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Tithonian-Volgian ammonites from Brzostówka near Tomaszów Mazowiecki, Central Poland

ABSTRACT: Described are ammonites collected in the classical section at Brzostówka, from deposits referable to the uppermost Lower Volgian (upper *pseudoscythica* Zone) and the lowermost Middle Volgian (lower *scythicus* Zone) on the one hand, and to the lowermost Upper Tithonian on the other. The ammonites belong to the genera *Ilowaiskya, Pseudovirgatites, Isterites, Lemencia(?)* and *Zaraiskites.* Four new species and three new subspecies are established. The ammonites from Brzostówka, which comprise several forms hitherto unknown from Poland, make it possible to recognize the genus *Pseudovirgatites* as ancestor of *Zaraiskites,* and to discuss some stratigraphical and biogeographical problems, concerning middle parts of the Tithonian and Volgian Stages in East-central Europe.

INTRODUCTION

The best exposures of the Volgian deposits in Poland are those in the area of Tomaszów Mazowiecki, on the Pilica river, c. 100 km southwest of Warsaw (Fig. 1*A*). In this area, the presence of sediments with Virgatitinae was recognized for the first time by Michalski (1884), and the well-known Lewiński's (1923) monograph, devoted to the Bononian of Poland, was entirely based on those exposures. Also Kutek (1962a, b, 1967) deals with the Volgian deposits exposed in this area.

The oldest Volgian deposits in the area considered were exposed at the village of Brzostówka, now within the administrative boundaries of the town of Tomaszów Mazowiecki. All the Volgian deposits formerly to be seen at a large clay-pit, now disused, were distinguished by Lewiński (1923) as his lithological horizon *I*, and ascribed to the *scythicus* Zone.

Excavations carried out recently in the Brzostówka clay-pit by Kutek have provided a rich collection of ammonites, which is described in

this paper. The ammonites from Brzostówka, which comprise several forms hitherto not reported from Central Poland, allow to discuss several stratigraphic, phylogenetic and biogeographic problems, concerning the middle parts of the Tithonian and Volgian Stages in East-central Europe.

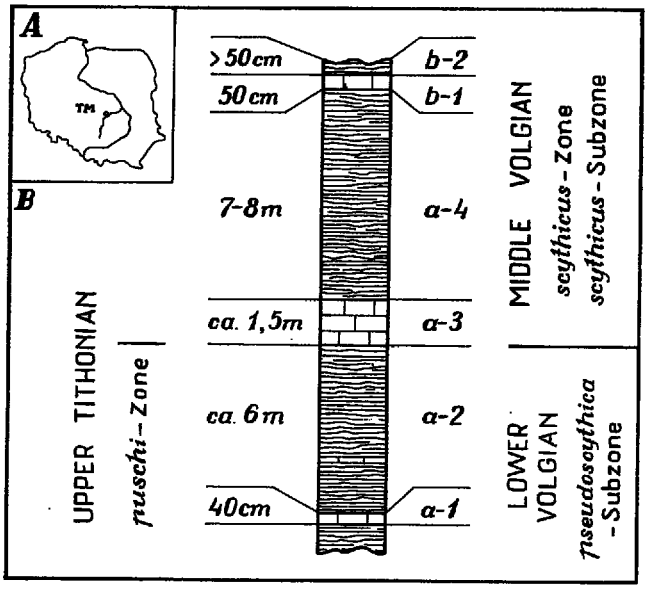

Fig. 1

A — location map, *TM* — Tomaszów Mazowiecki, *B* — the Volgian section section at the Brzostówka clay-pit

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THE SECTION AT THE BRZOSTÓWKA CLAY-PIT

At Brzostówka, the Volgian shales and marls are covered by Quaternary sediments of variable thickness, and the large clay-pit, now abandoned and overgrown, is the only site where these Volgian rocks are easily accessible, provided some digging operations being carried out. The Volgian section is as follows.

The section begins with 6 m of calcareous shales, overlain by a layer of marls 50 cm thick (layer *a-1* in Fig. 1*B*). This is succeded by the layer *a-2*, consisting of shales *c.* 6 m thick; there is a thin marly band about 2 m above its base. These sediments are overlain by marls *c.* 1.5 m thick (layer *a-3*), succeded by shales of layer *a-4*, the thickness of which is between 7 and 8 m. The highest part of the section is represented by marls 50 cm thick (layer *b-1*), and overlaying shales transitional to marls, of observable thickness of about 50 cm (layer *b-2*).

All the deposits have a southwest dip of about 10°. Thicknesses of thin layers (the layers *a-1*, *b-1* and *b-2*) were directly measured in excavations, but those of the thicker ones could only be estimated in an indirect way.

In the Volgian rocks from Brzostówka there is an admixture of fine detrital quartz, and flakes of muscovite are abundant. Some chemical analyses suggest that the calcium carbonate content is 60—70 per cent in marls, and 30—40 per cent in shales.

It is difficult to correlate in detail the lithological subdivision here established with that of Lewiński (1923). The layers *b-1* and *b-2* most probably correspond to lower parts of Lewiński's bed *F*, and the layer *a-4* can be regarded as equivalent of his beds C-E. Lewiński's bed *B* may correspond to the layer *a-3* (but possibly also the layers *a-2* and *a-1*), and his bed *A* to the layer *a-2*, or to the shales underlying layer *a-1*.

In the section under discussion ammonites are abundant in the layers *a-1*, *a-2*, *a-3* and *b-1*. In the layer *a-2* the occurrence of ammonites is restricted to its lower part, the highest ammonites having been found in the marly band 2 m above the base of the layer. The layer *b-2* yielded only one ammonite. No specimens of identifiable ammonites have been found in layer *a-4*, and they seem to be totally absent in the shales underlying layer *a-1*.

The ammonite succession in the Brzostówka section is as follows (aff.-forms omitted):

Layer *a-1*: *Ilowaiskya tenuicostata* (Michailov)
Ilowaiskya sp.
Pseudovirgatites passendorferi sp. n.
Pseudovirgatites puschi puschi sp. n. subsp. n.
Pseudovirgatites puschi zaraiskoides subsp. n.
Pseudovirgatites puschi simplicior subsp. n.
Isterites subpalmatus (Schneid)
Isterites spurius (Schneid)
Lemencia(?) lewinskii sp. n.

Layer *a-2*: *Pseudovirgatites passendorferi* sp. n.
Pseudovirgatites puschi puschi sp. n. subsp. n.
Pseudovirgatites puschi zaraiskoides subsp. n.
Pseudovirgatites puschi simplicior subsp. n.
Isterites subpalmatus (Schneid)
Isterites spurius (Schneid)
Lemencia(?) lewinskii sp. n.

Layer *a-3: Isterites mazoviensis* sp. n.
Zaraiskites quenstedti (Rouillier)
Zaraiskites scythicus (Vischniakoff)

Layer *b-1: Zaraiskites scythicus* (Vischniakoff)
Zaraiskites stschukinensis (Michalski)
Zaraiskites tschernyschovi (Michalski)

The non-ammonite fauna from Brzostówka has been described and illustrated by Lewiński (1923).

The section at the Brzostówka clay-pit represents the oldest Volgian deposits exposed in the area of Tomaszów Mazowiecki, but data from near-by boreholes indicate that they are underlain by 50 or 60 meters of marls and shales of Early Volgian age. The latter pass down without change in facies into the *autissiodorensis* Zone of the Upper Kimmeridgian.

The Volgian sediments overlying those from Brzostówka clay-pit are developed as alternating marly shales, marls and marly limestones; their thickness may be estimated as between 20 and 30 m (Kutek 1926b). All these rocks, which were not separated by Lewiński (1923) as a distinct lithostratigraphic unit, belong to the *zarajskensis* Subzone, with the possible exception of their lowermost part.

In the area of Tomaszów Mazowiecki, the highest Volgian sediments are developed as limestones, c. 30 m thick. They were subdivided by Lewiński into the lithological horizons *II*, *III* and *IV*. Limestones abundant in ammonites were assigned to the horizin *II*, and platy limestones with corbulids to horizon *III*. The horizon *IV* consists partly of limestones crowded with serpulids. It has been recognized recently (Kutek 1967) that all the three horizons belong to the *zarajskensis* Subzone (the upper subzone of the *scythicus* Zone, which is the lowest one of the Middle Volgian Substage). In the area under discussion there exists a conspicuous stratigraphic gap at the junction of Jurassic and Cretaceous, so that Berriasian sediments of the *rjasanensis* Zone cover the Middle Volgian limestones of the horizon *IV*.

Deposits of Volgian age extend only c. 50 km south of Brzostówka, and they do not occur in southern Poland, within the meta-Carpathian zone (*cf.* Kutek & Głazek 1972). From the latter area the Volgian were removed by erosion in the latest Tithonian and Early Cretaceous time. As indicated by several data concerning ammonites, facies development and geotectonics (Kutek 1962b and *in press*, Kutek & Głazek 1972), a broad marine connection existed between the Carpathian Tethys and the sea developed over Central and Northern Poland during Early Volgian and early Middle Volgian time.

CHRONOSTRATIGRAPHY AND CORRELATION WITH TITHONIAN SECTIONS

The occurrence of a mixed, Tithonian-Volgian ammonite fauna makes it possible to interpret the section at Brzostówka in terms of both the Tithonian and the Volgian stratigraphic subdivisions.

As the genus *Zaraiskites*, with the species *Z. scythicus*, appears at Brzostówka in the layer *a-3*, the base of the latter can be regarded as the lower boundary of the *scythicus* Zone. This is also the boundary between the Lower and the Middle Volgian Substages. Consequently, the deposits below layer *a-3* should be ascribed to the *pseudoscythica* Zone, which is the highest one of the Lower Volgian. This is confirmed by the occurrence of *Ilowaiskya tenuicostata* (a species reported from the *pseudoscythica* Zone of Russia), in the layer *a-1* at Brzostówka. It is quite possible that the lower boundary of the *scythicus* Zone is not exactly at the base of the layer *a-3*, but lays somewhere in the upper part of layer *a-2*, which is devoid of ammonites.

The part of the section from Brzostówka, which ranges from layer *a-3* to layer *b-2*, clearly belongs to the *scythicus* Zone. As *Zaraiskites zarajskensis* (Michalski), the species indicative of the *zarajskensis* Subzone, does not yet appear in these strata, they should be assigned to the lower subzone of the *scythicus* Zone. The writers propose to name the latter subzone in Poland the *scythicus* Subzone [with the same index species as for the *scythicus* Zone — *Zaraiskites scythicus* (Vischniakoff)]. The lower boundary of the *scythicus* Subzone is the same as that of the *scythicus* Zone, and its upper boundary is identical with the lower one of the *zarajskensis* Subzone. Thus the lower boundary of the *scythicus* Subzone is marked by the appearance of the genus *Zaraiskites* (represented at the base of the subzone by the species *Z. scythicus* and *Z. quenstedti*), and its upper boundary by the appearance of the species *Z. zarajskensis*. The *scythicus* Subzone as here defined is equivalent to the *pavlovi* Subzone established in Russia.

The *scythicus* Zone in Poland is equivalent to the *panderi* Zone of the Russian Volgian. For a long time, the species *Z. scythicus* and *Dorsoplanites panderi* (Vischn.), or the former species only, were regarded by Russian authors as index species of the latter zone. Later on, that zone was subdivided into the lower *Pavlovia pavlovi* Subzone and the upper *Zaraiskites zarajskensis* Subzone (Mikhailov 1962), and renamed the *Dorsoplanites panderi* Zone (Gierassimov & Mikhailov 1966). As Dorsoplanitinae are practically absent from Poland, it seems best to retain in this country the traditional name of the *scythicus* Zone, and to base the name of its lower subzone on a species occurring in abundance in the Polish Volgian.

The presence of *Pseudovirgatites* in Central Poland makes it possible to establish, as a new zone — the *puschi* Zone, with *Pseudovirgatites*

puschi sp. n. as index species. It is proposed here to distinguish this zone as the life-zone of the genus *Pseudovirgatites* in Central Poland; in accordance with the terminology proposed by Henningsmoen (1961) it may be called a topontozone. The upper boundary of the *puschi* Zone can be recognized in the Brzostówka section, where it is identical with the lower boundary of the *scythicus* Zone. At that boundary, the genus *Pseudovirgatites* is replaced by its evolutionary derivative, the genus *Zaraiskites* (*comp.* the section in this paper, concerning phylogenetic problems). The lower boundary of the *puschi* Zone is not exposed at Brzostówka; some borehole data from Central Poland suggest that it lays somewhere within the *pseudoscythica* Zone.

Most of the Lower Volgian ammonites collected so far in Central and Northern Poland, have been found in boreholes as fragmentary and crushed specimens, so that it is difficult to determine a large part of this material unequivocally even on generic level. Moreover, it was believed over a certain period of time that Tithonian ammonites are absent from Central and Northern Poland, so that the ammonites found in Volgian deposits of Poland were compared almost exclusively with Russian species. In consequence, ammonites with densely ribbed inner whorls were commonly referred to *Z. quenstedti;* a part of them, however, undoubtedly belong to *Pseudovirgatites.* Several ammonites with polygyrate or virgatotome ribbing on middle whorls were compared with *Zaraiskites,* especially with the species *Z. scythicus.* Some of those specimens may belong to *Pseudovirgatites, Isterites* and *?Danubisphinctes,* other interpretations also being possible. Also a part of the Polish ammonites hitherto referred to the Russian species of *Ilowaiskya* (mostly under the generic names *Subplanites* and *Pectinatites*) may be subject to other interpretations. Therefore a part of the paleontological and stratigraphical interpretations in the papers by Kutek (1962a, b), Kutek & Witkowski (1963), and Dembowska (1965, 1973) need revision. In particular, some upper parts of the Lower Volgian have often been included wrongly in the *scythicus* Zone. For instance, in the boreholes situated at Zarzęcin, *c.* 15 km southwest of Tomaszów Mazowiecki, the lowest unmistakable specimens of *Zaraiskites* seem to be those found about 40 m above the previously suggested lower boundary of the *scythicus* Zone (cf. Kutek & Witkowski 1963).

A few specimens found in the Zarzęcin boreholes below the beds with *Zaraiskites,* seem to belong to *Pseudovirgatites;* and some ammonites, illustrated by Dembowska (1973) from several boreholes in Central Poland, under the generic name *Zaraiskites,* belong, or possibly belong, to *Pseudovirgatites* and *Isterites.* This suggests that the *puschi* Zone is virtually recognizable over a large area in Central (and possibly also in Northern) Poland. At present, the thickness of the *puschi* Zone cannot be precisely stated; a thickness of more than 10 m cannot be ruled out. As suggested above, the lower boundary of the *puschi* Zone seems to lay at a remarkably higher level than that of the *pseudoscythica* Zone. It should be noted, however, that the latter boundary has not been recognized so far in any section of the Polish Volgian.

At present it is difficult to evaluate the *puschi* Zone as a possible component of the Volgian or Tithonian stratigraphic subdivisions. In Central Poland on the one hand, it probably could be incorporated into the Volgian subdivision as an upper subzone of the *pseudoscythica* Zone. On the other hand, it might be retained as a component of an independent set of Tithonian zones, provided that further biostratigraphical work ma-

kes it possible to recognize such zones within the Lower Volgian sediments in Poland. The stratigraphic position of the *puschi* Zone is about the same as that of the *scruposus* Zone of the Submediterranean province, but it is difficult to say anything more about the relationship between these two zones. The stratigraphic range of the "*Pseudovirgatites scruposus* Zone" has never been precisely defined, so that at present that name seems to denote some variable ammonite assemblages of earliest Upper Tithonian age, rather than a biostratigraphic zone with clearly defined boundaries (*cf.* Enay *in* Mouterde & *al.* 1971).

The section of Brzostówka supplies the following new stratigraphic and paleontological data, important from the viewpoint of correlations between the Tithonian and Volgian Stages.

1. The genus *Zaraiskites* is stratigraphically preceded by, and phylogenetically related to, the genus *Pseudovirgatites*.

2. *Isterites* is an earlier genus than *Zaraiskites*, and its stratigraphic range but slightly overlaps that of *Zaraiskites*.

3. Ammonites belonging to the genus *Pseudovirgatites* occur in some strata together with those of the *Isterites palmatus* group.

The possibility cannot be ruled out, however, that the stratigraphic range of *Pseudovirgatites* and that of *Isterites* are not exactly the same in the Submediterranean province and in Central Poland.

The Tithonian components of the ammonite assemblages from Brzostówka show affinities to the ammonite fauna of the Neuburg Formation in Franconia (Schneid 1915; Barthel 1962, 1964, 1965, 1969; Zeiss 1968; Barthel & Geyssant 1973), as well as to those of the Klentnice Beds and their equivalents in the Carpathians (Vetters 1905, Bachmaier 1958, Houša & *dl.* 1963, Książkiewicz 1963). It is best to compare the section at Brzostówka with that of the Neuburg Formation, in which ammonites has been collected from successive layers. The Neuburg Formation (Neuburger Folge, Neuburger Schichten) has been recently subdivided by Barthel (1969) into the lower Unterhausen Member (Unterhausener Schichten) and the upper Oberhausen Member (Oberhausener Schichten). The ammonite fauna of the Unterhausen Member was described by Schneid (1915), and some groups of ammonites from that member were described by Barthel (1962) and by Barthel & Geyssant (1973). The paleontological investigations of Barthel, concerning the perisphinctids of the Unterhausen Member, are not yet finished, nor have been described the ammonites of the genus *Isterites*, reported by him from the lower part of the Oberhausen Member.

In the Unterhausen Member, *Lemencia, Sublithacoceras, Parapallasiceras, Danubisphinctes* besides *Glochiceras, Haploceras, Virgatosimoceras* and other genera are represented. *Pseudolissoceras*, the much valuable fossil of the Middle Tithonian, ranges up to the bed 116 (89), which is the highest one of the Unterhausen Member. *Isterites* occurs only in

the upper part of the Unterhausen Member, and from all the ammonites of this member this genus alone passes on into the lower part of the Oberhausen Member. No other ammonites have been reported from the latter. The Unterhausen Member is commonly ascribed to the Middle Tithonian, and as *Pseudolissoceras* does not pass beyond the highest bed of that member, the boundary between the Unterhausen Member and the Oberhausen Member could be regarded as that between the Middle and Lower Tithonian. The lower part of the Oberhausen Member, however, has also been included by Barthel (1969) into the Middle Tithonian, mainly because of the presence of the genus *Isterites*.

Out of all the ammonites of the Neuburg Formation *Isterites* alone is represented in the layers *a-1* and *a-2* at Brzostówka (which correspond to the upper part of the *puschi* Zone). Therefore it is best to correlate them which the lower part of the Oberhausen Member. This opinion is supported by the fact that *Isterites* becomes extinct at Brzostówka in the lowest part of the *scythicus* Subzone, a few meters above the top of the layer *a-2*. The lowest part of the *scythicus* Subzone in Poland, which contains ammonites of the genus *Isterites*, may correspond to some higher beds of that part of the Oberhausen Member in which *Isterites* occurs. The upper part of the *scythicus* Subzone may be correlated with still higher parts of the Oberhausen Member. It is an open question whether any part of the *zarajskensis* Subzone is an equivalent to the highest part of the Oberhausen Member.

However, not much is known about the ammonite fauna occurring in the lower part of the *puschi* Zone in Poland. Therefore the possibility cannot be ruled out that that part of the *puschi* Zone corresponds to some upper parts of the Unterhausen Member.

The definition of the boundary between the Middle and Upper Tithonian is to some extent a matter of convention. At present, it seems best to draw this boundary where the wide-spread genus *Pseudolissoceras* becomes extinct. The appearance of the genus *Pseudovirgatites* itself could be regarded as indicative of the discussed boundary. The latter genus, however, seems not be appropriate in this respect because of its limited geographic distribution. *Isterites* does not seem to be a useful fossil for delimiting the Middle Tithonian, because its extinction in Franconia and Poland cannot be correlated with any other changes in the Tithonian ammonite faunas.

At present, the available data strongly suggest that *Pseudovirgatites* occurs above the upper boundary of the Middle Tithonian, as defined by the exctinction of *Pseudolissoceras*. A possibility that the stratigraphic range of *Pseudovirgatites* slightly overlaps that of Pseudolissoceras cannot be ruled out, but in default of any decisive evidence in favour of this supposition the layers *a-1* and *a-2* from Brzostówka, and the whole *puschi* Zone in Central Poland, will be regarded as Late Tithonian.

The data now available clearly demonstrate that the whole Middle Volgian *scythicus* Zone is of Late Tithonian age.

At present it is difficult to say whether the upper Klentnice Beds with *Pseudovirgatites* are synchronous with, or a little younger than, the beds with *Pseudovirgatites* in Central Poland. No true *Pseudovirgatites* has been noted in the collections from Štramberk, which may indicate that the Štramberk Limestone is still younger. However, the uppermost Klentnice Beds may overlap with lower Ernstbrunn Limestone, and the latter in turn with the Štramberk Limestone. Further research is needed to elucidate these questions more accurately; especially elaboration of the new ammonite collections from Ernstbrunn and Štramberk is necessary. It may be announced here that the Štramberk ammonites will be studied by Houša & Zeiss in collaboration.

Table 1

Correlation of the Volgian and Tithonian stratigraphic subdivisions, as compared with the sections of Tomaszów Mazowiecki and Southern Franconia

Subboreal substages, zones and subzones			Zones in Central Poland		Tomaszów Mazowiecki	Southern Franconia		Submediterranean substages and zones	
Upper Volgian	Craspedites nodiger Craspedites subditus Kachpurites fulgens							Berriasella jacobi	Upper Tithonian
Middle Volgian	Epivirgatites nikitini Virgatites virgatus							Paraulacosphinctes transitorius	
Middle Volgian	D. panderi	Zaraiskites zarajskensis	s. scythicus	Zaraiskites zarajskensis	Limestones with serpulids and corbulids Limestones and marls	Neuburg Formation	Oberhausen Member, upper part		
		Pavlovia pavlovi		Zaraiskites scythicus	b-1, b-2 a-3, a-4		Oberhausen Member, lower part	Pseudovirgatites, late representatives of Isterites	
Lower Volgian				P. pusohi	a-1, a-2				
Lower Volgian	Ilowaiskya pseudoscythica			Ilowaiskya pseudoscythica	Marls and shales		Unterhausen Member	Pseudolissoceras with Isterites /above/ and Lemencia /below/	Middle Tith.
Lower Volgian	Ilowaiskya sokolovi			?		Reinertshofen and Ussetal Beds		Danubisphinctes palatinum Franconites vimineus Necochstoceras mucronatum	Lower Tithonian
Lower Volgian	Ilowaiskya klimovi			Ilowaiskya klimovi		Altmuhltal Beds		Hybonoticeras hybonotum	

The correlation between the Tithonian/Volgian sections of southern Franconia and Tomaszów Mazowiecki, as well as that between the Tithonian zones of the Submediterranean province and the Volgian zones of Poland and Russia, are shown in Table 1. They are bound to a large extent on data from the following papers: Barthel 1962, 1964, 1969; Barthel & Geyssant 1973; Casey 1973; Dembowska 1973; Donze & Enay 1961; Enay 1972; Enay *in* Mouterde & *al.* 1971; Enay & Geyssant 1973; Gerassimov & Mikhailov 1966; Imlay & Jones 1970; Jeletzky 1965, 1966, 1973; Kutek 1967, and *in press;* Le Hagarat 1973; Mikhailov 1964; Saks 1972; Verma & Vestermann 1973; Zeiss 1968.

BIOGEOGRAPHICAL REMARKS

As suggested by Zeiss (1968) and Kutek (*in press*), the ammonites of the Volgian of Poland may be regarded as a mixed fauna composed of Volgian and Tithonian forms. The ammonite fauna from Brzostówka provides additional evidence in favour of this opinion. It contains the Tithonian genera *Isterites* and *Pseudovirgatites* hitherto not reported from Central Poland, and it allows to suggest phylogenetic connection between the "Tithonian" genus *Pseudovirgatites* and the "Volgian" genus *Zaraiskites*.

The ammonites of the genus *Zaraiskites* have been found in some parts of the "Tithonian" ammonite province. They have been reported from the Polish Carpathians (Książkiewicz 1963), from the Klentnitzer Schichten in Austria (Bachmaier 1958), and from Bulgaria (Nowak 1971). It is possible that *Zaraiskites* has so far been reported only from few Tithonian localites, because sections with ammonites of earliest Late Tithonian age are rare, or not yet thoroughly investigated. On the other hand, *Zaraiskites* is absent from the true boreal regions (Northern Siberia, England, Canada, the Arctic Islands); the most northern occurrences of this genus in the Russian platform seem to be those in the Petchora syneclise (Krymgolts 1972). Therefore it seems best to regard the genus *Zaraiskites* as characteristic of the "Subboreal-Submediterranean" areas of East-central Europe.

The Tithonian group of *Subplanites rueppellianus* (Qu.) and *S. reisi* (Schneid) most probably gave rise to the genus *Ilowaiskya* by way of *I. klimovi* (Ilov. & Flor.) (*comp.* Zeiss 1968). It may be also noted that representatives of *Subplanites* similar to the South-German ones occur in Central Poland in the latest Kimmeridgian (*autissiodorensis* Zone) and in the lowest Volgian (*klimovi* Zone); *I. klimovi* is present in the latter zone. This paleontological material has not yet been published.

Zeiss (1968) distinguished the Polish and Russian subprovinces as parts of the Tithonian (Early and Middle Volgian) Subboreal province. The latter subprovince, which comprises the Russian platform, is characterized by occurrence of the genera *Ilowaiskya, Zaraiskites* and *Virgatites*. Dorsoplanitinae also occur in profusion, but they are represented in that area by other species than in the Arctic regions (*comp.* Mikhailov 1966). The Polish subprovince comprises the area of Central and Northern Poland. It was distinguished because of the virtual absence of Dorsoplanitinae, and the occurrence of *Ilowaiskya* and *Zaraiskites* together with some Submediterranean ammonites. The latter, however, seem to be represented in Central Poland by a larger number of genera, than previously suggested; and it should also be taken into account that *Ilowaiskya* and *Zaraiskites* are phyllogenetically connected with some Submediterranean genera. Accordingly, the Polish subprovince, which corresponds to a passage area of the Subboreal and the Submediterranean

provinces, can be regarded with equally good reason as a part of either of these provinces.

THE AMMONITE FAUNA

Introduction

The state of preservation of the ammonites from the Brzostówka clay-pit leaves much to be desired. Most of the specimens are fragmentary; only in the case of a few specimens there is some indication of the adapertural part of body chamber being preserved. The specimens are internal or external casts, some of them with parts of test preserved. All the specimens are crushed (especially those found in shales, those from marls less so). Only in a few specimens of *Ilowaiskya tenuicostata* there are traces of badly preserved suture; in all other specimens the suture has been completely obliterated. The disposible paleontological material does not allow, in most cases, to distinguish microconchs from macroconchs, so that only few suggestions concerning dimorphism will be given.

The paleontological descriptions are based on 156 specimens, which are retained as the collection KB. 1. at the Institute of Geology, University of Warsaw. All the specimens belong to the family Perisphinctidae. Some strata of the Brzostówka section are abundant in ammonite debris, but even this material does not suggest any other contemporary families of ammonites to be represented within this section.

The following abbrevations are used in the paleontological descriptions: D — diameter of whorl; H — height of whorl; U — diameter of umbilicus; PR, 1/2 PR, 1/4 PR — number of primary ribs per one whorl, half a whorl or a quarter of a whorl, respectively; SR, 1/2 SR, 1/4 SR — number of secondary ribs per one whorl, half a whorl, or a quarter of a whorl. All the numerical data refer to measurements done on crushed material. Restored dimensions of some uncomplete specimens are indicated as (r).

Family Perisphinctidae

Two subfamilies of Perisphinctidae are represented in the writers' collection, namely the Pseudovirgatitinae and the Virgatitinae. They are described in stratigraphical order, so that the descriptions of the earlier Pseudovirgatitinae are followed by those of the Virgatitinae. The paleontological material under description suggests that these two subfamilies are closely related phylogenetically.

Taxonomic subdivision of the family Perisphinctidae has been discussed recently by Zeiss (1968, pp. 47—50). The taxonomic subdivisions then proposed could be modified to some extent on the basis of the following new data.

1. It was recognized by Cope (1968) that the Pectinatini were derived from *Propectinatites*, a form with relatively simple ribbing, which has some counterparts in the earliest Tithonian of southern Germany. Exact position of these forms within the Lithacoceratinae is not yet clarified; they seem to represent a relatively independent group of ammonites.

2. The paleontological material here described suggests that the genera *Ilowaiskya* and *Pseudovirgatites* are closely related.

3. As reported by Enay & Geyssant (1973), *Franconites, Usseliceras* and *Sublithacoceras* occur together in some ammonite faunas from southern Spain. This makes it probable that these genera are more closely related phylogenetically than it was previously suggested.

On account of the data, it would be possible to distinguish, instead of five tribes of Pseudovirgatitinae, three subfamilies, each corresponding to a group of ammonites derived from the Lithacoceratinae, namely the Pectinatitinae, Pseudovirgatitinae and Sublithacoceratinae. As the Lithacoceratinae contain the *Katroliceras — Pachysphinctes* group, which is regarded as ancestor of the Virgatosphinctinae, the latter subfamily would be the fourth group derived from the subfamily Lithacoceratinae. At present, however, as the investigations on several groups of Late Kimmeridgian and Early Tithonian ammonites of the Submediterranean province are not finished, and the relationship between the Submediterranean derivatives of the *Lithacoceras — Subplanites* group (Franconitini, Sublithacoceratini) and the true Virgatosphinctinae of the Pacific-Andean realm clearly understood, it seems more justified to retain the large subfamily Pseudovirgatitinae as a complex group, comprising various derivatives of the *Lithacoceras — Subplanites* group. This is more so as this group corresponds to a rather distinct grade in the development of the Tithonian perisphinctids.

Subfamily Pseudovirgatitinae

The taxonomic range of the subfamily Pseudovirgatitinae has been discussed by Zeiss (1968, pp. 49—50, Fig. 17), and the taxonomic subdivision of this subfamily introduced by him will be retained here with one modification. Namely, the closely related representatives of the tribes Pseudovirgatitini and Ilowaiskyini will be classified together under the name Pseudovirgatitini. The genus *Ilowaiskya*, which was probably derived from Lithacoceratinae in the latest Kimmeridgian or earliest Tithonian, leads to *Pseudovirgatites*. This genus in turn gave rise to the subfamily Virgatitinae on the one hand, and to the genus *Paraulacosphinctes* on the other.

The paleontological material under description comprises the following groups of the subfamily Pseudovirgatitinae:

1. Tribe Pseudovirgatitini, with genera *Ilowaiskya* and *Pseudovirgatites*.

2. Tribe Sublithacoceratini, with genera *Isterites* and *Lemencia(?)*.

Tribe Pseudovirgatitini Zeiss, 1968
(Synonim: Ilowaiskyini Zeiss, 1968)
Genus *ILOWAISKYA* Vialov, 1940

For remarks concerning spelling of the name, the type species of *Ilowaiskya*, and its relation to *Subplanites* see Zeiss (1968, pp. 115—116). It should be mentioned that *Ilowaiskya* distinctly differs from *Subplanites* by its more densely ribbed inner whorls, more numerous bidichotomous ribs, and a different development of ribbing on large whorls. Moreover, it seems that there are no microconchs with lappets in *Ilowaiskya*. *Subplanites* is a genus comprising microconchs bearing lappets; the corresponding macroconchs are to be found in the genus *Lithacoceras*.

As the forms placed in *Ilowaiskya* in 1941 by Ilovaisky and Florensky (and also most of those referred by Mikhailov, 1964, to *Subplanites* and *Pectinatites*), seem to be close to each other, it is best to retain them in the genus *Ilowaiskya*.

In the present writers collection the genus *Ilowaiskya* is represented by specimens belonging to the species *Ilowaiskya tenuicostata* (Michajlov), and a few related forms. Their relation to other species of *Ilowaiskya*, and to the genus *Pectinatites*, is discussed in the section devoted to that species.

Ilowaiskya tenuicostata (Michailov, 1964)
(Text-fig. 2; Pls 1—6)

1964. *Pectinatites (Pectinatites) tenuicostatus* Michailov; Michajlov, p. 67, Pl. 3, Figs 3, 5; Pl. 6, Fig. 2; Pl. 10, Figs 1, 3; Pl. 18, Fig. 1; Text-fig. 26.
1967. *Pectinatites tanschini;* Kutek, p. 41.
1973. *Pectinatites tenuicostatus* Mikhailov; Dembowska, pp. 63, 83, 101, Pl. 3, Figs 5—6.

Material. — Thirteen specimens (10 large specimens, 3 fragments of whorls), all from layer *a-1* at Brzostówka.

Dimensions:

Specimen	D in mm	H	U	r	1/2 r
KB.1.1, Pl. 3	191 160 150 118 90	0.29	0.49	63 53 51 59	35 28 25 25 34
KB.1.2, Pl. 1	143 127 107 96 88 80	0.28	0.45	58 56 51 67	30 30 28 26 33 41
KB.1.6, Pl. 2	162 150 128 115 105 90 68	0.29	0.45	73 72 71 76 81	39 35 34 37 37 43 44
KB.1.7, Pl. 4	195 190 165 145 120 112	0.32	0.45	50 45 41 40	28 23 23 22 20 18
KB.1.9	146 125 98	0.31	0.47	58 51	30 27 24

Description. — Whorls compressed, slightly convergent. Umbilical wall steep. Whorls involute at small diameters, becoming markedly evolute at greater diameters.

Inner whorls show dense biplicate ribbing. There occur constrictions bordered by simple and polygyrate ribs. Some biplicate ribs join at the umbilical edge, forming bidichotomous ribs At diameters ranging from 55 to 80 mm the ribbing becomes more distant, but it remains biplicate on middle whorls; there occur constrictions bordered by simple ribs and sporadical triplicate ribs. On the outer whorls the biplicate ribs become less densely spaced, and there appears a variable proportion of simple ribs. This change of ribbing takes place at diameters ranging from 145 to 185 mm.

On the middle and outer whorls, the ribs are more or less flexuous (those in more densely ribbed specimens less so — Pl. 2), and show a marked forward sweep on the venter. In the biplicate ribs the posterior secondary rib branches off backwards. Only in some specimens (Pl. 2) there are some intercalatary ribs, replacing the posterior secondaries of the biplicate ribs.

The specimens under description show strong variation with respect to density of ribbing and diameters of whorls, at which changes of ribbing take place (Pls 1—5,

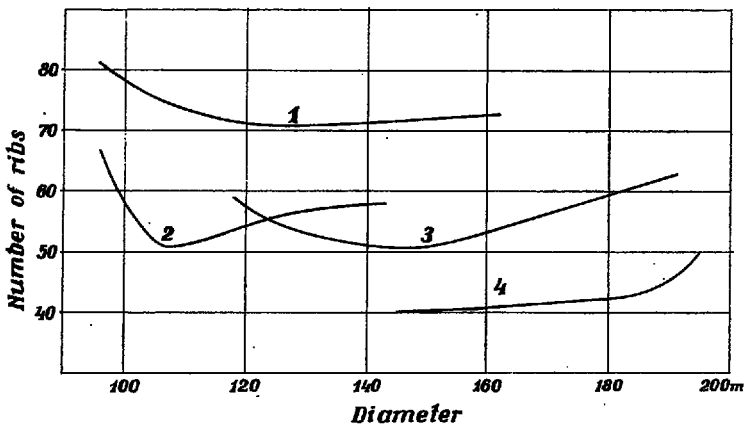

Fig. 2

Rib-curves of *Ilowaiskya tenuicostata* (Michailov)

1 — KB. I. 6, Pl. 2; 2 — KB. I. 2, Pl. 1; 3 — KB. I. 1, Pl. 3; 4 — KB. I. 7, Pl. 4

Text-fig. 2). In specimens with more distant ribbing on middle whorls the ribbing of these whorls is more contrasted with those of the inner and outer whorls.

In some specimens there are traces of badly preserved sutures, and in one specimen (Pl. 4) approximation of sutures can be recognized at whorl-diameter of about 180 mm, which indicates that the specimen is adult. As in that specimen the less distant ribbing sets in at a but slightly greater diameter of whorl, this type of ribbing can be regarded as characteristic of adult body-chambers of *I. tenuicostata*. This opinion is supported by the fact that in the specimens from Brzostówka no traces of sutures have been found on outer whorls showing such a ribbing. It can be estimated that some specimens of *I. tenuicostata* from Brzostówka have reached end diameters of about 230 mm, but smaller maximum size can be postulated for specimens in which the characteristic ribbing of outer whorls sets in at comparatively small diameters.

A specimen from layer *a-1* (Pl. 6) differs from those ascribed to *I. tenuicostata* only in having on the middle whorl some triplicate ribs, not connected with constrictions. It is referred to as *Ilowaiskya* aff. *tenuicostata*, but it is most probably conspecific with the specimens placed in *I. tenuicostata*. The discussed specimen shows traces of sutures up to a whorl-diameter of about 145 mm.

Remarks. — On the midle whorls of the Russian holotype of *I. tenuicostata* (Michailov 1964, Pl. 18, Fig. 1) the ribbing is similar to that seen in the specimen from Brzostówka shown in Plate 3. However, the fine ribbing characteristic of inner whorls seems to persist in the holotype to a smaller diameter than in the specimen of *I. tenuicostata* from Brzostówka. In another Russian specimens belonging to the same species (Michajlov 1964, Pl. 10, Fig. 3) this ribbing persists to a much greater diameter, but the ribbing of the middle whorl is replaced by more dense ribbing characteristic of outer whorls at a diameter of less than 115 mm, that is at a smaller diameter than in any conspecific specimen found at Brzostówka. As the forms from Brzostówka also show strong variation, it seems not to be justified to separate the highly variable Polish and Russian forms formally even on subspecific level.

Both the Polish and Russian specimens of *I. tenuicostata* markedly differ from the English ammonites of the genus *Pectinatites* in having more regular, flexuous ribbing on middle and outer whorls; on inner whorls, the ribbing is more dense in *I. tenuicostata* than in most representatives of *Pectinatites* (*comp.* Cope 1967). Moreover, specimens with ventral horns characteristic of the microconchs of *Pectinatites* have been found neither in Russia nor in Poland. On the other hand, the mere absence of triplicate ribs in the forms referred to *I.tenuicostata* cannot be regarded as a character justifying exclusion of this species from the genus *Ilowaiskya*, the general style of ribbing being in *I. tenuicostata* the same as in other species referable to *Ilowaiskya*. It is worth remembering that Ilovaisky & Florensky (1941, pp. 88—89) refferred some specimens devoid of triplicate ribs to the species *Ilowaiskya pseudoscythica* Ilov. & Flor., and called attention to a specimen of their collection, having some triplicate ribs on one whorl-side, but only biplicate ribs on the other.

The ribbing developed on inner and middle whorls of the specimens of *I. tenuicostata* from Brzostówka, is similar to that seen in the lectotype of *I. pseudoscythica* (Ilovaisky & Florensky 1941, Pl. 16, Fig. 31; designated by Michailov, 1964, p. 54). In the last mentioned specimen, however, the ribbing does not tend to become less distant on the outer whorl and the triplicate ribs occurring in the specimen of Ilovaisky & Florensky have their counterparts only in the specimen from Brzostówka referred to as *Ilowaiskya* aff. *tenuicostata*.

Ilowaiskya sp.
(Pl. 7, Figs 1—2)

A fragment of a huge whorl, c. 120 mm high (Pl. 7, Fig. 1), has been found in the layer *a-1* at Brzostówka. The diameter of this whorl can be estimated to have been about 400 mm. The whorl-fragment shows relatively dense ribbing; there occur biplicate and polygyrate ribs, associated with intercalatory ones.

A similar but more distant ribbing is to be seen on the outermost whorl preserved in another specimen from the layer *a-1* (Pl. 7, Fig. 2). That whorl, the original diameter of which should have been about 260 mm, is much distorted so that the venter is not visible on the protograph. In the specimen here described the two preceding whorls show strong and distant biplicate ribbing, similar to that found in middle whorls of *Ilowaiskya tenuicostata* (Michajlov).

All the other specimens of *Ilowaiskya* which have been collected at Brzostówka from layer *a-1*, are referable to *I. tenuicostata*. They are characterized by relatively dense, biplicate ribbing on outer whorl, and their end-size probably did not exceed 230 mm. This suggests that the specimens from Brzostówka referred to as *Ilowaiskya tenuicostata* (and *I.* aff. *tenuicostata*) are microconchs, and the larger specimens figured as *Ilowaiskya* sp. in Plate 7 — the corresponding macroconchs. This would imply that in some species of the genus *Ilowaiskya*, at least, the microconchs attain considerable end-size of more than 200 mm.

Genus *PSEUDOVIRGATITES* Vetters, 1905

This genus, which is to be defined only on the basis of illustrations of the type species *Pseudovirgatites scruposus* (Oppel), is represented at Brzostówka by forms showing the same succession of ribbing. The inner whorls are densely ribbed. Biplicate ribs branching low on the flanks predominate; there occur also some polygyrate and bidichotomous ribs. On the middle whorls the ribbing is stronger and more distant; it is distinctly polygyrate or fasciculate in most forms, but in some of them there is a tendency towards virgatotome ribbing. The outer whorls bear biplicate or polygyrate ribs.

The ribbing in the forms described above is highly variable, but the specimens of *P. scruposus* figured by Zittel (1870) and Vetters (1905) show also strong variation in this respect. The main differences between the representatives of *Pseudovirgatites* from Brzostówka and the type species are as follows: in the former, the changes in ribbing take place at remarkably smaller diameters; in some forms a different type of ribbing tends to develop on middle whorls; and in the outer whorls the primary ribs branch into less numerous secondary ribs.

Two new species of *Pseudovirgatites* have been established on the basis of the paleontological material from Brzostówka. In *P. passendorferi* sp. n. the inner and outer whorls show biplicate ribbing similar to that found in *I. tenuicostata*. The new species differs from the latter one by occurrence of polygyrate ribbing which is developed in the middle whorl over a relatively short distance. In *P. puschi* sp. n. polygyrate, fasciculate or virgatotome-like ribbing is developed in middle whorls over a considerable distance, and there occur polygyrate ribs on outer whorls.

Pseudovirgatites passendorferi sp. n.
(Pls 8—9; Pl. 10, Fig. 1)

Holotype: specimen KB. 1. 15 (Pl. 8).
Type horizon: layers *a-1* and *a-2* at Brzostówka; lowermost Upper Tithonian (*puschi* Zone), uppermost Lower Volgian (upper *pseudoscythica* Zone).
Type locality: Brzostówka.
Derivation of the name: in honour of Prof. Edward Passendorfer, the author of a paper on the Virgatitinae beds of the Tomaszów Mazowiecki syncline.

Material. — Five specimens; and seven presumably belonging to the species.
Dimensions:

Specimen	D	H	U	1/2 UR	1/2 SR
KB. 1. 15	150 mm (est.)	47 mm	67 mm		
KB. 1. 16	150	52	70	25	44

Diagnosis. — A species of the genus *Pseudovirgatites* of medium size. Inner whorls with dense, biplicate to polygyrate ribbing. Middle whorl with more distant polygyrate ribbing, reverting to biplicate ribbing on the outer whorl.

Description. — Inner whorls bear dense ribbing up to a diameter of about 60 mm. Most ribs branch low on the whorl-side into two secondaries. There are also occasional polygyrate and bidichotomous ribs. The ribbing is much disturbed by constrictions. At a diameter of about 60 mm, after a constriction, more distant ribbing sets in. Most of the ribs are polygyrate. There occur also bidichotomous ribs, composed of two polygyrate ribs, or of one polygyrate and one biplicate rib, which join near or above the umbilical edge. Constrictions followed by simple ribs are present. The polygyrate ribbing is developed on most part of the middle whorl up to a diameter of about 115 mm (*comp.* the paratype — Pl. 9). The outer whorl show biplicate ribbing; there occur biplicate and less numerous simple ribs. Constrictions are bounded by simple and triplicate ribs. On the outer whorl the ribs are straight or but slightly flexuous, and arch forward on the venter. In all growth-stages the ribs are recticostate, prorsiradiate ribs occurring only near constrictions. The larger paratype (Pl. 9) has a (restored) maximum diameter of about 190 mm, and is probably nearly complete.

The primary shape of shell can be restored to some degree. The whorls seem to have been moderately involute at small diameters, and have become increasingly evolute at greater diameters. The umbilical wall is low, steep, and rounds rather abrubtly into the flanks. The original whorl-section can be estimated to have been elliptical or subrectangular, higher than wide.

Sutures not preserved.

Remarks. — The new species seems to have similar end-size as (? the microconchs of) *I. tenuicostata,* and the inner and outer whorls of the former species resemble in development of ribbing those of *I. tenuicostata.* The main difference between these two species lays in the presence of polygyrate ribbing in the middle whorl of *P. passendorferi.* The correspondent whorls of *I. tenuicostata* show biplicate ribbing; in the specimen from Brzostówka referred to as *Ilowaiskya* aff. *tenuicostata* (Michajlov), triplicate ribs occur at a greater diameter of whorl, as in *P. passendorferi.*

P. scruposus (Oppel) is much larger that *P. passendorferi,* so that in the former the successive changes in ribbing take place at markedly larger diameters of whorl. On the outer whorl of *P. scruposus* the ribbing is more distant, the ratio of secondary to primary ribs is higher, and there occur numerous intercalatory ribs.

Pseudovirgatites puschi sp. n.

A large number of highly variable forms is assigned to this new species. All these forms have inner whorls with very dense biplicate ribbing. On the middle whorls the ribbing is fasciculate in some forms, but it tends to remain polygyrate, or to become virgatotome, in other forms. This allows to distinguish the following three groups:

1. Forms with well-developed fasciculate ribbing on middle whorls (*P. puschi puschi* subsp. n.).

2. Forms developing on middle whorls virgatotome ribbing which differs from that found in some species of the genus *Zaraiskites* only by occurrence of numerous intercalatory ribs (*P. puschi zaraiskoides* subsp. n.).

3. Forms in which the polygyrate ribbing of middle whorls does not modify to form fasciculate ribbing (*P. puschi simplicior* subsp. n.).

P. puschi puschi and *P. puschi simplicior* have outer whorls with polygyrate ribbing. It is more coarse in the former subspecies. Outer whorls of *P. puschi zaraiskoides* seem to bear moderately strong, biplicate and polygyrate ribs.

Pseudovirgatites puschi puschi sp. n. subsp. n.
(Pl. 10, Figs 2—3; Pl. 11, Figs 1—4; Pl. 12, Figs 1—3; Pl. 13, Figs 1—2);

Holotype: specimen KB. 1. 28 (Pl. 11, Figs 1, 4).

Type horizon: layers *a-1* and *a-2* at Brzostówka; lowermost Upper Tithonian (*puschi* Zone), uppermost Lower Volgian (*pseudoscythica* Zone).

Type locality: Brzostówka.

Derivation of the name: in honour of eminent German-Polish geologist G. G. (J. B.) Pusch-Koreński (1791—1846).

Material. — Ten specimens; and eight other presumably belonging to the subspecies.

Dimensions:

Specimen	D	H	U	1/2 UR	1/2 SR
KB. 1. 28	c. 140 mm (r)	44 mm			
KB. 1. 35	c. 90 (r)	38	32 mm	21	100

Diagnosis. — Dense biplicate ribbing on inner whorls; on middle whorls ribbing polygyrate and bidichotomous, then fasciculate, reverts to polygyrate ribbing on outer whorl.

Description. — The specimen KB. 1. 28, which shows coarse polygyrate ribbing on outer whorl, and fasciculate ribbing on the preceding whorl, is designated as holotype, but the diagnosis and description of the species must be based on several uncomplete specimens, showing successive growth-stages.

Inner whorls bear fine, dense, biplicate ribs. At a diameter from 50 to 60 mm a more distant, polygyrate and bidichotomous ribbing sets in. It gradually modifies to form fasciculate ribbing, which is typically developed from a diameter of about 100 mm. In the fasciculate ribs the primaries are thickened, the points of furcation tend to be obliterated, and the ratio of secondary ribs to one primary ranges up to six or seven. The fasciculate ribbing gradually becomes more simple. Coarse polygyrate ribbing is visible in the holotype on the outer whorl which is 44 mm high, and it is also found in the somewhat larger whorl-fragment illustrated in Plate 10, Fig. 2. That whorl, which is about 50 mm high, is in the writers collection the largest one attributable with certainty to *P. puschi puschi*. The maximum size of the subspecies remains unknown. Constrictions are present at all growth-stages. Sutures are not preserved.

Remarks. — This subspecies differs from other subspecies of the new species *P. puschi* by fasciculate ribbing on the middle whorls and coarse polygyrate ribbing on the outer whorls. In *P. scruposus* fasciculate ribbing is not typically developed, and particular changes in ribbing take place at markedly greater diameters of whorl. This suggests that *P. puschi puschi* attained smaller end-size than *P. scruposus*.

Pseudovirgatites puschi zaraiskoides subsp. n.
(Pl. 14, Figs 1—5; Pl. 15, Fig. 4; Pl. 16, Fig. 3; Pl. 17, Fig. 1)

Holotype: specimen KB. 1. 46 (Pl. 14, Fig. 2).

Type horizon: layers *a-1* and *a-2* at Brzostówka; lowermost Upper Tithonian (*puschi* Zone), uppermost Lower Volgian (upper *pseudoscythica* Zone).

Type locality: Brzostówka.

Derivation of the name: after the ribbing on middle whorls resembling that in the genus *Zaraiskites*.

Material. — Seven specimens; and three presumably belonging to the subspecies.

Dimensions:

Specimen	D	H	U		
KB. 1. 52	85 mm (r)	30 mm	30 mm	1/4 UR: 16	1/4 SR: 45
KB. 1. 55	130	37	61	1/2 UR: 22	1/2 SR: 73

Diagnosis. — Fine, dense biplicate ribbing on inner whorls; on middle whorls ribbing bidichotomous and polygyrate, then virgatotome with numerous intercalatory ribs; more simple ribbing on outer whorl.

Description. — Inner whorls show fine, dense biplicate ribbing. At a diameter of about 60 mm a more distant, bidichotomous and polygyrate ribbing sets in. This in turn modifies rather abrubtly, at a diameter of about 85 mm, to form yet more distant ribbing which may be regarded with some reservation as virgatotome. Most of the secondaries are intercalatory ribs, but they are arranged in the same characteristic fashion as are the secondaries within more typical virgatotome ribs. Except for the presence of numerous intercalatory ribs, the virgatotome ribbing observed in the subspecies under description is very similar to that in the genus *Zaraiskites.*

A fragment of a large whorl (Pl. 16, Fig. 3) can be regarded as corresponding to *P. puschi zaraiskoides.* Casts of densely arranged secondary ribs belonging to the preceding whorl can be observed in this specimen, and at the beginning of the outermost preserved whorl there occur virgatotome ribs with many intercalatories; the ribbing is slightly obliterated on the middle of the flank. As the whorl grows, the numbers of secondary ribs per one primary decrease, and near the end of the preserved part of the whorl the ribbing becomes more simple; polygyrate and biplicate ribs, and simple ribs bordering constrictions, occur. Maximum size of the subspecies under description remains unknown, but probably the adult individuals exceeded by one whorl only in size the specimen shown in Plate 16, Fig. 3.

Numerous constrictions occur in *P. puschi zaraiskoides* in all growth stages. Sutures are not preserved.

Two specimens (Pl. 14, Fig. 5; Pl. 15, Fig. 4) show unusually strong development of intercalatory ribs. Both this specimens are referred to as *P. puschi* aff. *zaraiskoides,* but they could be regarded as extreme variants of this subspecies as well.

Remarks. — *P. puschi zaraiskoides* differs from *P. puschi puschi* by different ribbing on the late middle whorls; it is more distant, and virgatotome in the former subspecies, while fasciculate in the latter. These two species, however, seem to be connected by passage forms, and some fragmentary specimens (such as those in Pl. 14, Figs 1, 3) could be ascribed with good reason to any of these subspecies.

Pseudovirgatites puschi simplicior subsp. n.
(Pl. 15, Figs 1—2)

Holotype: specimen KB. 1. 57 (Pl. 15, Fig. 1).

Type horizon: layers *a-1* and *a-2* at Brzostówka; lowermost Upper Tithonian (*puschi* Zone), uppermost Lower Volgian (upper *pseudoscythica* Zone).

Type locality: Brzostówka.

Derivation of the name: after ribbing on middle whorls which is more simple than that in the nominal subspecies of *Pseudovirgatites puschi* (Lat. *simplicior* — more simple).

Material. — Four specimens.
Dimensions:

Specimen	D	H
KB. 1. 57	c. 140 mm (r)	c. 45 mm
KB. 1. 56	c. 110 (r)	c. 40

Diagnosis. — Fine, dense ribbing on inner whorls; polygyrate ribbing on middle whorls, becoming more simple on outer whorls.

Description. — Fine ribbing characteristic of inner whorls is to be seen in the paratype (Pl. 15, Fig. 2). On the outer whorl preserved in this specimen the ribbing is less dense. Polygyrate ribs predominate; there are also some biplicate and bidichotomous ribs, and simple ribs bordering constrictions. The same style of ribbing is to be seen at the beginning of a larger whorl which is designated as holotype (Pl. 15, Fig. 1). The ribbing becomes less regular with growth of the whorl. There occur triplicate, biplicate and simple ribs, most of them joining at or near the umbilical edge to form bidichotomous rib-units. Constrictions bordered by simple ribs are present.

Remarks. — The new subspecies differs from *P. puschi puschi* by absence of fasciculate ribbing on late middle whorls. Furthermore, on whorls about 40 mm high the ribbing is more coarse in the latter subspecies.

P. puschi simplicior is possibly a conservative form, most similar to some earlier forms of *Pseudovirgatites* which probably gave rise to all the three subspecies of *P. puschi*. It may be montioned that the development of ribbing in *P. puschi simplicior* is to some extent similar to that in *P. scruposus*. In the latter species, however, changes in ribbing take place at markedly greater diameters, and there is no tendency to bidichotomy in whorls comparable with that of the holotype of *P. puschi simplicior*.

Nuclei of *Pseudovirgatites*
(Pl. 15, Fig. 3; Pl. 16, Figs 1—2; Pl. 20, Fig. 3)

The writers' collection contains 15 nuclei collected from layers *a-1* and *a-2* at Brzostówka. Most of them are very finely ribbed. All such specimens (*eg.* those shown in Pl. 15, Fig. 3; and Pl. 16, Figs 1—2) can safely be ascribed to *P. puschi*, because no other ammonites from the layers *a-1* and *a-2* have inner whorls with equally fine ribbing. Some not so finely ribbed nuclei (*eg.* Pl. 20, Fig. 3) may correspond to *P. passendorferi* or to *Ilowaiskya tenuicostata* (Michajlov).

There is no unequivocal indication of any of those nuclei being nearly complete microconchs of *Pseudovirgatites*.

Tribe Sublithacoceratini Zeiss, 1968
Genus *ISTERITES* Barthel, 1969

The genus *Isterites* was established by Barthel (1969, p. 151) without diagnosis; a corresponding paper announced by him (*l.c.*) has not yet been published. Therefore the present writers restrain from discussing the characteristics and taxonomic range of *Isterites*. In particular, the problem of taxonomic distinction between *Isterites* and *Danubisphinctes* (*comp.* Zeiss 1968, p. 109) will not be considered, nor the question whether *Isterites* should be interpreted as a genus, or a subgenus of *Danubisphinctes*. It may be mentioned, however, that *Danubisphinctes* gradually gave rise to *Isterites*, so that it would be difficult to draw a distinct taxonomic boundary between *Isterites* and *Danubisphinctes* s. s.

The following species are here ascribed to *Isterites: Isterites palmatus* (Schneid) — the type species; *I. scoparius* (Schneid); *I. subpalmatus* (Schneid); *I. franconicus* (Schneid); *I. advena* (Schneid); *I. spurius* (Schneid); *I. mazoviensis* sp. n.; *Isterites austriacus* nom. n. (pro *Perisphinctes* cfr. *Nikitini* in Vetters, 1905, p. 232; holotype — Pl. 22, Fig. 5; for detailed description *see* Vetters, pp. 232—233).

Danubisphinctes ramosus (Schneid) and *D. racemosus* (Schneid) seem to be the representatives of *Danubisphinctes* most closely related to *Isterites*.

The species of *Isterites* cited above, which were established by Schneid, are closely related to each other, and the differences between most of them seem to justify their separation only on subspecific level.

In Franconia *Isterites* occurs in upper Middle Tithonian, and ranges up into the lower Upper Tithonian (as understood in this paper). In Central Poland the occurrence of *Isterites* is restricted to the upper Lower Volgian (*pseudoscythica* Zone) and lowermost Middle Volgian (lower part of the *scythicus* Subzone).

As shown by the material from Brzostówka, *Isterites* is an earlier genus than *Zaraiskites*, and the stratigraphic range of *Isterites* but slightly overlaps that of *Zaraiskites*. The development of *Isterites*, however, gave rise to some forms homeomorphic with *Zaraiskites*. Such forms from Franconia were mentioned by Barthel (1964, p. 514), and a similar Franconian specimen was referred to by Zeiss (1968, p. 39, Pl. 26, Fig. 7) as *Zaraiskites* cf. *zarajskensis* (Michalski). It seems more justified, however, to regard this specimen a representative of *Isterites* developing ribbing of zaraiskoid type. The biostratigraphic data from Brzostówka make it clear that the discussed Franconian form remarkably differs in age from *Z. zarajskensis*, the latter species appearing at a higher stratigraphic level.

Isterites subpalmatus (Schneid)
(Pl. 18, Figs 1, 4; Pl. 20, Figs 2, 4)

1915. *Perisphinctes (Pseudovirgatites) subpalmatus* Schneid; Schneid, p. 381, Pl. 29, Figs 2, 2a.
?1973. *Zaraiskites scythicus* (Vischniakoff); Dembowska, pp. 64, 85, 102 (pars), Pl. 5, Fig. 6.

Material. — Six specimens.

Dimensions:

Specimen	D	H	U	1/2 UR	1/2 SR
KB. 1. 78	76 mm	25 mm	30 mm	11	37
KB. 1. 79	85	30	35	12	c. 40
KB. 1. 80	c. 90	35	40	12	44
Schneid's specimen (Pl. 29, Fig. 2)	110	35	45	13	44

Remarks. — The specimens from Brzostówka seem to correspond closely to the Franconian specimens of this species, as described by Schneid. On inner and middle whorls, the same ribbing can be observed in the Polish specimens and in the single specimen of *I. subpalmatus*, figured by Schneid.

I. subpalmatus differs from *I. palmatus* by being less evolute.

Occurrence. — Franconia: Neuburg Formation, Unterhausen Member, Middle Tithonian. Central Poland: layers *a-1* and *a-2* at Brzostówka, lowermost Upper Tithonian (*puschi* Zone), uppermost Lower Volgian (upper *pseudoscythica* Zone).

Isterites spurius (Schneid)
(Pl. 18, Figs 2—3; Pl. 19)

1915. *Perisphinctes (Pseudovirgatites?) spurius* Schneid; Schneid, p. 383, Pl. 26, Figs 5, 5a, 5b; Pl. 27, Figs 5, 5a.

Material. — Four specimens.
Dimensions:

Specimen	D	H	U	1/2 UR	1/2 SR
KB. 1. 84	100 mm	27 mm	46 mm	12	37
Schneid's syntype (Pl. 10, Fig. 5)	90	29	43	12	41

Remarks. — The specimens from Brzostówka seem to be close to the Franconian specimens of Schneid. The development of ribbing is the same, and in two specimens from Brzostówka the strong and distant biplicate ribbing, characteristic of the inner whorls of *I. spurius*, is to be seen. The largest specimen illustrated herein (Pl. 19), which is but moderately crushed, allows to recognize that the original section of whorls was broad and rounded. In that specimen the biplicate ribbing seems to be replaced by irregular, polygyrate one at about the same diameter as in Schneid's specimens, *i.e.* at a diameter of about 65 mm. In other specimens from Brzostówka, however, the first polygyrate ribs appear at whorl-diameters of about 45 mm. Such differences may be regarded as an expression of intraspecific variability.

The specimen of *I. palmatus* figured by Schneid (1915, Pl. 27, Fig. 3) shows some similarity to *I. spurius*. The latter species differs from *I. palmatus* by having thicker whorls and slightly more distant ribbing. In *I. franconicus* the number of primary ribs is about the same as in other species of the *palmatus* group at comparable diameters; the number of secondary ribs, however, is much smaller (31 against 41—44). *I. austriacus* (*comp.* p. 525) is also more densely ribbed (1/2 UR — 14; 1/2 SR — 45); the thickness of whorls, however, corresponds to that in *I. spurius*.

Occurrence. — Franconia: Neuburg Formation, Unterhausen Member, Middle Tithonian. Central Poland: layers *a-1* and *a-2* at Brzostówka, lowermost Upper Tithonian (*puschi* Zone), uppermost Lower Volgian (upper *pseudoscythica* Zone).

Isterites mazoviensis sp. n.

(Pl. 17, Fig. 3; Pl. 20, Fig. 1; Pl. 21, Figs 1—4; Pl. 22, Figs 1—3; Pl. 23, Figs 1—2; Pl. 24, Figs 2—3)

Holotype: specimen KB. 1. 89 (Pl. 22, Fig. 3).
Type horizon: layer *a-3* at Brzostówka; lower Upper Tithonian, lowermost Middle Volgian (lower *scythicus* Subzone).
Type locality: Brzostówka.
Derivation of the name: after the Mazowsze province in Central Poland.

Material. — Eighteen specimens; and eleven presumably belonging to the species. All from layer *a-3*.
Dimensions:

Specimen	D	H	U	1/2 UR	1/2 SR
KB. 1. 89	*c.* 85 mm			9	32
KB. 1. 101	*c.* 57	21 mm	21 mm	12	31
KB. 1. 94	54			14	37

Diagnosis. — A species of the genus *Isterites* in which fairly regular, polygyrate ribbing persists to a diameter of whorl of about 130 mm.

Description. — Innermost whorls show moderately dense, biplicate ribbing, which gradually becomes more distant as the whorls grow. At a diameter of about 45 mm triplicate polygyrate ribs appear, which at greater diameters become associated with some quadruplicate ribs. Ribbing remains fairly regular to a diameter of about 130 mm (as indicated by some fragmentary specimens with whorls about

40 mm high), and there is only a small proportion of intercalatory ribs. Secondary ribs in the particular specimen are more or less markedly inclined forwards. There occur numerous constrictions bordered from above by simple ribs.

A specimen showing more straight and coarse ribbing (Pl. 17, Fig. 3) is referred to as *Isterites* aff. *mazoviensis* sp. n.

Two large fragmentary specimens from the layer *a-3* probably belong to the species under description. The first specimen (Pl. 24, Fig. 2) shows on the outer whorl, which is about 40 mm high, transition from polygyrate to biplicate ribbing; on the preceding whorl distant primary ribs are visible. The second specimen (Pl. 23, Fig. 1) is a fragment of a whorl 55 mm high. The whorl bears biplicate, simple and intercalatory ribs, some of the latter ones showing a tendency to be joined with biplicate ribs.

Remarks. — The inner and middle whorls of the new species are similar to those of *I. subpalmatus* which probably gave rise to the former species. *I. mazoviensis* differs from *I. subpalmatus* by persistence of fairly regular, polygyrate ribbing to a larger diameter of whorl. *I. subpalmatus*, as indicated by Schneid (1915, pp. 79—80), shows at comparable diameters irregular ribbing, with a large proportion of intercalatory ribs. In most specimens of *I. mazoviensis* the secondary ribs are more strongly inclined forwards than they are in *I. subpalmatus*. In *I. austriacus*, which also shows fairly regular ribbing, the ribbing is more dense, and there is a higher ratio of secondary to primary ribs, than in *I. mazoviensis*.

The specimens of *I. mazoviensis* distinctly differ from all specimens of *Z. scythicus* and *Z. quenstedti* collected from the layer *a-1* at Brzostówka. In the two latter species, the biplicate ribbing is much more fine and dense on inner whorls, and it persists to remarkably larger diameters of whorls. In this respect there is a distinct morphological gap between all the representatives of *Zaraiskites* from the layer *a-3* and those of *I. mazoviensis*. The zaraiskitids from that layer bear typical virgatotome ribs with up to five or six secondaries on middle whorls, which allows these whorls to be easily distinguished from the middle whorls of *I. mazoviensis*, which show polygyrate ribbing. It may be difficult, however, to distinguish incomplete specimens of *I. mazoviensis* from fragmentary ones of some distantly ribbed variants of *Z. scythicus* and *Z. stschukinensis*.

Lemencia(?) lewinskii sp. n.
(Pl. 17, Figs 2, 4)

Holotype: specimen KB. 1. 76 (Pl. 17, Fig. 4).

Type horizon: layers *a-1* and *a-2* at Brzostówka; lowermost Upper Tithonian (*puschi* Zone), uppermost Lower Volgian (upper *pseudoscythica* Zone).

Type locality: Brzostówka.

Derivation of the name: in honour of Prof. J. Lewiński, author of a large monograph concerning the Bononian (Volgian) at Tomaszów Mazowiecki.

Material. — Four specimens.

Dimensions:

Specimen	D	H	U	1/4 UR	1/4 SR
KB. 1. 76	c. 80 mm (r)	28 mm (r)	35 mm (r)	17	52 (r)

Diagnosis. — Shell of medium size. Inner whorls with moderately dense biplicate ribbing which modifies to form densely spaced, regular triplicate ribs, and finally becomes more irregular and crowded.

Description. — Inner whorls show moderately dense biplicate ribbing which becomes less dense as the whorl grows. There also occur bidichotomous ribs and occasional polygyrate ribs. The biplicate ribs are followed by densely spaced, regular

polygyrate ribs, branching into three secondaries. This ribbing, visible in the holotype (Pl. 17, Fig. 4), seems to be developed only over a short part of whorl in the specimen illustrated as paratype (Pl. 17, Fig. 2). The triplicate ribs closely resemble those appearing in *Z. scythicus* at the transition from biplicate to distant virgatotome ribbing. In the specimens under description the regular triplicate ribbing changes abruptly to dense irregular one, characterized by alternation of polygyrate, biplicate, simple and/or intercalatory ribs. This changes of ribbing and a rather small size of the specimens suggest that they represent adult microconchs.

Remarks. — The new species here established cannot be classified in a satisfactory manner on generic level, because of insufficient knowledge on sexual dimorphism in several groups of Tithonian and Volgian ammonites. Some Tithonian ammonites have ribbing resembling to some extent that of *Lemencia (?) lewinskii* sp. n., as *e.g.* some forms assigned by Donze & Enay (1961) to *Subplanites* but probably belonging to *Parapallasiceras* (*l.c.*, Pl. 16, Figs 1, 3); also some forms of *Lemencia* (for instance, *L. rigida, l.c.*, Pl. 20, Fig. 2); and *Sublithacoceras (?) tortuosus* (Schneid 1915, Pl. 29, Fig. 1). The latter form, however, which seems to be a macroconch, shows different ribbing at the end of the last preserved whorl.

The discussed forms from Brzostówka are tentatively referred to *Lemencia* on account of their morphological features. It is, however, possible that they are dimorphic counterparts of one of the genera represented in the lower part of the Brzostówka section. It may be remarked that a specimen figured by Dembowska (1973, Pl. 2, Fig. 4) as *Subplanites* cf. *pseudoscythicus* resembles the forms here described in development of ribbing. In Dembowska's specimen, which seems to be a microconch, the ribbing also becomes crowded at a relatively small diameter. This specimen, however, shows biplicate ribbing on middle whorl, with only few triplicate ribs.

Family *Virgatitinae*
Genus *ZARAISKITES* Semenov, 1898
(Synonym: *Provirgatites* Lewiński, 1923)

The genus *Zaraiskites* comprises ammonites with biplicate ribbing on the inner whorls; on midle whorls the ribbing is typically virgatotome, with points of furcation relatively high on the flanks; the ribbing becomes biplicate on the outer whorls. The ammonites belonging to this genus have been discussed at length by Michalski (1890) as the group of *Perisphinctes zarajskensis*, as well as by Lewiński (1923) as *Provirgatites* and by Ilovaisky & Florensky (1941) as *Provirgatites*.

The present writers' collection contains specimens of the species *Zaraiskites quenstedti* (Rouillier), *Z. scythicus* (Vischniakoff), *Z. stschukinensis* (Michalski) and *Z. tschernyschovi* (Michalski). All these species will be interpreted in accordance with Michalski (1890). In the section at Brzostówka, the early representatives of *Z. scythicus* from the layer *a-3* grade morphologically into *Z. quenstedti*, and the late representatives of *Z. scythicus* from the layers *b-1* and *b-2*, in turn, seem to grade into *Z. stschukinensis*. Although this may imply that each of these two populations of *Zaraiskites* represents but one biological species, the three formal species cited above will be kept distinct for the following reasons. First, any taxonomic revision of the species of *Zaraiskites* should be based in the first place on the much better Russian material; it is also for this reason that no lectotypes are proposed here for those species of *Zaraiskites* for which they have not yet been designated. Second, it seems very probable that all, or almost all of the species of the genus *Zaraiskites* are interconnected by passage forms. For instance, in the *zarajskensis*

Subzone at Tomaszów Mazowiecki, the late representatives of *Z. stschukinensis* closely comparable with the lectotype designated by Arkell (1956, Pl. 45, Fig. 2) seem to grade into *Z. zarajskensis*, and some other forms of *Z. stschukinensis* are hardly distinguishable, in turn, from *Z. pilicensis* (Michalski). Thus, on the strength of the existence of transitional forms, all the existing species of *Zaraiskites* could possibly be referred to but one or two large species. It seems better, however, to retain the hitherto established formal species of *Zaraiskites* which, differing in their stratigraphic range, enable the *scythicus* Zone to be subdivided stratigraphically.

As yet not much is known about sexual dimorphism in *Zaraiskites*. Prof. Makowski, who examined Michalski's specimens in Leningrad, has kindly informed the present writers that one of the specimens of *Z. zarajskensis* figured by Michalski (1890, Pl. 6, Fig. 1) is an adult specimen, showing approximated sutures at a diameter of about 70 mm; the complete specimen could have a diameter of about 100 mm. As there are some remarkably larger specimens of *Z. zarajskensis* (*e.g.* that figured by Lewiński, 1923, Pl. 11, Fig. 1), the specimen of Michalski should be regarded as a microconch. This indicates that some microconchs of the genus *Zaraiskites* attained about 100 mm in size. However, in several species of *Zaraiskites* the successive changes in ribbing take place at highly variable diameters, which suggests that both the microconchs and macroconchs of *Zaraiskites* displayed strong variation with respect to their end size.

Phylogenetic problems concerning *Zaraiskites* are discussed in another section of this paper.

Zaraiskites quenstedti (Rouillier, 1849)
(Pl. 24, Fig. 1; Pl. 25, Figs 1—2; Pl. 26, Figs 1, 3—5; Pl. 27, Fig. 1)

1849. *Ammonites Quenstedti* Rouillier; Rouillier, p. 359, Pl. 50, Fig. 87.
1882. *Ammonites Quenstedti* Rouillier; Vischniakoff, Pl. 3, Figs 3, 5—6 (non Fig. 4).
1890. *Perisphinctes Quenstedti* Rouillier; Michalski, pp. 156, 436, Pl. 9, Figs 6—8.
1916. *Virgatites Quenstedti* Rouillier; Ptshelincev, p. 87, Pl. 4 (1), Fig. 2 (non Fig. 1).
?1923. *Provirgatites Sauvageí* Lewiński; Lewiński, p. 99, Pl. 8, Figs 2—3.
1941. *Virgatites (Provirgatites) quenstedti* Rouillier; Ilovaisky & Florensky, pp. 116, 126.
1965. *Virgatites virgatus* (Buch); Dembowska, Pl. 1, Fig. 1 (non Fig. 2).
1973. *Zaraiskites quenstedti* (Rouillier); Dembowska, pp. 64, 84, 102, Pl. 5, Fig. 1 (non Pl. 4, Figs 1—2, non Pl. 5, Fig. 3).
1973. *Virgatites(?)* sp. indet.; Dembowska, pp. 70, 89, 107, Pl. 8, Fig. 1.

Material. — Thirteen specimens.

Description. — All the specimens from Brzostówka referable to *Z. quenstedti* have been found in layer *a-3*. All the very densely ribbed nuclei from *a-3* can be safely ascribed to *Z. quenstedti*, which is the only species in this layer, displaying such a ribbing on inner whorls.

The inner whorls (Pl. 25, Fig. 1; Pl. 26, Figs 1, 3) show dense and somewhat irregular ribbing. Biplicate ribs commonly join at the umbilical edge to form bidichotomous ribs. Occasionally more than two biplicate ribs merge down, thus forming polydichotomous rib-units (*cf.* Ilovaisky & Florensky 1941, p. 116), whereas some biplicate ribs do not extend down to the umbilical edge. There are numerous narrow prorsiradiate constrictions, followed by single ribs. On a very densely ribbed specimen (Pl. 26, Fig. 3) there occur parabolae.

Dense ribbing of the inner whorls is gradually replaced by ribbing consisting of rather densely spaced, polygyrate and narrow virgatotome ribs, associated with

bidichotomous ones. This ribbing is developed only over a short distance in the specimen of *Z. quenstedti* shown in Pl. 25, Fig. 1, but it persists much longer in a whorl-fragment from *a-3* (Pl. 26, Fig. 2) that may be referred either to *Z. quenstedti* or to *Z. scythicus*.

The ribbing discussed above is replaced by distant virgatotome one characteristic of the middle whorls of *Z. quenstedti*. The latter ribbing is of zaraiskoid type: the points of furcation are high on the whorl-sides, the interstices between primary ribs are large, and the secondaries in the virgatotome ribs show a well-marked bend backward. To most of the primary ribs there correspond five or six secondary ones. Majority of the secondaries is connected with each other within the virgatotome rib-units, but intercalatory ribs are quite common. Some of them are markedly bent toward the following virgatotome ribs, which in turn are followed by an intercalatory rib stretching in radial direction. There occur numerous constrictions, followed by simple ribs (Pl. 24, Fig. 1; Pl. 25, Fig. 1; Pl. 26, Figs 4—5; Pl. 27, Fig. 1).

The largest fragment of whorl attributable to *Z. quenstedti* (Pl. 25, Fig. 2) displays the same style of ribbing, the ratio of secondary to primary ribs being but slightly decreased with respect to that in the middle whorls of smaller diameter. Traces of dense ribbing of the preceding whorl are preserved on side not shown on the photograph.

Remarks. — As *Z. quenstedti* is the only species of *Zaraiskites*, displaying very dense biplicate ribbing up to a considerable diameter of whorls, the specimens described above must be ascribed to this species. So far, only one figure of *Z. quenstedti* showing distant virgatotome ribbing on middle whorl has been figured (Vischniakoff 1882, Pl. 3, Fig. 3). Now, several specimens of *Z. quenstedti* with middle whorls preserved, have been found at Brzostówka. The whorl-fragment shown in Pl. 25, Fig. 2, that should correspond to a whorl-diameter of about 120 mm, is the largest specimen of *Z. quenstedti* so far figured.

Z. quenstedti displays strong affinities to the specimens from Brzostówka referred to *P. puschi zaraiskoides*, the only significant difference being that in the middle whorls of the latter specimens there occur more numerous intercalatory ribs, so that the virgatotome ribbing is not so typically developed in *P. puschi zaraiskoides* as it is in *Z. quenstedti*.

One of the two specimens assigned by Lewiński (1923, Pl. 8, Fig. 2) to his species *Provirgatites sauvagei*, displays on the middle whorl distant virgatotome ribbing very similar to that of *Z. quenstedti*. This specimen, as well as the other one referred to *P. sauvagei* (Lewiński 1923, Pl. 8, Fig. 3), possibly belong to *Z. quenstedti*. In the paper of Lewiński (1923) there are contradictory statements as to the provenance of the specimens ascribed by him to *P. sauvagei*. They are reported to have come from beds *B* and *F* (pp. 11—12), from the bed *F* only (p. 101), or from the beds *G* and *H* (p. 94). All the ammonites in the present authors' collection, that reveal similarity to the discussed specimens of Lewiński, come from layer *a-3* which presumably corresponds to Lewiński's bed *B*.

The uncomplete specimen figured by Dembowska (1965, Pl. 1, Fig. 1) as *Virgatites virgatus* (Buch) and refigured as Virgatites(?) sp. indet. (Dembowska 1973, Pl. 8, Fig. 1) may be referred to *Z. quenstedti*. This specimen shows ribbing with pronounced "polydichotomous" rib-units which is quite similar to that found in specimens of *Z. quenstedti* figured by Vischniakoff (1882, Pl. 3, Fig. 3) and Ptshelincev (1916, Pl. 4, Fig. 2).

Three specimens figured by Dembowska (1973, Pl. 4, Figs 1—2; Pl. 5, Fig. 3) as *Z. quenstedti* show dense ribbing up to considerable diameters of whorl, and can be easily accomodated in the genus *Pseudovirgatites* (these specimens seem to be close to such forms as those here described as *P. puschi puschi*). One of Dem-

bowska's specimens (Pl. 5, Fig. 3) show relatively dense primary ribs on the last preserved whorl. On middle whorls of similar diameter, such a ribbing is found in some forms belonging to *Pseudovirgatites*, whereas it does not occur in *Z. quenstedti*.

Occurrence. — Central and Northern Poland: Middle Volgian, *scythicus* Zone (probably in the *scythicus* Subzone only). Russian platform: Middle Volgian, *panderi* Zone. ? Polish Flysch Carpathians, Upper Tithonian.

Zaraiskites scythicus (Vischniakoff, 1882)
(Pl. 27, Figs 2—5; Pl. 28, Figs 1—4; Pl. 29, Figs 1—3; Pl. 30, Figs 1—2; Pl. 31, Figs 1—4; Pl. 32, Figs 3—5)

1861. *Ammonites biplex truncatus* Trautschold; Trautschold, p. 84 (21), Pl. 8, Figs 3—4.
1882. *Ammonites scythicus* Vischniakoff, Vischniakoff, Pl. 3, Figs 1—2 (non Pl. 2, Fig. 6).
1890. *Perisphinctes scythicus* Vischniakoff; Michalski, pp, 121, 425, Pl. 5, Figs 6—7; Pl. 7, Figs 5—7; Pl. 8, Fig. 1; Pl. 13, Fig. 10.
1923. *Provirgatites scythicus* Michalski (Vischniakoff); Lewiński, p. 101, Pl. 9, Figs 3—4.
1923. *Provirgatites aff. Quenstedti* Roullier; Lewiński, p. 99, Pl. 8, Figs 4, ? 5.
?1923. *Provigatites pilicensis* Michalski; Lewiński, p. 98 (pars), non Text-fig. 12.
1941. *Virgatites (Provirgatites) scythicus* (Vischniakoff) Michalski var. *diprosopa* Ilovaisky et Florenski; Ilovaisky & Florensky, p. 117, Pl. 23, Fig. 43; Pl. 24, Figs 44—45, Text-fig. 20.
1941. *Virgatites (Provirgatites)* cf. *scythicus* (Vischniakoff); Ilovaisky & Florensky, f. A — p. 122, f. B — p. 122, Pl. 25, Fig. 46, ? f. C — p. 123, Pl. 25, Fig. 47, ? f. D — p. 124, Pl. 25, Fig. 48.
?1962. *Zaraiskites scythicus* (Vischniakoff) Michalski; Wilczyński, p. 76, Pl. 7, Fig. 2.
1973. *Zaraiskites scythicus* (Vischniakoff); Dembowska, pp. 84, 85, 102 (pars), ? Pl. 5, Figs 2, 4—5, non Pl. 5, Fig. 6.

The specimens of *Z. scythicus* found at Brzostówka in the layer *a-3* and, at a higher stratigraphic level, in the layers *b-1* and *b-2*, represent two populations differing in age and morphological development. They deserve separate description, although no attempt will be made to separate them as distinct taxonomic units.

Population from layer *a-3*

Material. — Seven specimens from layer *a-3*. Several fragments of large whorls found in this layer possibly also belong to *Z. scythicus*.

Description. — Inner whorls bear relatively dense biplicate ribbing, a variable proportion of biplicate ribs being joined into bidichotomous ribs in particular specimens (Pl. 27, Figs 4—5; Pl. 28, Figs 2—4). Polydichotome rib-units do not occur. There are numerous constrictions bounded by simple ribs. In the specimen shown in Plate 28, Fig. 3 the biplicate ribbing ranges up to a diameter of c. 50 mm, but in other specimens (Pl. 27, Figs 4—5; Pl. 28, Fig. 4) it seems to persist up to diameters of about 60 mm.

The middle whorls bear distant virgatotome ribs of the zaraiskoid type (Pl. 27, Fig. 3; Pl. 28, Figs 1—3). Most of the virgatotome ribs branch into four secondaries, and in some of the virgatotome ribs there correspond five secondary ribs to one primary. Intercalatory ribs occur in variable proportions (*comp.* Pl. 27, Fig. 3 with Pl. 28, Fig. 1). Constrictions followed by simple ribs are present. At the transition of the biplicate ribbing of the inner whorls to the distant virgatotome ribbing of the middle whorls there occur variable numbers of densely spaced polygyrate and quadruplicate virgatotome ribs together with bidichotomous rib-units composed of polygyrate and biplicate ribs.

Some fragments of large whorls from *a-3*, such as that figured in Pl. 27, Fig. 2, presumably represent outer whorls of *Zaraiskites scythicus*.

Remarks. — The specimens of *Z. scythicus* from layer *a-3* show following differences with respect to *Z. quenstedti*. The inner whorls of the latter species display more dense biplicate ribbing, which persists, as average, to greater diameters of whorls. Polydichotomous rib units occur only in *Z. quenstedti*. The middle whorls of *Z. quenstedti* are characterized, with respect to those of *Z. scythicus*, by a higher ratio of secondary to primary ribs, and, usually, by a higher proportion of intercalatory ribs. These differences allow most of the specimens of *Zaraiskites* from the layer *a-3* to be ascribed either to *Z. quenstedti* or to *Z. scythicus*. On the other hand, the specimens from *a-3* ascribed to these species display morphological gradation with respect to density and persistence of biplicate ribbing, and the development of ribbing on middle whorls. This suggests that all the specimens of *Zaraiskites* found in layer *a-3* at Brzostówka represent but one biological species.

It was already suggested by Michalski (1890, p. 157), and later on by Ilovaisky & Florensky (1941, p. 116), that the specimens referable to *Z. quenstedti* are mere variants of a highly variable species, comprising also all the forms referred to *Z. scythicus*. Although the paleontological material from Brzostówka adds new evidence in favour of this opinion, the formal species *Z. scythicus* is retained here for practical reasons. Namely, it is probable that the stratigraphic range of *Z. quenstedti* is more restricted than that of *Z. scythicus*, and that the former species is characteristic only of the lower part of the *scythicus* Subzone.

Population from layers *b-1* and *b-2*

Material. — About forty specimens from layer *b-1*, and one specimen from layer *b-2*.

Dimensions:

Specimen	D	H	U	1/2 UR	1/2 SR
KB. 1. 132	104 mm	37 mm	40 mm	15	40
KB. 1. 133	c. 130	—	48	19	c. 42
KB. 1. 134	95	—	—	17	49
KB. 1. 141	c. 82	—	—	16	48

Description. — The inner whorls display relatively dense biplicate ribbing, some of the biplicate ribs being joined into bidichotomous pairs. In most specimens, however, only a small proportion of ribs forms bidichotomous rib-units. There occur constrictions followed by simple ribs. The particular specimens show variations with respect to density and persistence of the biplicate ribbing. At its transition to the virgatotome ribbing of the middle whorls, biplicate ribs are gradually replaced by triplicate ones, which, in turn, become associated with virgatotome ribs branching into four secondaries. First triplicate ribs not connected with constrictions appear at diameters ranging from *c.* 40 up to *c.* 50 mm (*comp.* Pl. 29, Fig. 3; Pl. 31, Fig. 4; Pl. 32, Figs 4—5).

In the specimens shown in Plate 32, Fig. 4, there occur numerous constrictions near the end of the last (? preserved) whorl, and the last two ribs show a characteristic bend forwards, which suggests that the peristome is partly preserved in this specimen. There may be some suspicion that the discussed specimen is an adult microconch of *Z. scythicus*, although no decisive evidence can be given in favour of this supposition.

The middle whorls show distant ribbing of the zaraiskoid type. The virgatotome ribs have only up to four secondaries, and the quadrifurcate ribs are restricted to younger parts of the middle whorls. On the adapertural parts of these whorls there occur triplicate ribs which, as the whorls grow, become associated with increasing numbers of biplicate ribs. Constrictions, followed by simple ribs, are present,

and in some specimens there occur occasional intercalatory ribs (Pl. 29, Figs 1—3; Pl. 30, Figs 1—2; Pl. 31, Figs 1, 4; Pl. 32, Fig. 3).

This ribbing is gradualy replaced at variable diameters of whorls by more dense, biplicate ribbing (in the specimen shown in Pl. 29, Fig. 2 the last triplicate rib is found at a diameter of about 80 mm, whereas in that shown in Pl. 29, Fig. 1, triplicate ribbing persists to a diameter of *c.* 105 mm). The outer whorls show strong variation with respect to density of ribbing (*comp.* Pl. 29, Fig. 1; Pl. 31, Figs 2—3).

As a half of whorl at least has been broken off from the specimen shown in Pl. 29, Fig. 1, it can be estimated that some representatives of *Z. scythicus* from layers *b-1* and *b-2* reached a maximum diameter of at least 175 mm.

Remarks. — The differences between the population of *Z. scythicus* from layer *a-3* and that from layers *b-1* and *b-2* are as follows. Within the latter population, in most specimens, the biplicate ribbing of inner whorls is less dense and persists to smaller diameters of whorls. Moreover, there is a smaller proportion of bidichotomous ribs. On the middle whorls, the virgatotome ribs branch only into four secondaries, whereas in the specimens from *a-3* the numbers of secondary ribs per one primary range up to five. Finally, a morphological gradation may be observed in the layer *a-3* between forms referable to *Z. scythicus* and *Z. quenstedti*, whereas all the forms of *Z. scythicus* from the layers *b-1* and *b-2* differ distinctly from *Z. quenstedti;* the latter species does not occur in these layers. On the other hand, only the population of *Z. scythicus* from layers *b-1* and *b-2* shows strong affinity with the species *Z. stschunkinensis* (*comp.* the section concerning the latter species).

At present, no data are available concerning differences in the morphological development of the Russian populations of *Z. scythicus* differing in age. It can be stated, however, that the specimens of *Z. scythicus* from the layer *a-1* at Brzostówka, as well as those from the layers *b-1* and *b-2*, have counterparts in Russian specimens figured so far (compare, for instance, Pl. 28, Figs 1—3 in this paper with Pl. 5, Figs 6—7 *in* Michalski 1890; Pl. 28, Fig. 4 with Pl. 7, Fig. 2; Pl. 29, Fig. 3 with Pl. 7, Fig. 7 and Pl. 13, Fig. 10; and the outer whorls of *Z. scythicus* figured in this paper with those figured by Michalski, 1890, and Trautschold, 1861). A comparison of the specimens of *Z. scythicus* from Brzostówka with those from Russia leads to the conclusion that the discussed species displays the same range of variability both in Poland and Russia. The statement of Lewiński (1923, p. 102) that the Polish specimens of *Z. scythicus* bear virgatotome ribs with only up to four secondary ribs to one primary, is true in the case of the populations from layers *b-1* and *b-2* at Brzostówka; but, in the specimens from the layer *a-3*, there occur virgatotome ribs branching into five secondaries.

The specimens described by Ilovaisky & Florensky (1941) as *Virgatites (Provirgatites) scythicus* var. *diprosopa* are placed here in the synonymy of *Z. scythicus* without any attempt to distinguish them formally as a distinct taxonomic unit. Some fragmentary specimens referred to *Z. scythicus* in early publications are omitted in the synonymy (for discussion *see* Ilovaisky & Florensky, 1941, p. 116). Some fragmentary specimens from Poland (Wilczyński 1962, Pl. 7, Fig. 2; and Dembowska 1973, Pl. 5, Figs 2, 4—5) may belong to *Z. scythicus*, but other interpretations are possible as well. One of the specimens figured as *Z. scythicus* by Dembowska (1973, Pl. 5, Fig. 6) is an *Isterites* of the *palmatus* group. The specimens from Stobnica, referred to *Z. scythicus* by Kutek (1961, Pl. 19, Fig. 1; Pl. 20, Fig. 1), seem to represent either *Isterites* or *Danubisphinctes*.

Occurrence. — Central and Northern Poland — Middle Volgian, *scythicus* Subzone and lower part of the *zarajskensis* Subzone. Russian platform — Middle Volgian, *panderi* Zone. Austria — Upper Tithonian.

Zaraiskites stschukinensis (Michalski, 1890) (Pl. 32, Figs 1—2)

1890. *Perisphinctes stschukinensis* Michalski; Michalski, pp. 110, 423, Pl. 6, Figs 8—9; Pl. 13, Fig. 9.
1956. *Virgatites stschukinensis* (Michalski); Arkell, Pl. 45, Fig. 2.

Material. — Two specimens from layer *b-1*.

Description. — Both the specimens show dense ribbing on inner whorls. One specimen (Pl. 32, Fig. 1) that bears numerous, distant biplicate ribs and only a few triplicate ribs on the last preserved whorl, is close to the specimen of *Z. stschukinensis* figured by Michalski (1890) in Plate 13, Fig. 8. The second specimen from Brzostówka (Pl. 32, Fig. 2) shows distant biplicate ribs, a few simple ribs and but one triplicate rib on the last preserved whorl. It is similar to that figured by Michalski in Pl. 6, Fig. 9.

Remarks. — Some specimens of *Z. stschukinensis* with distant biplicate ribs (such as those figured in this paper in Pl. 32, Fig. 1, and by Michalski, 1890, Pl. 13, Fig. 9) show ribbing that resembles in many respects that in some specimens of *Z. scythicus* (*e.g.* Pl. 29, Fig. 3 in this paper, and Pl. 7, Fig. 7 *in* Michalski 1890). The main difference between the discussed specimens of *Z. stschukinensis* and *Z. scythicus* lays in the stronger development of triplicate and quadruplicate ribbing in the latter specimens; and there is also no direct indication that in some specimens of *Z. scythicus* this ribbing is replaced by biplicate one at diameters but slightly exceeding those at which a similar change of ribbing occurs in some forms of *Z. stschukinensis*. It is known, however, that in *Z. scythicus* the successive types of ribbing are replaced by each other at highly variable diameters of whorls. Thus the possibility cannot be ruled out that the specimens of *Z. stschukinensis* from Brzostówka are conspecific with the representatives of *Z. scythicus* from layers *b-1* and *b-2*, and represent its extreme variants with highly supressed virgatotome ribbing.

It is worth of note that Kutek posseses some other specimens referable to *Z. stschukinensis;* they were collected together with *Z. zarajskensis*, in the region of Tomaszów Mazowiecki, from the beds that overlie those exposed in the clay-pit at Brzostówka. These specimens resemble the specimen of *Z. stschukinensis* figured by Arkell (1956, Pl. 45, Fig. 2), and show much stronger affinity to *Z. zarajskensis*, than to *Z. scythicus*.

Zaraiskites tschernyschovi (Michalski, 1890) (Pl. 24, Fig. 4)

1890. *Perisphinctes Tschernyschovi* Michalski; Michalski, pp. 139, 423, Pl. 8, Figs 2—3.
?1923. *Provirgatites* cf. *Tschernyschovi* Michalski; Lewiński, p. 102.

Material. — One specimen from layer *b-1*.

Description. — The specimen shows distant ribbing in all visible whorls, and the style of ribbing is that of *Z. tschernyschovi* (*comp.* Michalski 1890, Pl. 8, Fig. 3).

PHYLOGENETIC REMARKS

Ilowaiskya and Pseudovirgatites

As previously noted, the *rueppellianus-reisi* group probably gave rise to the genus *Ilowaiskya*. A discussion about evolution of that genus is beyond the scope of this paper. It will be only suggested that the genus

Pseudovirgatites evolved from some forms of *Ilowaiskya* by acquisition of distant polygyrate ribbing in the middle growth-stage. In this respect, it is of interest that the late ilowaiskyids of the species. *I. tenuicostata* are characterized by different ribbing on the inner, middle and outer whorls, the ribbing on the outer whorls being relatively less distant, and more

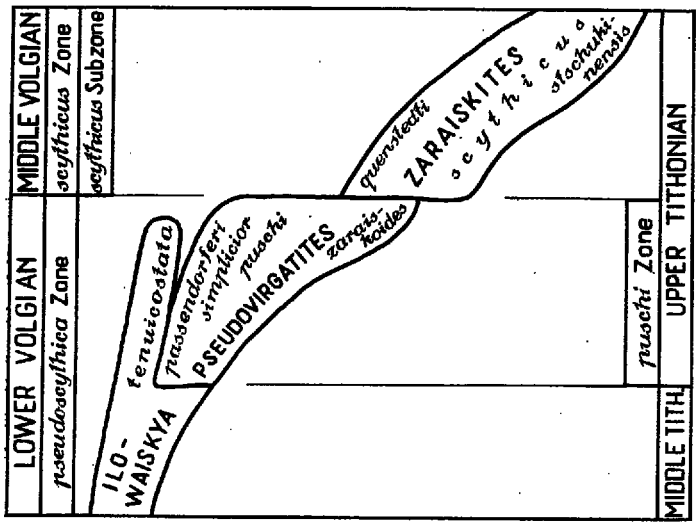

Fig. 3

Suggested phylogenetic relationship between the species of *Ilowaiskya*, *Pseudovirgatites* and *Zaraiskites*, occurring at Brzostówka

simple, than on the middle whorls. A similar difference in the development of ribbing in the middle and late growth-stages seems not to be recognizable in the earlier species of *Ilowaiskya*, but it is displayed by the representatives of *Pseudovirgatites* from Brzostówka. It should be also stressed that *P. passendorferi* is a form closely comparable to *I. tenuicostata;* it only differs substantially from the latter species in having polygyrate ribbing developed in a part of the middle whorl. Therefore *P. passendorferi* may be regarded as a species of *Pseudovirgatites* directly derived from some forms of *Ilowaiskya* (possibly the same which gave rise to *I. tenuicostata*). From this conservative species there probably diverged the more specialized forms included in *P. puschi.* Out of these forms those referred to *P. puschi simplicior,* which develop relatively simple, polygyrate ribbing on middle and outer whorls, are probably the earliest and most conservative ones; they probably gave rise to the forms referred to *P. puschi puschi* and *P. puschi zaraiskoides,* which are cha-

racterized by fasciculate or virgatotome-like ribbing on late-middle whorls (Fig. 3).

Zaraiskites

It has been suggested by Ilovaisky & Florensky (1941, pp. 130—134) that some species of *Ilowaiskya* (*I. pseudoscythica* or *I. schaschkovae* Ilov. & Flor.) evolved directly into *Zaraiskites* by development of virgatotome ribs branching into numerous secondaries. Accordingly, the successive populations of *Zaraiskites* might be expected to show an increasing ratio of secondary to primary ribs in middle whorls. Such a development of ribbing in successive forms of *Zaraiskites* could not be recognized, however, in the condensed strata of the classical sections of the Russian Volgian.

The paleontological material from Brzostówka supplies strong evidance against the supposition of Ilovaisky & Florensky (1941). First, the latest representatives of *Ilowaiskya* in the Brzostówka section, which belong to *I. tenuicostata,* distinctly differ from the earliest representatives of *Zaraiskites* from the layer *a-3*. On the middle whorls, the ribbing is strongly virgatotome in *Z. quenstedti* and *Z. scythicus,* whereas it is biplicate in *I. tenuicostata.* Therefore, any direct ancestor-descendant relationship between these forms must be ruled out. Second, the highest ratio of secondary to primary ribs is found in the virgatotome ribbing of the earliest zaraiskitids from the layer *a-3*. In the representatives of *Z. scythicus* and *Z. stschukinensis* from the layers *b-1* and *b-2,* the virgatotome ribs gave rise to less numerous secondary ribs.

On the other hand, the representatives of *Zaraiskites* from Brzostówka are closely comparable to the earlier forms of *Pseudovirgatites.* All these ammonites show similar development of ribbing. The inner whorls show dense biplicate ribbing; the ribbing of the middle whorls is characterized by occurrence of distant ribs, branching into numerous secondaries; and it becomes more simple on outer whorls. As previously mentioned, the species *Z. quenstedti* shows strong affinity to the earlier subspecies *P. puschi zaraiskoides.* In this subspecies, the secondaries are more closely connected in the virgatotome ribs, but a remarkable proportion of intercalatory ribs is still to be observed in *Z. quenstedti.*

Three successive biological populations seem to be represented by the three subspecies of the species *P. puschi* from the layers *a-1* and *a-2;* by the representatives of *Z. quenstedti* and *Z. scythicus* from the layer *a-3;* and by the representatives of *Z. scythicus* and *Z. stschukinensis* from the layers *b-1* and *b-2*. All these populations are highly variable with respect to ribbing, and they seem to have displayed a consecutive shifting of the range of variability. In *P. puschi,* the inner whorls are densely and

finely ribbed to a considerable diameter. On the middle whorls the ribbing ranges from polygyrate through fasciculate to virgatotome. In most forms, there is a large proportion of intercalatory ribs, and the ratio of secondary ribs to one primary ranges up to seven. In the population of *Zaraiskites* from the layer *a-3*, the ribbing is still fine in *Z. quenstedti;* it is less dense, and persists to smaller diameters, in *Z. scythicus*. There is a smaller proportion of intercalatory ribs in the middle whorls, which show virgatotome ribbing. The virgatotome ribs gave rise to up to six secondary ribs in *Z. quenstedti*, and five secondary ribs in *Z. scythicus*. In the population from the layers *b-1* and *b-2*, represented by *Z. scythicus* and *Z. stschukinensis*, the biplicate ribbing characteristic of the inner whorls is still more pressed back, and less dense. The virgatotome ribs give rise to up to four secondaries only.

As indicated by the size of the largest whorl-fragments referable to *Pseudovirgatites* and *Zaraiskites*, the representatives of these genera from Brzostówka did not differ substantially in their maximum size. It should be noted, however, that the largest fragments of whorls, possibly belonging to *Pseudovirgatites*, are 60 mm high, whereas those of *Zaraiskites* found in the layer *b-1* only about 50 mm. This may indicate a slightly larger end-size of the species of *Pseudovirgatites*. The fact that in the specimens of *Z. scythicus* from layer *b-1* ribbing becomes more simple at slightly smaller diameters, seems to support this view.

The above discussion leads to the conclusion that the genus *Zaraiskites* is a descendant of the genus *Pseudovirgatites*. The early representatives of *Zaraiskites*, which belong to the species. *Z. quenstedti* and *Z. scythicus*, appear to derive from the species *P. puschi* through the forms referred to *P. puschi zaraiskoides* (Fig. 3). It may be remembered that Vetters remarked as early as 1905 on the similarity of *P. scruposus* to the ammonites of the family Virgatitinae. A similar opinion was expressed by Lewiński (1923), who regarded *Provirgatites* (= *Zaraiskites*), *Euvirgatites* (= *Virgatites*) and *Pseudovirgatites* as subgenera of the genus *Virgatites*. He also suggested that *Pseudovirgatites* is a descendant of *Provirgatites*, on the assumption that *Pseudovirgatites* appeared at a higher stratigraphic level. Now the earliest representatives of *Zaraiskites* are known to occur at Brzostówka in beds directly overlying those with *Pseudovirgatites*, the latter genus being here represented by forms closely comparable with *Zaraiskites*.

The genus *Pseudovirgatites* may be regarded as phylogenetic link between the genera *Ilowaiskya* and *Zaraiskites*. At present, however, the possibility cannot be entirely ruled out that some forms of *Zaraiskites* are direct derivatives of some forms of *Ilowaiskya* or *Isterites*.

Isterites

The Franconian material makes it clear that *Danubisphinctes* gave rise to *Isterites*. It may be mentioned that *Danubisphinctes* seems to be present in Central Poland. Thus it is probable that *Isterites* evolved from *Danubisphinctes* at the same time in the area of Southern Germany and in that of Poland.

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TYTOŃSKO-WOŁŻAŃSKA FAUNA AMONITOWA Z BRZOSTÓWKI POD TOMASZOWEM MAZOWIECKIM

(Streszczenie)

Dzięki robotom ziemnym, wykonanym przez pierwszego z autorów niniejszej publikacji, możliwe było zebranie licznych amonitów z zarzuconej obecnie glinianki w Brzostówce, w obrębie której Lewiński (1923) wyróżnił horyzont litologiczny *I*, odniesiony do poziomu *Zaraiskites scythicus*. Wśród amonitów opisanych i zilustrowanych w niniejszej publikacji znajduje się szereg rodzajów i gatunków nie znanych dotychczas z obszaru środkowej i północnej Polski.

W najniższej części utworów wołgu odsłoniętych w gliniance w Brzostówce, w warstwach *a-1* i *a-2* (Fig. 1), występują: *Ilowaiskya tenuicostata* (Michajlov), *Pseudovirgatites passendorferi* sp. n., *P. puschi* sp. n. z trzema podgatunkami, *Isterites subpalmatus* (Schneid), *Isterites spurius* (Schneid), i *Lemencia(?) lewinskii* sp. n. Wspomniane warstwy odpowiadają najwyższemu dolnemu wołgowi (górnej części poziomu *Ilowaiskya pseudoscythica*), z drugiej zaś strony górnej części ustanowionego w niniejszej publikacji poziomu *Pseudovirgatites puschi*. Zasięg stratygraficzny tego poziomu odpowiada zasięgowi wiekowemu rodzaju *Pseudovirgatites* w środkowej Polsce.

W wyższej warstwie *a-3* znaleziono *Zaraiskites quenstedti* (Rouillier), *Z. scythicus* (Vischniakoff) i *Isterites mazoviensis* sp. n., a w warstwach *b-1* i *b-2* — *Z. scythicus*, *Z. stschukinensis* (Michalski) i *Z. tschernyschovi* (Michalski). Wszystkie te warstwy odpowiadają dolnemu podpoziomowi poziomu *Zaraiskites scythicus*, stanowiącego najniższy poziom środkowego wołgu. Proponuje się określanie tego podpoziomu nazwą *Zaraiskites scythicus*. Dolna jego granica, będąca zarazem dolną granicą poziomu Z. scythicus, wyznaczona jest pojawieniem się rodzaju *Zaraiskites*, a górna granica identyczna jest z dolną granicą podpoziomu *Zaraiskites zarajskensis* i odpowiada pojawieniu się gatunku *Z. zarajskensis*.

Dzięki obecności amonitów typu tytońskiego można stwierdzić, że wszystkie utwory wołgu odsłonięte w gliniance w Brzostówce odpowiadają dolnym partiom górnego tytonu (Fig. 1, Tab. 1). Utwory te można m. in. korelować z dolnymi częściami ogniwa z Oberhausen, stanowiącego górne ogniwo formacji Neuburg południowej Frankonii (Tab. 1). Profil z Brzostówki dostarcza następujących nowych danych biostratygraficznych, pozwalających na uściślenie korelacji stratygraficznych między środkowymi partiami piętra tytońskiego i piętra wołżańskiego: 1) rodzaj *Zaraiskites* występuje powyżej rodzaju *Pseudovirgatites*, 2) zasięg wiekowy rodzaju *Zaraiskites* nieznacznie tylko zazębia się z zasięgiem wcześniejszego rodzaju *Isterites*, 3) w pewnych warstwach współwystępują amonity z rodzaju *Isterites* i *Pseudovirgatites*.

Materiał paleontologiczny z Brzostówki pozwala na uzasadnienie wniosku, że rodzaj *Zaraiskites* wywodzi się z rodzaju *Pseudovirgatites*, a ten ostatni z rodzaju *Ilowaiskya* (Fig. 3).

Amonity z Brzostówki dostarczają dodatkowych dowodów na to, iż fauny amonitowe polskiego wołgu mają mieszany, submedyterańsko-subborealny charakter (*por.* Zeiss 1968, Kutek w druku). Okazy zebrane w Brzostówce pozwoliły po raz pierwszy na stwierdzenie obecności w środkowej Polsce rodzaju *Isterites* i *Pseudovirgatites*, znanych dotychczas tylko z prowincji submedyterańskiej, a także na wykazanie filogenetycznego związku pomiędzy „tytońskim" rodzajem *Pseudovirgatites* i „wołżańskim" rodzajem *Zaraiskites*.

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