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Biostratigraphy and Paleozoogeography of the Lowermost Tithonian in the Extra-Carpathian Poland

by

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Summary. The analysis of macrofauna, especially ammonites of the genera *Subplanites* and *Usseliceras*, shows that the basin of the extra-Carpathian Poland belonged to the Submediterranean province in the earliest Tithonian times. The genus *Subplanites*, widely distributed in central Europe and regarded as highly typical of the IIIrd area of the European Upper Jurassic, is here proposed as characteristic of the lowermost Tithonian of the Submediterranean province. In the extra-Carpathian Poland, the S. klimovi Zone of the lowermost Tithonian is subdivided here into three subzones. Of these, the youngest, S. postrueppellianus Subzone is characterized by the best paleontological record. The connections of the Polish Lowlands basin with the Tethys appear undoubtful and fairly wide in the earliest Tithonian, and with the north-western European basin—rather impeded. Any direct connections of the Polish Lowlands basin with the eastern zone were broken at that time but some faunistic influences of the south-eastern zone may be traced.

Introduction. The present paper, dealing with stratigraphy and paleozoogeographic nature of post-Upper Kimmeridgian strata in the extra-Carpathian Poland, is based on detail analysis of fauna from numerous drillings in that area (Fig. 1) and partly published data.

In Polish literature it was accepted for quite a long time that in post-Late Kimmeridgian times the Polish Lowlands basin was directly connected with the eastern one and, therefore, faunal influences of the former are strong enough to give the basis for accurate correlation of the post-Upper Kimmeridgian strata with the Volgian zones. However, it should be mentioned that some authors indicated a possibility to correlate these strata with zones typical of the Portlandian, while others suggested that it might be reasonable to differentiate a Polish subprovince as a part of the Subboreal province. The review of literature clearly showed that the presence of southern faunistic elements, i.e. elements typical of the Submediterranean province, was hitherto underestimated. Therefore, no attempts were made to look for evidence for

direct connections between the Polish and southern seas. This changed in 1974 when Kutek and Zeiss [25] reported the presence of ammonites of the genus *Subplanites*, similar to representatives of south German species of that genus.

The above remarks and the available faunistic material justify the assignation of the strata to the Tithonian stage and the use of zonation typical of the Submediterranean province.

Conclusions drawn in stratigraphic papers dealing with the uppermost Jurassic of the extra-Carpathian Poland were usually limited to statements such as "... rocks of the Lower Portlandian occur above the Upper Kimmeridgian...". Such general conclusions were, especially in the case of borehole columns, drawn on the well log data. No attempts were made to introduce subdivision of the strata into biosubzones and correlate them with western European equivalents. Moreover, the faunistic boundary of the Upper Kimmeridgian and younger strata is still awaiting delineation. Therefore, the analysis of these problems seems fully justified.

Analysis of the faunistic material. Rocks of lower parts of the Lower Tithonian with faunistic record appear limited to SW parts of the basin: Mogilno and Łódź Basins, Kujawy Swell, Warsaw Basin, and NW margin of the Holy Cross Mts. (Fig. 1). The rocks here assigned to the S. klimovi Zone were subjected to erosion by the end of the Deister phase (Neocimmerian movements) in the whole extra-Carpathian Poland. The erosion varied in intensity from place to place but sections displaying all the three subzones of the lowermost Tithonian are known from a few drillings only. The most complete section was found in the drilling Kcynia IG 1 (Mogilno Basin—Fig. 2) only. The faunistic record is here very good but I think that neither lower nor upper boundary of the S. klimovi Zone is accurately delineated in that section. The upper boundary may be drawn with some probability at the depth 311.70 m, in a packet of gray-olive marly mudstones with sandy intercalations, phosphatic nodules, glauconite and dispersed mica. The rocks yield fragments of sponges, rich plant detritus and poorly preserved fauna. Delineation of the upper boundary of the S. klimovi Zone at that depth is further supported by comparison of the section with that of the upper part of the Mörnsheim Beds (Franconian Jura). Tha lowermost Tithonian is presumably 21 m thick in that borehole column.

The faunistic material of the lowermost Tithonian from drillings in the Łódź Basin is still waiting for detail analysis. The exception are here ammonites from the drillings Bełchatów 5 and Tuszyn 5 [30] and those recently found in the drilling Zgierz IG 1 (Fig. 3). In the latter case we may speak about fairly good faunistic record.

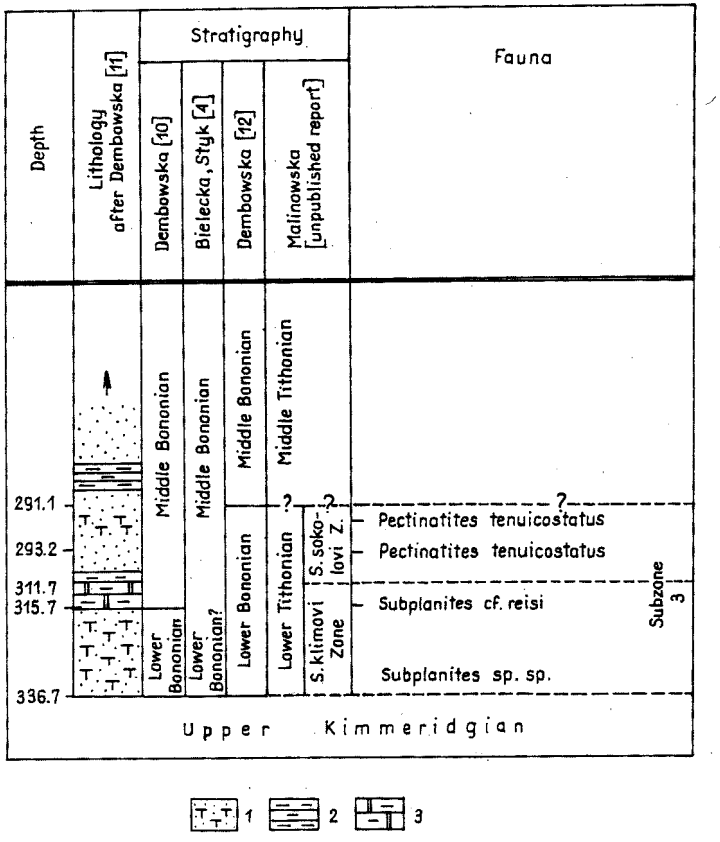


Fig. 2. Biostratigraphic subdivision of the lower part of Lower Tithonian in the borehole column Kcynia IG 1

1—sandstones with marly intercalations, 2—mudstones, 3—dolomite passing into mudstone

The available data indicate that the lack of faunistic record for the lowermost Tithonian from the NW margin of the Holy Cross Mts. may be due to erosion of the strata [22]. The possibility of presence of the strata of the S. klimovi Zone is shown by the record of *Subplanites klimovi* (Ilovaisky et Florensky) from mudstones encountered at the depth of 98 m in the drilling Łęczno 74B near Sulejów [26].

In the Pomeranian Basin the lowermost Tithonian with ammonite record is known from the drilling Biały Bór 2. The ammonites are, however, too poorly preserved for any reliable specific identifications, so it is unclear which

zones are represented here. According to Dembowska [11], the strata were affected by synsedimentary erosion in that area.

In the Kujawy Swell area the strata with faunistic record are known from the drillings Zosin 54/52, Łagiewniki 70/28, Władysławów 18/12, Rogoźno 18/17 and 17.5/18.5, Nowy Antoniew KT-47, Borów K36, and Zagłoba. The record is, however, insufficient for accurate delineation of the Kimmeridgian/Tithonian boundary in these sections. *Subplanites* sp. (ex gr. *schaschkovae*), reported from the drilling Rogoźno 17.5/18.5, indicates the possibility of presence of a higher subzone of the lowermost Tithonian.

At the NE margin of the Holy Cross Mts. the presence of the Lower Tithonian was shown by micropaleontological data only [31]. Basal parts of the Lower Tithonian were also evidenced in the Warsaw Basin (drillings Kamionki 1, Cieszkowo 1, and Nidzica IG 1 [13]). The age is shown by the record of *Subplanites klimovi* (Ilovaisky et Florensky).

Paleontological evidence for the lowermost Tithonian in the Lublin Basin is still missing. Portlandian age was suggested for the Babczyn Fm. in that area [27] on the basis of record of gastropods and ostracods [3]. The fossils [3] are undoubtedly post-Upper Kimmeridgian in age but the record appears insufficient for zonation of the rocks.

In the Peribaltic Depression the Lower Tithonian with ammonite record is known from the drilling Pasłęk IG 1 [14] but the question of presence of its lowermost part remains open.

Biostratigraphy. The differentiation of basal zone of the Lower Tithonian and its subdivision into subzones became possible after detail analysis of stratigraphic ranges of ammonite species known from that part of the section in Europe, especially southern German Jura. This part of the section is characterized in the Submediterranean province of Europe by the following ammonite genera: *Neochetoceras, Aspidoceras, Physodoceras, Glochiceras, Hybonoticeras, Gravesia, Katroliceras, Lithacoceras, Ochetoceras, Streblites, Pterolytoceras, Hoelderia, Taramelliceras, Subplanites, Sutneria, Torquatisphinctes, Pachysphinctes, Subdichotomoceras, Phanerostephanus, Procraspedites, Usseliceras, Pectinatites sensu anglico,* and *Protancyloceras.* Genera such as *Haploceras, Phylloceras, Calliphylloceras, Ptychophylloceras* and *Holcophylloceras* are known from innumerous findings in southernmost parts of the province only.

As it was mentioned above, the lowermost Tithonian was subjected to erosion to a varying degree in the whole extra-Carpathian Poland. That is why the sections are incomplete, the number of ammonite findings limited, and ammonites sufficiently preserved for detail paleontological analysis not numerous. Nevertheless, the material is large enough to indicate the possibilities of subdivision of the strata into subzones.

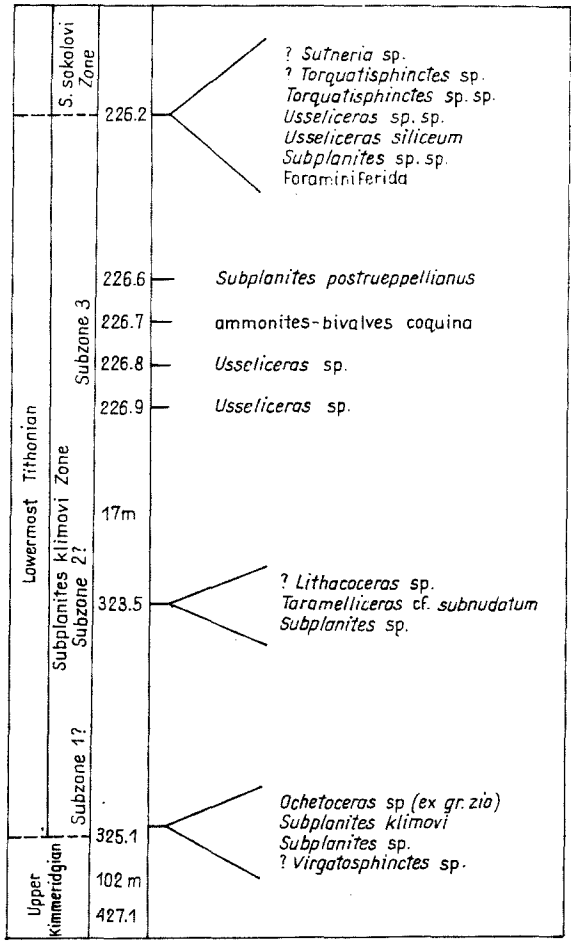


Fig. 3. Biostratigraphic subdivision of the lower part of Lower Tithonian in the borehole column Zgierz IG 1

It appears that the basal zone of the Lower Tithonian of the Submediterranean province should not be named after index species from the genus *Hybonoticeras* but rather of *Subplanites*. The former would be better as index taxon for Mediterranean zonation. The genus *Subplanites* is widely distributed in central Europe and highly characteristic of the area III of the Upper Jurassic in Europe.

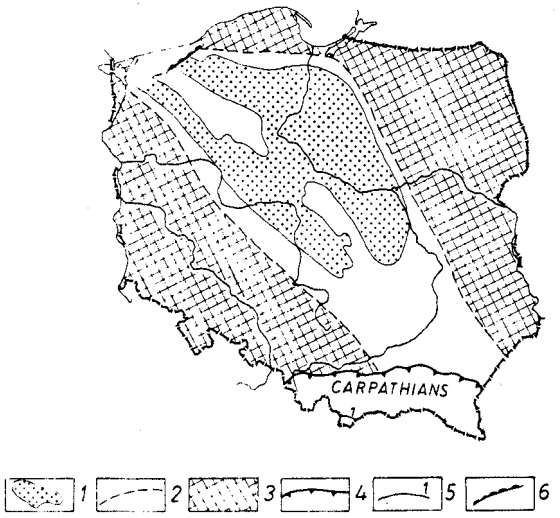


Fig. 4. Extent of sedimentary basin in extra-Carpathian Poland in the earliest Tithonian

1—present extent of rocks. 2—original extent of basin. 3—land areas. 4—Carpathian overthrust. 5—Pieniny Klippen Belt. 6—infraformational erosion

In the extra-Carpathian Poland the strata of the lowermost Tithonian may be assigned to the S. klimovi Zone and further subdivided into three subzones. However, it should be noted that the subzones 1 and 2 are so far traceable in some areas only (Table II).

The Subplanites klimovi Zone. The S. klimovi Zone is taxon-range zone, according to definition characterized by the presence of the index species throughout the whole interval. Its lower boundary (and, at the same time, Kimmeridgian/Tithonian boundary) was drawn on the basis of faunistic record in the borehole column Borów K36. In that column ammonites *Subplanites klimovi* (Ilovayski et Florenski) were found in 19 m interval above those of the genus *Virgataxioceras*. The boundary also appears traceable in the columns Zosin 54/52, Kcynia IG 1, Zgierz IG 1, and Zagłoba. The upper boundary of that zone was accurately drawn in the borehole columns Zgierz IG 1 and Borów K36. Moreover, the record of ammonites with characteristic ribbing in the columns Zosin 54/52 and Rogoźno 17.5/18.5 suggests the possibility to prove the underlying zone and delineate the boundary. The data concerning the position of the base of the S. klimovi Zone are usually fragmentary, which makes estimation of thickness difficult. The zone appears 19 m thick in the borehole column Borów K36, 25 m in Kcynia IG 1, about 36 m in Zagłoba, and about 100 m thick in Zgierz IG 1.

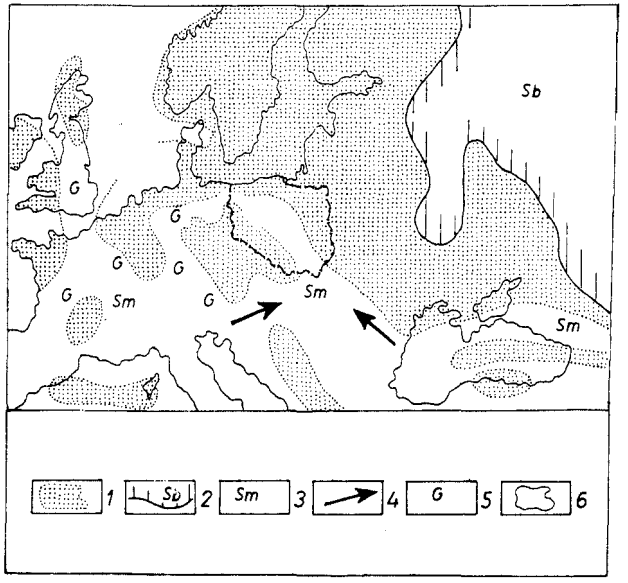


Fig. 5. A tentative reconstruction of connections of basins in the Submediterranean province in the earliest Tithonian

1—land areas. 2—Subboreal province. 3—Submediterranean province. 4—routes of migration of fauna. 5—*Gravesia*. 6—outline of land areas

In the extra-Carpathian Poland the zone is usually represented by mudstone-marly and often sandy rocks. The zone may be correlated with the H. hybonotum and G. lithographicum zones of the Submediterranean zonation used in western Europe. Similarities of ammonite fauna are especially visible when we compare Polish collections and those from more marly sequences in the Swabian Jura.

Subzone 1. Ammonites indicating the possibility to differentiate subzone 1 were found in the drilling Zgierz IG 1 (depth 325.1 m). The recorded assemblage comprises fragmentary specimens of *Subplanites* spp., *Ochetoceras* sp. (ex gr. *zio*), *Subplanites klimovi* (Ilovaisky et Florensky) and *?Virgatosphinctes* sp. The record of *Ochetoceras* sp. (ex gr. *zio*) is here most important as it may prove that we are dealing with the basal Lower Tithonian [2]. The genus *Virgatosphinctes* is mainly known from the Upper Kimmeridgian but some species also occur in younger rocks [16], e.g. *Virgatosphinctes supinus* (Schneid). The specimen from the borehole column Zgierz IG 1 (depth 325.1 m) suggests proximity of the Kimmeridgian/Tithonian boundary. It seems that the subzone 1 may also be traceable in the borehole column Borów K36, where

TABLE I

List of ammonite species recorded in rocks of the S. klimovi Zone in the extra-Carpathian Poland

Species	U. Kimmeridgian	Lowermost Tithonian: S.klimovi Zone, subzones 1	2	3	S.sokolovi zone	Occurrence (borehole—depth)
Hybonoticeras pressulum subsp. B, Berckhemer, Hölder (tab. V, fig. 7)	+					Ł-771.1
Hybonoticeras hybonotum autharis (Oppel) (tab. V, fig. 3, 4)	+					Ł-771.1
Virgataxioceras sp.	+					$R_{16/21}$-84.8
Ochetoceras sp. (*ex gr zio*) (tab. I, fig. 2)		+				Z-325.1
? *Virgatosphinctes* sp.		+				Z-325.1
Subplanites sp. sp.		+	+	+		$R_{18/17}$-66.5;68.7 Z-226.2;323.5; 325.1 K-336.7
Subplanites klimovi (Ilovayski, Florenski)		+	+	+		Zś-101.2 Łg-91.5 Br-359.0 Zg-298.0 Z-325.1 Łę-98.0 B_5-771.0-778.0
Taramelliceras cf. *rebouletianum fridigense* (Berckhemer, Hölder)			+			B_5-778.0-789.0
Taramelliceras cf. *subnudatum* (Fontannes) (tab. V, fig. 5, 6)			+			Z-322.5
Taramelliceras wepferi (Berckhemer) (tab. V, fig. 1, 2)			+			$R_{17.5/19}$-90.0
Hybonoticeras sp.			+			B_5-771.0 — 778.0
? *Lithacoceras* sp.			+			Z-323.5
Ochetoceras cf. *irregulare gracile* Berckhemer, Hölder			+			B_5-765.0 — 771.0
? *Sutneria* sp.				+		Z-226.2
Subplanites irregulare Ohmert, Zeiss				+		$R_{18/17}$-66.5;68.1;71.0 $R_{17.5/18.5}$-61.0
Subplanites kokeni (Behrendsen)				+		Zś-103.1 L-108.7
Subplanites cf. *reisi* (Schneid)				+		K-315.5
Subplanites postrueppellianus Ohmert, Zeiss				+		Z-226.6
Usseliceras siliceum (Quenstedt)				+		Z-226.2
Usseliceras sp. sp.				+		Zś-102.6;W-105.6;NA-81.6 Z-226.2 226.8 226.9
Torquatisphinctes cf. *laxus* Ohmert, Zeiss (tab. II, fig. 1)				+		$R_{17.5/18.5}$-71.0
? *Torquatisphinctes* sp.				+		Z-226.2
Torquatisphinctes sp. sp.				+		Z-226.2
Subplanites sp. (*ex gr* schaschkovae)					+	$R_{17.5/18.5}$-59.5

Boreholes: Ł — Łowicz IG 1, Z — Zgierz IG 1, R — Rogoźno, B — Bełchatów, Zg — Zagłoba, W — Władysławów 18/12, Zś — Zosin 54/52, Łg — Łagiewniki 70/28, Br — Borów K 36, Łę — Łęczno 74 B, L — Lubrańczyk 54/51, K — Kcynia IG 1, NA — Nowy Antoniew KT-47.

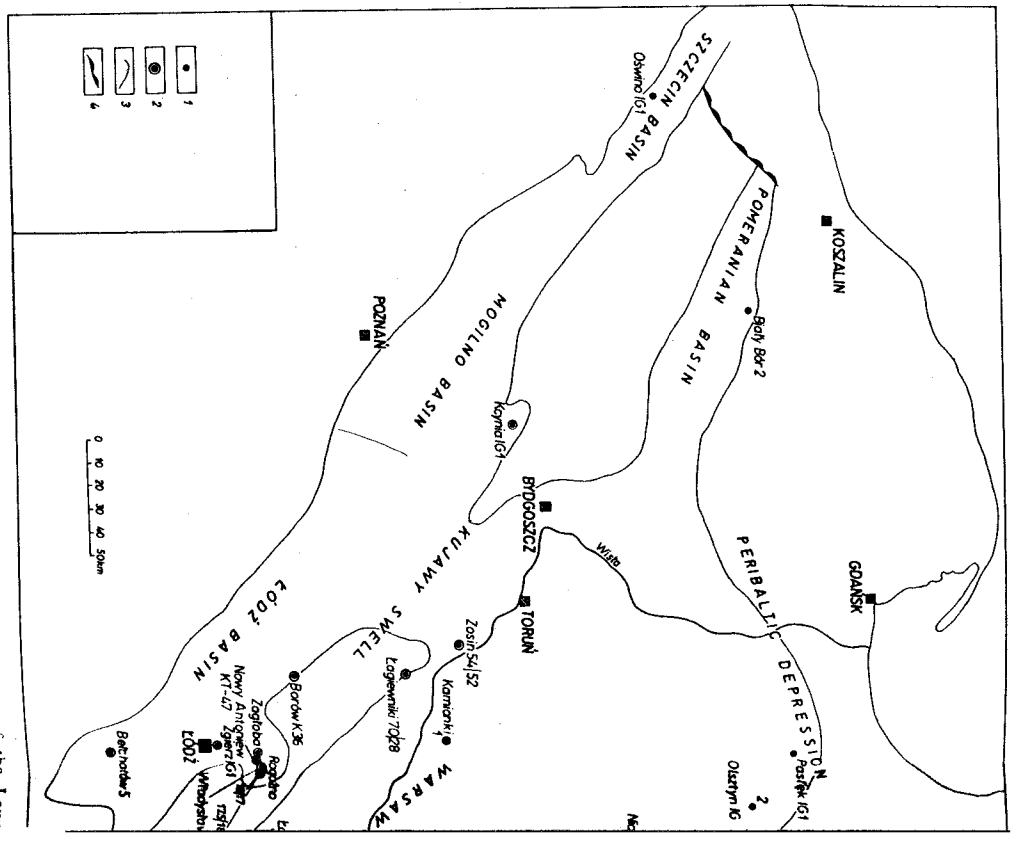


Fig. 1. Location map of drillings encountering rocks of the lowermost zone of the Lowe the basin simplified)

1—drillings, 2—drillings with record of fauna of the lowermost zone of the Lower Tithonian, 3—present extent of Lowe national erosion

TABLE II

Subdivision of the lowermost Tithonian in the Submediterranean province

SE France	Southern FRG			Extra-Carpathian Poland			SE Caucasus USSR
		Franconian Jura	Swabian Jura				
Zones	Zone	Subzones	Beds	Zone	Subzones		Zone
Glochiceras lithographicum	Hybonoticeras hybonotum	Subplanites mömsheimense	Hangende Bankkalk	Subplanites klimovi	3	Subplanites postrueppellianus	Lithacoceras ulmense and Glochiceras lithographicum
		Subplanites rueppellianus	Zementmergel		2		
		Lithacoceras riedense	Ulmensis Schichten		1		

the upper boundary of the Kimmeridgian was drawn at the depth of 338.0 m (borehole column as compiled by S. Marek and S. Z. Różycki).

Rocks of subzone 1 also yield representatives of *Scurria maeotis* (d'Orbigny), *Ostrea* cf. *plastica* Trautschold, *Isognomon* sp. and numerous *Astarte* spp.

Subzone 2. This subzone may be defined by the presence of ammonites *Taramelliceras* cf. *subnudatum* (Fontannes), *Subplanites* sp. and *?Lithacoceras* sp., found in the drilling Zgierz IG 1 (depth 325.50). The subzone may also be shown by the record of *Subplanites* sp. in the drilling Kcynia IG 1 (on account of its position in that borehole column), and *Taramelliceras wepferi* (Berckhemer et Hölder), *Subplanites klimovi* (Ilovaisky et Florensky), *Ochetoceras* cf. *irregulare gracile* Berckhemer et Hölder and *Taramelliceras* cf. *rebouletianum* fridingense Berckhemer et Hölder in the drilling Bełchatów 5.

Subzone 3 (Subplanites postrueppellianus Subzone). Subzone 3 is characterized by a better paleontological record than the two remaining ones. It was differentiated in the drillings Kcynia IG 1, Zosin 54/52, Rogoźno 17.5/18.5, and Zgierz IG 1. Its lower boundary still remains to be delineated whereas the upper one was firmly established in the drilling Rogoźno 17.5/18.5, where ammonites of the species *Subplanites* sp. (ex gr. *schaschkovae*), typical of the overlying zone, were found above those of subzone 3. Ammonites with ribbing typical of the assemblage of the younger zone were also found in material from drillings Zosin 54/52 and Zgierz IG 1.

Subzone 3 has also a better ammonite record than the two older subzones. It is characterized by ammonites of the genera *Subplanites*, *Usseliceras* and *Torquatisphinctes*. Attention should be paid to *Subplanites reisi* (Schneid), the range of which is limited to the youngest subzone in the Franconian Jura

[37]. The ammonite assemblage of subzone 3 allows for accurate correlation with the so-called Hangende Bankkalk of Swabian Jura and the S. moernsheimense subzone of Franconian Jura. In Europe this part of the section is characterized by exceptionally good faunistic record and it is widely assumed that there are no difficulties in its identification.

Ammonite assemblage of subzone 3 especially resembles that of Hangende Bankkalk from Swabian Jura in the presence of *Subplanites postrueppellianus* Ohmert et Zeiss. According to creators of that species [29], it forms the bulk of representatives of *Subplanites* in Hangende Bankkalk whereas only its close relatives are found in Franconian Jura. The specimen of *S. postrueppellianus* Ohmert et Zeiss from the drilling Zgierz IG 1 is almost identical as that described and figured for the first time by Ohmert and Zeiss [29]. Therefore, it appears fully justified to choose this species as an index for subzone 3.

The assemblage also comprises specimens resembling those of *S. irregulare*, also first described from Swabian Jura by Ohmert and Zeiss [29]. Such specimens were found in material from drillings in the Rogoźno area. Moreover, there occur some specimens here assigned to the genus *Usseliceras*. The question of the presence of representatives of this genus in the corresponding subzone in Swabian Jura was open and the identifications made so far—rather imprecise [17]. However, Zeiss showed in 1968 [37] that the species *Usseliceras siliceum* (Quenstedt) is represented by typical forms in the Hangende Bankkalk (Natheim) in Swabian Jura only.

Other ammonites of this assemblage comprise specimens assigned to the genus *Torquatisphinctes*. The genus *Sutneria* is represented by a single specimen from the drilling Zgierz IG 1 (depth 266.2 m). The presence of the latter indicates possibilities of correlation of the strata and those of other parts of central and western Europe [18].

Paleozoogeographic remarks. The available faunistic data are rather insufficient for drawing any unequivocal conclusions concerning the development of the basin in extra-Carpathian Poland in the earliest Tithonian. At that time tectonic movements resulted in shallowing of the basin, which explains erosion and infraformational scourings noted by Dembowska [11]. The erosion, varying in extent from place to place, also resulted in destruction of fossils—the only undoubtful indicators of age. Nevertheless, the fauna gathered so far is fairly numerous and gives the basis for reconstructing sedimentary environments and connections with other basins. Here R. Trümpy is worth citing: "A bad fossil is more valuable than a good working hypothesis".

In the earliest Tithonian the Polish basin became clearly narrower than in the Kimmeridgian (Fig. 4). I fully accept the point of view of Kutek [4] that the connections between the basin and Carpathian sea were not limited

to the Dnestr area and the whole Holy Cross Mts. region was flooded. The southern influences are already traceable in the Upper Kimmeridgian. This is evidenced by the record of *Hybonoticeras pressulum* subsp. indet. *B* (Berckhemer et Hölder) (see Pl. V, Fig. 7). *Hybonoticeras hybonotum autharis* (Oppel) (Pl. V, Figs. 3, 4) and other species in the drilling Łowicz IG 1.

According to some authors [38], Tethyan elements were reaching central parts of the Polish Lowlands basin at that time through Podolia and NE

PLATE 1

1—*Subplanites klimovi* (Ilovayski et Florenski), nat. size, borehole Zgierz IG 1, depth 325.10 m, MUZ PIG 1580.II.1; 2—*Ochetoceras* sp. (ex gr. *zio*), nat. size, borehole Zgierz IG 1, depth 325.10 m, specimen lost; 3—*Subplanites* sp. (ex gr. *schaschkovae*), nat. size, borehole Rogoźno 17.5/18.5, depth 59.5 m, MUZ PIG 1580.II.3, the S. sokolovi Zone; 4—*Subplanites postrueppellianus* Ohmert et Zeiss, nat. size, borehole Zgierz IG 1, depth 226.6 m, MUZ PIG 1580.II.4

All specimens come from the S. klimovi Zone, otherwise stated

PLATE 2

1—*Torquatisphinctes* cf. *laxus* Ohmert et Zeiss, somewhat reduced, borehole Rogoźno 17.5/18.5, depth 71.0 m, MUZ PIG 1580.II.5; 2—*Subplanites irregulare* Ohmert et Zeiss, nat. size, borehole Rogoźno 18/17, depth 66.5 m, MUZ PIG 1580.II.6; 3, 5—*Subplanites* cf. *reisi* (Schneid), nat. size, 3—left side, 5—right side, borehole Kcynia IG 1, depth 315.7 m, MUZ PIG 465, II, 449a, b; 4—*Subplanites klimovi* (Ilovaisky et Florensky), nat. size, borehole Zgierz IG 1, depth 325.10 m, MUZ PIG 1580.II.7

PLATE 3

1–6—*Usseliceras* sp. sp., borehole Zgierz IG 1, 1—right side, 2—left side, ×2, depth 226.2 m, MUZ PIG 1580.II.8, 3—positive, 4—negative, nat. size, depth 226.8 m, MUZ PIG 1580.II.9, 5—negative, 6—positive, nat. size, depth 226.9 m, MUZ PIG 1580.II.10, the S. klimovi Zone

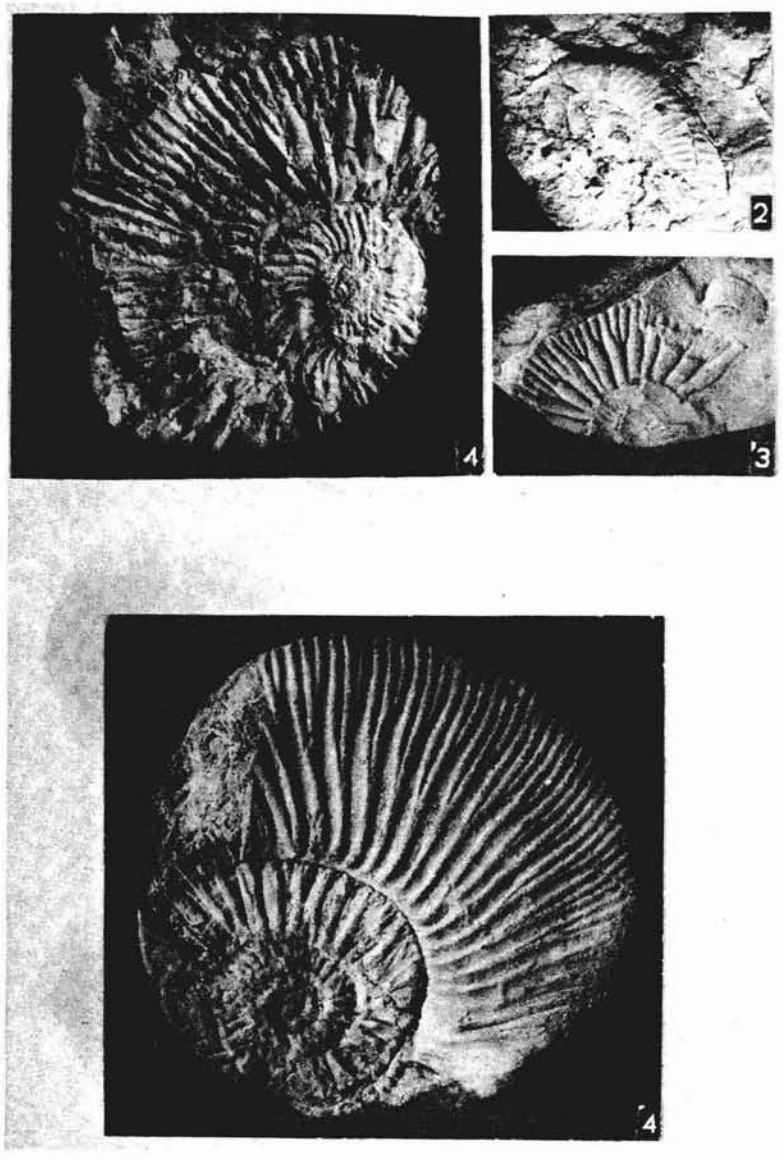
PLATE 4

1—coquina formed of fragments of shells of bivalves (*Astarte*, *Corbula* and others) and ammonites (*Usseliceras*), nat. size, borehole Zgierz IG 1, depth 226.2, MUZ PIG 1580.II.11, the S. klimovi Zone; 2—*Usseliceras siliceum* (Quenstedt), b—negative, nat. size, a—fragment of whorl, ×2, borehole Zgierz IG 1, depth 226.2 , MUZ PIG 1580.II.12, the S. klimovi Zone

PLATE 5

1, 2—*Taramelliceras wepferi* (Berckhemer), ×2, borehole Rogoźno 17.5/19, depth 90.0 m, MUZ PIG 1580.II.13, the S. klimovi Zone; 3, 4—*Hybonoticeras hybonotum autharis* (Oppel), ×2, borehole Łowicz IG 1, depth 771.1 m, MUZ PIG 1580.II.14, Upper Kimmeridgian; 5, 6—*Taramelliceras* cf. *subnudatum* (Fontannes), ×2, borehole Zgierz IG 1, depth 323.5 m, MUZ PIG 1580.II.15, the S. klimovi Zone; 7—*Hybonoticeras pressulum* subsp. *B* Berckhemer et Hölder, ×2, borehole Łowicz IG 1, depth 771.1 m, MUZ PIG 1580.II.16, Upper Kimmeridgian

PLATE 1



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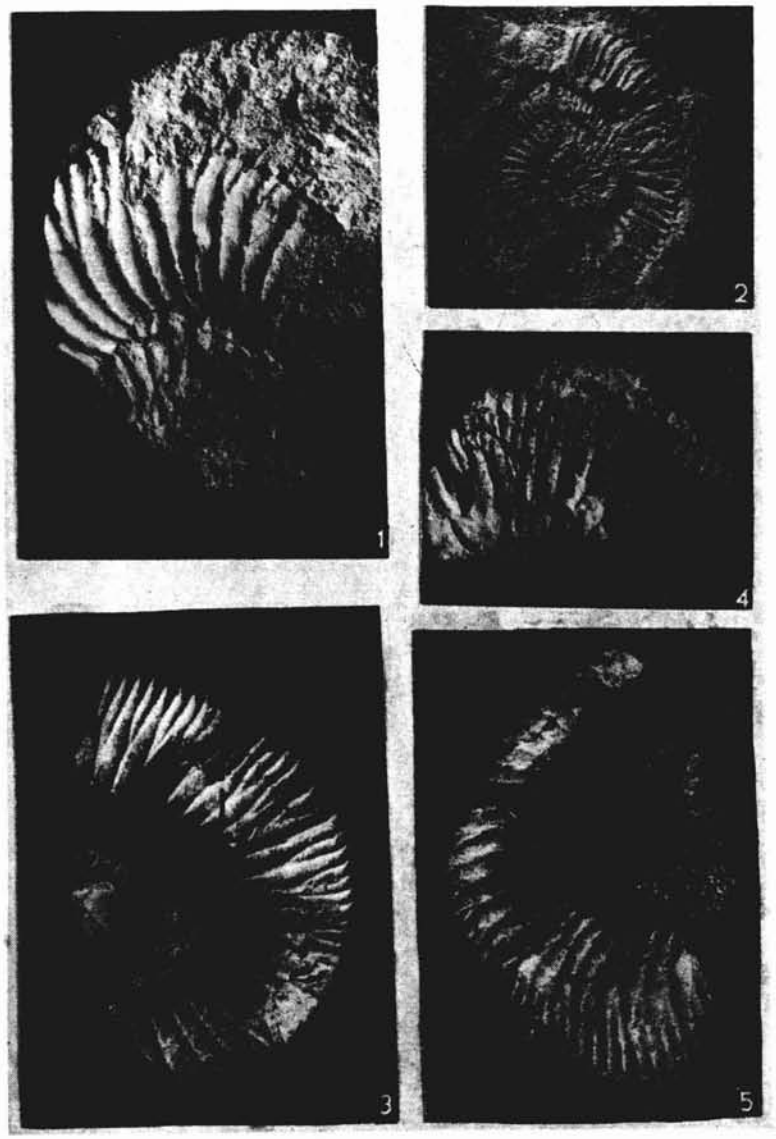

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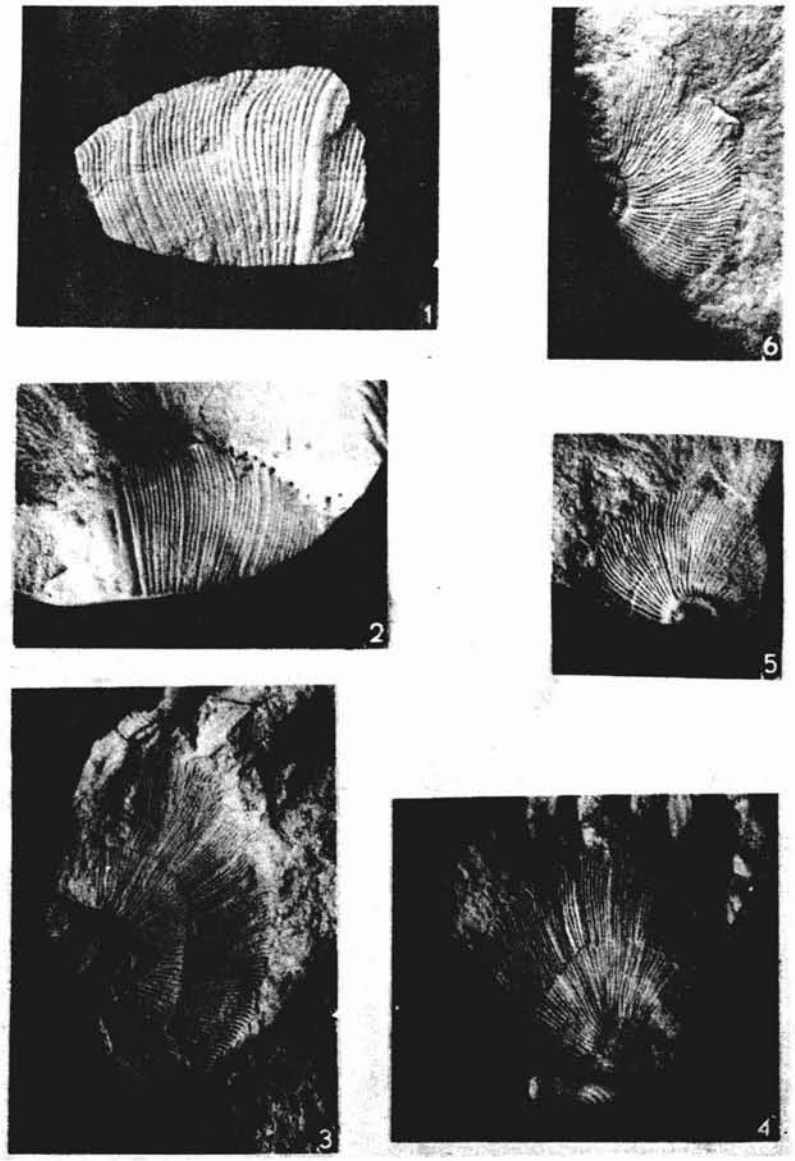
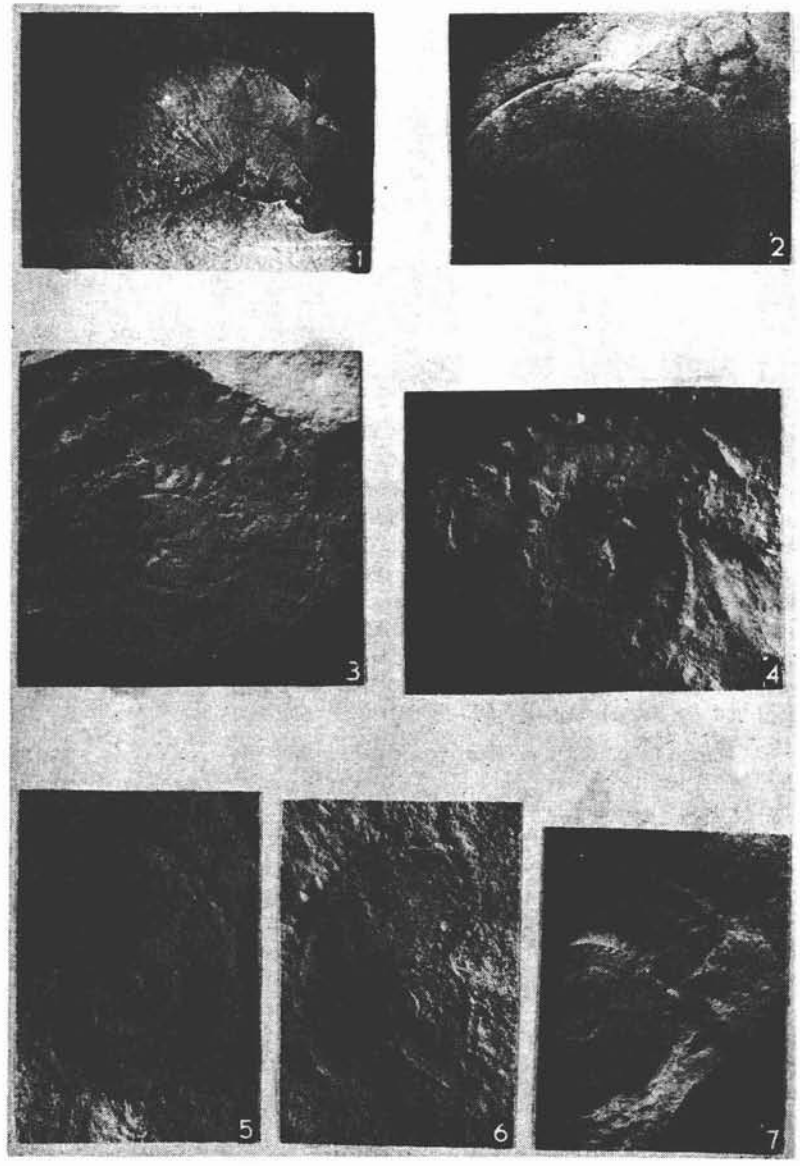


PLATE 4

PLATE 5



margin of the Holy Cross Mts., and according to others [9]—Tethyan fauna was coming to the Danish–Polish basin through the Miechów Basin and Przemyśl Gate. Dembowska [11] indicated independent migration routes of Boreal and Tethyan fauna to the Polish Lowlands basin. The former was coming to the basin from the north, through the North Sea and narrow northern Denmark strait, which is supported by the fauna found in Danish drillings (*Pavlovia* and *Aucella*). Such an interpretation may be valid for the Middle Tithonian as the fauna indicates such age. However, it cannot be treated as the basis for reconstruction of migration routes for the whole time interval including the earliest Tithonian. Niemczycka and Brochwicz-Lewiński (1985MS) hold that the migration routes are nowadays difficult to reconstruct and debatable. The studies on Upper Jurassic foraminifers showed [4] that there was no direct connection between the basins of the extra-Carpathian Poland and East-European Platform. The last representatives of the southern genus *Everticyclammina* are found in western and central Poland in the lowermost Lower Tithonian which may evidence still existing Tethyan influences in these times in areas situated so far to the north. A similar opinion was expressed by Pachucki [30].

In the literature the area of extra-Carpathian Poland was often treated as a part of the Subboreal province in the Early Tithonian. Taking into account various lines of evidence Zeiss [37] stated that at that time there existed direct connections between central European and East-European Platform basins across Poland and assigned the latter area to that province as Polish subprovince. Subsequently, Hölder [20] noted that this subprovince displays eastern as well as Submediterranean influences. Direct connections between the Polish and Russian basins in the Early Tithonian were also accepted by French authors [8].

My analysis of the available data showed that the connections between the Polish Lowlands basin and the Tethys were unquestionable and wide in the earliest Tithonian. In turn, those between the former and the northwestern sea were rather limited and with the northern and eastern seas—non-existing (Figs. 4, 5) but some faunistic influences of the south-eastern zone (NE Caucasus) are clear. The nature of faunistic assemblages shows that the extra-Carpathian Poland should be treated as a part of the Submediterranean province in the earliest Tithonian. It appears that this part of Poland belonged at that time to the area III of the Upper Jurassic of Europe (see [33]). At the beginning of the Tithonian the extent of that province was narrower in relation to the Mediterranean province. It is characterized mainly with reference to classic sections of the Swabian Jura, Franconian Jura, and those of SE France, and it could also comprise a limited area in western Bulgaria [33] and NE Caucasus [32, 34]. Its faunistic assemblage comprises numerous representatives of the families *Perisphinctidae*, *Aspidoceratidae* and *Oppeliidae*.

In more southern parts, phylloceratids are also sometimes found whereas *Lytoceratidae* seem completely absent.

It is also worth noting that the genus *Gravesia* appears so far unknown from extra-Carpathian Poland. It mainly occurs in the upper parts of the H. hybonotum zone [1, 37] so it should be also present in Poland where the equivalent strata have fairly good paleontological record. Its lack may be explained in two ways. It may be due to the fact that the available sections of strata of that age are fragmentary and not numerous in Poland. This lack may be the effect of failure in collecting, as good connections between the Polish basin and those of Swabian and Franconian Jura indicate that this genus should also be present here. The other solution, perhaps more probable, is connected with a somewhat shallower character of sublittoral basin in Poland. This was an area of origin of silty-marly and often sandy sediments, often with glauconite and plant detritus and, therefore, rather unfavourable for ammonites of the genus *Gravesia*. The latter explanation seems to be supported by the fact that records of these ammonites usually come from areas where the relevant strata are represented by thin or thick-bedded limestones and marls, i.e. formed in a somewhat deeper basin.

The genus *Gravesia* focused much attention as its distribution appears limited to western Europe (Fig. 5) and any new records outside that area would contribute to the knowledge of its endemism. Ammonites of this genus are very rare in lower parts of the H. hybonotum zone in the Swabian Jura as well as the Franconian Jura whereas it is nowadays clear that the upper part of that zone displays the peak in their development. That is why Ohmert and Zeiss [29] are inclined to treat the latter interval as the Gravesia gigas Acme zone *sensu* Hedberg [19]. Representatives of *Gravesia* are also known from some areas in the south: Switzerland, Western Alps and Spain.

The genus *Usseliceras*, here reported for the first time from Poland, is very important for solving several paleozoogeographic questions. The earliest, single representatives of that genus, characterized by highly involute coiling, appear (see [37]) in the Mörnsheim Beds which correspond to the Subzone 3. The finding of ammonites of the genus *Usseliceras* in Poland may indicate connections between the Swabian–Franconian region and NE Caucasus through that area.

The presence of individuals of the genera *Taramelliceras* and *Ochetoceras* in the Polish sections confirms close connections with the southern sea. Several published reports show that fragmentary specimens of *Oppeliidae* are very common here. Moreover, there were reported some species indicating mainly contacts with the Swabian basin.

Attention should also be paid to conclusions drawn by Vašiček [35] from his studies on exotic blocks from the flysch section in a quarry at Roštin near Kromèriž (Gottwaldov area, Czechoslovakian Outer Carpathians). From these blocks he reported *Usseliceras* (*U.*) cf. *parvinodosum* Zeiss.

Neochetoceras mucronatum Berckhemer et Hölder. *Streblites (S.) folgariacus* (Oppel). *Parastreblites circumnodesum* (Fontannes). *Glochiceras* (P.) *lithographicum* (Oppel). *Haploceras carachteis* (Zejszner). *H. elimatum* (Oppel) and numerous *Calliphylloceras*. *Ptychophylloceras*. *Sowerbyceras*. and *Hypophylloceras*. The whole assemblage was assigned to the Mediterranean province. This may be a good solution but he decided to use zonation typical of the Franconian Jura, i.e. the area belonging to the Submediterranean province.

The basin of NE Caucasus, formerly treated as a part of the Subboreal province in the Early Tithonian times, has recently been assigned to the Submediterranean province. This approach [32, 34] was confirmed by new findings of ammonites: *Neochetoceras praecursor* Zeiss. *Lithacoceras ulmense* (Oppel). *Glochiceras* aff. *lithographicum* (Oppel). *Hybonoticeras* sp.. *Taramelliceras* cf. *prolithographicum* (Fontannes), *Lithacoceras albulum* (Quenstedt) and *L. siliceus paraboliferum* Berckhemer.

In conclusion it should be said that connections between the Submediterranean Polish basin and the Tethys were undoubtful. The detail studies of fauna of the Czorsztyn unit in the Pieniny Klippen Belt [32, 34, 28, 36, 6] were fairly important for evaluation of these connections. Rocks of the Czorsztyn unit originated in geosynclinal basin far in the south to be subsequently transported to their present position as a result of tectonic processes [7]. The ammonite assemblage comprises [24] relatively numerous specimens of genera, subgenera and species also known from European cratonic areas belonging to the Submediterranean province.

Descriptions of selected species of ammonites.

The collection of fauna discussed here is housed in the Museum of the State Geological Institute, Warsaw (collection MUZ PIG 1580.II).

Order Ammonitida Zittel, 1884
Family Perisphinctidae Steinmann, 1890
Genus *Subplanites* Spath, 1925
Subplanites irregulare Ohmert et Zeiss, 1980
(Pl. II, Fig. 2)

1959 *Perisphinctes (Lithacoceras)* cf. *pubescens* (Schneid); F. Berckhemer, H. Hölder, p. 56, pl. 11, figs. 54, 55.
1980 *Lithacoceras (?) (Subplanites?) irregulare* n. sp.; W. Ohmert, A. Zeiss, p. 33, pl. 12, fig. 4.

Collection. MUZ PIG 1580.II.6.

Description. Specimens small, with narrow umbilicus and irregular ribbing. Ornamentation consisting of bifurcate ribs with point of furcation situated close to umbilical margin or in the middle of whorl height or at external part of the whorl, and single and polygyratic as well as merged ribs.

Occurrence. The type species comes from the uppermost, H. hybonotum zone. Polish specimens were found in the S. klimovi Zone (subzone 3) in drillings from the Kujawy Swell area.

Subplanites klimovi (Ilovaisky et Florensky, 1941)
(Pl. I, Fig. 1; Pl. II, Fig. 4)

1941 *Ilovaiskya klimovi* sp. n.: D. I. Ilovaisky, K. P. Florensky, p. 100, pl. 21, fig. 40.
1973 *Subplanites klimovi* (Ilovaisky et Florensky): J. Dembowska, p. 60, pl. I, figs. 2, 5, 6 (*cum synonimica*).
1979 *Subplanites klimovi* (Ilovaisky et Florensky): J. Małecki, p. 39, pl. I, fig. 1.

Collection. MUZ PIG 1222.II.39, 40; MUZ IG 1223.II.37; MUZ PIG 1580.II.1, 7.

Remarks. The importance of that species is connected with the fact that it makes possible correlation of the relevant strata of central Europe and East-European Platform. A marked morphological similarity of specimens of the *Subplanites klimovi* group to those of the "*rueppellianus*" group, known from the southern German Jurassic, was emphasized already by Ilovaisky and Florensky [21] and subsequently Zeiss [37].

Occurrence. The type specimen comes from the Bierdianka River valley section (region between the Ural and Ilek Rivers, USSR). In Poland, this species is known from drillings in the Kujawy Swell area, Łódź Basin, and northern part of NW margin of the Holy Cross Mts. Moreover, poorly preserved specimens presumably belonging to this species were found in the drillings Cieszkowo 1 and Nidzica, Warsaw Basin. Zeiss [37] reported a form affined to *S. klimovi* (Ilovaisky et Florensky) from the Mörnsheim Beds (corresponding to the uppermost H. hybonotum zone) from the Franconian Jura.

Subplanites kokeni (Behrendsen, 1891)

1973 *Subplanites kokeni* (Behrendsen); J. Dembowska, p. 61, pl. II, figs. 1, 2, 5 (*cum synonimica*).

Collection. MUZ IG 1222.II.25, 45; MUZ IG 1224.II.20.

Occurrence. The specimens were found in the S. klimovi zone (subzone 3) in drillings from the Kujawy Swell area.

Subplanites postrueppellianus Ohmert et Zeiss, 1980
(Pl. I, fig. 4)

1980 *Lithacoceras (Subplanites) postrueppellianum* n. sp.; W. Ohmert, A. Zeiss, p. 29, pl. 13, figs. 1–3; pl. 14, fig. 1.

Collection. MUZ PIG 1580.II.4.

Description. A fragment of specimen about 120 mm in diameter. Outer whorl with well preserved sculpture: sculpture poorly visible on inner whorls. Whorls high ovate in cross-section, with somewhat convex sides;

umbilicus fairly wide and flat, with indistinct margin. Outer whorl ornamented mainly with polygyrate ribs; bifurcate ribs rare.

Occurrence. The type specimen comes from limestones of the upper subzone of the H. hybonotum zone. According to the creators of this species, it comprises the bulk of representatives of the genus *Subplanites* in the Hangende Bankkalk (Swabian Jura) whereas only its close relatives may be found in the Franconian Jura. In Poland it was found in the S. klimovi zone (subzone 3) in the Łódź Basin.

Subplanites cf. *reisi* (Schneid, 1915)
(Pl. II, Figs. 3, 5)

Collection. MUZ IG 465.II.449a, b.

Description. A fragment of a relatively large specimen, somewhat deformed, probably representing body chamber. Ribs mainly bifurcate, accompanied by single and polygyrate ones.

Occurrence. The specimen was found in the S. klimovi zone (subzone 3) in the Mogilno Basin.

Subplanites sp. (ex gr. *schaschkovae*)
(Pl. I, Fig. 3)

Collection. MUZ PIG 1580.II.3.

Remarks. Whorl sculpture very closely resembles that of specimens of *Subplanites schaschkovae* (Ilovaisky et Florensky, 1941).

Occurrence. The specimen was found in the younger zone in the Kujawy Swell area.

Genus *Usseliceras* Zeiss, 1968)

This genus (type species—*U. franconicum* Zeiss, 1968), comprises both macro- and microconchs. Microconchs display ornamentation with dichotomous ribs as well as polygyrate and bidichotomous ones. Merged ribs are missing. Outer part of inner whorls often flattened or with furrow.

Stratigraphic range of the genus *Usseliceras* still remains to be precised. Some authors state that the earliest representatives occasionally appear in the upper parts of the H. hybonotum zone [37] and others—that species of this genus first appear in the upper part of the H. beckeri zone (Upper Kimmeridgian) of Spain [15].

Usseliceras sp. sp.

1968 *Usseliceras* Zeiss; A. Zeiss, p. 52. (Pl. III, Figs. 1–6)
1973 *Pectinatites* sp. (*a*); J. Dembowska, p. 63, pl. III, fig. 7.
1973 *Pectinatites* sp. (*b*); J. Dembowska, p. 64, pl. III, figs. 8–10.
1973 *Pectinatites (Pectinatites)* cf. *boidini* (de Loriol); J. Dembowska, pl. III, fig. 4.
1973 *Subplanites* sp. (cf. *klimovi*); J. Dembowska, pl. I, fig. 3.

Collection. MUZ IG 888.II.19; MUZ IG 925.II.102; MUZ IG 1222.II.26, 44; MUZ PIG 1580.II.8, 9, 10.

Description. Shell small with very narrow umbilicus. Umbilical margin rounded. Outer whorl, as visible on several separate fragments, with flattening typical of this genus. Ribs very densely spaced, bidichotomous (with branching point somewhat above umbilical margin) and polygyrate (with point of branching situated below the midheight), bent forward. Constrictions well visible.

Remarks. The specimens described and figured here match the diagnosis of representatives of the genus *Usseliceras* which are known from older strata.

Occurrence. The specimens come from the S. klimovi zone (subzone 3) in the Kujawy Swell area and Łódź Basin.

Usseliceras (Subplanites) siliceum (Quenstedt, 1857)
(Pl. IV, Fig. 2a, b)

Collection. MUZ PIG 1580.II.12.

Description. Shell small, strongly flattened, involute, with high whorls. Ribs closely spaced, single, dichotomous, branching in the midheight, and bidichotomous, branching somewhat above umbilical margin. One polygyrate rib was also found. Ribs bent forwards, becoming somewhat wavy in the middle part of sides of the last whorl. Constrictions shallow and poorly visible.

Remarks. The specimen differs somewhat from the type specimen in wavy course of ribs in the middle part of sides of the outer whorl.

Occurrence. The specimen comes from the S. klimovi zone (subzone 3) in the Łódź Basin.

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Л. Малиновска, **Биостратиграфия и палеозогеография нижней части титона позакарпатской Польши**

Анализ макрофауни, в особенности аммонитов рода *Subplanites* и *Usseliceras* показал, что бассейн позакарпатской Польши принадлежал в самом нижном титоне к субмедитеранской провинции. Род *Subplanites* который широко распространяется в Европе, а для III района верхней юрской системы Европы является очень характерным, предложено настоящей работой как род показателя для самого нижнего титона субмедитеранской провинции. В пределе самого нижнего титона в позакарпатской Польше выделены три субзоны в пределе зоны *S. klimovi*. Особенно самая младшая субзона *S. postrueppellianus* является наилучше удокументированная. Соединение низинного бассейна Польши с Тетидой, находилось в самом низком титоне, было несомненное и широкое, а с северо-западном морем затрудненное, с северным и восточным морем непосредственного соединения не было. Установлены зато фаунистические влияния из юго-восточной зоны.