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New data on ammonites and stratigraphy of the Upper Kimmeridgian and Lower Volgian (Upper Jurassic) of the middle Volga Region (Russia)

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With 8 figures

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Abstract: New collections around the Kimmeridgian/Volgian boundary at the Volgian lectostratotype nearby Gorodishche (Central Russia) allow giving a general view of the stratigraphic distribution of some stratigraphically important ammonite genera. The Volgae Subzone is newly introduced and is given priority over the Fallax Zone of ILOVAISKY (1941) sensu MIKHAILOV (1962). *Sutneria eumela* (D'ORGIBNY) and *Sutneria subeumela* SCHNEID are illustrated from the Upper Kimmeridgian, and *Aulacostephanus volongensis* KHUDYAEV is identified. The latter is interpreted as the macroconch partner of *Aulacostephanus undorae* (PAVLOW). These discoveries indicate the evidence of the chronostratigraphic equivalence between the Eudoxus and Fallax zones of the Russian Platform with the Pseudomutabilis and Beckeri zones (Submediterranean region). *„Discosphinctoides" subborealis* KUTEK & ZEISS is assigned to the genus *Sarmatisphinctes* KUTEK & ZEISS, and a new ammonite genus, *Rogoviceras* n. gen. (type species: *Glochiceras* (*Paralingulaticeras*) *efimovi* ROGOV), is introduced. At the beginning of the Volgian Secondary Standard Stage a strong faunal provincalism is recognised which makes a correlation with areas beyond the Russian Platform and central Poland more difficult. The base of the Lower Volgian (Klimovi Zone) seems to be at least still in parts, if not wholly, of Late Kimmeridgian age.

Zusammenfassung: Neue Aufsammlungen an der Grenze Kimmeridgium/Volgium am Lectostratotypus des Volgiums unweit von Gorodishche (Zentralrussland) ermöglichen es einen Überblick über die stratigraphische Verbreitung einiger stratigraphisch wichtiger Ammonitengattungen zu geben. Die biochronostratigraphische Einheit der Volgae-Subzone wird neu eingeführt und gegenüber dem Zonenbegriff Fallax-Zone ILOVAISKY (1941) sensu MIKHAILOV (1962) Priorität eingeräumt. Erstmals werden aus dem Oberkimmerdigium *Sutneria eumela* (D'ORGIBNY) und *Sutneria subeumela* SCHNEID abgebildet sowie *Aulacostephanus volongensis* KHUDYAEV nachgewiesen. Letzterer ist der mutmaßliche Makroconch zu

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Aulacostephanus undorae (PAVLOW). Diese Funde unterstreichen eine chronostratigraphische Äquivalenz zwischen der subborealen Eudoxus-/Fallax-Zone der Russischen Plattform mit der submediterranen Pseudomutabilis-/Beckeri-Zone. „*Discosphinctoides*" *subborealis* KUTEK & ZEISS wird der Gattung *Sarmatisphinctes* KUTEK & ZEISS zugeordnet. Eine neue Ammonitengattung, *Rogoviceras* n. gen. mit der Typusart *Glochiceras* (*Paralingulaticeras*) *efimovi* ROGOV wird eingeführt. Mit Beginn des Volgiums macht sich ein verstärkter Faunenprovinzialismus bemerkbar, der die Korrelation mit Gebieten außerhalb der Russischen Plattform und Zentralpolens erschwert. Die Basis des Untervolgiums (Klimovi-Zone) scheint zumindest noch teilweise oder vollständig ein Oberkimmeridgium-Alter zu besitzen.

1. Indroduction

The correlation between the Tithonian Primary Standard Stage and the Volgian Secondary Standard Stage is one of the most complicated problems in Jurassic stratigraphy. In 1990 the International Subcommission on Jurassic Stratigraphy (ISJS) voted for a "short" version of the Kimmeridgian Stage. This meant that in future the upper boundary of the Kimmeridgian Stage should be coincident with the lower boundary of the Tithonian Stage and its Boreal "equivalent", the Volgian Stage (ZEISS 1991). There have been numerous publications dealing with this item in the recent past (e.g. KUTEK & ZEISS 1988, 1994; COPE 1993, 1995, 1996; HANTZPERGUE et al. 1998a, b; ZEISS 2003). The correlations are often hardly convincing; they include taxonomic misinterpretations based on poorly preserved material (KUTEK & ZEISS 1997; ROGOV 2001, 2002b, 2004a, b). Therefore much information is not suitable for correlation research. Satisfactory results can only be obtained by defining a high degree of stratigraphic resolution based on ammonite faunal horizons which can be precisely dated referring to sequence stratigraphy. A stratigraphic log is absolutely necessary.

The Volgian Stage is a Secondary Standard Stage, following the recognition of the Tithonian as the Primary Standard (COPE 1993, 1996). We agree with COPE and are now able to demonstrate that the Kimmeridgian/Volgian boundary is probably stratigraphically older than the Kimmeridgian/Tithonian boundary (in the present usage with the Hybonotum Zone as its base).

The ammonite genera *Sutneria* ZITTEL, *Physodoceras* HYATT (= *Aspidoceras* pars in previous papers; *Schaireria* is considered as a subjective junior synonym of *Physodoceras*, see SCHWEIGERT 1997), *Amoeboceras* HYATT and *Aulacostephanus* SUTNER & POMPECKJ in TORNQUIST are of most importance, because they are distributed throughout Western Europe, Central Russia, and Central Poland. *Sutneria* ZITTEL and *Physodoceras* HYATT have a wide palaeogeographic distribution in Europe (incl. Russia), Africa, South America, Central America, Far East, and Anatolia. More information about *Sutneria* is mentioned e.g. by ARKELL (1956), GEYER (1969), CALLOMON &

COPE (1971, 1996), MESEZHNIKOV et al. (1977), ZEISS (1979), BIRKELUND et al. (1983), KUTEK & ZEISS (1994, 1997), HOWARTH (1998), SEYED-EMAMI et al. (1998), MALINOWSKA (2001), ROGOV (2001, 2002a, b, 2004a, b), and COPE (1991). For precise information about the distribution of *Aulacostephanus* SUTNER & POMPECKJ in TORNQUIST see e.g. KHUDYAEV (1932), ZIEGLER (1958, 1961, 1962), HÖLDER (1971), BIRKELUND et al. (1983), ZAKHAROV & MESEZHNIKOV (1984), BIRKELUND & CALLOMON (1985), HANTZPERGUE (1989), SCHWEIGERT (1992), SCHWEIGERT & SCHERZINGER (1997), BAIER & SCHWEIGERT (2001), SCHWEIGERT & VALLON (2005), and for Late Kimmeridgian *Amoeboceras* HYATT e.g. SCHMIDT (1905), SALFELD (1915), CALLOMON & COPE (1971, 1996), BIRKELUND & CALLOMON (1985), KUTEK & ZEISS (1997), HANTZPERGUE et al. (1998a, b), and MALINOWSKA (2001).

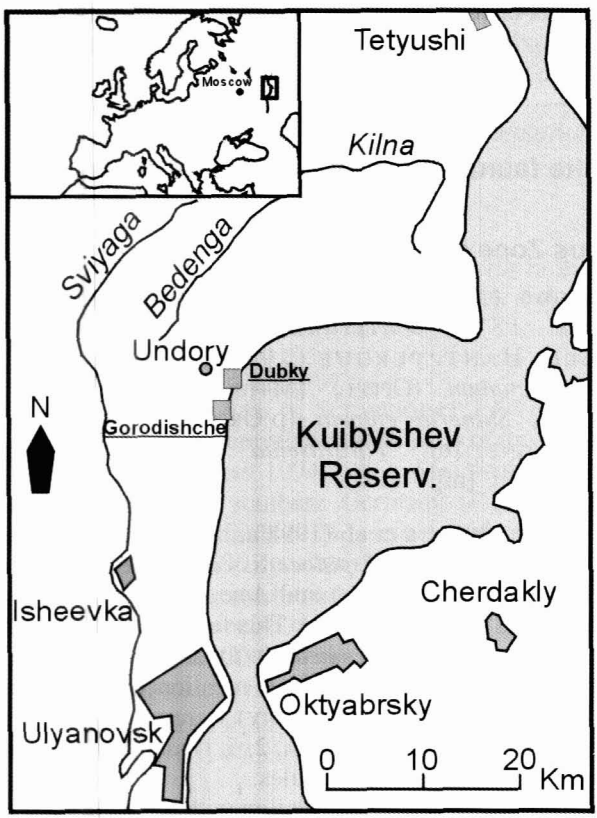

Fig. 1. Geographic situation around the Kuibyshev Reservoir (River Volga) with the Dubky and Gorodishche sections (both with little grey boxes).

The section of Gorodishche (Fig. 1), north of Ulyanovsk (Central Russia), the later lectostratotype of the Volgian Secondary Standard Stage (GERASIMOV & MIKHAILOV 1966), was discovered during a travel of PALLAS in 1768, published by PALLAS (1773). The section was published by MURCHISON et al. (1845) for the first time, and taxonomic studies have been published by PAVLOW (1886), which are well-known outside Russia.

Since then these deposits have often been subject of scientific publications and field trips. V. MITTA is one of the authors who have worked on this section since 1984. Most of the material was destroyed some years ago by a fire; the remaining finds have been considered in our studies. The most extensive field work has been done by a mixed Russian-French team under participation of V. MITTA in 1995. The results were published in HANTZPERGUE et al. (1998a, b).

The authors started with new field work in July 2005. Our material is kept in the collections of the "Paleontological Institute of the Russian Academy of Science Moscow (N 5123)" and the "Staatliches Museum für Naturkunde Stuttgart (SMNS)".

2. Ammonite faunas around the Kimmeridgian/Volgian boundary

2.1. Eudoxus Zone (NEUMAYR 1873)

Eudoxus Zone (NEUMAYR 1873), Caletanum Subzone (DE LORIOL et al. 1872), *Caletanum* Horizon (DE LORIOL et al. 1872) emend. HANTZPERGUE (1979):
Aspidoceras caletanum (OPPEL) [M+m], *Physodoceras longispinum* (SOWERBY) [M], *Sutneria eumela* (D'ORBIGNY) [m], *Aulacostephanus eudoxus* (D'ORBIGNY) [m], "*Pararasenia*" (?) cf. *hybridus* ZIEGLER [m] and *Amoeboceras* sp. [m].

According to HANTZPERGUE et al. (1998 a, b) bed Du1 contains *Aulacostephanus eudoxus* (D'ORBIGNY), *Aspidoceras caletanum* (OPPEL), *Physodoceras* ex gr. *longispinum* (SOWERBY) and *Amoeboceras* sp. in the section of Dubky and Kamenyi Ourag (bed Ko1). This fauna can now be supplemented with the evidence of *Sutneria eumela* (D'ORBIGNY) (Figs. 2, 3.1-3.2). In other papers the species has only been mentioned but never illustrated. Our finds of *Sutneria eumela* (D'ORBIGNY) were associated with *Physodoceras* cf. *longispinum* (SOWERBY) (Figs. 2, 3.3) and *Aspidoceras caletanum* (OPPEL) in light grey, calcareous nodules.

The fauna from Du1 allows a correlation with the well known *Caletanum* Horizon in western France, southern England and north-west Germany (see BIRKELUND et al. 1983; CALLOMON & COPE 1971, 1996; HANTZPERGUE

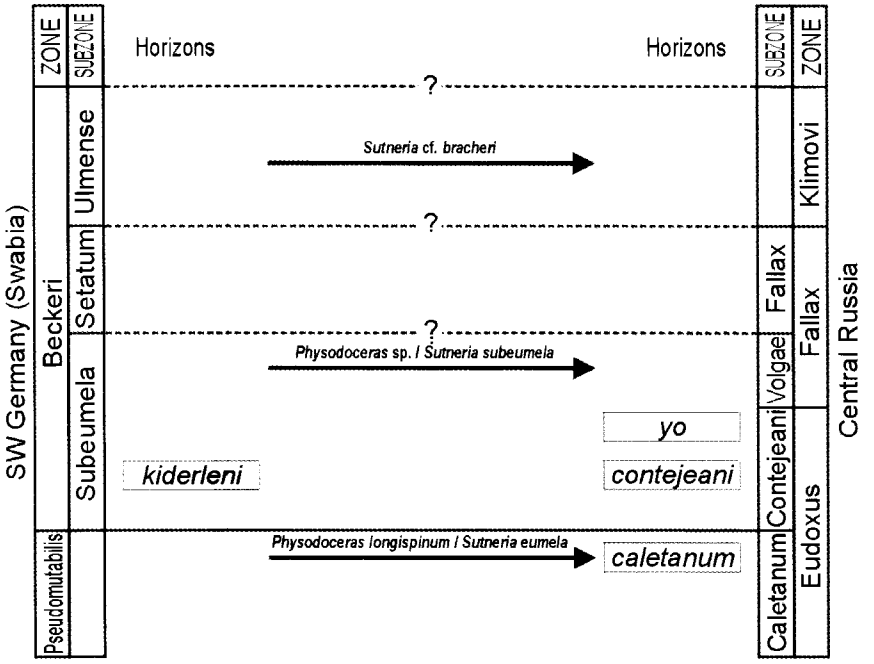

Fig. 2. Distribution of the genera *Sutneria* and *Physodoceras* in the Gorodishche section during the Upper Kimmeridgian and lowest Volgian, and its possible correlation with the submediterranean Upper Kimmeridgian.

1989; HANTZPERGUE et al. 1998a, b; SCHWEIGERT 1999). There are good possibilities of comparison and correlation with parts of the Eudoxus Zone of Central Poland (KUTEK & ZEISS 1994, 1997; MALINOWSKA 2001). Additional connections exist with southern Germany (Fig. 2) and south-east France. In both regions many finds of *Sutneria eumela* (D'ORBIGNY) occur (e.g. HÖLDER & ZIEGLER 1959; ZIEGLER 1977). In southern Germany the species occurs in several different horizons (ZIEGLER 1958, 1977, and own results in the field). A more precise stratigraphic description of the Pseudomutabilis Zone (sensu SCHWEIGERT & VALLON 2005) is still in progress.

Eudoxus Zone (NEUMAYR 1873), Contejeani Subzone (CONTINI & HANTZPERGUE 1975), *Contejeani* Horizon (CONTINI & HANTZPERGUE 1975):
Aspidoceras quercynum HANTZPERGUE [M+m], *Aulacostephanus contejeani* (THURMANN) [M] and *Tolvericeras sevogodense* (CONTINI & HANTZPERGUE) [M+m].

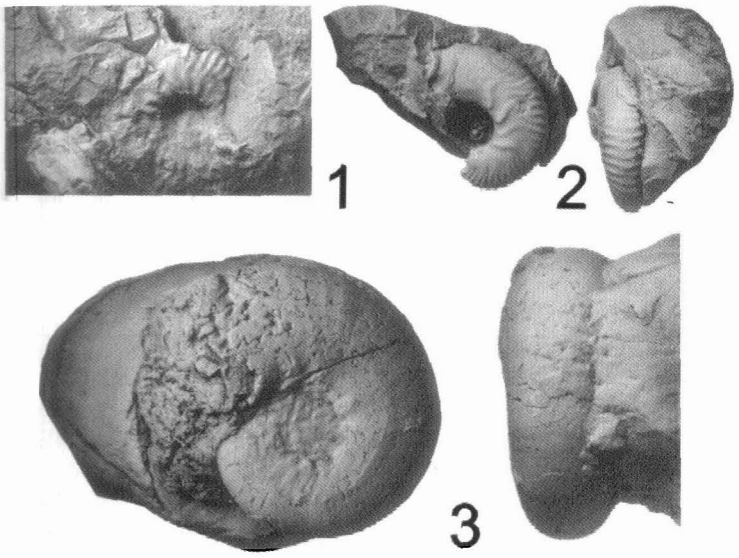

Fig. 3. Ammonites from the *Caletanum* Horizon, Caletanum Subzone, Eudoxus Zone, Locality: Dubky near the River Volga, layer Du1 see HANTZPERGUE et al. 1998, (Coll. MITTA, 1995-96), all natural size:
1 - *Sutneria eumela* (D'ORBIGNY) [m], N 5123/1.
2 - *Sutneria eumela* (D'ORBIGNY) [m], N 5123/2.
3 - *Physodoceras* cf. *longispinum* (SOWERBY). [M], N 5123/3.

Eudoxus Zone (NEUMAYR 1873), Contejeani Subzone (CONTINI & HANTZPERGUE 1975), *Yo* Horizon (SALFELD 1913) emend. HANTZPERGUE (1979):
Aulacostephanus yo (D'ORBIGNY) [M], *Aspidoceras* ex gr. *quercynum* HANTZPERGUE [M+m] and *Tolvericeras sevogodense* (CONTINI & HANTZPERGUE) [M+m].

In the section of Dubky the *Caletanum* Horizon (Eudoxus Zone) is followed by the *Contejeani* (bed Du2) and *Yo* (beds 3-6) horizons (HANTZPERGUE et al. 1998b). There are good possibilities for correlation to the Upper Kimmeridgian of western France and north-western Germany (HANTZPERGUE 1989, SCHWEIGERT 1996, 1999). Light grey clays with calcareous nodules at the base of the Gorodishche section could belong to this stratigraphic sequence. For a final conclusion it is necessary to collect additional material.

According to SCHWEIGERT (1992), BAIER & SCHWEIGERT (2001) and SCHWEIGERT & VALLON (2005) a correlation is well established between

the Subboreal Eudoxus Zone and the Submediterranean Pseudomutabilis Zone (sensu BAIER & SCHWEIGERT 2001) and the lower part of the Beckeri Zone (Subeumela Subzone, e.g. *Kiderleni* Horizon) (HANTZPERGUE et al. in CARIOU & HANTZPERGUE 1997), supported by rare finds of *Aulacostephanus contejeani* (THURMANN & ETALLON), *Aulacostephanus yo* (D'ORBIGNY), and *Aulacostephanus plataulax* (BUCKMAN).

2.2. Fallax Zone ILOVAISKY in ILOVAISKY & FLORENSKY (1941)

Fallax Zone ILOVAISKY in ILOVAISKY & FLORENSKY (1941), Volgae Subzone (= nom. nov. pro Autissiodorensis Subzone auct., and Subeumela Subzone GEYER 1969):
Amoeboceras volgae (PAVLOW) [m], *Aulacostephanus* ex gr. *autissiodorensis* (COTTEAU) [M], *Aulacostephanus volgensis* (D'ORBIGNY) [m], *Aulacostephanus volongensis* KHUDYAEV [M], *Aulacostephanus undorae* (PAVLOW) [m], *Aspidoceras* cf. *catalaunicum* (DE LORIOL) [M], *Physodoceras* sp. [M], *Sutneria subeumela* SCHNEID [m], *Sarmatisphinctes subborealis* (KUTEK & ZEISS) [M+m] and Oppeliidae n. gen et sp. n. [M+m].

From the Fallax Zone in the Gorodishche section GEYER (1969: 68) reported a single specimen of "*Sutneria* cf. *subeumela* SCHNEID" (Fig. 6.1). This specimen was said to come from about 7 m below the Kimmeridgian/Volgian boundary. According to the information in MESEZHNIKOV et al. (1977: 24) and our own experience that was obtained in Gorodishche during our field work in 2005 the lithological matrix indicates that the specimen comes from Fallax Zone. The identification of the specimen is confirmed. For comparison we illustrated two additional specimens from the Subeumela Subzone of Swabia (Fig. 4.2-4.3). No further specimens of *Sutneria subeumela* have been recorded from Central Russia. Nevertheless we think this results only from collecting bias.

In southern England CALLOMON & COPE (1971) reported the occurrence of *Sutneria rebholzi* BERCKHEMER in the section of the Warlingham Borehole approximately 8-9 m above the base of the Autissiodorensis Zone. In southern Germany from where this taxon has been decribed for the first time, it occurs in the higher part of the Beckeri Zone (Ulmense Subzone, *Zio-Wepferi* Horizon α and β),

In future studies it is necessary to examine how complete the Autissiodorensis Zone is in individual localities of Subboreal Europe (inclusive the Fallax Zone of Central Russia), and whether the bases and the tops of this stratigraphical unit are coeval in various sections.

Amoeboceras volgae (PAVLOW) is recorded from Russia (PAVLOW 1886; SALFELD 1915), Central Poland (MALINOWSKA 1976, 2001; KUTEK & ZEISS 1997; this paper Figs. 5.1, 6.4) and from southern England (CALLOMON &

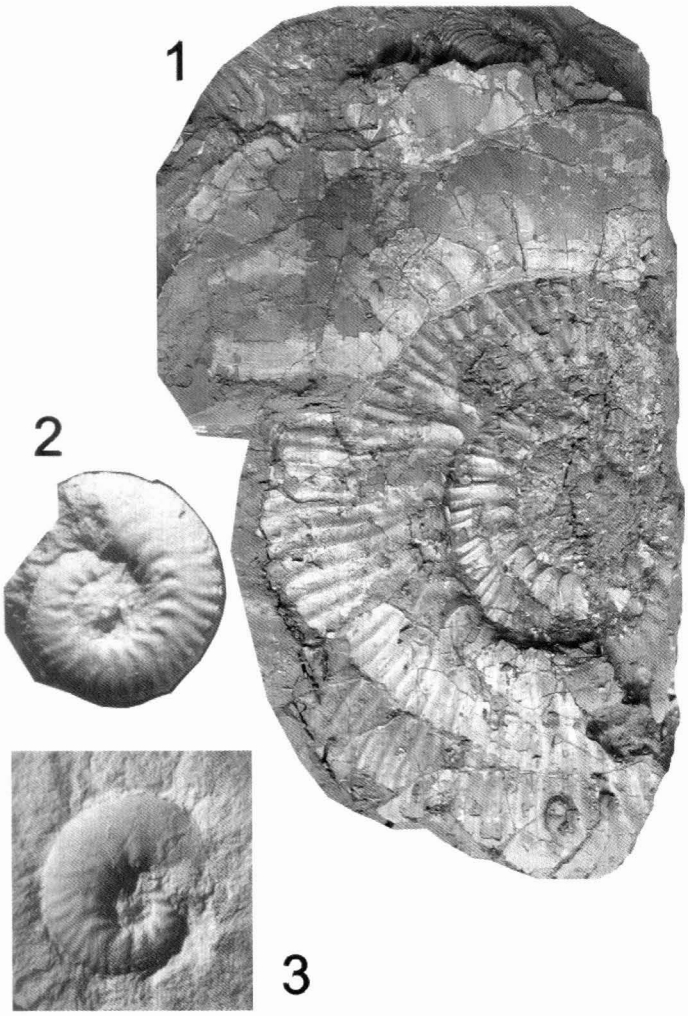

Fig. 4. Ammonites from the Volgae Subzone, Fallax Zone, Locality Gorodishche near the River Volga, (photograph in the field by the authors, July 2005: *Aulacostephanus* ex gr. *autissiodorensis* (COTTEAU) [M]), and from the Subeumela-Subzone, Beckeri Zone, Subeumela Subzone, SW Germany.

1 - *Aulacostephanus* ex gr. *autissiodorensis* (COTTEAU) [M].

2 - *Sutneria subeumela* SCHNEID [m], Herrlingen-Lautern, SW Germany, SMNS 66202 (BRACHER collection). – × 2.

3 - *Sutneria subeumela* SCHNEID [m], Grabenstetten, small airport W of the village, SW Germany, SMNS 66203 (Coll. G. SCHWEIGERT). – × 2.

COPE 1996). After J. H. CALLOMON (personal communication 13.10.2005) this species occurs in the Dorset section 2-5 m above the Washing Ledge Stone Band, at the base of the Autissiodorensis Zone. *Amoeboceras volgae* (PAVLOW) represents a suitable guide fossil between different Subboreal localities in the lowermost Autissiodorensis Zone and the Fallax Zone. Additional faunal studies are in preparation.

For the lower part of the "Autissiodorensis Zone" = Fallax Zone (sensu GERASIMOV & MIKHAILOV 1966, and this paper) ZEISS (2003) proposed a Subborealis Subzone. But up to the present it is unclear if species "*Divisosphinctes sublacertosus*" ILOVAISKY and "*Discosphinctoides subborealis*" KUTEK & ZEISS are conspecific (see KUTEK & ZEISS 1997). The morphological variation and the exact stratigraphic range of the first species are unknown. Here more precise studies are necessary. We prefer using *Amoeboceras volgae* (PAVLOW) as the index fossil.

Amoeboceras anglicum (SALFELD) and *Amoeboceras krausei* (SALFELD) are very frequent in southern England (CALLOMON & COPE 1971). In the Warlingham Borehole section both forms occur in very high levels of the Autissiodorensis Zone. These horizons are much younger in age than the level at which *Sutneria rebholzi* BERCKHEMER (see above) occurs. These forms are missing from Central Russia.

At the moment it is impossible to make any statements about the completeness of the sections in western France. According to the information of HANTZPERGUE (1989) there is one discontinuity described from the lower part of the Autissiodorensis Zone in the northern Aquitaine Basin.

The genus *Gravesia* SALFELD has not been recorded yet in the Volga region, despite its distribution in the upper Autissiodorensis Zone of western France, southern England, north-western Germany (e.g. HANTZPERGUE 1989; SCHWEIGERT 1996, 1999; CALLOMON & COPE 1996) and its time equivalents in southern Germany (SCHWEIGERT 1993a, b). MESEZHNIKOV (1963, 1974, 1984) illustrated very doubtful specimens of '*Gravesia*'. In our view these ammonites represent *Eosphinctoceras* or related forms (see SCHERZINGER et al. 2006). Presumably the reason for the apparent lacking of *Gravesia* is that older parts of the zone have been deposited in which this genus was still not present, apart from paleobiogeographic reasons. In the type section of the Kimmeridge Clay of Dorset the genus *Gravesia* (e.g. *Gravesia gigas* ZIETEN, pl. 1, fig. 1 in COPE 1967) is associated with *Pectinatites* (*Virgatosphinctoides*), the latter also missing in the Volga region.

Within our newly collected material there are also ammonites resembling *Rasenia* SALFELD or *Zonovia* SASONOV (Fig. 6.3). But our studies have shown that there is a closer resemblance to *Aulacostephanus volongensis* KHUDYAEV, which has been only reported by KHUDYAEV (1932) from Timan, near the Volonga River, in northern Russia. With the exeption of

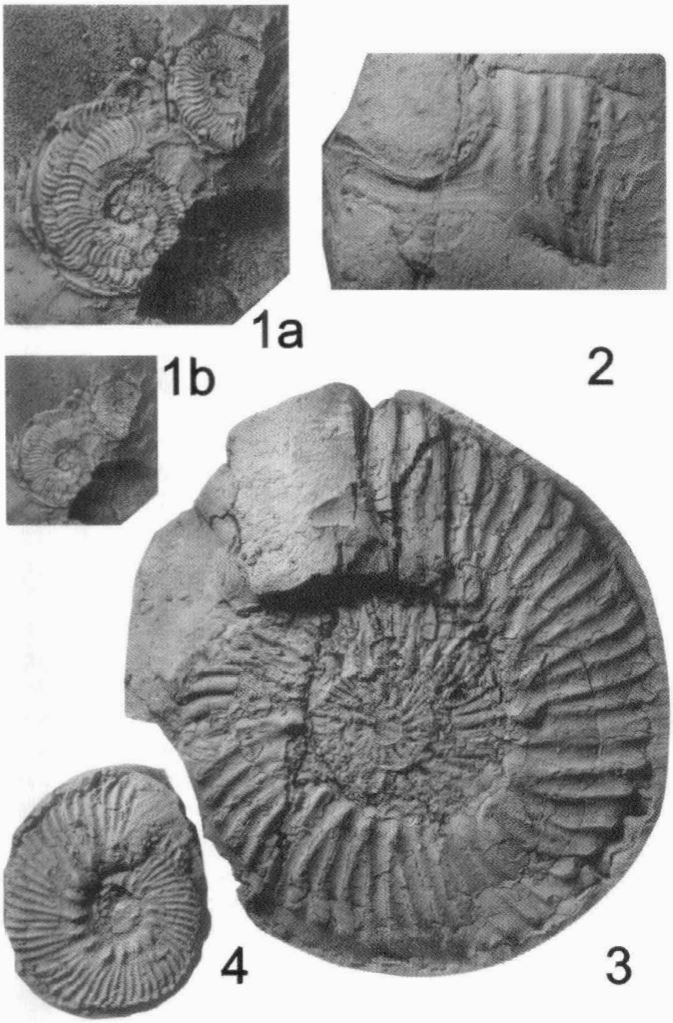

Fig. 5. Ammonites from the Volgae Subzone, Fallax Zone, Locality: Gorodishche near the River Volga, (Coll. MITTA & SCHERZINGER 2005), 1a – ×2, 1b-4. – Natural size.

1 - *Amoeboceras volgae* (PAVLOW) [m], N 5123/4.
2 - *Aulacostephanus* cf. *volgensis* (VISCHNIAKOFF) [m], N 5123/5.
3 - *Aulacostephanus volgensis* (VISCHNIAKOFF) [m], N 5123/6.
4 - *Aulacostephanus volgensis* (VISCHNIAKOFF) [m], N 5123/7.

ZIEGLER (1962) this taxon has not been mentioned since its introduction by KHUDYAEV. The specimen figured as "*Aulacostephanus* cf. *autissiodorensis*" in ZIEGLER (1962, pl. 14, fig. 1) from the Orenburg district probably also belongs to this species. In our opinion it represents the macroconch partner of *Aulacostephanus undorae* (PAVLOW) (Fig. 6.2). Both taxa co-occur in the lower Fallax Zone of Gorodishche. The ribbing of the innermost whorls of *Aulacostephanus volongensis* KHUDYAEV and the sculpture of *Aulacostephanus undorae* (PAVLOW) are very similar (Fig. 6.2-6.3), as already reported by ZIEGLER (1962: 75). The precise age of the holotype specimen of *Aulacostephanus volongensis* KHUDYAEV is unknown. Most likely the horizon of this find corresponds more or less to the finding level at Gorodishche. ZIEGLER (1962) presumed that the specimens could perhaps stem from the Eudoxus Zone. The problem is that he had no material that had been collected bed-by-bed.

SCHWEIGERT (1993a) figured a specimen of *Aulacostephanus eudoxus* (D'ORBIGNY) from the Obere Felsenkalke Formation in Swabia which is somewhat different from specimens of the Pseudomutabilis Zone and which shows closer resemblance to younger microconch aulacostephanids from the early Fallax Zone of Gorodishche (Fig. 5.2-5.4). Unfortunately it is impossible to reconstruct the exact stratigraphic position of that specimen.

Fallax Zone ILOVAISKY in ILOVAISKY & FLORENSKY (1941), Fallax Subzone (MESEZHNIKOV 1977, 1982):
Sarmatisphinctes fallax (ILOWAISKY) [M+m], *Aulacostephanus* ex gr. *autissiodorensis* (COTTEAU) [M], *Aulacostephanus volgensis* (D'ORBIGNY) [m], *Aulacostephanus undorae* (PAVLOW) [m], *Physodoceras* sp. [M], *Sutneria* sp. [m] and Oppeliidae n. gen et sp. n. [M+m].

MESEZHNIKOV et al. (1977) mentioned *Sutneria subeumela* SCHNEID, and HANTZPERGUE et al. (1998a) and MESEZHNIKOV in KRYMHOLTS et al. (1988) reported *Sutneria* sp. from the Fallax Zone of Gorodishche. Unfortunately we do not have more precise information. We assume that the stratigraphical sequence between the middle Volga and the Orenburg district probably is equivalent to the lower parts of the Autissiodorensis Zone (sensu anglico and gallico).

The genus *Sarmatisphinctes* KUTEK & ZEISS hardly shows morphological changes within the Fallax Subzone of Central Russia and Central Poland. It seems that this subzone includes only one or two faunal horizons. A more precise elaboration is proposed. In our opinion the specimen published by SCHWEIGERT (2000) as "*Sarmatisphinctes* aff. *fallax* (ILOVAISKY)" from the Ulmense Subzone, *Zio-Wepferi* Horizon β of SW Germany does not belong to that genus. Possibly it represents a last descendant of the Submediteranean genus *Virgataxioceras* ARKELL.

The Fallax Subzone was proposed by MESEZHNIKOV (MESEZHNIKOV et al. 1977) and supported by latest research (BLOM et al.1984; MESEZHNIKOV 1988; KUTEK & ZEISS 1994, 1997). The precise position of the top of the Fallax Zone in comparison with the Autissiodorensis Zone in Western Europe is still unclear.

2.3. Klimovi Zone MIKHAILOV (1962), as Subzone of the Pseudoscythica – Sokolovi Zone; GERASIMOV & MIKHAILOV (1966), as *Subplanites klimovi & Gravesia* sp. Zone

With the beginning of the Volgian Secondary Standard Stage on the Russian Platform an increasing faunal provincialism is observable, starting already in the Fallax Zone.

The following ammonites were listed by MESEZHNIKOV (in BLOM et al. 1984):
Ilowaiskya klimovi (ILOVAISKY & FLORENSKY), *Gravesia* cf. *gigas* (ZIETEN), *Gravesia* cf. *gravesiana* (D'ORBIGNY), *Neochetoceras* cf. *steraspis* (OPPEL), *Glochiceras* cf. *lithographicum* (OPPEL), and *Sutneria* cf. *subeumela* SCHNEID.

From the Klimovi Zone of Central Poland KUTEK & ZEISS (1997) have reported *Sutneria* cf./aff. *bracheri* BERCKHEMER. In the Submediterranean Province this taxon is restricted to the latest Kimmeridgian. ROGOV (2004b) mentioned *Sutneria eugyra* BARTHEL from the Klimovi Zone, which occurs in southern Germany only in the higher part of the Hybonotum Zone (SCHWEIGERT & SCHERZINGER 1995; SCHWEIGERT 1996; DIMKE & ZEISS 1997). Nevertheless the Russian material is insufficiently preserved and does not allow further conclusions.

Despite repeated reports in literature (e.g. MIKHAILOV 1964, GERASIMOV & MIKHAILOV 1966, BLOM et al. 1984, ROGOV 2002b; 2004a, b) extensive searching in public collections have not revealed any records of the ammonite genus *Gravesia* SALFELD. SAZONOV (1961) even designated the lowermost subdivision of the Volgian Stage as *Gravesia gravesiana* Zone based on this species said to be found in the section of Gorodishche. But it was not illustrated in his publication. It is very likely that this information is based on a mistaken identification made with other genera such as *Eosphinctoceras* MESEZHNIKOV.

Aulacostephanus and *Amoeboceras* which are well-known during the complete Upper Kimmeridgian (in Russian sense) are missing since the beginning of the Klimovi Zone (e.g. MESEZHNIKOV et al. 1977; MESEZHNIKOV 1982; MESEZHNIKOV in KRYMHOLTS et al. 1988; ROGOV 2002a, b, 2004a, b).

A phyletic lineage linking the genera *Sarmatisphinctes* KUTEK & ZEISS and *Ilowaiskya* VIALOV is observable. The small morphological change between late *Sarmatisphinctes* and early *Ilowaiskya* in the middle Volga Region (Gorodishche, Dubky) was reported already by ROGOV (2004b).

A useful drawing of the lower boundary of the Volgian on the Russian Platform seems only possible with the disappearance of *Aulacostephanus*. It is not clear if the assumption that this boundary is synchronous in Northwest Europe, Poland and Russia is correct (KUTEK & ZEISS 1997). The question is if the Klimovi Zone in parts (or even completely) has a Late Kimmeridgian (sensu gallico) age (Fig. 2).

The oppeliids received new attention in the latest papers by ROGOV (2002a, b, 2004a, b). Most of them are rare in the Subboreal area (Central Russia, Central Poland) besides the predominant perisphinctids. They were reported in former publications (e.g. MESEZHNIKOV et al. 1977; MESEZHNIKOV in KRYMHOLTS et al. 1988) and assigned to the genera *Glochiceras* HYATT, *Neochetoceras* SPATH, and *Haploceras* ZITTEL. We cannot agree with a correlation between the Upper Jurassic of the Russian Platform and the Submediterranean or even the Mediterranean Upper Jurassic of Central or South Europe based on these forms because of paleobiogeographic and morphoanalytical reasons. We propose to erect a new genus (see below) for the forms occurring in the Klimovi Zone of Gorodishche which were published by ROGOV (2002b) as "*Glochiceras lithographicum efimovi*" ROGOV.

2.4. Sokolovi Zone ILOVAISKY in ILOVAISKY & FLORENSKY (1941)

In numerous papers we find information about the presence of the ammonite genus *Sutneria* ZITTEL (e.g. MESEZHNIKOV et al. 1977; MESEZHNIKOV in KRYMHOLTS et al. 1988; MESEZHNIKOV 1982; BLOM et al. 1984; GERASIMOV et al. 1995; OLFERIEV 1997; ROGOV 2001, 2002b, 2004b). Unfortunately none of these specimens have been illustrated yet.

The morphological change from *Sarmatisphinctes klimovi* (ILOVAISKY) to *Ilowaiskya sokolovi* (ILOVAISKY) lets us presume that both zones have been transmitted very defectively. One link could be the remarkable lithological differences within the layers of the Sokolovi Zone in the type section of Gorodishche. The thickness is reduced and shows a change between grey marls and phosphoritic and calcareous nodules.

A correlation between the Polish Sokolovi Zone and the Medierranean Darwini Zone on the basis of strongly crushed oppeliids, which have been identified as *Neochetoceras mucronatum* BERCKHEMER & HÖLDER (KUTEK & ZEISS 1994, 1997) is not efficient enough for a reliable comparison. In southern Franconia there is good evidence of this taxon, mainly from the

vicinity of Ammerfeld (BERCKHEMER & HÖLDER 1959, ZEISS 1968, SCHERZINGER & SCHWEIGERT 2003). The occurrence of this taxon outside the Submediterranean Province has not been proved yet.

2.5. Pseudoscythica Zone ILOVAISKY in ILOVAISKY & FLORENSKY (1941)

According to ROGOV (2002b, 2004a, b) one stratigraphic level within the Pseudoscythica Zone of Gorodishche exists which yields *Physodoceras neoburgense* (OPPEL). In the Submediterranean Upper Jurassic this taxon appears for the first time in the Mucronatum Zone and is said to persist up to the upper Palmatus Zone (bed 116 = *Palmatus* Horizon) of the Neuburg Formation (BARTHEL 1975). However, the material housed in the Bayerische Staatssammlung für Paläontologie und Geologie in Munich comprises only finds up to bed 42 (Ciliata Zone, *Ciliata* Horizon). This level corresponds to the Mediterranean Fallauxi Zone (ENAY & GEYSSANT 1975; KUTEK & ZEISS 1988; GEYSSANT 1997; SCHERZINGER & SCHWEIGERT 1999, 2003; SCHWEIGERT & SCHERZINGER 2004). Other records exist e.g. from the middle Volga Region and the vicinity of Orenburg. For a secure identification of *Physodoceras neoburgense* (OPPEL) in crushed preservation it is helpful to identify its microconch partner *Sutneria asema* (OPPEL). The hitherto existing records (ROGOV 2002b; 2004a, b) are poorly preserved because of the clay facies. Because of their long stratigraphic range these taxa can only be used for an approximate correlation. Hence, a reliable correlation between parts of the Pseudoscythica Zone with lower beds of the Neuburg Formation (Franconia) using these two species is impossible. In southern Germany both taxa are only abundant within the Ciliata Zone. In the beds above and below the Ciliata Zone, *Physodoceras neoburgense* (OPPEL) and *Sutneria asema* (OPPEL) only rarely occur (STREIT 1963; ZEISS 1968; SCHERZINGER & SCHWEIGERT 2003). In the sections of the Pieniny Klippen Belt in the Polish Carpathians (KUTEK & WIERZBOWSKI 1986; WIERZBOWSKI 1990) *Sutneria asema* (OPPEL) occurs from the base of the Darwini Zone up to the Fallauxi Zone. This is confirmed by our observations in South Germany. Supposed finds of *Physodoceras neoburgense* (OPPEL) from the Hybonotum Zone most likely have been erroneously identified and represent either incomplete, juvenile stages or inner whorls of other species of *Physodoceras*. On the other hand an insufficient correlation with upper parts of the Palmatus Zone across the boundary of the Tenuicostata/Scythicus zones in Central Poland seems possible (KUTEK 1994; KUTEK & ZEISS 1974, 1988, 1994 u. 1997; SCHERZINGER & SCHWEIGERT 1999; SCHWEIGERT & SCHERZINGER 2004). In the section of Brzostówka *Danubisphinctes palmatus* (SCHNEID) and *Zaraiskites quenstedti* (ROUILLIER) are associated. But it is not finally clear if the specimen identified as *Zaraiskites quenstedti* (ROUILLIER) represents

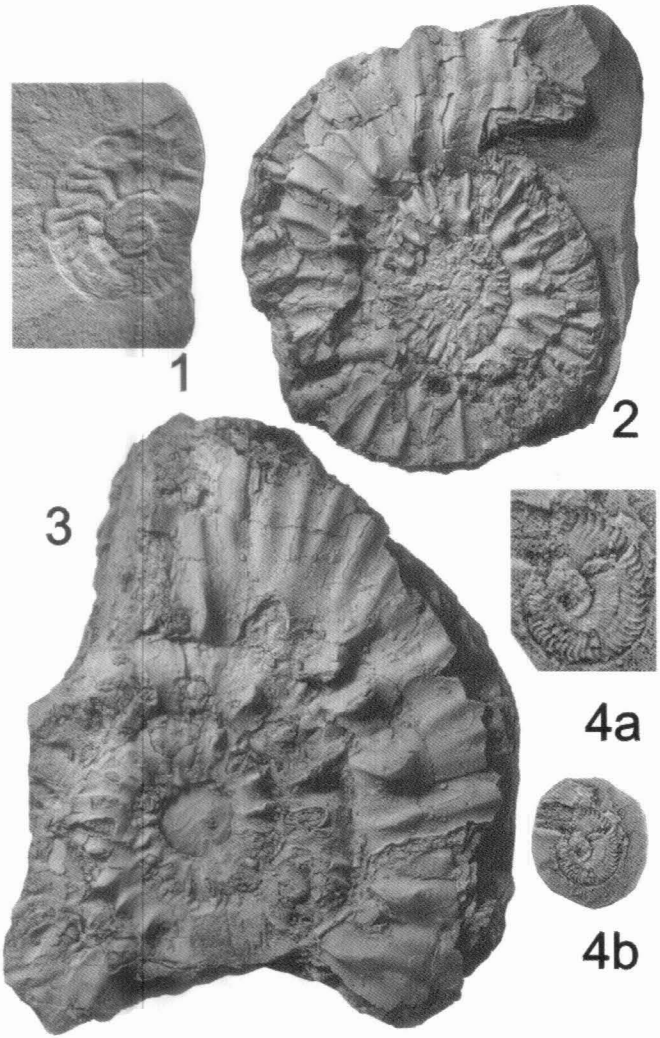

Fig. 6. Ammonites from the Volgae Subzone, Fallax Zone, Locality: Gorodishche near the River Volga, (1 Coll. O. F. GEYER 1967; 2-4 Coll. MITTA & SCHERZINGER 2005), 4a – × 2; 1-3, 4b. – Natural size.
1 - *Sutneria subeumela* SCHNEID [m], SMNS 66201.
2 - *Aulacostephanus undorae* (PAVLOW) [m], N 5123/8.
3 - *Aulacostephanus volongensis* KHUDYAEV [M], N 5123/9.
4 - *Amoeboceras volgae* (PAVLOW) [m], N 5123/10.

exactly the same chronospecies as those coming from the Panderi Zone of the Russian Platform.

2.6. Panderi Zone (Rosanov 1906)

According to Mesezhnikov et al. (1977) and Mesezhnikov (1988) the genus *Sutneria* also occurs in the Panderi Zone. Rogov (2004b) supposed this form could represent *Sutneria asema* (Oppel). Because appropriate material was neither illustrated nor documented in public collections we will not consider this information further.

3. Remarks on several ammonite genera

3.1. *Aulacostephanus*

Our systematic studies show that there exist several dimorphic pairs (cf. Callomon & Cope 1971; Kutek & Zeiss 1997) of the genus *Aulacostephanus* Sutner & Pompeckj in Tornquist in the Fallax Zone. *Aulacostephanus volongensis* Khudyaev is considered to represent the macroconch partner of *Aulacostephanus undorae* (Pavlow) (= *Aulacostephanus subundorae* (Pavlow), see Ziegler (1962, pl. 6, fig. 10)) because of its coexistence and their remarkable similar sculptures (Fig. 6.2-6.3). *Aulacostephanus volongensis* was previously only known from the paper of Khudyaev (1932, pl. 1, figs. 3-5). Another well distinguishable group occurring in the Gorodishche section is represented by *Aulacostephanus* ex gr. *autissiodorensis* (Cotteau) and its supposed microconch partner *Aulacostephanus volgensis* (Vischniakoff) (Figs. 4.1, 5.2-5.4). They are very close to specimens figured by Kutek & Zeiss (1997) from the Autissiodorensis Zone of Central Poland. The third group includes *Aulacostephanus* cf./aff. *jasonoides* (Pavlow) [M+m]. In this group the macroconchs reach almost twice the size of the corresponding microconchs.

For a better classification of the genus *Aulacostephanus* a detailed revision of all occurring chronospecies is necessary.

3.2. *Sarmatisphinctes* and *Ilowaiskya*

Here we assign "*Discosphinctoides*" *subborealis* Kutek & Zeiss, 1997, pl. 15, fig. 5 (HT) from Central Poland to *Sarmatisphinctes*. Kutek & Zeiss (1997) supposed this taxon could be a Subboreal species with a Submediterranean origin. Adult macroconchs have more or less twice the size of our illustrated specimen (Fig. 7.2-7.3). The genus *Subdiscosphinctes* Olóriz, 1978 is a taxon of the Tethyan Realm. Subboreal perisphinctids look somewhat similar, but are only homeomorphic. Probably there is a relationship between *Sarmatisphinctes* Kutek & Zeiss and *Subdichotomoceras* Spath.

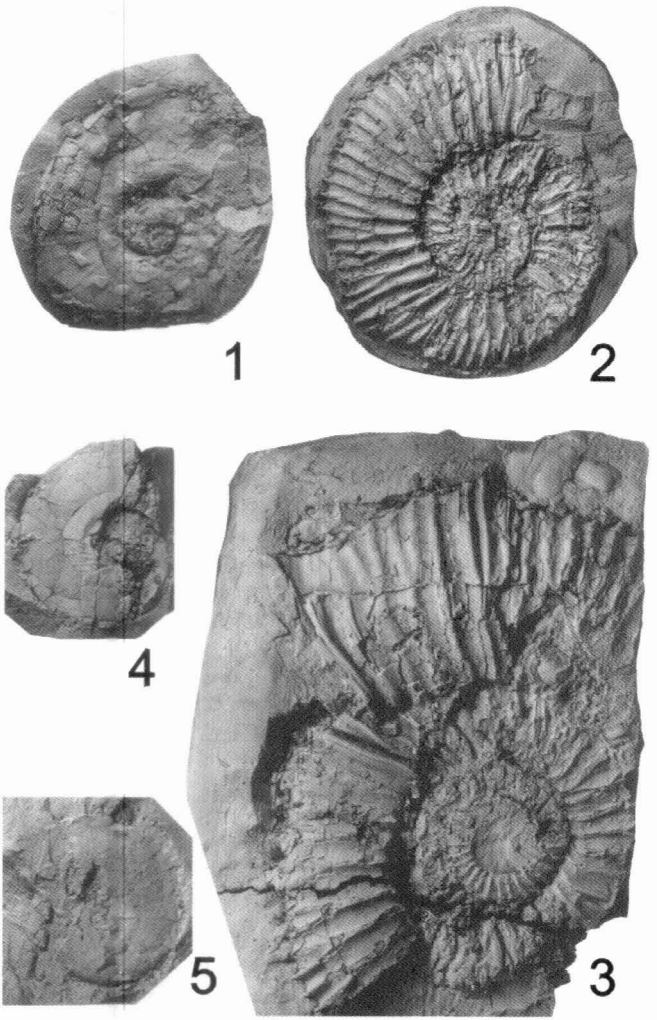

Fig. 7. Ammonites from the Volgae Subzone, Fallax Zone, Locality: Gorodishche near the River Volga, (1-5 Coll. MITTA & SCHERZINGER 2005), all natural size:
1 - *Aspidoceras* cf. *catalaunicum* (DE LORIOL) [M], N 5123/11.
2 - *Sarmatisphinctes subborealis* (KUTEK & ZEISS) [m], N 5123/12.
3 - *Sarmatisphinctes subborealis* (KUTEK & ZEISS) [M], N 5123/13.
4 - *Lingulaticeras* (?) n. sp. [m], N 5123/14.
5 - *Neochetoceras* (?) n. sp. [M], N 5123/15.

The crushed preservation of the studied specimens coming from clay facies does not allow further conclusions.

Due to the unequivocal phylogenetic lineage between the two perisphinctid ammonite taxa *subborealis* and *fallax* we propose to use the same genus name: *Sarmatisphinctes* KUTEK & ZEISS. More information about the variation of *Sarmatisphinctes fallax*, the occurrence of specimens with essentially biplicate ribs, which could be placed in *subborealis* and others more resembling "*Ilowaiskya*" *klimovi* ILOVAISKY in the Polish Fallax Subzone (KUTEK & ZEISS 1997) supports this view. We here also include "*Ilowaiskya*" *klimovi* ILOVAISKY in the genus *Sarmatisphinctes*. The genus *Ilowaiskya* VIALOV starts with its type species *Ilowaiskya sokolovi* ILOVAISKY, because the older chronospecies of this perisphinctid lineage are morphologically still closer to *Sarmatisphinctes*. Contrary to ROGOV (2004b) we assume that *Ilowaiskya* VIALOV, 1940 does not occur in the Lower Tithonian of southern Germany. Citations from literature (ZEISS 1968) are supposed to be erroneous determinations (SCHERZINGER & SCHWEIGERT 1999; SCHWEIGERT & SCHERZINGER 2004). Two crushed specimens interpreted as *Franconites* ZEISS (determinations by MIKHAILOV) from the Sokolovi Zone in the area of Orenburg (MIKHAILOV 1964, pl. 11, fig. 1; MITTA 2004, pl. 2, fig.1) probably belong to *Ilowaiskya* VIALOV.

3.3. *Amoeboceras*

All studied specimens of *Amoeboceras* belong to *Amoeboceras volgae* (PAVLOW) and come from the lower part of the Fallax Zone (Volgae Subzone) (Figs. 5.1, 6.4). Additional research will show whether the occurrence is restricted to only one or more faunal horizons.

3.4. Oppeliid genera

In our opinion the previously reported finds of *Pseudolissoceras* SPATH, *Haploceras* ZITTEL, *Fontannesiella* SPATH, *Paralingulaticeras* ZIEGLER, *Ochetoceras* HAUG, *Neochetoceras* SPATH, and *Lingulaticeras* ZIEGLER (and the perisphinctids *Pseudovirgatites* VETTERS and *Franconites* ZEISS) in the section of Gorodishche (see ROGOV 2001, 2002a, b, 2004a, b; ROGOV & EGOROV 2002) are mostly homoeomorphs. These taxa occur mostly either in the Mediterranean or in the Submediterranean Province. The bulk of the illustrated finds is poorly or incompletely preserved, and the specimens differ significantly from the assigned genera in their sculptures and ontogenetic developments.

Family Oppeliidae DOUVILLÉ, 1890
Subfamily indet.
Genus *Rogoviceras* n. gen.

Type species: *Glochiceras lithographicum efimovi* ROGOV (2002).

Derivation of name: In honour to Dr. M. ROGOV, who described the type species.

Diagnosis: See diagnosis of type species.

Rogoviceras efimovi (ROGOV, 2002) [M] Fig. 8.3-8.5

Holotype: *Glochiceras* (*Paralingulaticeras*) *lithographicum efimovi* (ROGOV, 2002, pl. 2, fig. 2), SGM-572-11, collection: State Geological Vernadsky Museum, Moscow.

Type locality: Uljanovsk region, right bank of the Volga near the village of Gorodishche.

Type horizon: Lower Volgian, Klimovi Zone, "*Efimovi* Horizon" sensu ROGOV (2002b, 2004a, b).

Diagnosis: Shell small, involute, high oval cross-section, venter smooth, finely dentate lateral groove on mid-height of the flank, many simple crescent falcoid ribs arising from this groove.

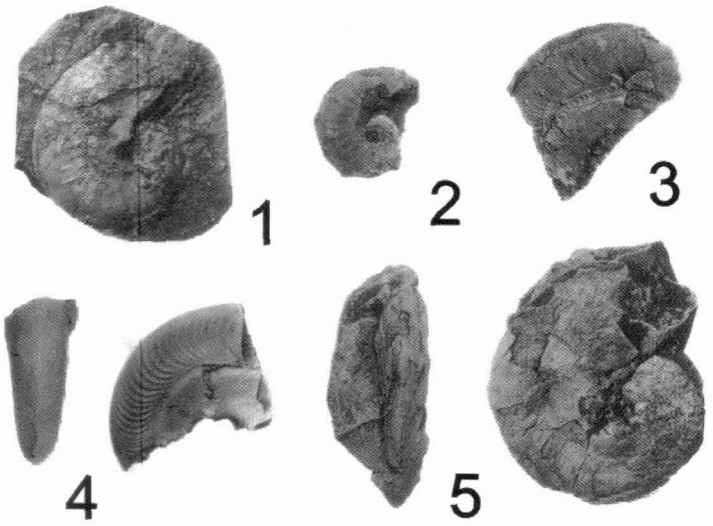

Fig. 8. Ammonites from the Klimovi Zone, Locality: Gorodishche near the River Volga, (Coll. MIKHAILOV, material lost), 1-5 natural size:
1-2. *Glochiceras* (?) n. sp. [m].
3-5. *Rogoviceras efimovi* (ROGOV) [M].

Remarks and comparisons: ZONOV (1937, 1939) reported "*Glochiceras fialar* (OPPEL)" for the first time. The type of *Glochiceras fialar* (OPPEL) originally comes from the the 'Badener Schichten' (Upper Kimmeridgian) of Baden in northern Switzerland. Our material from Russia shows a similar falcoid sculpture and lateral groove but is lacking nodules on the venter.

There is hardly any resemblance with the genus *Paralingulaticeras* ZIEGLER. Its type species *Paralingulaticeras lithographicum* (OPPEL) exhibits numerous thick ventrolateral and ventral nodules on its innermost whorls which have a roughly falcoid ribbing. Specimens of the latter genus are much larger than *Rogoviceras*. There is some resamblance with *Paralingulaticeras parcevali* (FONTANNES), even though the ribs are less densely spaced, and numerous nodules are present. Moreover, *Paralingulaticeras* exhibits a much more evolute coiling. *Neochetoceras*, especially its type species *Neochetoceras steraspis* (OPPEL), exhibits falcoid ribs, which become more irregular at larger sizes. Also this falcoid sculpture is less regularly spaced than in *Rogoviceras*. *Lingulaticeras planulatum* BERCKHEMER exhibits a similar falcoid ribbing stage but at much larger diameters; the latter is a microconch with a lappet at the peristome. *Suboxydiscites taimyrensis* (MESEZHNIKOV) becomes larger and shows an irregular ribbing sculpture and a serrate venter, closer to *Ochetoceras* HAUG or *Neochetoceras* SPATH.

We suppose that *Rogoviceras* belongs to an endemic stock of oppeliids living inside the Subboreal Province of the Russian Platform. Currently only the type species *Rogoviceras efimovi* (ROGOV) is known. As shown above no closer relationships to oppeliids from the Mediterranean/Submediterranean and even from the Subboreal Upper Jurassic exist. This supports our general observations concerning faunal provincialism in other regions during the higher Upper Jurassic, not only restricted to perisphinctids.

4. Conclusions

Since the first description by PAVLOW (1886) the Late Kimmeridgian ammonites from the Russian Platform, especially in the sections near Uljanovsk, have not undergone a fundamental revision. All succeeding papers included only faunal lists and there are only a few illustrations which show very poorly preserved specimens.

The Lower Volgian ammonites described by ILOVAISKY (in ILOVAISKY & FLORENSKY 1941) from the Orenburg area also occur at Gorodishche (MIKHAILOV 1964). Regretfully MIKHAILOV (1964) did not illustrate any ammonites from the Lower Volgian of the Volga Basin in his monograph. A short paper by ROGOV (2002b) about the "Autissiodorensis Zone" (= Fallax Zone in this paper) contains the figures of five oppeliids and one *Sarmatisphinctes*. Only one of these specimens was collected in the area of Uljanowsk. From this view we can still call the classical Upper Kimmeridgian/Lower Volgian section from Gorodishche a "terra incognita".

Because of different interpretations (ZIEGLER 1962; COPE & CALLOMON 1971; MESEZHNIKOV 1982, 1984, 1988; HANTZPERGUE 1989; KUTEK &

ZEISS 1994, 1997) of the Autissiodorensis Zone of ZIEGLER (1962) in the localities of West Europe and Central Russia we prefer the usage of the Fallax Zone of ILOVAISKY (in ILOVAISKY & FLORENSKY 1941) in the Volga area (Fig. 2). The term "Autissiodorensis Subzone" seems to be inappropriate for the lowermost Subzone of the Fallax Zone in the Russian Kimmeridgian. Hitherto no illustration of *Aulacostephanus autissiodorensis* (COTTEAU) from the Russian Platform existed. Hence we had some doubts if this taxon truely occurs there.

In this study we have documented well preserved new ammonite finds (Figs. 3-8). With the occurrence of *Sutneria subeumela* SCHNEID it is possible to correlate the lower part of the Fallax Zone in Central Russia with the lower part of the Beckeri Zone (Subeumela Subzone) of southern Germany (Fig. 2). GEYER (1969) used an occurrence of "*Sutneria* cf. *subeumela*" as the basis for the term "Subeumela Zone". But a single find published in open nomenclature is not enough to establish a new Subzone having a vertical range. Unfortunately we do not know the full stratigraphic range of this taxon in Central Russia, because it seems to be very rare. In our opinion the best index fossil for the base of the Fallax Zone in the study area is *Amoeboceras volgae* (PAVLOW), and therefore we recommend the use of the term Volgae Subzone (Fig. 2).

The previous correlations between the Kimmeridgian/Volgian and Kimmeridgian/Tithonian boundaries are based on insufficient data. The poorly preserved, often even indeterminable ammonites and the doubtful presence of *Gravesia* SALFELD in the Klimovi Zone are extraordinarily poor foundations. The disappearance of the genus *Aulacostephanus* and the first appearance of *Sarmatisphinctes klimovi* (ILOVAISKY) define the Kimmeridgian/Volgian boundary. The top of the Fallax Zone in Central Russia must not necessarily be coeval with the top of the Autissiodorensis Zone, as it is used in southern England, western France, or north-western Germany. Further detailed studies of ammonite faunas collected bed-by-bed are necessary.

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