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Ammonite biostratigraphy of the Middle and Upper Oxfordian in East Taimyr, East Siberia

ABSTRACT: The new ammonite findings in East Taimyr, at the Chernokhrebetnaya river, display a full succession of *Cardioceras* and *Amoeboceras* species in the Middle and Upper Oxfordian. This succession is very close to those of Scotland and East Greenland, what permits a recognition of the standard Boreal zones. The Densiplicatum Zone, and the Tenuiserratum Zone are distinguished in the Middle Oxfordian, whereas the Glosense Zone (with Ilovaiskii Subzone, and Glosense Subzone), the Serratum Zone, the Regulare Zone, and beds with *Amoeboceras* ex gr. *rosenkrantzi* (possibly corresponding to the Rosenkrantzi Zone) are stated in the Upper Oxfordian.

INTRODUCTION

In East Siberia, the most complete fossiliferous section through the Oxfordian strata is exposed in East Taimyr, at the Chernokhrebetnaya river (Text-fig. 1). It is the Oxfordian zonal classification used here, which appears also valid not only for the East Taimyr structural-facies zone of the Lena-Anabar subregion (*RESOLUTION 1981*), but also for the entire East Siberia.

Until recently, the succession of ammonites in the Middle and Upper Oxfordian in Taimyr was relatively poorly known. The ammonite *Amoeboceras* ex gr. *alternans* (VON BUCH) was reported from a 100 m thick sandstone unit (BASOV & *al.* 1963) and it was a basis for attributing these deposits to the Upper Oxfordian in a twofold division of the Oxfordian stage. Later, *Cardioceras (Plasmatoceras)* spp. and *C. (Vertebriceras)* spp. recognized here were assumed as typical of the lower part of the Upper Oxfordian, whereas *Amoeboceras (Amoeboceras)* spp., and *A. (Prionodoceras)* spp. as these of its upper part. Those findings resulted in the following zonal subdivision of the

interval in question (KAPLAN & *al.* 1974, *STRATIGRAPHY 1976*; *see also* Text-fig. 2):

(*i*) Alternoides Zone with *Cardioceras (Plasmatoceras) tenuicostatum* (NIKITIN), *C. (Vertebriceras) densiplicatum* BODEN, *C.(V.)* cf. *vertebrale* (SOWERBY), *C.(Scoticardioceras) excavatum* (SOWERBY), and *Amoeboceras (Prionodoceras)* cf. *alternoides* (NIKITIN);

(*ii*) Alternans Zone with *Amoeboceras (Amoeboceras)* cf. *alternans* (VON BUCH), *A.(A.)* ex gr. *alternans*, and *A.(A.) bauhini* (OPPEL);

(*iii*) Ravni Zone with *Amoeboceras (Prionodoceras)* cf. *pectinatum* MESEZHNIKOV, *A.(P.)* cf. *freboldi* SPATH, and *A.(Amoeboceras)* s..

As the subdivision of the Boreal Oxfordian into three substages became generally accepted in the biostratigraphic charts of Middle Siberia, the above presented zones of Taimyr have been correlated with the Middle and Upper Oxfordian. The Alternoides Zone has been correlated with the Middle Oxfordian and subdivided into the two parts: a lower one with *Cardioceras (Plasmatoceras)*, and an upper one with *Amoeboceras alternoides* (NIKITIN); on the other hand, the Alternans Zone and the Ravni Zone have been correlated with the Upper Oxfordian (MESEZHNIKOV *et al.* 1989, MESEZHNIKOV & KALACHEVA 1989). In the last report for Middle Siberia (MESEZHNIKOV 1988), the *Plasmatoceras* beds are distinguished already in the lower part of the Middle Oxfordian, whereas the Alternoides Zone, beds with *Amoeboceras* sp., and the Ravni Zone are included in the Upper Oxfordian.

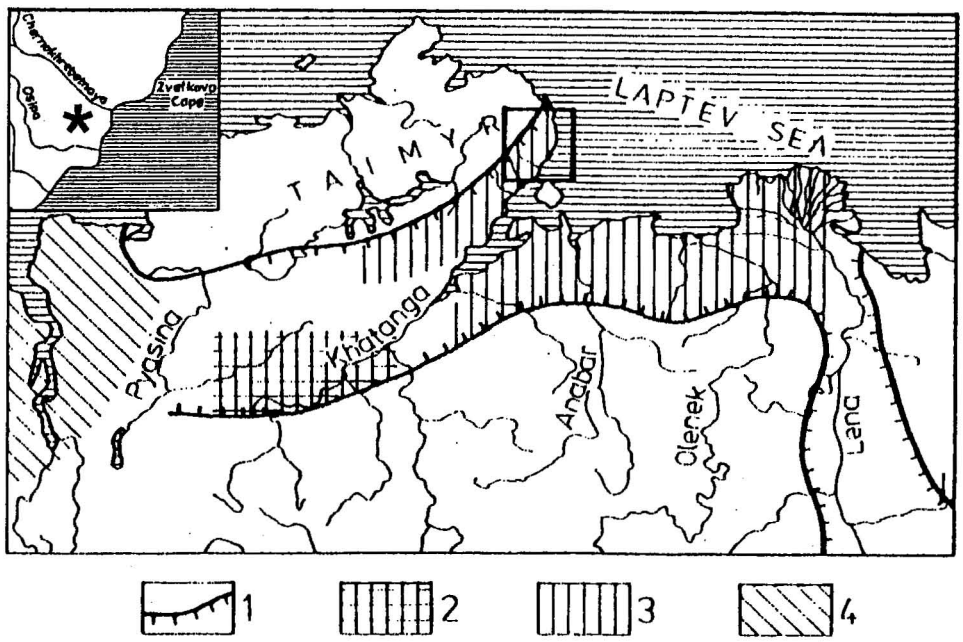

Fig. 1. Location map and structural-facies subregions (*see RESOLUTION 1981*) of the study area in East Siberia

1 — Present-day outline of Jurassic outcrops, 2 — Khatanga subregion, 3 — Lena-Anabar subregion, 4 — Ust-Yenisey subregion

A new unified zonal scheme for the Middle and Upper Oxfordian of the Russian Platform has been elaborated recently (Text-fig. 2; MESEZHNIKOV & *al.* 1984, 1989) after revision of the ammonite genus *Amoeboceras*. With reference to East Taimyr, this zonal scheme can be interpreted as follows (MESEZHNIKOV 1988): the Middle Oxfordian corresponds partly to the Densiplicatum Zone, but the Tenuiserratum Zone has not been recognized here; the Upper Oxfordian includes the Alternoides Zone, the beds with small *Amoeboceras* (earlier determined as *A. alternans*), apparently corresponding by their position in the section to the Serratum Zone, as well as the Ravni Zone.

Of the discussed ammonites from East Taimyr, only four species of the genus *Cardioceras* of Middle Oxfordian age have been described so far (*see* KNIAZEV 1975, Pl.14, Fig.2; Pl.16, Fig.6; Pl.17, Figs 5-6; Pl.19, Fig.9): *Cardioceras (Vertebriceras) densiplicatum* BODEN, *C.(V.) vertebrale* (SOWERBY), *C.(Plasmatoceras) tenuicostatum* (NIKITIN), and *C. (Scoticardioceras) excavatum* (SOWERBY).

One of the present authors (A.N. ALEYNIKOV) studied the Oxfordian deposits at the Chernokhrebetnaya river in 1987. The collected ammonites enabled the differentiation of the full range of zones of the Middle and Upper Oxfordian of the standard Boreal scheme (Text-figs 2-3; *cf. also* SYKES & CALLOMON 1979). It should be remembered that during the last decade this standard zonal scheme has been proved to be suitable for the Russian Boreal regions, such as West Siberia (MESEZHNIKOV & *al.* 1984, VYACHKILEVA 1987), the European part of Russia, and the northern part of East Siberia (MESEZHNIKOV & *al.* 1989, MESEZHNIKOV & KALACHEVA 1989); however, the precise tracing of the standard Boreal zones within the particular sections of these regions has not been possible.

The ammonites collected are housed in the Central Siberian Geological Museum in Novosibirsk.

GENERAL FEATURES OF THE SECTION

The Oxfordian deposits succeed the Callovian ones being completely cropped out at the right bluff bank of the Chernokhrebetnaya river. The lowest Callovian deposits occur 16.5 km away from the river mouth, and the section continues upriver where the Oxfordian deposits are exposed (Text-figs 1 and 3).

The Lower Oxfordian of this section has been described in details by KNIAZEV (1975), and hence it is not discussed in the present paper. Following KNIAZEV (1975), it is considered that the boundary of the Lower and Middle Oxfordian should be drawn at the base of the sandstone member in which *Cardioceras (Plasmatoceras) tenuicostatum* (NIKITIN), *C.(Vertebriceras) densiplicatum* BODEN, and *C.(Scoticardioceras) excavatum* (SOWERBY) appear. The ammonites of the subgenus *Cardioceras*, such as *Cardioceras (Cardioceras)*

cordatum (SOWERBY) and *C. (C.) arcticum* PAVLOV, are known from older beds, and they do not cross this boundary.

The Middle and Upper Oxfordian of the section is summarized below (*see also* Text-fig. 3). The fauna occurs mostly in the carbonate nodules grouped in fourteen horizons (numbered *I-XIV*), and it is usually well preserved; only some poorly preserved fossils have been found in the separating beds (numbered *1-13*).

The oldest are light-gray fine-grained sandstones (beds *1-4*) showing streaks of bivalve coquinas at the base. There occur, at different levels, four horizons (*I-IV*) of argillaceous limestone nodules which yield a complex of *Cardioceras* species indicative of the Densiplicatum Zone, described by KNIAZEV (1975). Some poorly preserved specimens of *Cardioceras (Subvertebriceras)* ex gr. *densiplicatum* and *Cardioceras (Plasmatoceras)* sp. have been discovered also in the uppermost part of this sandstone member, well above the nodule horizon *IV*. The total thickness of the sandstone member is 10 meters.

Fig. 2. Correlation of zonal charts of the Middle and Upper Oxfordian in the Boreal Realm

<table>
<tr><td rowspan="3">STAGE</td><td rowspan="3">SUBSTAGE</td><td colspan="2">Western Europe</td><td colspan="2">Russian Platform</td></tr>
<tr><td colspan="2">Sykes & Callomon (1979)</td><td colspan="2">Mesezhnikov & al. (1989)</td></tr>
<tr><td>ZONES</td><td>SUBZONES</td><td>ZONES</td><td>SUBZONES</td></tr>
<tr><td rowspan="10">OXFORDIAN</td><td rowspan="7">UPPER</td><td rowspan="2">Rosenkrantzi</td><td>Bauhini</td><td rowspan="3">Ravni</td><td rowspan="3"></td></tr>
<tr><td>Marstonense</td></tr>
<tr><td>Regulare</td><td></td></tr>
<tr><td rowspan="2">Serratum</td><td>Serratum</td><td rowspan="2">Serratum</td><td>Serratum</td></tr>
<tr><td>Koldeweyense</td><td>Koldeweyense</td></tr>
<tr><td rowspan="2">Glosense</td><td>Glosense</td><td rowspan="2">Alternoides</td><td>Alternoides</td></tr>
<tr><td>Ilovaiskii</td><td>Ilovaiskii</td></tr>
<tr><td rowspan="3">MIDDLE</td><td rowspan="2">Tenuiserratum</td><td>Blakei</td><td rowspan="2">Tenuiserratum</td><td>Cardioceras (Maltoniceras) sp.</td></tr>
<tr><td>Tenuiserratum</td><td>Zenaidae</td></tr>
<tr><td rowspan="2">Densiplicatum</td><td>Maltonense</td><td rowspan="2">Densiplicatum</td><td rowspan="2">Densiplicatum</td></tr>
<tr><td>Vertebrale</td></tr>
<tr><td colspan="4"></td><td>Popilaniense</td></tr>
</table>

Then, there occur dark-gray fine- and medium-grained siltstones (beds *5-8*). The nodule horizon (*V*) of argillaceous limestones occurs at the base of this siltstone member; the limestones contain lenses of coquinas composed of numerous bivalve shells (identified by A.S. TURBINA), such as *Camptonectes (Boreionectes) broenlundi* RAVN, *Isognomon taimyricum* ZAKHAROV & SCHURAVSKI, *Musculus czekanovskii* (LAHUSEN), *Entolium demissum* (PHILLIPS), as well as rare ammonites *Cardioceras (Subvertebriceras)* sp. and *C. (Maltoniceras)* sp. Three younger horizons of ellipsoidal carbonate nodules (*VI-VIII*) occur at 10 m, 8 m and 5 m below the top of the siltstone member, respectively (*see* Text-fig. 3). These nodules yielded ammonites: *Cardioceras (Subvertebriceras)* sp., *C. (Maltoniceras) schellwieni* BODEN, *C.(M.) bodeni* MAIRE, *C.(Cawtoniceras) kokeni* BODEN, *C. (Scoticardioceras) laevigatum* BODEN, *C. (Vertebriceras) vertebrale* (SOWERBY), as well as such bivalves as *Camptonectes (Boreionectes) broenlundi* RAVN, *Musculus czekanovskii* (LAHUSEN), *Arctica* sp., *Pleuromya* sp., *Buchia concentrica* (SOWERBY), *Lima (Plagiostoma)* ex gr. *calvata* ZAKHAROV, *Entolium demissum* (PHILLIPS). However, the poorly preserved

<table>
<tr><th colspan="4">East Taimyr</th></tr>
<tr><th colspan="2">Kaplan & al. (1974)
"RESOLUTION 1981"</th><th>Mesezhnikov
& al. (1989)</th><th colspan="2">Aleynikov & Meledina,
this paper</th></tr>
<tr><td colspan="2">ZONES AND LAYERS</td><td>ZONES</td><td>ZONES</td><td>SUBZONES</td></tr>
<tr><td colspan="2" rowspan="2">Ravni</td><td rowspan="2">Ravni</td><td colspan="2">layers with
A. ex gr. rosenkrantzi</td></tr>
<tr><td>Regulare</td><td rowspan="2"></td></tr>
<tr><td colspan="2" rowspan="3">Alternans</td><td>Serratum</td><td>Serratum</td></tr>
<tr><td>Alternoides</td><td rowspan="2">Glosense</td><td>Glosense</td></tr>
<tr><td>?</td><td>Ilovaiskii</td></tr>
<tr><td rowspan="2">Alternoides</td><td>layers with Amoeboceras alternoides</td><td>?</td><td>Tenuiserratum</td><td rowspan="2"></td></tr>
<tr><td>layers with Cardioceras (Plasmatoceras)</td><td>Densiplicatum
? ?</td><td>Densiplicatum</td></tr>
</table>

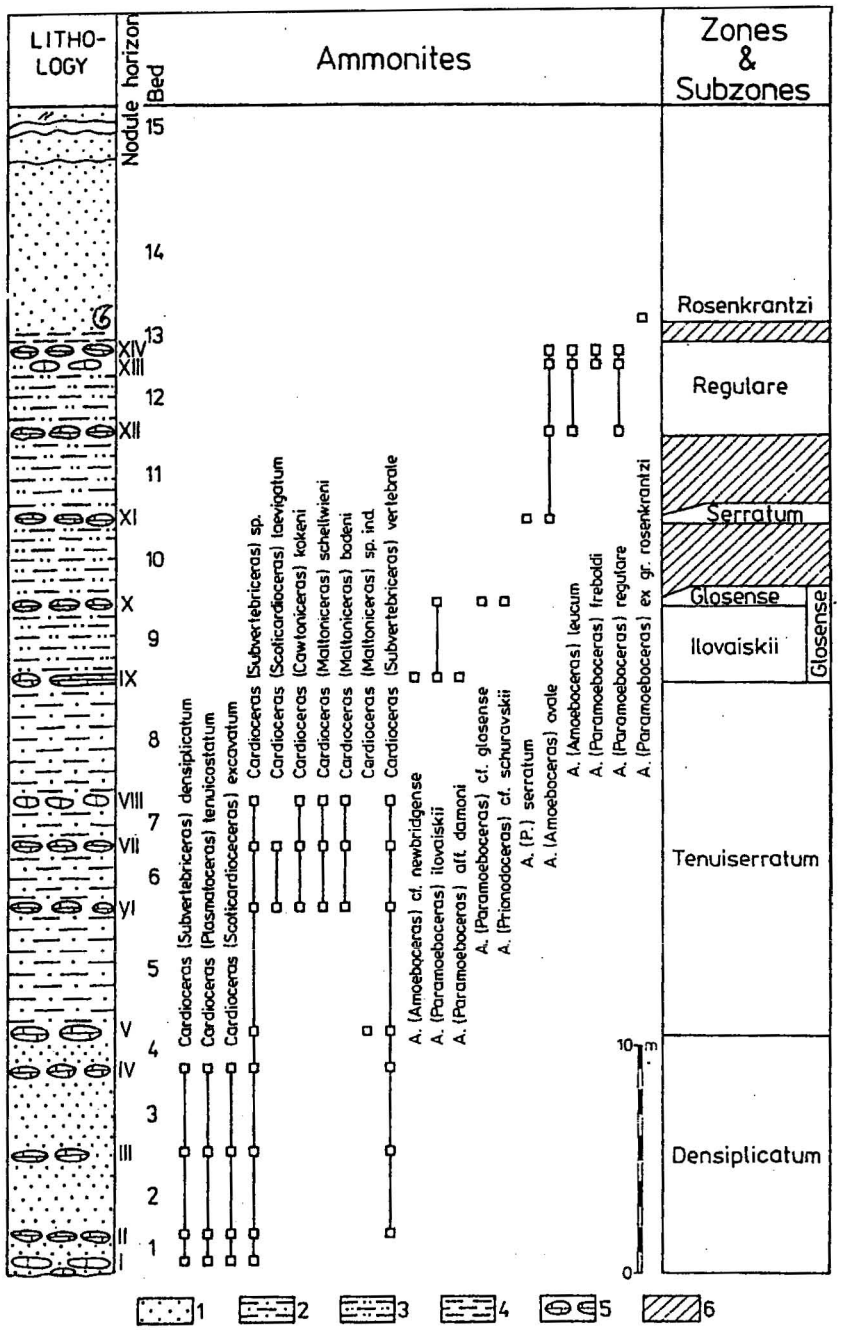

Fig. 3. Ammonite distribution in the Middle and Upper Oxfordian at Chernokhrebetnaya river, East Taimyr

1 — sandstones, 2 — siltstones, 3 — sandy siltstones, 4 — clays, 5 — carbonate nodule horizons, 6 — stratigraphic uncertainty intervals

ammonites of the genus *Cardioceras* are known also from the siltstones up to the top of the member. The total thickness of the siltstone member is 15 meters.

Still higher in the section, there occur dark-gray sandy siltstones (bed *9*), 3 m in thickness. A horizon of ellipsoidal carbonate nodules (*IX*), 0.3-0.4 m in thickness, occurs at the base of the bed. The nodules yielded numerous small ammonites *Amoeboceras (Paramoeboceras) ilovaiskii* (SOKOLOV), as well as rare *A.(Amoeboceras)* cf. *newbridgense* SYKES & CALLOMON and *A. (Paramoeboceras)* aff. *damoni* SPATH. Moreover, some ammonites *A.(P.)* ex gr. *ilovaiskii* have been found in siltstones well above the horizon of carbonate nodules.

A younger sandy siltstone bed (no. *10*) is 4 m thick. It contains also at the base a level of ellipsoidal flattened carbonate nodules (horizon *X*), 0.3-0.4 m in thickness. The ammonites found in the nodules are: *Amoeboceras (Paramoeboceras)* cf. *glosense* (BIGOT & BRASIL), *A.(P.) ilovaiskii* (SOKOLOV), and *A. (P.)* cf. *schuravskii* (SOKOLOV).

Then come 3.5 m of sandy siltstones (bed *11*) similar to those occurring below. The ammonites such as *Amoeboceras (Prionodoceras) serratum* (SOWERBY) and *A. (Amoeboceras) ovale* (QUENSTEDT) have been collected in the ellipsoidal carbonate nodules forming a horizon (*XI*) at the base of this bed.

The higher bed (no. *12*) consists of sandy siltstones, 4 m in thickness. The nodule layers of argillaceous limestones occur at the base of the bed (horizon *XII*, 0.25-0.3 m in thickness), as well as in its uppermost part (horizons *XIII* and *XIV*, each of them 0.2 m thick). These nodule layers yielded the ammonites: *Amoeboceras (Amoeboceras) leucum* SPATH, *A. (A.) ovale* (QUENSTEDT), *A. (Paramoeboceras) regulare* SPATH, and *A. (P.) freboldi* SPATH.

Above are 0.3 m of plastic, brown colored clays (bed *13*), followed by 8 m of greenish-gray, fine-grained, poorly cemented sandstones (bed *14*) with carbonized wood and pockets of clays. The ammonites *Amoeboceras (Paramoeboceras)* ex gr. *rosenkrantzi* SPATH occur at the base of bed *14*, but bivalves *Buchia* cf. *concentrica* (SOWERBY), and *B.* ex gr. *tenuistriata* (LAHUSEN) occur throughout.

Still younger are gray, fine-grained, cross-bedded sandstones (bed *15*), 32 meters in thickness. No fossils have been found there. The occurrence of *Amoeboceras (Amoebites)* sp. in overlying bed *16* indicates already the Lower Kimmeridgian.

THE CARDIOCERATID ZONATION

The discussed ammonite assemblages permit the identification of the standard Boreal ammonite zones in the Middle and Upper Oxfordian deposits of the section studied (Text-fig. 3). The two ammonite zones are recognized in the Middle Oxfordian: the Densiplicatum Zone which embraces beds *1-4*, and

the Tenuiserratum Zone corresponding to beds *5-8*. Whereas the Densiplicatum Zone has previously been recognized in this area (KNIAZEV 1975; *cf. also* MESEZHNIKOV 1988), the occurrence of the Tenuiserratum Zone is stated for the first time here. The latter is characterized by a number of species including those of the subgenera *Maltoniceras* and *Cawtoniceras*, such as (Pl.1, Figs 3 and 5-6): *Cardioceras (Maltoniceras) schellwieni* BODEN, *C.(M.) bodeni* MAIRE, and *C.(Cawtoniceras) kokeni* BODEN, but without the index species of this zone which has not yet been found in Taimyr.

In the Upper Oxfordian deposits are recognized: the Glosense Zone, to which corresponds bed *9* and nodule horizon *X*, with the Ilovaiskii Subzone (bed *9*) and the Glosense Subzone (nodule horizon *X*), the Serratum Zone (nodule horizon *XI*), the Regulare Zone (bed *12*) and possibly the Rosenkrantzi Zone (beds with *A.* ex gr. *rosenkrantzi* SPATH), to which corresponds, at least partly bed *14*.

The ammonites *Amoeboceras (Paramoeboceras) ilovaiskii* (SOKOLOV), *A.(P.)* cf. *glosense* (BIGOT & BRASIL), and *A.(Prionodoceras)* cf. *schuravskii* (SOKOLOV) are reported from East Siberia for the first time (Pl.1, Figs 9-13 and 16). These ammonites are indicative of the Glosense Zone, a basal zone of the

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PLATE 1

Middle and Upper Oxfordian ammonites from Chernokhrebetnaya river section

1 — *Cardioceras (Maltoniceras)* sp.; Specimen No. 970/1; Middle Oxfordian, Tenuiserratum Zone, nodule horizon (n.h.) VI

2a-2b — *Cardioceras (Vertebriceras) vertebrale* (SOWERBY); Specimen No. 970/2; Middle Oxfordian, Tenuiserratum Zone, n.h. VI

3a-3b — *Cardioceras (Maltoniceras) bodeni* MAIRE; Specimen No. 970/3; Middle Oxfordian, Tenuiserratum Zone, n.h. VI

4 — *Cardioceras (Subvertebriceras)* sp.; Specimen No. 970/4; Middle Oxfordian, Tenuiserratum Zone, n.h. VII

5 — *Cardioceras (Maltoniceras) schellwieni* BODEN; Specimen No. 970/5; Middle Oxfordian, Tenuiserratum Zone, n.h. VII

6a-6b — *Cardioceras (Cawtoniceras) kokeni* BODEN; Specimen No. 970/6; Middle Oxfordian, Tenuiserratum Zone, n.h. VII

7 — *Amoeboceras (Prionodoceras) serratum* (SOWERBY); Specimen No. 970/7; Upper Oxfordian, Serratum Zone, n.h. XI

8 — *Amoeboceras (Paramoeboceras)* aff. *damoni* SPATH; Specimen No. 970/8; Upper Oxfordian, Glosense Zone, n.h. IX

9a-9b, 13, 16 — *Amoeboceras (Paramoeboceras)* cf. *glosense* (BIGOT & BRASIL); Upper Oxfordian, Glosense Zone, n.h. X; **9a-9b** — Specimen No. 970/9; **13** — Specimen No. 970/10; **16** — Specimen No. 970/17

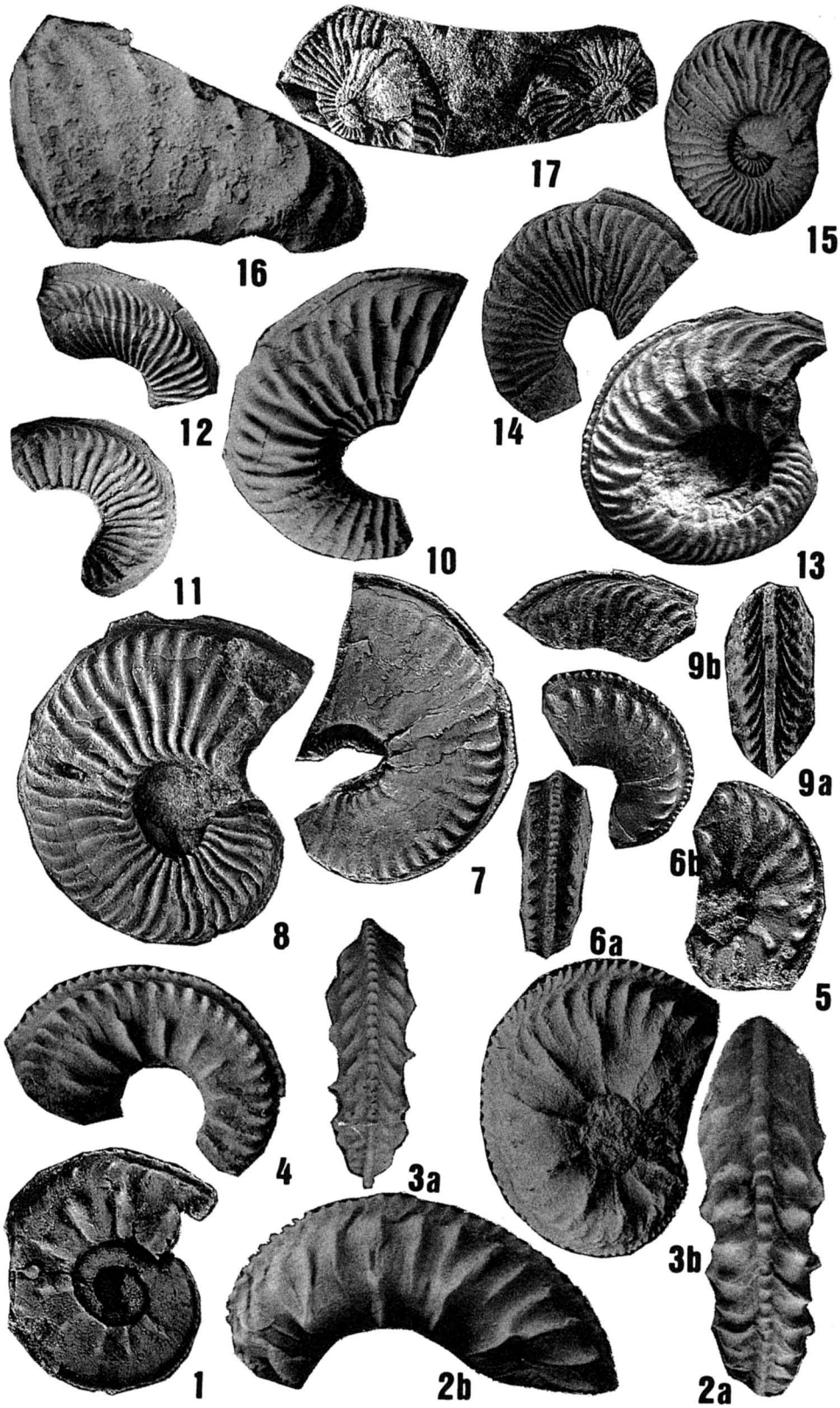
10 — *Amoeboceras (Prionodoceras)* cf. *schuravskii* (SOKOLOV); Specimen No. 970/11; Upper Oxfordian, Glosense Zone, n.h. X

11-12 — *Amoeboceras (Paramoeboceras)* cf. *ilovaiskii* (SOKOLOV); Upper Oxfordian, Glosense Zone, Ilovaiskii Subzone; **11** — Specimen No. 970/12, n.h. IX; **12** — Specimen No. 970/13, n.h. X

14 — *Amoeboceras (Paramoeboceras) regulare* SPATH; Specimen No. 970/14; Upper Oxfordian, Regulare Zone, n.h. XII

15 — *Amoeboceras (Amoeboceras) ovale* (QUENSTEDT); Specimen No. 970/15; Upper Oxfordian, Serratum Zone, n.h. XI

17 — *Amoeboceras (Paramoeboceras)* ex gr. *rosenkrantzi* SPATH; Specimen No. 970/16; Upper Oxfordian, Rosenkrantzi Zone, bed 14


17
16
15
12
14
10
13
11
9b
9a
8
7
6b
6a
5
4
3a
3b
1
2b
2a

Boreal Upper Oxfordian (*see* SYKES & CALLOMON 1979). On the other hand, the former two species are the indices of the two subzones of the Glosense Zone, namely the Ilovaiskii Subzone and the Glosense Subzone of SYKES & CALLOMON (1979). It is worth noting that the species *A. glosense* appears generally higher than the species *A. ilovaiskii*; then, these two species occur together (*see* Text-fig. 3; *also* SYKES & CALLOMON 1979, Fig.3). Taking into account the distribution of these two species it would be more reasonable to treat as the index of this zone, *Amoeboceras ilovaiskii* instead of *Amoeboceras glosense*, distinguishing the Glosense Subzone in its upper part. However, following the accepted standard, corresponding beds in the section at the Chernokhrebetnaya river are attributed to the Glosense Zone, with the Ilovaiskii Subzone below, and the Glosense Subzone above.

The findings (*see* Pl. 1, Fig. 7) of *Amoeboceras (Prionodoceras) serratum* (SOWERBY) substantiate the presence in Taimyr of the Serratum Zone which as previously suggested has been corresponding to the "strata with small *Amoeboceras*" (MESEZHNIKOV 1988, MESEZHNIKOV & *al.* 1989)

The species *Amoeboceras (Paramoeboceras) regulare* SPATH is reported from Taimyr also for the first time (Pl. 1, Fig. 14). It occurs together with *A.(P.) freboldi* SPATH, and *Amoeboceras (Amoeboceras) leucum* SPATH, which have been treated as indicative of the Ravni Zone (KAPLAN & *al.* 1974). The Ravni Zone of the Upper Oxfordian was proposed in Middle Siberia by MESEZHNIKOV (1967), who described the assemblage of the *Amoeboceras* species indicative of this zone from the Kheta river basin, precisely from the section at the Levaya Boyarka river which became the type section of the Ravni Zone. When compared with the standard Boreal zonation (SYKES & CALLOMON 1979), the two ammonite zones, *i.e.* the Regulare Zone and the Rosenkrantzi Zone, should be treated as an equivalent to the Siberian Ravni Zone (MESEZHNIKOV & *al.* 1989).

The *Amoeboceras* species discovered in bed *12* at the Chernokhrebetnaya river are indicative of the Boreal Regulare Zone (Text-fig.3; *see also* SYKES & CALLOMON 1979). The ammonite *Amoeboceras* ex gr. *rosenkrantzi* SPATH discovered in the lowermost part of bed *14* in the section studied (*see* Text-fig.3 and Pl. 1, Fig. 17) allows to delimit the upper boundary of the Regulare Zone, which has to run below the base of bed *14*. On the other hand, the bed *14* corresponds partly at least to the Rosenkrantzi Zone. It is possible, that a thick bed *15* of cross-bedded sandstones, devoid of fauna, but overlain without any unconformity by the Lower Kimmeridgian deposits, may still correspond to the Rosenkrantzi Zone.

It is worth noting that an introducing of the Ravni complex Zone in East Taimyr (*see* Text-fig. 2) seems at that moment unreasonable. This zone, still undivided, should be retained however in a more southward areas, in the Kheta river basin, in the Khatanga subregion (*see* Text-fig. 1).

It should also be remembered that the Middle and Upper Oxfordian zonal scheme of East Taimyr corresponds very well at the zonal level to that of the Boreal standard (*see also* Text-fig. 2). The subzones of the Boreal standard are applicable to the Siberian scheme to a limited extent.

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