BIOSTRATIGRAPHY OF THE HIGHEST KIMMERIDGIAN AND LOWER VOLGIAN IN POLAND

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ABSTRACT

In Poland, the ammonite succession in several continuous and expanded sections makes it possible to recognize the *Eudoxus* and *Autissiodorensis* Zones in the Upper Kimmeridgian as well as the *Klimovi, Sokolovi, Pseudoscythica* and *Tenuicostata* Zones in the Lower Volgian, and to reconstruct an evolutionary lineage leading from Discosphinctoides through the genera *Virgataxioceras, Ilowaiskya* and *Pseudovirgatites* to *Zaraiskites*. Some interregional stratigraphical correlations are suggested.

KEY-WORDS : JURASSIC, KIMMERIDGIAN, VOLGIAN, BIOSTRATIGRAPHY, AMMONITES.

RÉSUMÉ

La succession des faunes d'ammonites observée dans plusieurs coupes complètes et continues en Pologne permet de distinguer les zones à *Eudoxus* et à *Autissiodorensis* dans le Kimméridgien supérieur ainsi que les zones à *Klimovi*, à *Sokolovi*, à *Pseudoscythica* et à *Tenuicostata* dans le Volgien inférieur, et de reconstruire un rameau phylétique issu de *Discosphinctoides*, comprenant les genres *Virgataxioceras, Ilowaiskya, Pseudovirgatites* et *Zaraiskites*. Quelques corrélations stratigraphiques interrégionales sont suggérées.

MOTS-CLÉS : JURASSIQUE, KIMMÉRIDGIEN, VOLGIEN, BIOSTRATIGRAPHIE, AMMONITES.

INTRODUCTION

The highest Kimmeridgian and Lower Volgian sediments still preserved in Poland beyond the Carpathians (Fig. 1) are developed in part as shales which belong to the Paluki Formation, a formation rich in ammonites but very poorly exposed. Still, fairly large numbers of ammonites have been collected from this formation by the first of the present authors over the last 30 years, mainly from temporary exposures and some fully cored boreholes in the region of Tomaszow Mazowiecki, and from several boreholes in the Lodz Synclinorium (Fig. 1). The palaeontological material will be described in a large paper by Kutek and Zeiss, now in preparation. The essential features of the Upper Kimmeridgian to Lower Volgian ammonite succession, displayed in the Paluki Formation, are presented in the following sections of the present paper.

Some Late Kimmeridgian and Early Volgian ammonites from platformic Poland have hitherto been figured in several papers (eg. Kutek 1961, Dembowska 1973) but a large proportion of them need taxonomical and stratigraphical reinterpretion.

LITHOSTRATIGRAPHY

In central Poland, the Paluki Formation is underlain by an unnamed formation consisting of *Nanogyra coquinas* alternating with calcarous shales and micritic limestones. The topmost part of the latter formations belongs to the *eudoxus* Zone, as indicated by occurrences of *Aulacostephanus eudoxus* (D'ORB.), *A. pseudomutabilis* (DE LOR.) and *A. pinguis* DURAND (comp. Kutek 1961).

The Paluki Formation is built up of calcarous shales and mudstones with intercalations of limestone. No discontinuities of biostratigraphical significance have been detected in the expanded sections of this formation, which extends from the Upper Kimmeridgian (Eudoxus Zone) trough the Lower Volgian into the Middle Volgian (Scythicus Zone). Both the Kimmeridgian and the Lower Volgian portions of the formation are about 60 m thick in the region of Tomaszow Mazowiecki.

Other measurements given below also refer to thicknesses of strata in that region.

UPPER EUDOXUS ZONE

Ammonites do not yet occur in profusion in the lowest part of the Paluki Formation, below the beds attribuable with confidence to the Autissiodorensis Zone, and most of the specimen from this interval are of poor preservation. There have been found specimens attribuable to *Glochiceras solenoides* ZIEGLER, *Sutneria eumela* (D'ORB.), *Aspidoceras acanthicum* (OPP.), *A. longispinum* (SOW.), *Discosphinctoides stenocyclus* (FONT.) and *D. roubyanus* (FONT.), and some specimens of *Aulacostephanus* and *Amoeboceras*, not identifiable on specific level. The assemblage indicates that the basal part of the Paluki Formation belongs to the Eudoxus Zone. An important point is that this assemblage of ammonites is essentially still of Sub-Mediterranean type, as are the Early Kimmeridgian ammonite faunas of platformic Poland.

AUTISSIODORENSIS ZONE

In central Poland the lower boundary of the Autissiodorensis Zone cannot be drawn with desirable precision because of the absence of *Aulacostephanus* in the critical interval, but strata over 25 m thick can be assigned with confidence to this zone. The following taxa are common in the bulk of the zone, benath the base of the Fallax Subzone.

Most forms of the genus *Aulacostephanus* can easily be accomodated within the spectra of variability commonly ascribed to *A. undorae* (PAVL.), *A. volgensis* (VISCHN.), *A. autissiodorensis* (COT.) and *A. jasonoides* (PAVL.).

The genus *Amoeboceras* is almost exlusively represented by the species *A. krausei* (SALF.) and *A. volgae* (PAVL.), which appear in a few narrow bands in the lower part of the Autissiodorensis Zone, commonly forming ammonite plasters.

Figure 1 - Limits of Lower Volgian sediments in Poland. *Limite actuelle des sédiments du Volgien inférieur en Pologne.*

The commonest ammonites from the interval here described are representatives of *Discosphinctoides* which all can be accomodated in one new species of this genus. The species includes lappeted microconchs with diameters up to c. 80 mm, and larger macroconchs. Their ribbing is virtually bifurcate but, in the last few metres below the base of the *fallax* Subzone, there appear forms with occasional trifurcate ribs not connected with constrictions, this, together with some irregularities in the arrangement of ribs, heralding the transformation of the discussed species into *Virgataxioceras fallax*. The new Polish species seems to be close to the poorly known Late Kimmeridgian representatives of *Discosphictoides*, such as e. g. *D. magistri* (ILOV.) (Ilovaisky & Florensky 1941, pl. 4, fig. 9).

FALLAX SUBZONE

The topmost portion of the Autissiodorensis Zone, usually 2-3 m thick, can be separated out as the Fallax Subzone ; the range of this subzone is defined by the range of the species *Virgataxioceras fallax* (ILOV.). The genus *Aulacostephanus* disappears in the midst of the subzone, being still fairly frequent in its lower part.

The Polish forms of *Virgataxioceras fallax* are closely comparable with the Russian representatives of this species, and are clearly distinct from the South-German group of *Virgataxioceras setatum* (comp. Ilovaisky & Florensky 1941, and Berckhemer & Hölder 1959). The Polish material includes lappeted microconchs of *V. fallax* with diame-

ters up to c. 80 mm. This material also includes a few specimens with lappets, which only differ from typical forms of *V. fallax* in displaying bifurcate ribbing ; they can be interpreted as mere variants of this species.

KLIMOVI ZONE

The Klimovi Zone, which is the lowest zone of the Volgian Stage, is c. 12 m thick. All the perisphinctacean ammonites, found in the discussed region in this zone, can be assigned to the species *Ilowaiskya klimovi* (ILOV.). The Polish material includes specimens which are closely comparable with forms of this species from the Russian Platform, but there are also some extreme variants displaying exclusively, or retaining to a large diameter of whorl, bifurcate ribbing. The Polish sections supply good evidence indicating an evolutionary link between *Virgataxioceras fallax* and *Ilowaiskya klimovi*, this transformation having been connected with loss of lappets in microconchs. In this context it is worth of note that no perisphinctacean ammonites with lappets have ever been found in the Polish Volgian, up to and including the Scythicus Zone, nor have any ammonites with ventral horns reminiscent of *Pectinatites*.

As the trifurcate ribbing of *Ilowaiskya klimovi* is similar to that in forms of *Subplanites*, this species was included in the genus *Subplanites* by several authors (e. g. Mikhailov 1964 ; Zeiss 1968 ; Kutek & Zeiss 1974). However, *I. klimovi* differs from species of *Subplanites* in not having microconchs with lappets. Moreover, no specimens of *Lithacoceras*, the taxon that includes macroconchs corresponding to *Subplanites*, have been found in the Polish Klimovi Zone, which, on the contrary, yielded some fragments of very large whorls with bifurcate ribbing. The reverting ot ornamentation to bifurcate ribbing on outermost whorls of macroconchs is a feature found in ammonites of the subfamily Virgatitinae (in the genera *Pseudovirgatites, Zaraiskites* and *Virgatites*). From all this it follows that *Ilowaiskya klimovi* should be kept distinct from *Sublanites*, so more as this species belongs to a different evolutionary lineage.

SOKOLOVI ZONE

Again all the perisphinctacean ammonites found in this zone, about 15 m thick, can be assigned to one species, *Ilowaiskya sokolovi* (ILOV.). The Polish specimens show gradation from forms with ribs branching into three or four secondaries, and with numerous intercalatory ribs, trough forms with bifurcate and trifurcate ribs, to forms with bifurcate ribbing. This range of variability is comparable with that displayed by the Russian forms separated out by Ilowaisky (*in* Ilovaisky & Florensky 1941) as *Ilowaiskya sokolovi* var. *typica*, var. *pavida* and var. *juvenilis*.

PSEUDOSCYTHICA ZONE

Only ammonites referrable to *Ilowaiskya pseudoscythica* (ILOV.) have been recognized in this thin zone which thickness may but slightly exceed 5 m.

TENUICOSTATA ZONE

The uppermost portion of this zone, c. 6 m thick was recognized beneath the base of the Middle Volgian at outcrop, at Brzostowka near Tomaszow Mazowiecki ; it yielded specimens of *Ilowaiskya tenuicostata* (MIKH.) as well as of species of *Pseudovirgatites* and *Isterites*, which were described by Kutek and Zeiss (1974). Afterwards a few boreholes made it possible to recognize that the Tenuicostata Zone is 20-25 m thick ; its lower boundary has been taken at the level of first appearance of the index species. Specimens of *I. tenuicostata* and of *Pseudovirgatites* and *Isterites*, but no specimens of *I. pseudoscythica* have been found in the lower strata of the zone (those not exposed at Brzostowka). It is worth of note that in this interval there have been found a few fragmentary specimens comparable with the Russian forms assigned by Mikhailov (1964, p. 72, pl. 13, fig. 1, pl. 17, fig. 1) to his species *Pectinatites (Wheatleyites) spathi* ; these forms can be interpreted as belonging to Isterites.

THE BASE OF THE MIDDLE VOLGIAN

The lower boundary of the *Sscythicus Zone, which is also that of the Middle Volgian Stage, is marked by the transformation of Pseudovirgatites* into *Zaraiskites*. This boundary has been recognized in central Poland at outcrop and in several boreholes. In this region, expanded sections make it possible to recognize four successive assemblages of *Zaraiskites* in the Scythicus Zone, which is over 50 m thick. This problem, however, is beyond the scope of this paper.

ORIGIN OF VIRGATITINAE

In an earlier paper (Kutek & Zeiss) it was demonstrated that *Pseudovirgatites* evolved from *Ilowaiskya* and gave rise to *Zaraiskites* ; the lat-

ter genus is the ancestor of *Virgatites*. Now this evolutionary lineage can be traced back into the Upper Kimmeridgian, as a link can be shown between *Discosphinctoides* and *Ilowaiskya* via *Virgataxioceras fallax*. Virgatotome ribbing began to develop with *V. fallax*, whereas its transformation into *Ilowaiskya klimovi* was connected with loss of lappets in microconchs.

In the lowest Volgian, several features found in the Middle Volgian representatives of Virgatitinae (*Zaraiskites* and *Virgatites*) are already clearly developed in *Ilowaiskya klimovi* : simple peristome in microconchs, bifurcate ribbing on outermost whorls of macroconchs, and intraspecific variability expressed by gradations of forms with different secondary to primary ribs ratio.

It is worth pointing out that *Discosphinctoides*, which is essentially a Mediterranean and Sub-Mediterranean genus, gave rise to a series of Sub-Boreal taxa.

CORRELATIONS WITH NW EUROPE

The Polish Autissiodorensis Zone correlates with the Autissiodorensis Zone of Nort-West Europe (comp. e. g. Callomon & Cope 1971). Higher up, no direct correlations are possible between the zones of the Polish Volgian and those established in the British Upper Kimmeridge Clay because of the total absence of *Pectinatites* and *Gravesia*, and the extreme rarity of *Pavlovia*, in Poland.

CORRELATIONS WITH THE RUSSIAN PLATFORM

The following zonal scheme is commonly used in the area of the Russian Platform (comp. e. g. Mikhailov 1964 ; Mesezhnikov 1982) : the autis-Siodorensis Zone with the Fallax Subzone at the top of the Upper Kimmeridgian, the Klimovi, Sokolovi and Pseudoscythica Zones in the Lower Volgian, and the Panderi (= Scythicus) Zone at the base of the Middle Volgian. As the same biostratigraphical units have been recognized in Poland, correlations between the two regions are self-evident, except for the Tenuiscostata Zone, which has not hitherto been separated out in Russian sections.

The ammonites of the Polish Tenuicostata Zone have some counterparts on the Russian Platform only in the region of the Ural and Ilek Rivers. The Lower Volgian sediments in this region are variable lithologicallly, rich in glauconite and phosphatic deposits, and usually very thin ; for instance, except for a section on the Vetlanka River, the sediments ascribed by Mikhailov (1964) to the Pseudoscythica Zone, are c. 1 m or less, in some sections only 25 - 30 cm, thick. These features are suggestive of stratigraphical condensation and sedimentary discontinuity. Specimens of *Ilowaiskya tenuicostata* (MIKH.) have been found only in the section on the Vetlanka River were they were collected by Mikhailov (1964) from a sandstone 3.6 m thick, together with specimens of *I. pseudoscythica* (ILOV.) and forms referred to as *Pectinatites (Wheatleyites)* aff. *eastlecottensis* (SALF.), *P. (W.) arkelli* (MIKH.) and *P. (W.) spathi* (MIKH.) ; the latter forms can be transferred to *Pseudovirgatites* and *Isterites*. The ammonite were not collected from more precise horizons so that it is probable that the stratigraphical ranges of particular taxons are not the same.

In the type section of the Volgian stage at Gorodishtshe on the Middle Volga the Pseudoscythica Zone, which yielded here only *Ilowiskya pseudoscythica*, is overlain by the basal Middle Volgian Panderi Zone. In the complementary type section at Kashpirovka in the same region the latter zone rests directly on sediments with *I. sokolovi*, and in the Moscow region directly on pre-Volgian rocks (Mikhailov 1964). These data suggest that a stratigraphical discontinuity at the base of the Middle Volgian may also exist in the Gorodishtshe section.

The general conclusion that can be drawn from the data presented above is that the Tenuicostata Zone is absent from some of the classical sections of the Russian Volgian because of a stratigraphical gap at the base of the Middle Volgian, and that it has not yet been separated out from other, very thin or condensed sequences.

The time interval corresponding to the *tenuicostata* Zone should be taken into account when establishing interregional correlations with the Volgian Stage because this zone can correspond to a considerable span of time.

CORRELATIONS WITH SUB-MEDITERRANEAN REGIONS

In the Polish sections, several crushed specimens of *Glochiceras* and *Taramelliceras* have been found in the Autissiodorensis and Klimovi Zones, of *Sutneria* in the Klimovi Zone, and of *Neochetoceras* in the Sokolovi Zone. A large proportion of the material is difficult to identify unequivocally at specific level, so that its stratigraphical evaluation should be coupled with its detailed pa-

laeontological interpretation. Therefore only a few data will be given below.

Sutneria bracheri BERCKHEMER has been found in the topmost part of the Polish Klimovi Zone. As this species does not extend in South German above the Hybonotum Zone (Ziegler 1977), the topmost part of the Klimovi Zone should have his equivalent still in the Hybonotum Zone.

Neochetoceras is not uncommon in the Polish Sokolovi Zone, being represented at several levels by *N. mucronatum* BERCKHEMER & HOLDER and *N. usselensis* ZEISS. In Franconia *N. mucronatum* extends up from the upper Hybonotum Zone almost to the base of the Middle Tithonian (the base of the Neuburg Formation) ; the known stratigraphical range of *N. usselensis*, which is restricted to a rather narrow interval in the midst of the Lower Tithonian, most probably represents but a part of the total range of this species (Zeiss 1968). This, together with the absence of Oppelidae in the Polish Volgian above the Sokolovi Zone, makes it difficult to evaluate stratigraphically the occurences of *Neochetoceras* in the Polish sections. In any case, they indicate an Early Tithonian age of the whole Sokolovi Zone.

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