing of the shelf.

Volgian, Ryazanian, ammonites, biodiversity, Russian Platform

1 Introduction

The end of the Jurassic was marked by global paleogeographic transformations. Fundamental changes to sedimentary settings and paleoenvironments greatly affected ammonoid evolution. Late Jurassic ammonites of the Russian Platform have been studied over a long time and are described in numerous publications, including classical works by Michalsky[1] and Gerasimov[2] on ammonites from the Middle and Upper Volgian. However, even the most detailed papers on taxonomy and stratigraphic distribution of these ammonites do not analyze changes in the shell shape during their evolution, or changes in their habitats.

This paper discusses the phenotype evolution of the Late Jurassic ammonites in the marine basin on the Russian Platform. The position of this basin at the junction of the Boreal Realm and the Submediterranean Province, its frequent periods of isolation from northern/eastern and southern/western basins, and the relative frequency of faunal invasions from these basins during comparatively short time intervals greatly increased the potential of ammonoids found in this region for global Boreal-Tethyan correlations; it is potentially valuable for the study of evolution of marine biota during the epochs of frequent environmental change.

2 Material

The study of ammonites from the Upper Jurassic of the Russian Platform was initiated by one of the authors in 1980. Since then, extensive material has been collected from various localities, mainly from the Moscow, Yaroslavl, Kostroma, Ulyanovsk, Samara, and Ryazan regions of Central Russia. The study of these collections, which exceed 15000 specimens, allowed a precise reinterpretation of the taxonomic position and stratigraphic distribution of many Late Jurassic ammonoid taxa, primarily Perisphinctoidea from the Volgian Stage[3]. Below, changes in the form of ammonite conchs from the Central Russian basin by the end of the Jurassic, and their possible association with abiotic events, are discussed. Apparently, these changes were associated with the shallowing of the Central Russian marine basin, which began at the end of the Middle Volgian and continued in

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the Late Volgian. Beginning from the *Epivirgatites nikitini* Zone, relatively deep water sediments of the Volgian Stage were replaced upwards in the section by the shallow water glauconite sandy sediments with abundant phosphorites, and by shellstones.

3 Results and discussion

The first endemic ammonoid faunas appeared in the Central Russian Basin as early as the latest Kimmeridgian-earliest Volgian. However, the basic types of shells of these ammonites did not differ markedly from those of their precursors that occurred almost everywhere in the Northern Hemisphere, which had mainly roots among the Tethyan taxa and showed a wide range of shell coiling types. The most significant event during this time interval was the final disappearance of Cardioceratidae, a large family that had already appeared by the Bajocian in boreal regions and by the end of the Middle Jurassic was distributed subglobally in Jurassic seas. Note that sediments of that time (Late Kimmeridgian-Early Volgian) of the Russian Platform are represented by dark calcareous clays similar to the classical Kimmeridge Clay of Dorset.

Figure 1 showing succession and phylogenetic relationships of the Middle and Late Volgian ammonites illustrates a decrease in the number of genus-level taxa. For the Early Volgian the composition of ammonites at the genus level has not been considered, but the number of genera in each bio-chronozone is similar to that registered in the earliest Middle Volgian deposits. In the Middle Volgian of the Russian Platform the following ammonite genera are recorded in ascending order:

Dorsoplanites panderi Zone: including *Zaraiskites*, *Acuticostites*, *Michalskia*, *Dorsoplanites*, *Pavlovia*.

Virgatities virgatus Zone, consiting of three subzones as follows:

Virgatities gerassimovi Subzone: including *Virgatites*, *Lomonossovella*, *Dorsoplanites*.

Virgatities virgatus Subzone: including *Virgatites*, *Lomonossovella*, *Dorsoplanites*, *Serbarinovella*.

Craspedites ivanovi Subzone: including *Virgatites, Lomonossovella*, *Dorsoplanites, Craspedites*.

Epivirgatities nikitini Zone: including *Epivirgatites*, *Lomonossovella*, *Laugeites*, *Craspedites*.

During the whole Early Volgian (and part of the Middle Volgian), members of two relatively small boreal families of perisphinctoid origin, Virgatitidae and Dorsoplanitidae, predominated in the Central Russian Sea. Shells of these ammonites are well-sculptured planorbiconic-to-serpenticonic and platyconic (Figure 2-6 and 2-7 respectively), determining their ecotype as nekto-benthic[5]. Apparently by the earliest Middle Volgian (*D. panderi* Zone), small-sized Oppeliidae with discoconic to oxyconic shells finally disappeared. Note that the extensive distribution of oil shales and bituminous clays on the Russian Platform was confined to the *D. panderi* time. The Late Jurassic was the period when dysoxic-anoxic environments were most widespread in this territory, whereas previous similar episodes at the Middle/Upper Oxfordian boundary and in the middle Lower Kimmeridgian, as well as the episode at the Jurassic/Cretaceous boundary, were very restricted in time and space[6].

In the next chron (*V. virgatus*) of the Middle Volgian, an essentially new taxon was separated from Dorsoplanitidae: the genus *Craspedites*, which is a progenitor of the family Craspeditidae and the following (entirely Cretaceous) Polyptychitidae. These ammonites, at first identifiable as small-sized poorly sculptured discocones (Figure 2-5) and platycones, were probably best adapted for sublittoral conditions within the shallowing basin. At the end of *V. virgatus* time, the last Virgatitidae went extinct, and at the end of *E. nikitini* time, Dorsoplanitidae also disappeared from the Central Russian Sea. Note that one of the latest dorsoplanitids, the genus *Laugeites*, has a planorbiconic shell with relatively subtle sculpture. The deposits of the latest Middle Volgian are usually represented by shallow-water glauconitic sands and sandstones, often with phosphorite interlayers, rarely by ferruginous quartz sand in near-shore areas.

In the Upper Volgian of the Russian Platform the following ammonites are recorded: *Kachpurites fulgens* Zone, bearing *Kachpurites*, *Craspedites*, *Garniericeras*; *Craspedites subditus* Zone, bearing *Craspedites*, *Garniericeras*; *C. nodiger* Zone, bearing *Craspedites*, *Garniericeras*.

During the Late Volgian, the Central Russian ammonites were exclusively represented by the family Craspeditidae, showing shell morphotypes that clearly differ from those of most of the preceding perisphinctoids: these are smooth or poorly sculptured and relatively inflated platy-discocones (*Craspedites*, *Kachpurites*; Figure 2-3) and classical oxycones with undulating sinuosus sculpture (*Garniericeras*; Figure 2-4). By the mid-Nodiger time of the Late Volgian, the regression reached

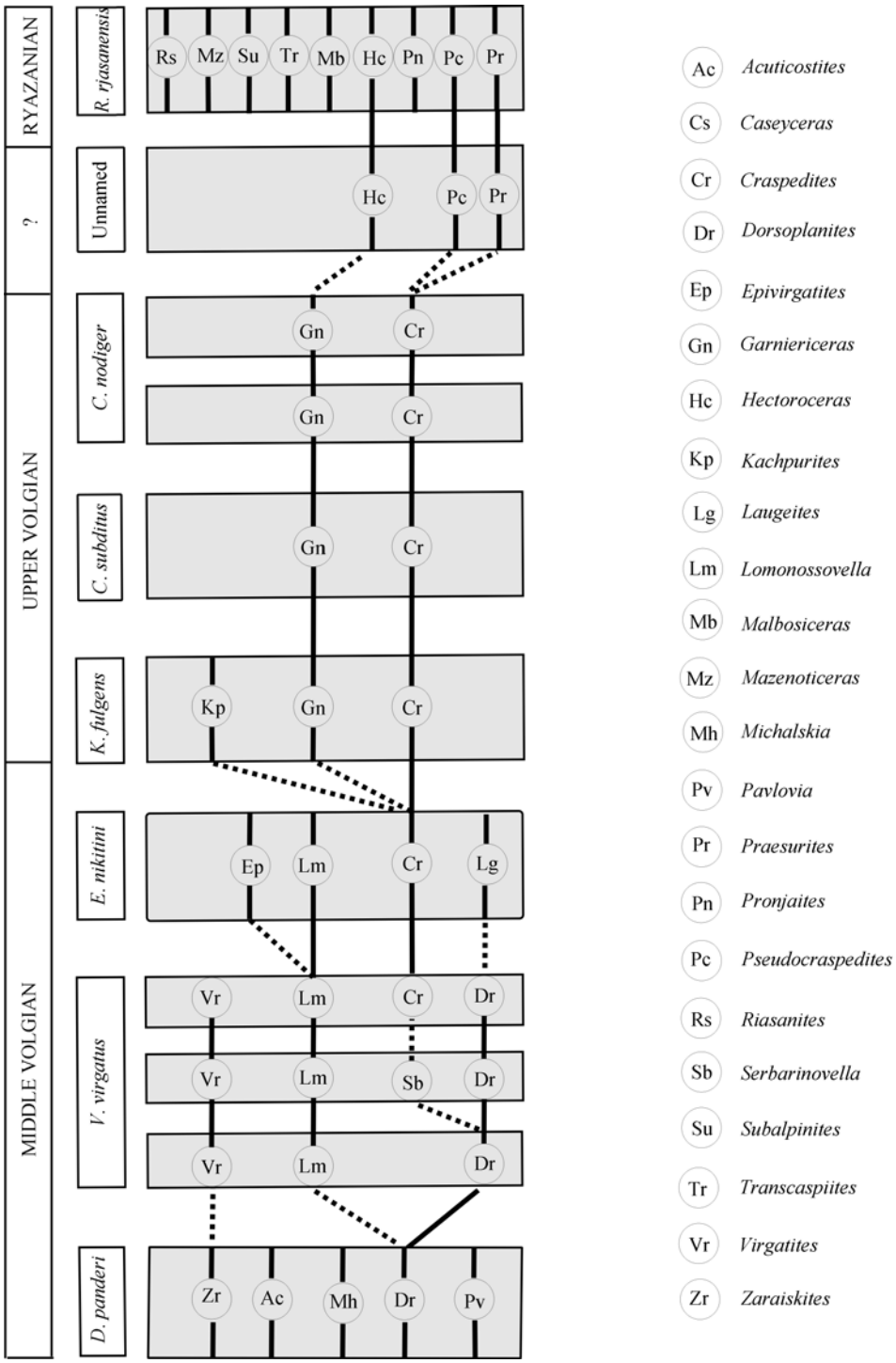

Figure 1 Succession of ammonite genera of the Russian Platform and their phylogenetic relationships from the Middle Volgian, Panderi Zone, up to the Lower Ryazanian, Rjasanensis Zone (modified from Mitta[4]).

its maximum. In the second half of that time (*Milkovensis* Chron), a new transgression started[7], reaching its apogee at the *R. rjasanensis* time of the Ryazanian Stage (equivalent to Berriasian Stage, Lower Cretaceous), when numerous immigrants of Tethyan and Boreal origin reached the Central Russian Basin throughout corridors from southwestern, northern, and northeastern areas. On the Russian Platform, the terminal zone of the Jurassic (*Craspedites nodiger*), as well as the basal zone of the Cretaceous (*Riasanites rjazanensis*), is usually represented by glauconitic sandstones and sands with phosphorites, rarely by near-shore quartz sands.

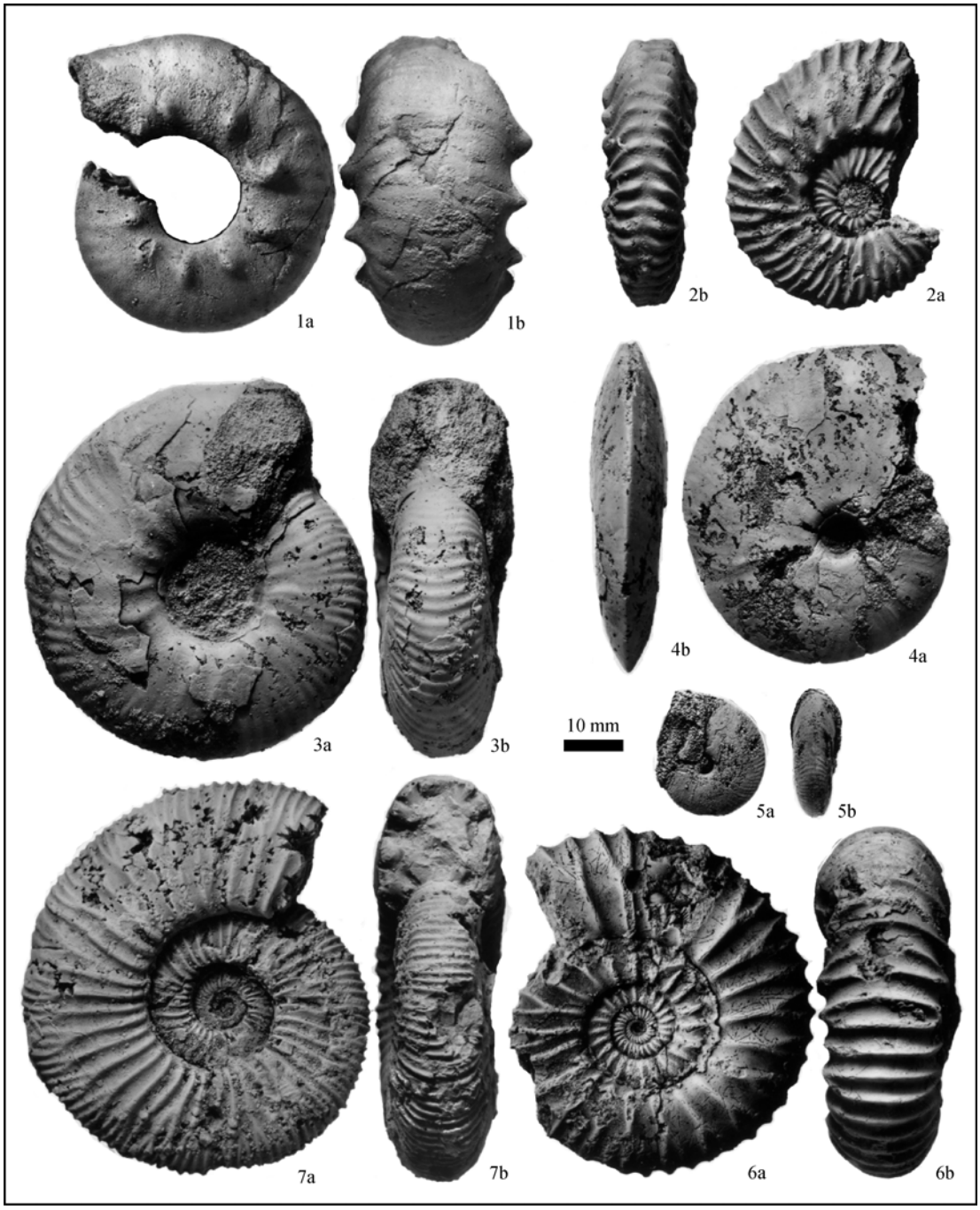

Figure 2 Ammonoid morphotypes from the Russian Platform in the latest Jurassic-earliest Cretaceous. 1. Cadicone-like shell with spine-like lateral tubercles (*Craspedites milkovensis* (Stremooukhov), Vernadsky Geological Museum, Moscow, No VI-36/1; Moscow, Upper Volgian *C. Nodiger* Zone). 2. Well sculptured platycones (*Mazenoticeras* sp., Paleontological Institute, Moscow, No. 3990/272; Moscow region, Lower Ryazanian *R. rjasanensis* Zone). 3. Relatively subtly sculptured and inflated platy-to-discocones (*Craspedites subditus* (Trautschold), Paleontological Institute, Moscow, No. 3990/269, Moscow region, Upper Volgian *C. subditus* Zone). 4. Oxyconic with sinuous ribs (*Garniericeras catenulatum* (Fischer V. Waldheim), Paleontological Institute, Moscow, No 3990/268; Moscow region, Upper Volgian *C. subditus* Zone). 5. Poorly sculptured discocones (*Craspedites ivanovi* Gerasimov, Paleontological Institute, Moscow, No 3990/271, Yaroslavl region, Middle Volgian *V. virgatus* Zone). 6. Well sculptured planorbicones-to-serpenticones (*Pavlovia pavlowi* (Michalsky), Museum of All-Russian Geological Institute, S.-Petersburg, No 197/300; Moscow, Middle Volgian Panderi Zone). 7. Moderately sculptured platyconic (*Ilowaiskya schaschkovae* Ilovaisky), Paleontological Institute, Moscow, No 3990/270; Chuvashiya, Lower Volgian *Pseudoscythica* Zone).

Environmental events at the Jurassic/Cretaceous boundary deserve special attention. Here we note that on the shell of the last Volgian craspeditid, *Craspedites milkovensis,* spine-like lateral outgrowths are developed (Figure 2-1) in contrast to all its congeners. Are these correlated with environmental change, or do they merely coincide with the beginning of transgression? No conclusive answer is available at present.

In the lower zone of the Ryazanian Stage (and of the whole Cretaceous), besides the descendants of Craspeditidae (*Praesurites*, *Pseudocraspedites*, *Hectoroceras*, *Pronjaites*), immigrants from the southwest belonging to the family Neocomitidae (*Riasanites*, *Mazenoticeras*, *Subalpinites*, *Transcaspiites*, and *Malbosiceras*) are present. Note that among the diverse shell morphotypes developed in Berriasian ammonoids of the Rjasanensis Zone, it is exactly the well sculptured platycones (Figure 2-2) with one, two or even three rows of tubercles, often developed into spine-like outgrowths that prevailed in Tethyan immigrants. Such diversity is interpreted as the evidence of deepening of the basin, with a corresponding increase in the number of ecological niches.

4 Conclusions

Analysis of data on ammonoid diversity dynamics during the terminal age of the Late Jurassic shows that by the end of this epoch a considerable decrease in the number of taxa occurred (Late Volgian crisis), and ammonite shell morphotypes changed noticeably. By the end of the Volgian, ammonites were represented by only two genera, differing markedly in the shell form. The end-Jurassic decrease in ammonoid biodiversity started in the mid-Volgian and was most probably correlated with changes in the hydrodynamic regime (or simply regression), primarily, shallowing of the shelf.

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