Infrazonal Subdivision of the Volgian Stage in its Type Area Using Ammonites and Correlation of the Volgian and Tithonian Stages

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Abstract The Volgian Stage of the Russian Platform is subdivided into 3 substages and 9 zones, within which 37 biohorizons are recognized. Only the lower Volgian is characterized by occurrences of ammonites of Sub-Mediterranean origin, which permits direct correlation to be made with the Tithonian Stage. Rare records of *Haploceras* in the basal middle Volgian are not able to be used for correlation, and the overlying part of the Volgian stage lacks any Sub-Mediterranean or Mediterranean faunal elements in the ammonite faunas. Recent advances in magnetostratigraphic studies of the upper part of the Volgian Stage in northern Siberia lead to a correlation of the uppermost middle and upper Volgian of this area with the Tithonian succession. These results can also be effectively used for correlating the Volgian ammonite zones of the Russian Platform with those of the Tithonian Stage.

Keywords Volgian Stage · Russian Platform · Infrazonal subdivision · Ammonites

The Volgian Stage, the Boreal and Sub-Boreal equivalent of the Tithonian Stage, is characterized by specific ammonite faunas showing more or less strong endemism. Nevertheless, the presence of some Sub-Mediterranean taxa in the Volgian Stage of the Russian Platform permits the possibility of directly correlating the lower Volgian with the Tithonian succession (Rogov 2004, 2010). In addition, recent palaeomagnetic studies on J–K boundary beds of northern Siberia provide evidence for correlating the uppermost middle to upper Volgian with their non-Boreal equivalents (Houša et al. 2007; Bragin et al. 2013). The zonal succession for the lower Volgian was proposed some 50 years ago, whereas the middle and upper Volgian zones in the type area of this stage, the Russian Platform, were established at the end of the nineteenth and beginning of the twentieth centuries.

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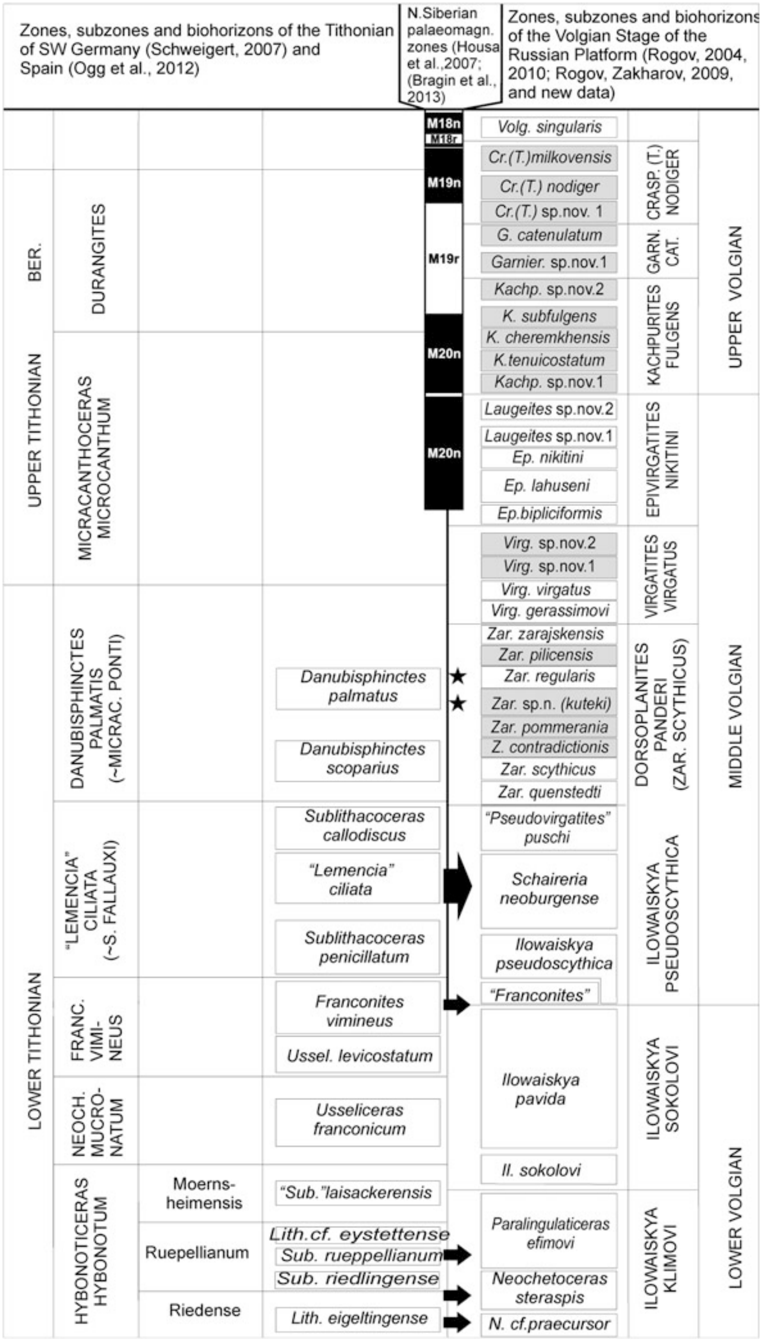

Fig. 1 Infrazonal subdivision of the Volgian Stage of the Russian Platform and its correlation with the Tithonian Stage based on ammonites and palaeomagnetic reversals. Biohorizons that still are not described in detail are marked by a *grey* pattern. Sub. *Subplanites*; Lith. *Lithacoceras*; Z., Zar. *Zaraiskites*; Virg. *Virgatites*; Ep. *Epivirgatites*; K., Kachp. *Kachpurites*; G., Garnier. *Garniericeras*; Cr. (T.) *Craspedites* (*Trautscholdiceras*)

Only during the last 10 years has an infrazonal subdivision been established for the lower and some parts of the middle Volgian of this area (Rogov 2004, 2010; Rogov and Zakharov 2009).

In this paper, the succession of biohorizons for the whole Volgian Stage of the Russian Platform is presented for the first time (Fig. 1). It is based mainly on the evolution of the eudemic ammonite lineages, belonging to the Virgatitidae, Dorsoplanitidae, and Craspeditidae families, except for a few immigrational biohorizons in the lower Volgian, based on immigrant taxa of Sub-Mediterranean origin (*Neochetoceras, Paralingulaticeras,* and *Schaireria*).

In the lower Volgian, ammonites of Sub-Mediterranean origin occur in abundance in some places (Rogov 2010), providing a direct correlation with the Tithonian Stage (such levels or intervals are marked by arrows in Fig. 1). However, above the *neoburgense* horizon, such ammonites abruptly disappear, and only in the *Dorsoplanites panderi* Zone do small-sized *Haploceras* sporadically occur (marked by asterisks in Fig. 1). The overlying part of the Volgian is characterized by Sub-Boreal and Boreal ammonites only. The subdivision of the middle Volgian *Virgatites virgatus* Zone is based on the succession of the ammonite genus *Virgatites*. The *Epivirgatites nikitini* Zone includes horizons based on the *Epivirgatites* lineage and, in the uppermost part of the zone, where *Epivirgatites* are absent, on *Laugeites* species. This zone is very well correlated with the Siberian zones through the same succession of species, as well as the lowermost part of the upper Volgian, which is characterized by *Craspedites (Craspedites)* of the *C. (C.) okensis* group throughout the Volgian except in the areas of England and the North Sea, where *Subcraspedites* is dominant. Subdivision of the *Kachpurites fulgens* and *Garniericeras catenulatum* zones is based on the succession of rapidly evolved members of the Garniericeratinae subfamily. Above these zones, Craspeditinae become the most intensively evolved group, forming the eudemic subgenus *Craspedites (Trautscholdiceras).* At the top of the Volgian, the *Volgidiscus singularis* horizon, which very nearly corresponds to the uppermost Volgian zones of the Arctic (*Chetae* Zone) and NW Europe (*Lamplughi* Zone), can be recognized.

The absence of faunal exchange between the two major super-realms of Tethys–Panrthalassa and Pan-Boreal during the middle and late Volgian led to a 100-year-long discussion concerning the correlation of the Tithonian and Volgian stages. New palaeomagnetic results from northern Siberia (Houša et al. 2007; Bragin et al. 2013) have revealed that the Tethyan J–K boundary corresponds to a level within the *Craspedites (Taimyroceras) taimyrensis* Zone of the Arctic, which almost coincides with the *C. (Trautscholdiceras) nodiger* Zone of the Russian Platform.

Therefore, we have strong evidence for a Tithonian–Volgian correlation except for the interval spanning from the uppermost lower Volgian to the uppermost middle Volgian, which is still lacking palaeontological or palaeomagnetic signatures that could be used for correlational purposes.

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