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Ammonite Stratigraphy of the Upper Jurassic in Bulgaria. IV. Tithonian: Substages, Zones and Subzones

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И. Г. Сапунов — Аммонитовая стратиграфия верхней юры в Болгарии. IV. Титонский ярус: подъярусы, зоны и подзоны. Болгарские Ammonitina титонского яруса принадлежат к семействам Haploceratidae, Glochiceratidae, Perisphinctidae, Aspidoceratidae, Berrisellidae и Olcostephanidae. На основании установленных закономерностей в их стратиграфическом распространении на территории Болгарии, разработана схема аммонитовых Oppel-зон:

Верхний титонский подъярус —
зона *Paraulacosphinctes transitorius*
Средний титонский подъярус —
зона *Parapallasiceras* spp.
зона *Virgatosimoceras rothpletzi*
Нижний титонский подъярус —
зона *Franconites vimineus*
зона *Subplanitoides schwertschlageri*
зона *Hybonoticeras hybonotum*

В верхней части зоны *H. hybonotum* выделена подзона *Subplaninites moernsheimensis*, а в верхней части зоны *F. vimineus* выделена подзона *Franconites pseudojubatus*. Зона *P. transitorius* расчленена на две подзоны: верхняя — подзона *Malbosiceras chaperi* и нижняя — подзона *Himalayites (Micracanthoceras) microcanthus*.

Приведены сведения об индексном виде и номенклатуре (по болгарской литературе) каждого поделения, определены границы и сообщены характерные виды. Приведены данные о распространении (под)зон в Болгарии, сделаны биокорреляции.

Abstract. The Tithonian Ammonitina in Bulgaria belong to the following families: Haploceratidae, Glochiceratidae, Perisphinctidae, Aspidoceratidae, Berriasellidae and Olcostephanidae. On the basis of the regularities found in their successions in this country, the following scheme of Oppel-zones is worked out:

Upper Tithonian —
Paraulacosphinctes transitorius Zone
Middle Tithonian —
Parapallasiceras spp. Zone
Virgatosimoceras rothpletzi Zone
Lower Tithonian —
Franconites vimineus Zone

Subplanitoides schwertschlageri Zone
Hybonoticeras hybonotum Zone

In the upper part of the *H. hybonotum* Zone the *Subplanites moernsheimensis* Subzone is distinguished and in the uper part of the *F. vimineus Zone* the *Franconites pseudojubatus* Subzone is separated. The *P. transitorius* Zone is subdivided into two subzones: an upper — *Malbosiceras chaperi* Subzone, and a lower— *Himalayites (Micracanthoceras) microcanthus* Subzone.

For each subdivision information is given on the index species, nomenclature (with regard to the Bulgarian literature), the boundaries are defined and the typical species are given. Data on the distribution of the (sub)zones in Bulgaria are given and biocorrelations are made.

The Lower- and Middle Tithonian Ammonitina in Bulgaria exhibit certain similarities with the corresponding representatives from Southern Germany (Berckhemer & Hölder, 1959; Barthel, 1959, 1962; 1964; 1975; Zeiss, 1968; 1975; Barthel & Geyssant, 1973) and Southeastern France (Donze & Enay, 1961) (the third facies-faunal district according to Sapunov & Ziegler, 1976, p. 8). These simiarities are expressed not only in the taxonomic composition of Ammonitina but as a rule in the range-zones of the taxa form the generic and specific groups as well. It should be emphasized, however, that Lytoceratina and Phylloceratina are frequently abundant in the faunas in this country which is not typical of this facies-faunal district. In comparing the Bulgarian Lower- and Middle Tithonian Ammonitina with the corresponding representatives from Southern Europe (Enay, 1973; Enay & Geyssant, 1975) (the fourth facies-faunal district) the similarities observed involve primarily those elements which are to be found in the third facies-faunal district as well. This is supported by the fact that no representatives of *Pseudolissoceras, Cyrtosiceras, Semiformiceras, Simoceras, Simocosmoceras* and *Pseudhimalayites* (see Enay, 1973, p. 300) have been found so far among the Bulgarian Ammonitina. On the other hand, there are certain differences between the range-zones of some genera (cf. Enay & Geyssant, 1975, Fig. 3, with Figs. 1, 2 in this paper) and species common to Bulgaria and the fourth facies-faunal district.

The Upper-Tithonian Ammonitina in Bulgaria resemble more strongly the faunas with abundant berriasellids, *Proniceras* and *Spiticeras* from the border of the Massif Central and the Subalpine ranges (Southeast France) (Le Hégarat, 1973), Crimea and Caucasus (Enay, 1973), the high plains and the Tellian Atlas (Algeria), as well as central Tunisia (Memmi, 1968; Enay, 1973) (third facies-faunal district) rather than the faunas from the fourth facies-faunal district rich in himalayitids (incl. *Tithopeltoceras*), *Djurdjuriceras* and *Simoceras* (Enay, 1973, p. 303; Sapunov, 1976a). As is known, these faunas occur extensively in the Alps, the Appennines, Sicily, the Balearic Islands, Andalusia, Stramberg, the Rif and Djurdjura. On the other hand, however, the numerous Bulgarian Upper Tithonian berriasellids, *Proniceras* and *Spiticeras* occur together with frequent *Haploceras,* Phylloceratina, Lytoceratina and less frequent *Paraulacosphinctes* which brings them closer to the faunas from the fourth facies-faunal district.

This discussion shows that in taxonomic composition the Bulgarian Upper-Tithonian ammonite faunas occupy an intermediate position with respect to the faunas from the third and fourth facies-faunal districts. This conclusion may be applied to the Lower- and Middle-Tithonian faunas in this country, too.

The specific features in the composition and stratigraphic occurrence of the Bulgarian Tithonian ammonite faunas discussed here are expressed in the scheme of ammonite Oppel-zones and subzones worked out here for this country. The fact that this scheme is the first attempt at a general zonation of the Tithonian in Bulgaria makes me regard it as the starting point for further detailed research rather than as a finished study.

The Substages, Ammonite Zones and Subzones of the Tithonian in Bulgaria

The substages of the Tithonian. The first palaeontological evidence (based primarily on ammonites) for the presence of the Tithonian in Bulgaria go back to the end of the last century. Besides, certain substages are already mentioned in the literature of that time. Thus Toula (1889, p. 54) notes the presence of the Lower Tithonian in the Ginci Formation (probably in its upper part) in the Klimaški Dol valley (a western tributary of the Černi Vit River, near the place where the Černi Vit and the Beli Vit Rivers flow together, south of the village of Gložene, area of Teteven) on the basis of an ammonite fauna identified by V. Uhlig (see also Sapunov & Ziegler, 1976, p. 5). Among the several reported genera and species of Phylloceratina, Lytoceratina, Perisphinctidae and Haploceratidae, two are figured as "*Haploceras verruciferum* Mngh." (Toula, 1889, p. 72, pl. 8, fig. 1) (=*Haploceras* sp. indet.) and "*Perisphinctes*" *richteri* Opp. (Toula, 1889, p. 72, pl. 8, fig. 2) [=*Richterella* cf. *richteri* (Oppel, 1865)]. From the viewpoint of the modern subdivision of the Tithonian into substages these ammonite taxa justify the assumption that the corresponding sediments belong to the lower part of the Middle Tithonian. At the same time, however, Toula also reports some species which probably belong to *Orthosphinctes* (e. g. "*Perisphinctes colubrinus* Rein"). This justifies the conclusion that some of the "Lower-Tithonian" species of Toula's prove the presence of the Kimmeridgian. It seems that the ammonites from the Klimaški Dol valley were collected from a wider interval of the Ginci Formation or that the faunas are condensed. Златарски (1908, p. 207) likewise notes the presence of the Kimmeridgian there as well in his interpretation of the taxa reported by Toula.

Vankov (1892, p. 14) had made a comparatively rich collection of ammonites, aptychi and belemnites from the flysch deposits (probably the Zlatarica Formation) near the village of Topleš, southwest of the town of Gabrovo. This fauna was also identified by V. Uhlig. The presence of "*Perisphinctes*" cf. *moravicus* Opp. (=*Berriasella*) caused Vankov to refer the respective sediments to the Upper Tithonian. Besides , the presence of *Spiticeras* ("*Holcostephanus* cf. *grotei* Oppel") further supports the conclusion that these sediments are of Upper Tithonian Age.

Considerably later Берегов (1935, p. 69) made an attempt to divide the Tithonian into a lower and an upper substage on the basis of his biostratigraphic studies on the formations of the Central-Balkan Flysch Group in the Kraište area. According to this author the Lower Tithonian is proved by "*Oppelia steraspis*, Oppel" [=*Ochetoceras (Ochetocaras) irregulare* Berckhemer & Hölder, 1959] and "*Perisphinctes contiguus*, Catullo" (the specimen is lost). The presence of *O. (O.) irregulare* in the lower part of

the Zlatarica Formation between the villages of Berende and Svetlja, District of Pernik, cannot be considered reliable evidence of the Early Tithonian Age of these sediments since this species occurs both in the Upper Kimmeridgian (*Hybonoticeras beckeri* Zone) and in the Lower Tithonian (*Hybonoticeras hybonotum* Zone). According to Б е р е г о в the Upper Tithonian is characterized by "*Perisphinctes* cfr. *transitorius* Oppel" (the specimen is lost) and "*Perisphinctes (Berriasella) calisto* d ' O r b." [=*Pseudosubplanites (Hegaratella) paramacilentus* (M a z e n o t, 1939)]. It is known, however, that the latter species occurs both in the upper part of the Upper Tithonian and in the *Pseudosubplanites (Pseudosubplanites) grandis* Zone of the Berriasian. In the specific case, however, Б е р е г о в 's specimen comes from the Upper Tithonian since it is accompanied by *Proniceras pseudonegreli* (D j a n é l i d z é, 1922).

С т е ф а н о в in С а з о н о в & С т е ф а н о в (1965, p. 118, 121, Table 2) has made a considerably better grounded subdivision of the Tithonian in Bulgaria into substages. In accordance with the ammonite species mentioned for the two substages of the Tithonian, the Lower Tithonian of С т е ф а н о в corresponds approximately to the Danubian Substage or the so-called Lower Tithonian s. l. (Z e i s s, 1965; E n a y in M o u t e r d e et al., 1971). The Upper Tithonian corresponds approximately to the Ardescian Substage. The Tithonian substages are similarly understood by С а п у н о в et al. (1965, p. 26).

Н а ч е в (1968, p. 207) is another author who has discussed the subdivision of the Tithonian in Bulgaria into substages. His treatment lacks originality being a repetition of the views of С т е ф а н о в in С а з о н о в & С т е ф а н о в (1965) and С а п у н о в et al. (1965).

S a p u n o v & Z i e g l e r (1976, p. 23, 31) were the first to prove the presence of the Middle Tithonian in this country on the basis of *Virgatosimoceras rothpletzi* (S c h n e i d, 1915) found in the upper part of the Ginci Formation in the section near the village of Ginci, District of Sofia. After Middle Tithonian ammonite faunas were recently found in other sections and localities in Bulgaria, too, it has become possible to distinguish three substages in the Tithonian, their stratigraphic scopes corresponding to the Lower, Middle and Upper Tithonian in the sense of E n a y (1964), Z e i s s (1971), B a r t h e l (1962), E n a y in M o u t e r d e et al. (1971), etc., as follows [each substage is defined by the standard Oppel-zones of the third facies-faunal district according to Z e i s s (1968; 1975); B a r t h e l (1962; 1975); E n a y in M o u t e r d e et al. (1971); L e H é g a r a t (1973)]:

(3) U p p e r T i t h o n i a n (*Paraulacosphinctes transitorius* Zone and *Berriasella (Berriasella) jacobi* Zone)

(2) M i d d l e T i t h o n i a n (*Pseudolissoceras bavaricum* Zone)

(1) L o w e r T i t h o n i a n (*Hybonoticeras hybonotum* Zone, *Usseliceras tagmersheimense* Zone, *Dorsoplanitoides triplicatus* Zone, *Usseliceras parvinodosum* Zone, *Franconites vimineus* Zone and *Danubisphinctes palatinum* Zone)

T h e a m m o n i t e z o n e s a n d s u b z o n e s o f t h e T i t h o n i a n. The successions of representatives of the suborder Ammonitina found in the Bulgarian sections have made it possible to work out a scheme of Oppel-zones and subzones for the Tithonian in this country. It is shown in Table 1.

Table 1

Substages, ammonite zones and subzones of the Tithonian in Bulgaria

Upper Tithonian	
	Malbosiceras chaperi Subzone
	Paraulacosphinctes transitorius Zone
	Himalayites (Micracanthoceras) microcanthus Subzone
Middle Tithonian	
	Parapallasiceras spp. Zone
	Virgatosimoceras rothpletzi Zone
Lower Tithonian	
	Franconites pseudojubatus Subzone
	Franconites vimineus Zone
	Subplanitoides schwertschlageri Zone
	Subplanites moernsheimensis Subzone
	Hybonoticeras hybonotum Zone

Lower Tithonian

This Substage in Bulgaria is characterized by *Glochiceras (Paralingulaticeras), Taramelliceras (Fontannesiella), Subplanites, Subplanitoides, Usseliceras, Franconites, Parakeratinites* (Fig. 1, 2), as well as by some species of the genera *Hybonoticeras, Ochetoceras* and *Pachysphinctes.*

Ammonite Zones

Hybonoticeras hybonotum Zone

Index species. *Hybonoticeras hybonotum* (Oppel, 1863) (Pl. I, fig. 1).

Nomenclature. The Zone was introduced by Стефанов in Сазонов & Стефанов (1965, p. 118).

Stratigraphy. The lower boundary of the Zone, which is also a boundary between the Kimmeridgian and the Tithonian, is marked by the appearance of the earliest *Hybonoticeras hybonotum* accompanied by *Glochiceras (Paralingulaticeras)* (Fig. 1). Its upper boundary is defined by the appearance of *Usseliceras* together with some species of *Subplanitoides,* which is preceded by the disappearance of *Subplanites, Hybonoticeras, Ochetoceras* and *Taramelliceras (Taramelliceras)* (see Figs. 1, 2).

The Bulgarian *H. hybonotum* Zone is based on the range-zone of the index species. The zonal association also includes *Glochiceras (Paralingulaticeras)*

lithographicum (O p p e l, 1863), *G. (P.) thoro* (O p p e l, 1863), *Taramelliceras (Fontannesiella) disceptandum* (Fontannes, 1879), *T. (?F.) prolithographicum* (F o n t a n n e s, 1879), *T. (Taramelliceras) rebouletianum* (F o n t a n n e s, 1879) (it is restricted to the lower part of the zone), *Ochetoceras (Ochetoceras)* cf. *ornatum* B e r c k h e m e r & H ö l d e r, 1959, *Lithacoceras* sp. n., *L.* cf. *ulmense* (O p p e l, 1863), *Subplanitoides ardescicus* (F o n t a n n e s, 1879), *Hybonoticeras* sp. n. According to the data available to me, the range-zone of *Glochiceras (Glochiceras) carachtheis* (Z e j s z n e r, 1846) in Bulgaria is restricted within the *H. hybonotum* Zone. The zonal association also includes species occurring below the lower boundary of the zone, viz. *Hybonoticeras mundulum mundulum* (O p p e l, 1865), *Taramelliceras (Taramelliceras) franciscanum* (F o n t a n n e s, 1879) and probably *Aspidoceras bispinosum* (Z i e t e n, 1831). *Aspidoceras cyclotum* (O p p e l, 1865) probably appears in the zone but occurs above its upper boundary.

D i s t r i b u t i o n. The Zone is present in the section near the village of Belotinci, District of Vidin (Ginci Formation, No 17, the lower 4 m); near the village of Falkovec, area of Belogradčik, Vidin District (Gložene Formation, the lower part); in the section near the village of Komštica, Sofia District (Ginci Formation, No 12, in the lower 2 m); in the section near the village of Ginci, Sofia District (Ginci Formation, No 7, in the interval between the second and ninth meters of No 7); in the section near the Javorec Peak, east of the village of Bov, Sofia District (Ginci Formation, No 7); southwest of the village of Smolča, Sofia District (Ginci Formation, probably from the middle part); 1.5 km to the east-northeast of the village of Gubeš, Sofia District (Ginci Formation, probably from the middle part); in the valley of the Ljava Vidima River, south of the village of Vidima, Loveč District (Kostel Formation, probably some 500 m or 600 m above the base); near the mountain chalet of Mazalat, in the valley of the River Gabrovnica, area of Kazanlăk, District of Stara Zagora (Kostel Formation, about 500 m or 600 m above the base); in the eastern part of the village of Malka Željazna, Loveč District. (Gložene Formation, in the lower 3 or 4 m); in the section of the valley of the Agălnica River, 3 km to the east of the village of Drenta, District of Veliko Tărnovo (Agălnica Formation, No 3) (see S a p u n o v, 1976a).

C o r r e l a t i o n s. The Bulgarian *H. hybonotum* Zone corresponds entirely to the zone of the same name from the third and fourth facies-faunal districts (see Table 2).

Subplanites moernsheimensis S u b z o n e

I n d e x s p e c i e s. *Subplanites moernsheimensis* (S c h n e i d, 1915) (Pl. II, figs. 2a, b).

N o m e n c l a t u r e. The Subzone is introduced here.

S t r a t i g r a p h y. The lower boundary of the Subzone is marked by the appearance of the index species. Its upper boundary coincides with the upper boundary of the *H. hybonotum* Zone (see above).

The Bulgarian *S. moernsheimensis* Subzone is characterized by the index species. Taking into account that *Pachysphinctes major* S p a t h, 1931 in southern Franconia occurs in the same Subzone (Z e i s s, 1968, p. 26), I assume that this species is probably also present in this Subzone in Bulgaria (the only Bulgarian specimen comes from an isolated locality).

Table 2

Correlation among the Tithonian ammonite zonal schemes of the third facies-faunal district (according to Zeiss, 1968, 1975; Enay in Mouterde et al., 1971; (Barthel, 1962, 1964, 1975; Le Hégarat, 1973), the fourth facies-faunal district (according to Enay & Geyssant, 1975) and Bulgaria

Substages		Facies-faunal districts (according to Sapunov & Ziegler, 1976)					Bulgaria	
		Third		Fourth				
		(sub)zones		(sub)zones			(sub)zones	
Berrias.		*P. (Pseudosubplanites) grandis*		*P. (Pseudosubplanties) grandis*			*P. (Pseudosubplanites) grandis*	
Ardescian	Upper	*B. (Berriasella) jacobi*	*P. transitor.*	*B. (Berriasella) jacobi*		*Paraulacosphinctes transitorius*		*Malbosiceras chaperi*
		Paraulacosphinctes transitorius	*Pseudovirgatites scruposus*	*"Durangites"*				*Himalayites (Micracanthoceras) microcanthus*
				Micracanthoceras micracanthum				
Danubian	Middle	*Pseudolissoceras bavaricum*	*Isterites palmatus*	*"Micracanthoceras" ponti*			*Parapallasiceras* spp.	
			Lemenica ciliata	*Semiformiceras fellauxi*			*Virgatosimoceras rothpletzi*	
				Semiformiceras semiforme				
	Lower	*Danubisphinctes palatinum*		*Neochetoceras darwini*			*Franconites pseudojubatus*	*Franconites vimineus*
		Franconites vimineus					—	
		Usseliceras parvinodosum	*Neochetoceras mucronatum*				*Subplanitoides schwertschlageri*	
		Dorsoplanitoides triplicatus						
		Usseliceras tagmersheimense						
		Subplanites moernsheimensis	or *Gravesia gigas*	*Hybonoticeras hybonotum*				*Subplanites moernsheimensis*
		S. rueppellianus						—
		Lithacoceras riedense						

D i s t r i b u t i o n. The Subzone is present in the section near the village of Belotinci, Vidin District (Ginci Formation, No 17, 4.10 m above the base); probably in the Trojan District, the exact locality is unknown (Černiosăm Formation, from the lower part) (S a p u n o v, 1976a).

C o r r e l a t i o n s. The Bulgarian *S. moernsheimensis* Subzone corresponds to the same Subzone from the third facies-faunal district (see Table 2).

Subplanitoides schwertschlageri Z o n e

I n d e x s p e c i e s. *Subplanitoides schwertschlageri* (Z e i s s, 1968) (Pl. I, figs. 3a, b).

N o m e n c l a t u r e. The Zone is introduced here.

S t r a t i g r a p h y. The lower boundary of the Zone is defined in the description of the *H. hybonotum* Zone (see above). Its upper boundary is marked by the appearance of the genera *Franconites* and *Parakeratinites,* which is connected with the disappearance of *Usseliceras,* and in Bulgaria of *Subplanitoides* as well (see Fig. 2).

The Bulgarian *S. schwertschlageri* Zone is characterized by the index species. It is accompanied by *Subplanitoides* sp. n., ?*Subplanitoides* sp. (with ventral groove), *Usseliceras* aff. *franconicum* Z e i s s, 1968, Aulacostephaninae gen. & sp. n. In this country *Aspidoceras pipini* (O p p e l, 1863) occurs in the *S. schwertschlageri* Zone. The zonal association also includes some species occurring below and(or) above the zone, viz. *Haploceras elimatum* (O p p e l, 1865) (it occurs above the upper boundary of the zone but it is possible that it may be present in the *H. hybonotum* Zone as well, although this is not proved beyond doubt for this country), *Aspidoceras cyclotum* (O p p e l, 1965) (it occurs below and above the zone, too).

D i s t r i b u t i o n. The Zone is present in the section near the village of Belotinci, Vidin District (Ginci Formation, No 17, 7.30 m above the base); in the section near the village of Komštica, Sofia District (Ginci Formation, No 12, probably in the interval between 2 m and 4.50 m above the base of No 12); in the section near the village of Ginci, Sofia District (Ginci Formation, No 7, in the lower part of the upper 9 m of No 7); in the Berende River between the villages of Berende and Svetlja, Pernik District (Zlatarica Formation, the middle part); in the quarry to the north of the village of Gložene, along the road to the Boaza locality, Loveč District (Gložene Formation, about 10 m above the base) (S a p u n o v, 1976a).

C o r r e l a t i o n s. The Bulgarian *S. schwertschlageri* Zone is equivalent to the *Neochetoceras mucronatum* Superzone (Z e i s s, 1975) or to the total of the *Usseliceras tagmersheimense* Zone, *Dorsoplanitoides triplicatus* Zone and *Usseliceras parvinodosum* Zone (Z e i s s, 1968) from the third facies-faunal district. It is equivalent to the lower part of the *Neochetoceras darwini* Zone (E n a y & G e y s s a n t, 1975) from the fourth facies-faunal district (see Table 2).

Franconites vimineus Z o n e

I n d e x s p e c i e s. *Franconites vimineus* (S c h n e i d, 1915) (Pl. IV, fig. 1).

N o m e n c l a t u r e. The Zone is introduced here.

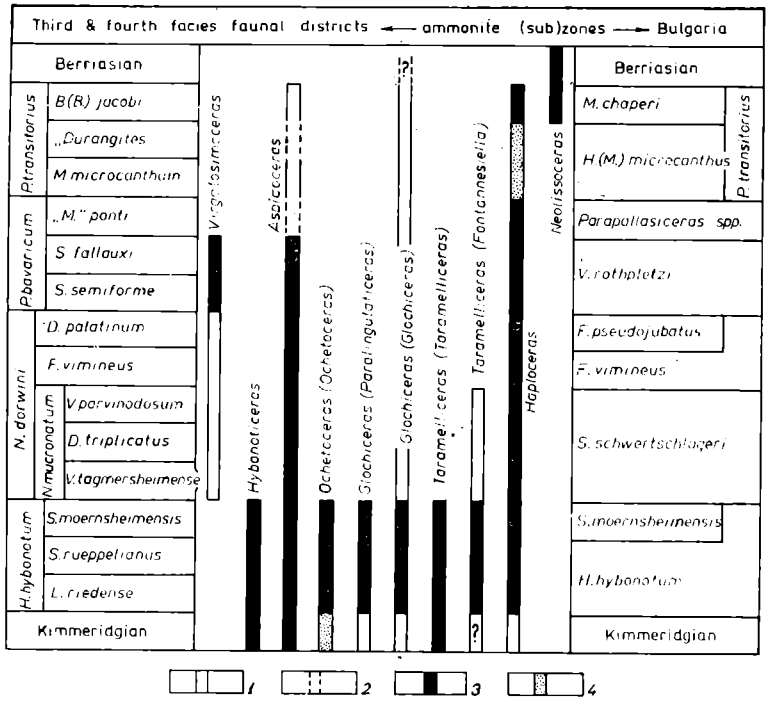

Fig. 1. Stratigraphic occurrence of the genera from the families Aspidoceratidae, Haploceratidae and Glochiceratidae in the Tithonian

1 — total stratigraphic occurrence in the third and fourth facies-faunal districts according to Ziegler (1958; 1974b), Berckhemer & Hölder (1959), Barthel (1959; 1962; 1975), Höroldt (1964), Zeiss (1968; 1975), Enay & Geyssant (1975), Sapunov & Ziegler (1976) and others; *2* — probable stratigraphic occurrence in the third and fourth facies-faunal districts according to the same authors; *3* — stratigraphic occurrence in Bulgaria; *4* — probable stratigraphic occurrence in Bulgaria

Stratigraphy. The lower boundary is defined in the description of the *S. schwertschlageri* Zone (see above). Its upper boundary, which is also a boundary between the Lower and the Middle Tithonian, is marked by the appearance of the first *Virgatosimoceras, Danubisphinctes* and probably *Richterella* in this country, which is connected with the disappearance of *Franconites* and *Parakeratinites* (see Fig. 2).

The Bulgarian *F. vimineus* Zone is defined by the range-zones of the genera *Franconites* and *Parakeratinites* in this country (Fig. 2). It is characterized by the following association: *Franconites vimineus, Franconites* sp. indet. and *Parakeratinites* cf. *communis* (Zeiss, 1968).

Distribution. The Zone is present in the section near the village of Komštica, Sofia District (Ginci Formation, No 12, in the interval 4.50 m to 7 m above the base of No 12); near the hamlet of Todorčeta, southwest of Gabrovo (Zlatarica Formation, lower half, middle part) (Sapunov, 1976a).

Correlations. The Bulgarian *F. vimineus* Zone is equivalent to the *Franconites vimineus* and *Danubisphinctes palatinum* Superzone (Zeiss,

1975) or to the total of the *F. vimineus* Zone and *D. palatinum* Zone (Z e i s s, 1968) in the third facies-faunal district. It is equivalent to the upper part of the *Neochetoceras darwini* Zone (E n a y & G e y s s a n t, 1975) from the fourth facies-faunal district (see Table 2).

Franconites pseudojubatus S u b z o n e

I n d e x s p e c i e s. *Franconites pseudojubatus* (D o n z e & E n a y, 1961) (Pl. III, fig. 1).

N o m e n c l a t u r e. The Subzone is introduced here.

S t r a t i g r a p h y. The lower boundary of the Subzone is proved by the appearance of some species of the genus *Franconites* occurring in the upper part of the *F. vimineus* Zone. Its upper boundary coincides with the upper boundary of the *F. vimineus* Zone (see above).

The Bulgarian *F. pseudojubatus* Subzone is based on some species of the genus *Franconites*. It is characterized by *Franconites pseudojubatus* and *F. tenuiplicatus magnus* Z e i s s, 1968.

D i s t r i b u t i o n. The Subzone is present in the section along the valley of the Agălnica River, 3 km east of the village of Drenta, District of Veliko Tărnovo (Agălnica Formation, No 4, probably from the upper half of No 4) (S a p u n o v, 1976a).

C o r r e l a t i o n s. The Bulgarian *F. pseudojubatus* Subzone is equivalent to the *Danubisphinctes palatinum* Zone (Z e i s s , 1968) from the third facies-faunal district (see Table 2).

Middle Tithonian

This Substage in Bulgaria is characterized by the genera *Virgatosimoceras, Danubisphinctes, Parapallasiceras* and some representatives of *Richterella*. Besides, it seems probable that the first Berriasellidae represented by the genus *Aulacosphinctes* will appear in its upper part.

Ammonite Zones

Virgatosimoceras rothpletzi Z o n e

I n d e x s p e c i e s. *Virgatosimoceras rothpletzi* (S c h n e i d, 1915) (Pl· IV, fig. 2).

N o m e n c l a t u r e. The zone is introduced here.

S t r a t i g r a p h y. The lower boundary of the zone is defined in the description of the *F. vimineus* Zone (see above). Its upper boundary is marked by the disappearance of the representatives of the genera *Virgatosimoceras* and *Danubisphinctes* (see Fig. 2).

The Bulgarian *V. rothpletzi* Zone is based on the range-zone of the genera *Virgatosimoceras* and *Danubisphinctes* in this country (see Fig. 2). Besides the index species, the zonal association includes *Virgatosimoceras broilii* (S c h n e i d, 1915), *Danubisphinctes* cf. *loeschi* (S c h n e i d, 1915), *Richterella patruliusi* (A v r a m, 1974), and *R. richteri* (O p p e l, 1865). The presence of *Parapallasiceras* in the Zone in Bulgaria has not been proved so far though they may possibly be

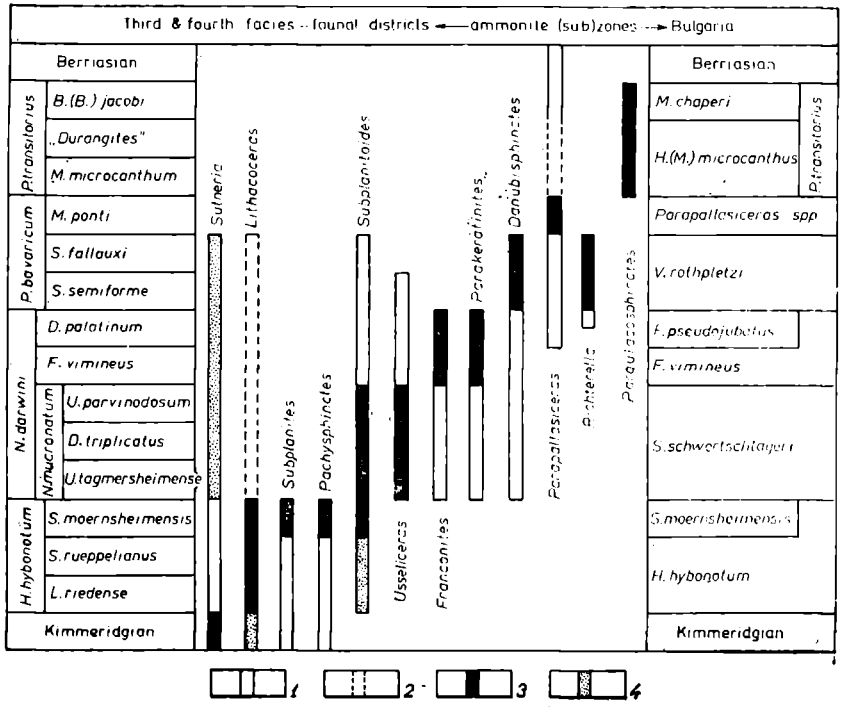

Fig. 2. Stratigraphic occurrence of the genera from the family Perisphinctidae during the Tithonian

1 — total stratigraphic occurrence in the third and fourth facies-faunal districts according to Berckhemer & Hölder (1959), Barthel (1959; 1962; 1975), Zeiss (1968; 1975); Memmi (1968); Geyer (1969), Enay & Geyssant (1975), Sapunov & Ziegler (1976) and others; *2* — probable stratigraphic occurrence in the third and fourth facies-faunal districts according to the same authors; *3* — stratigraphic occurrence in Bulgaria; *4* — probable stratigraphic occurrence in Bulgaria

present considering the faunas from the lower part of the Middle Tithonian near Neuburg, Bavaria (Barthel, 1975). *Haploceras elimatum* (Oppel, 1865) and *Aspidoceras cyclotum* (Oppel, 1865) are also present in the zone but they are found above its upper boundary and below its lower boundary as well.

Distribution. The Zone is present in the section near the village of Belotinci, Vidin District (Gložene Formation, the Ogosta Member, No 19, in the base); in the section near the village of Ginci, Sofia District (Ginci Formation, No 7, the upper part of the top 9 m); in the Červen Peak, north of the town of Teteven, Loveč District (Ginci Formation, in the interval between the 15th and 30th meter); near the village of Bojkovec (former Ravna), west of the town of Etropole, Sofia District (Černiosăm Formation, the exact position in the section is unknown) (Sapunov, 1976a).

Correlations. The Bulgarian *V. rothpletzi* Zone is equivalent to the larger portion of the lower part of the *Lemencia ciliata* Zone (Barthel, 1962; 1964; Zeiss, 1968) from the third facies-faunal district. It corresponds to the *Sublithacoceras penicillatum* Zone (called also *Virgatosimoceras rothpletzi*

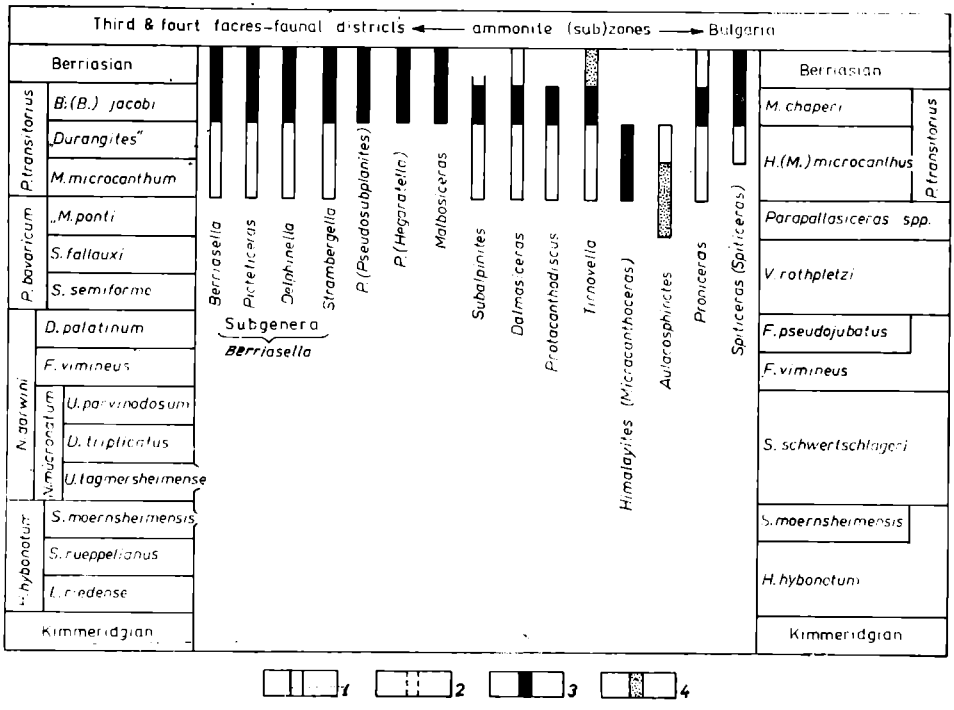

Fig. 3. Stratigraphic occurrence of the genera from the families Berriasellidae and Olcostephanidae during the Tithonian

1 — total stratigraphic occurrence in the third and fourth facies-faunal districts according to Djanélidzé (1922), Memmi (1968), Le Hégarat (1973), Enay & Geyssant (1975) and others; *2* — probable stratigraphic occurrence in the third and fourth facies-faunal districts according to the same authors; *3* — stratigraphic occurrence in Bulgaria; *4* — probable stratigraphic occurrence in Bulgaria

Zone) from Southeastern France (Enay in Mouterde et al., 1971). The total of the *Semiformiceras semiforme* Zone and *Semiformiceras fallauxi* Zone (Enay & Geyssant, 1975) from the fourth facies-faunal district is equivalent to the Bulgarian *V. rothpletzi* Zone (see Table 2).

Parapallasiceras spp. Zone

Nomenclature. The Zone is introduced here. No index species is given because the representatives of the genus *Parapallasiceras* in Bulgaria are insufficiently studied.

Stratigraphy. The lower boundary of the Zone is defined in the description of the *V. rothpletzi* Zone (see above). The upper boundary, which is also a boundary between the Middle and the Upper Tithonian, is marked by the appearance of the earliest *Himalayites (Micracanthoceras)* and *Paraulacosphinctes*. In Bulgaria *Parapallasiceras* does not occur above this boundary (Figs. 2, 3).

The Bulgarian *Parapallasiceras* spp. Zone is based on the range-zone of the genus *Parapallasiceras* in this country. In Southern Germany (third facies-

faunal district) *Parapallasiceras* is present in the lower part of the Middle Tithonian (B a r t h e l, 1975), while in Southern Spain, as in Bulgaria, individual representatives of the group of *P. praecox* are found in the upper part of this Substage (the "*Micracanthoceras*" *ponti* Zone) (E n a y & G e y s s a n t, 1975).

The zonal association is represented by *Parapallasiceras* sp. n., *Parapallasiceras* sp. indet. and *P. praecox* (S c h n e i d, 1915). *Haploceras elimatum* (O p p e l, 1865) and *Aspidoceras cyclotum* (O p p e l, 1865) are present in the Zone, but occur below its lower boundary as well. The representatives of the genus *Aulacosphinctes* occur sporadically in Bulgaria and come from an isolated locality. Thus it is not clear at present if they occur in the *Parapallasiceras* spp. Zone or in the lower part of the Upper Tithonian *Himalayites (Micracanthoceras) microcanthus* Subzone resting above it (see below the section "Tithonian Ammonite Species of Uncertain Stratigraphic Distribution").

D i s t r i b u t i o n. The Zone is present in the section near the village Komštica, Sofia District (Ginci Formation, No 12, from 10 m to 13.20 m above the base of No 12); north of the hamlet of Jankovo, area of Breznik, Pernik District (Zlatarica Formation, the middle part); near the village of Dolna Sekirna, Pernik District (Černiosăm Formation, the middle part) (S a p u n o v, 1976a).

C o r r e l a t i o n s. The Bulgarian *Parapallasiceras* spp. Zone is equivalent to the uppermost part of the *Lemencia ciliata* Zone and to the *Isterites palmatus* Zone (B a r t h e l, 1962; 1964; Z e i s s, 1968) from the third facies-faunal district. It is equivalent to the "*Micracanthoceras*" *ponti* Zone from the the fourth facies-faunal district (E n a y & G e y s s a n t, 1975) (see Table 2).

Upper Tithonian

This Substage coincides with the scope of the Bulgarian *Paraulacosphinctes transitorius* Zone.

Ammonite Zones and Subzones

Paraulacosphinctes transitorius Z o n e

I n d e x s p e c i e s. *Paraulacosphinctes transitorius* (O p p e l, 1865) (Pl. V, fig. 2).

N o m e n c l a t u r e. The Zone is introduced here.

S t r a t i g r a p h y. The lower boundary of the Zone is defined in the description of the *Parapallasiceras* spp. Zone. Its upper boundary, which is also a boundary between the Tithonian and Berriasian is marked by the disappearance of *Paraulacosphinctes* together with *Haploceras* and *Protacanthodiscus,* and, in Bulgaria, *Proniceras* as well (see Figs. 2, 3).

The Bulgarian *P. transitorius* Zone is based on the range-zone of *Paraulacosphinctes* (see Fig. 2). The zonal association is characterized by *Paraulacosphinctes transitorius, P. senex* (O p p e l, 1865) and *Paraulacosphinctes* spp. indet.

D i s t r i b u t i o n. The Zone is present in the section near the village of Komštica, Sofia District (Gložene Formation, Ogosta Member, No 15, lower half); near the village of Bornarevo (former name Deli Baltin Čiflik), southwest of the town of Radomir, Pernik District (informal marly formation above the Černiosăm Formation, from the lower part); in the valley of the Tăža River, area of Kazanlăk, District of Stara Zagora (Kostel Formation, lower half, from the upper part); near the villages of Ugorelec and Lăgăt, south of the village of Stokite, Gabrovo District (Zlatarica Formation, lower half, upper part); in the River Tiča Gorge, south of the village of Preslav, Šumen District (the core of the Preslav anticline) (Tiča Formation, lower half) (S a p u n o v, 1976a).

C o r r e l a t i o n s. As pointed out above, the stratigraphic scope of the Bulgarian *P. transitorius* Zone is equivalent to the Upper Tithonian. Unlike some regions of the third facies-faunal district (L e H é g a r a t, 1973) where *P. transitorius* occurs in the lower part of the Upper Tithonian only, in Bulgaria this species is present also in the top levels of the Upper Tithonian, immediately below the faunas of the *Pseudosubplanites (Pseudosubplanites) grandis* Zone. Therefore, the Bulgarian *P. transitorius* Zone is equivalent to the total of *P. transitorius* Zone and *Berriasella (Berriasella) jacobi* Zone from Southeastern France. It seems that in some regions of the same district *P. transitorius* occurs only in the upper part of the Upper Tithonian, which has caused E n a y in M o u t e r d e et al. (1971) to distinguish two zones in the Upper Tithonian, a lower, *Micracanthoceras microcanthum* Zone or *Pseudovirgatites scruposus* Zone, and an upper, *P. transitorius* Zone or "*Berriasella*" *delphinersis* Zone or "*Protacanthodiscus*" *chaperi* Zone.

On the other hand, the Bulgarian *P. transitorius* Zone is equivalent to the total of the *M. microcanthum* Zone, "*Durangites*" Zone and *Berriasella jacobi* Zone from Southern Spain (the fourth facies-faunal district) (E n a y & G e y s s a n t, 1975) (see Table 2).

Himalayites (Micracanthoceras) microcanthus S u b z o n e

I n d e x s p e c i e s. *Himalayites (Micracanthoceras) microcanthus* (O p p e l, 1865) (Pl. V, fig. 3).

N o m e n c l a t u r e. The Subzone is introduced here.

S t r a t i g r a p h y. The lower boundary of the Subzone coincides with the lower boundary of the *P. transitorius* Zone. Its upper boundary is marked by the appearance of the first *Malbosiceras, Pseudosubplanites* and *Neolissoceras* (see Figs. 1, 3). Besides, according to the data available to me, in Bulgaria this boundary is connected with the appearance of *Berriasella (Berriasella), B. (Picteticeras), B. (Strambergella), Subalpinites, Dalmasiceras, Protacanthodiscus, Tirnovella, Spiticeras* and *Proniceras*. In Bulgaria, *Himalayites (Micracanthoceras)* disappear below this boundary (Fig. 3).

The Bulgarian *H. (M.) microcanthus* Subzone is based on the range-zone of *Himalayites (Micracanthoceras)* in this country (Fig. 3). Besides the index species, *H. (M.) fraudator* (Zittel, 1868) is also present in the association of the Subzone. The sporadically occurring representatives of the genus *Aulacosphinctes* in Bulgaria come from an isolated locality and it is not clear at present if they belong to the lower part of the subzone or occur in the Middle-Tithonian *Parapallasiceras* spp. Zone (see below the section "Tithonian Ammonite Species of Uncertain Stratigraphic Distribution").

The finding of *Zaraiskites* sp. in the lower half of the Černi ošam Formation near the hamlet of Neškovci, District of Loveč, made by N o w a k (1971, pl. 1), seems to confirm the presence of the Subzone in this locality.

D i s t r i b u t i o n. The Subzone is present in the section near the village of Komštica, Sofia District (Gložene Formation, the Ogosta Member, No 15, lower half, from the lower part); near the village of Dolna Sekirna, Pernik District (Černi osăm Formation, upper part); near the hamlet of Neškovci District of Loveč (Černi osăm Formation, lower part) (S a p u n o v, 1976a).

C o r r e l a t i o n s. The Bulgarian *H. (M.) microcanthus* Subzone is equivalent to the *Paraulacosphinctes transitorius* Zone (L e H é g a r a t, 1973); to the *Pseudovirgatites scruposus* Zone or to the *Micracanthoceras microcanthum* Zone (E n a y in M o u t e r d e et al., 1971) from the third facies-faunal district. It is equivalent to the total of the *Micracanthoceras microcanthum* Zone and the "*Durangites*" Zone (E n a y & G e y s s a n t, 1975) from the fourth facies-faunal district (see Table 2). It correlates also with the beds containing the so-called "faune propre" or "faune principale" in the Stramberg Limestone, Czechoslovakia (H o u s a, 1975, p. 344, 345) (fourth facies-faunal district).

Malbosiceras chaperi S u b z o n e

I n d e x s p e c i e s. *Malbosiceras chaperi* (P i c t e t, 1868) (Pl. VI, fig. 2).

N o m e n c l a t u r e. This biostratigraphic unit was introduced by Н и к о л о в (1967, p. 729) as a separate zone in the gorge of the Zlatarica River, north of the town of Elena, District of Veliko Tărnovo.

S t r a t i g r a p h y. The lower boundary of the Subzone is defined in the description of the *H. (M.) microcanthus* Subzone (see above). Its upper boundary coincides with the upper boundary of the *P. transitorius* Zone.

The Bulgarian *M. chaperi* Subzone is based on the range-zones of *Subalpinites, Protacanthodiscus* and *Proniceras* in this country (see Fig. 3). The subzone is characterized by an association abundant in species, which, besides the index species, includes also *Berriasella (Berriasella) moreti* M a z e n o t, 1939, *B. (B.)* cf. *oppeli* (K i l i a n, 1889), *B. (Delphinella)* cf. *delphinensis* (K i l i a n, 1889), *B. (D.) obtusenodosa* (R e t o w s k i, 1893), *Malbosiceras asper* (M a z e n o t, 1939) (wrongly cited as *M. aizyensis* by S a p u n o v, 1976a, p. 36), *Protacanthodiscus andreaei* (K i l i a n, 1889), *Dalmasiceras subloevis* M a z e n o t, 1939, *D. subprogenitor* (J a c o b) in *M a z e n o t*, 1939, *Spiticeras (Spiticeras) cautleyi* (O p p e l, 1863), *S. (S.)* cf. *celsum* (O p p e l, 1865), *S. (S.) pseudograteanum* D j a n é l i d z é, 1922, *Proniceras jacobi* (D j o n é l i d z é, 1922), *P. pseudonegreli* (D j a n é l i d z é, 1922), *P. simplex* (D j a n é l i d z é, 1922). They are accompanied by the following species, whose range-zones in this country, according to the data available to me up to this date, do not exceed the scope of the Bulgarian *M. chaperi* Zone: *Pseudosubplanites (Pseudosubplanites)* cf. *berriasensis* Le Hégarat, 1971, *P. (P.) lorioli* (Z i t t e l, 1868), *P. (P.) ponticus* (R e t o w s k i, 1893), *P. (Hegaratella) subrichteri* (R e t o w s k i, 1893), *Berriasella (Berriasella) jacobi* M a z e n o t, 1939, *B. (Picteticeras) enayi* Le Hégarat, 1973, *B. (P.) oxycostata* (J a c o b) in M a z e n o t, 1939, *B. (Strambergella) carpathica* (Z i t t e l, 1868), *Dalmasiceras djanelidzei* M a z e n o t, 1939, *Subalpinites aristidis* (K i l i a n, 1895), *Tirnovella allobrogensis* (M a z e n o t, 1939), *T. beneckei* (J a c o b in M a z e n o t, 1939). It seems possible, however,

that further detailed studies of the Tithonian /Berriasian boundary will discover some of these species in the Berriasian of this country, too, as has already happened elsewhere, notably in Southeastern France (L e H é g a r a t, 1973).

The association of the Bulgarian *M. chaperi* Subzone includes also species which occur outside its boundaries as well: *Pseudosuplanites (Hegaratella) paramacilentus* (M a z e n o t, 1939) (it occurs above the upper boundary of the Subzone as well), *Berriassella (Picteticeras) chomeracensis* (T o u c a s, 1890) (it occurs above the upper boundary of the Subzone, too), *Haploceras staszicii* (Z e j s z n e r, 1846) (it occurs below the lower boundary of the Subzone), *Neolissoceras grasianum* (d ' O r b i g n y, 1840) (it occurs above the upper boundary of the Subzone).

D i s t r i b u t i o n. The Subzone is present in the section near the village of Komštica, Sofia District (Gložene Formation, Ogosta Member, No 15, lower half, upper part); in the Berende River between the villages of Berende and Svetlja, Pernik District (Zlatarica Formation, upper part); near the village of Priboj, Pernik District (Černiosăm Formation, upper part); south of the town of Trojan, Loveč District (Černiosăm Formation, lower half, upper part); near the village of Lopjan, Sofia District (Černiošam Formation, lower half, upper part); between the villages of Malka Željazna and Lesidren, Loveč District (Černiosăm — Gložene formation, lower half, upper part); near the villages of Stokite and Boazăt, Gabrovo District (the core of th e Černivrăh anticline) (Zlatarica — Černiosăm formation,lower half, upper part); near the village of Šipkovo, Loveč District (Černiosăm Formation, lower half, upper part); in the section in the Straža Pass, south of the village of Straža, Tărgovište District (the core of the Preslav Anticline) (Tiča Formation, No 4); south of the village of Kostel, District of Veliko Tărnovo (the core of the Bujnovci Anticline) (Kostel Formation, lower half); near the village of Bujnovci, District of Veliko Tărnovo (the core of the Bujnovci Anticline) (Kostel Formation, lower half); northeast of the Slatinski-Răg locality, village of Drenta, District of Veliko Tărnovo (the core of the Lipovci Anticline) (Kostel Formation, lower half); in the gorge of the Zlatarica River, near the mineral spring, north of the town of Elena, District of Veliko Tărnovo (the core of the Elena Anticline) (Zlatarica Formation, lower half) (S a p u n o v, 1976a).

C o r r e l a t i o n s. The Bulgarian *M. chaperi* Subzone is equivalent to the *Berriasella (Berriasella) jacobi* Zone (L e H é g a r a t, 1973); to the "*Berriasella*" *delphinensis* Zone, or to the "*Protacanthodiscus*" *chaperi* Zone or to the *Paraulacosphinctes transitorius* Zone (E n a y in M o u t e r d e et al., 1971) from the third facies-faunal district. It is also equivalent to the *Berriasella jacobi* Zobe (E n a y & G e y s s a n t, 1975) from the fourth faciesfaunal district (see Table 2). The young elements in the faunas from the Stramberg Limestone, Czechoslovakia, found in the so-called "exotic boulders" (H o u s a, 1975, p. 345), correspond probably to the lower part of the Bulgarian Subzone.

Phylloceratina and Lytoceratina in the Tithonian in Bulgaria

The representatives of these two suborders form an appreciable portion of the ammonite faunas in the Tithonian in this country.

Phylloceratina. Species belonging to the genera *Phylloceras, Sowerbyceras, Holcophylloceras, Ptychophylloceras* and *Partschiceras* have been found, as

follows: *Phylloceras serum* (O p p e l, 1865) (Tithonian), *Sowerbyceras loryi* (M u ñ i e r - C h a l m a s in H e b e r t, 1875) (Lower Tithonian, *H. hybonotum* Zone; it occurs in the Kimmeridgian, too), *Holcophylloceras polyolcum* (B e n e c k e, 1866) (Lower Tithonian; it occurs in the Kimmeridgian, too), *H. silesiacum* (O p p e l, 1865) (Tithonian), *Ptychophylloceras ptychoicum* (Q u e n s t e d t, 1847) (Tithonian; it occurs in the Kimmeridgian and Berriasian as well), *P. inordinatum* (T o u c a s, 1890) (Upper Tithonian), *Partschiceras ptychostoma* (B e n e c k e, 1866) (Upper Tithonian).

Lytoceratina. Species belonging to the genera *Lytoceras* and *Protetragonites* have been found, as follows: *Lytoceras strambergense* Z i t t e l, 1868 (Tithonian; it occurs in the Berriasian as well), *L. liebigi* (O p p e l, 1865) (Upper Tithonian; it occurs in the Berriasian as well), *L. sutile* (O p p e l, 1865) (Upper Tithonian; it occurs in the Berriasian as well), *Protetragonites quadrisulcatus* (d ' O r b i g n y, 1840) (Tithonian).

Tithonian Ammonite Species of Uncertain Stratigraphic Occurrence

During the present study several species belonging to Glochiceratidae, Perisphinctidae, Aspidoceratidae and Berriasellidae have been found, whose stratigraphic distribution in Bulgaria has remained uncertain:

(1) *Ochetoceras (Ochetoceras) irregulare* B e r c k h e m e r & H ö l d e r, 1959 — ?Upper Kimmeridgian (*H. beckeri* Zone) — ?Lower Tithonian (*H. hybonotum* Zone) (locality in the Berende River between the villages of Berende and Svetlja, Pernik District; Zlatarica Formation, lower part);

(2) *Hybonoticeras extraspinatum* B e r c k h e m e r & H ö l d e r, 1959 — ?Upper Kimmeridgian (*H. beckeri* Zone) — ?Lower Tithonian (*H. hybonotum* Zone) (the eastern ridge of the Ginci Cliff, east of the village of Ginci, Sofia District; Ginci Formation, No 4, according to S a p u n o v & Z i e g l e r, 1976, p. 24);

(3) *Aspidoceras rogoznicense* (Z e j s z n e r, 1846) — ?Lower Tithonian — ?Middle Tithonian (locality to the northwest of the Goljama Glama Peak at the turn of the road to the town of Dimovo, Vidin District; Gložene Formation, lower part);

(4) *Aulacosphinctes linoptychus* (U h l i g, 1910) — ?Middle Tithonian — (*Parapallasiceras* spp. Zone) — ?Upper Tithonian (lower part of the *H. (M.) microcanthus* Subzone) (locality to the north of the village of Sredorek, Kjustendil District; Kostel Formation, probably from the middle part);

(5) *Aulacosphinctes venustus* C o l l i g n o n, 1960 — ?Middle Tithonian (*Parapallasiceras* spp. Zone) — ?Upper Tithonian (lower part of the *H. (M.) microcanthus* Subzone) (locality to the north of the village of Sredorek, Kjustendil District; Kostel Formation, probably from the middle part);

(6) *Pseudosubplanites (Pseudosubplanites) euxinus* (R e t o w s k i, 1893) — ?Upper Tithonian (*P. transitorius* Zone, *M. chaperi* Subzone) — ?Berriasian (*P. (P.) grandis* Zone) (locality to the southeast of the village of Bujnovci, District of Veliko Tărnovo, from the core of the Bujnovci Anticline; Kostel Formation, lower half) (S a p u n o v, 1976a).

The Problem of the Jurassic/Cretaceous Boundary

Present concepts concerning the position of the Jurassic /Cretaceous boundary are controversial which is to be seen from the numerous suggestions made at the International Colloquium on this problem held in Lyon Neuchâtel in September, 1973. They are all more or less justified and probably further suggestions could be made not lacking in justification.

It seems that in order to reach an unambiguous solution of this problem, international cooperation on a wide basis is needed. The carrying out of a long-term project within the scope of the activities of the International Geologic Correlation Programme (UNESCO) in coordination with the Subcommissions on the Jurassic Stratigraphy and the Cretaceous Stratigraphy of the IUGS Commission on Stratigraphy might lead to, or at least might bring us closer to the desired result. The outcome of such a project seems promising, considering the results of the joint international studies on the unification of the boundary between the Silurian and Devonian. Such a study might lead not only to the discovery of fresh facts but might also reveal the possibility of unifying the criteria, on the basis of which an agreement may be reached about the position of the Jurassic/Cretaceous boundary on a global scale.

In accordance with the accepted practice in this country, the boundary between the Jurassic and the Cretaceous Systems is considered as coinciding with the boundary between the Tithonian and Berriasian Stages. It is also a boundary between the *Paraulacosphinctes transitorius* Zone and the *Pseudosubplanites (Pseudosubplanites) grandis* Zone.

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EXPLANATION OF PLATE I

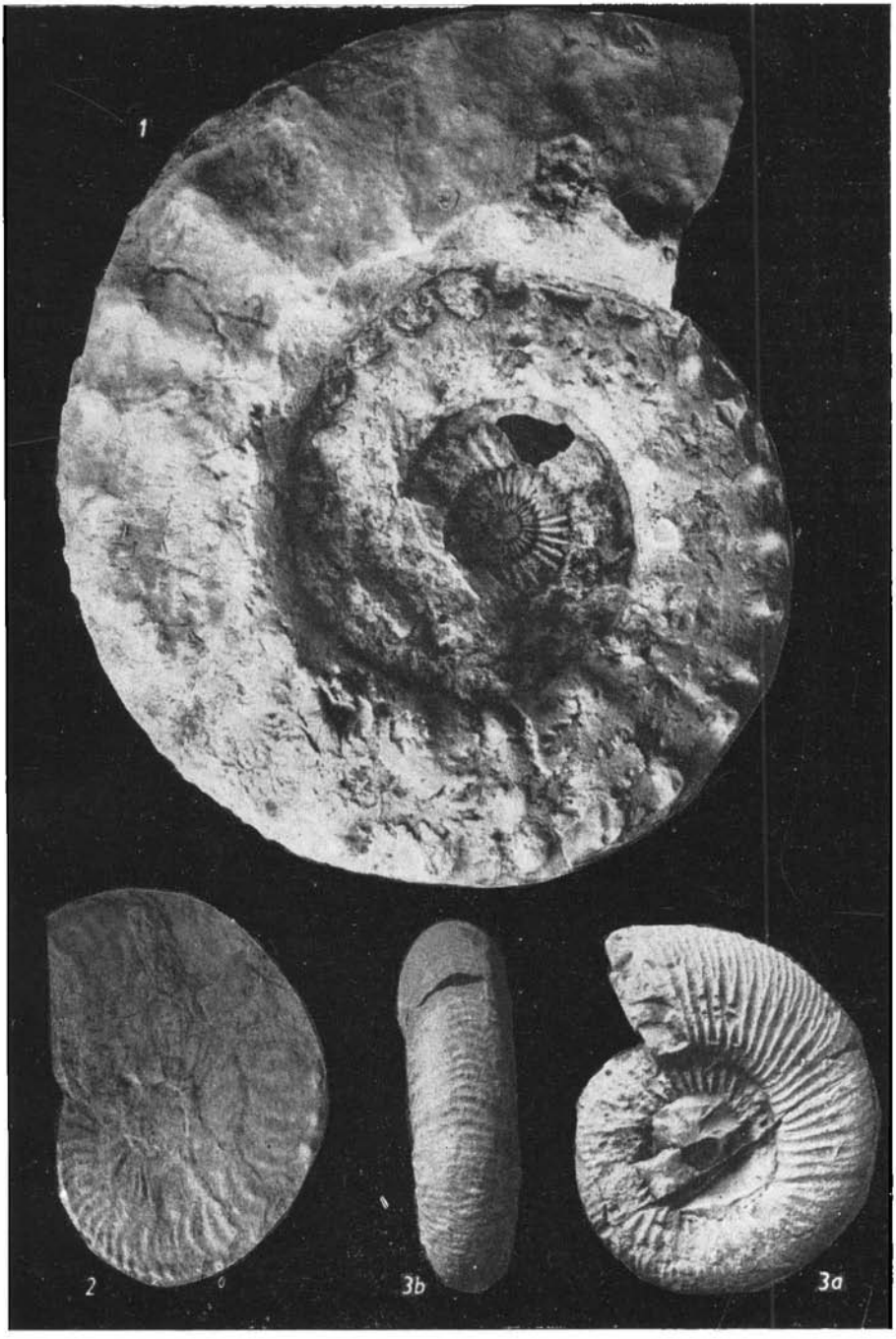
(Early Tithonian ammonites)

Fig. 1. *Hybonoticeras hybonotum* (O p p e l, 1863). Section near the village of Komštica, area of Godeč, District of Sofia (West Balkan). Ginci Formation, No. 12, from the lower 2 m (S a p u n o v, 1976a, p. 31); Lower Tithonian, *Hybonoticeras hybonotum* Zone. Specimen of С т е ф а н о в (1959, p. 96, pl. 1, figs. 1, 3), described and figured as "*Hybonoticeras hybonotum* (O p p e l)". Pal. Mus. Univ. Sofia, J84/25—1. × 1.0

Fig. 2. *Taramelliceras (?Fontannesiella) prolithographicum* (F o n t a n n e s, 1879). Locality in the valley of Gabrovnica River, below the mountain chalet of Mazalat, area of Kazanlák, District of Stara Zagora (Central Balkan). Kostel Formation, at 500—600 m above the very base (S a p u n o v, 1976a, p. 34). Lower Tithonian, *Hybonoticeras hybonotum* Zone. Pal. Mus. Univ. Sofia, J147/49—1. × 1.0

Figs. 3a, b. *Subplanitoides schwertschlageri* (Z e i s s , 1968). Section near the village of Belotinci, area of Belogradčik, District of Vidin (West Forebalkan). Ginci Formation, member of the upper nodular limestones, No. 17, at 7.30 m above the base (S a p u n o v, 1976a, p. 28); Lower Tithonian, *Subplanitoides schwertschlageri* Zone. Pal. Mus. Univ. Sofia, J127/49—2. × 1.0

PLATE I



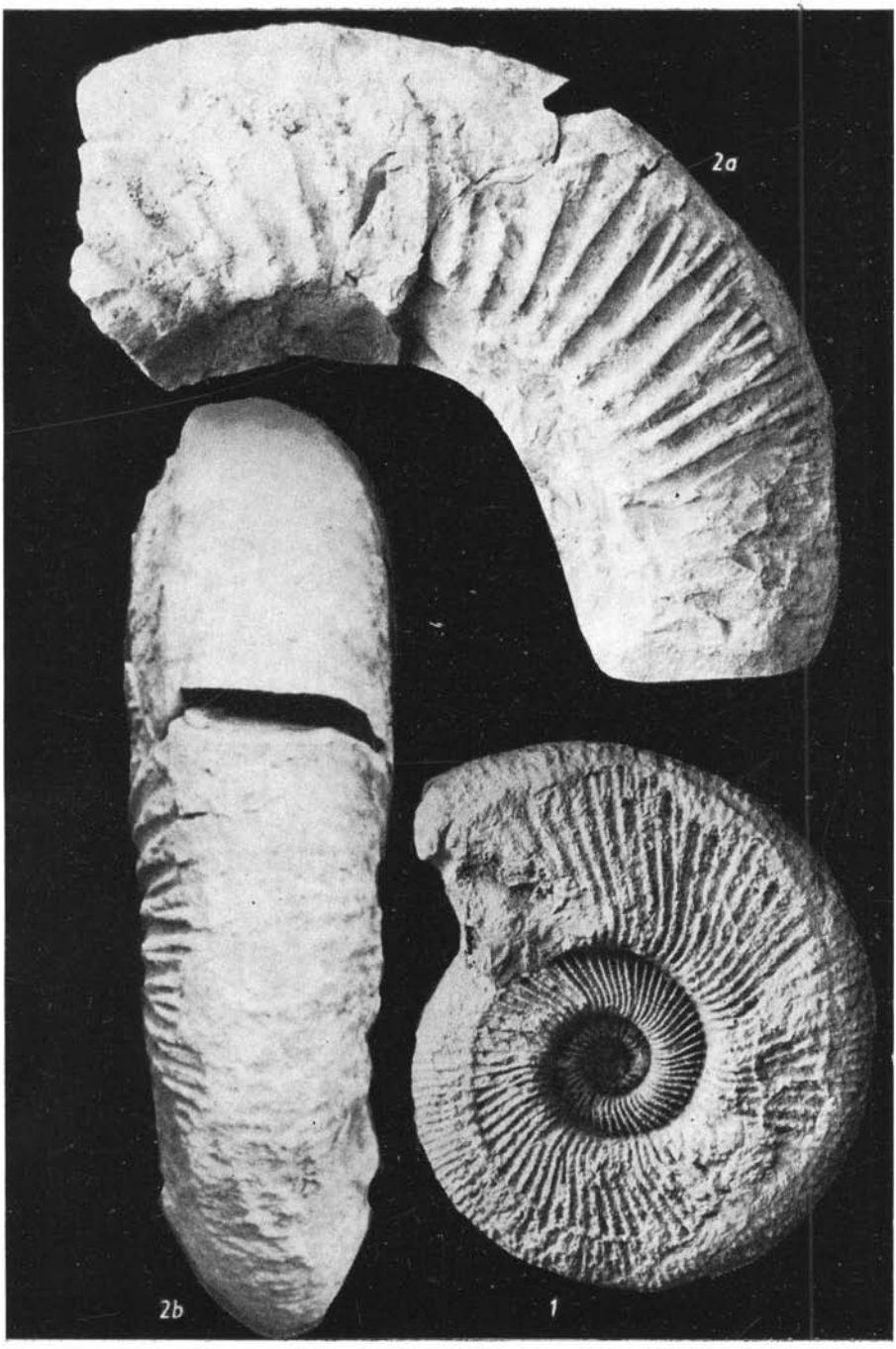
EXPLANATION OF PLATE II

(Early Tithonian ammonites)

Fig. 1. *Subplanitoides ardescicus* (F o n t a n n e s, 1879). Section near the village of Komštica, area of Godeč, District of Sofia (West Balkan). Ginci Formation, No. 12, from the lower 2 m (S a p u n o v, 1976a, p. 31); Lower Tithonian, *Hybonoticeras hybonotum* Zone. Specimen of К а м е н о в (1934, p. 38), described as "*Perisphinctes ardescicus*, F o n t a n n e s — Kimmeridgian". Pal. Mus. Univ. Sofia, J 131/8—1. × 1.0

Figs. 2a, b. *Subplanites moernsheimensis* (S c h n e i d, 1915). Section near the village of Belotinci, area of Belogradčik, District of Vidin (West Forebalkan). Ginci Formation, member of the upper nodular limestones, No. 17, at 4.10 m above the base (S a p u n o v, 1976a, p. 28); Lower Tithonian, *Hybonoticeras hybonotum* Zone, *Subplanites moernsheimensis* Subzone. Pal. Mus. Univ. Sofia, J 123/49—3. × 1.0

PLATE II



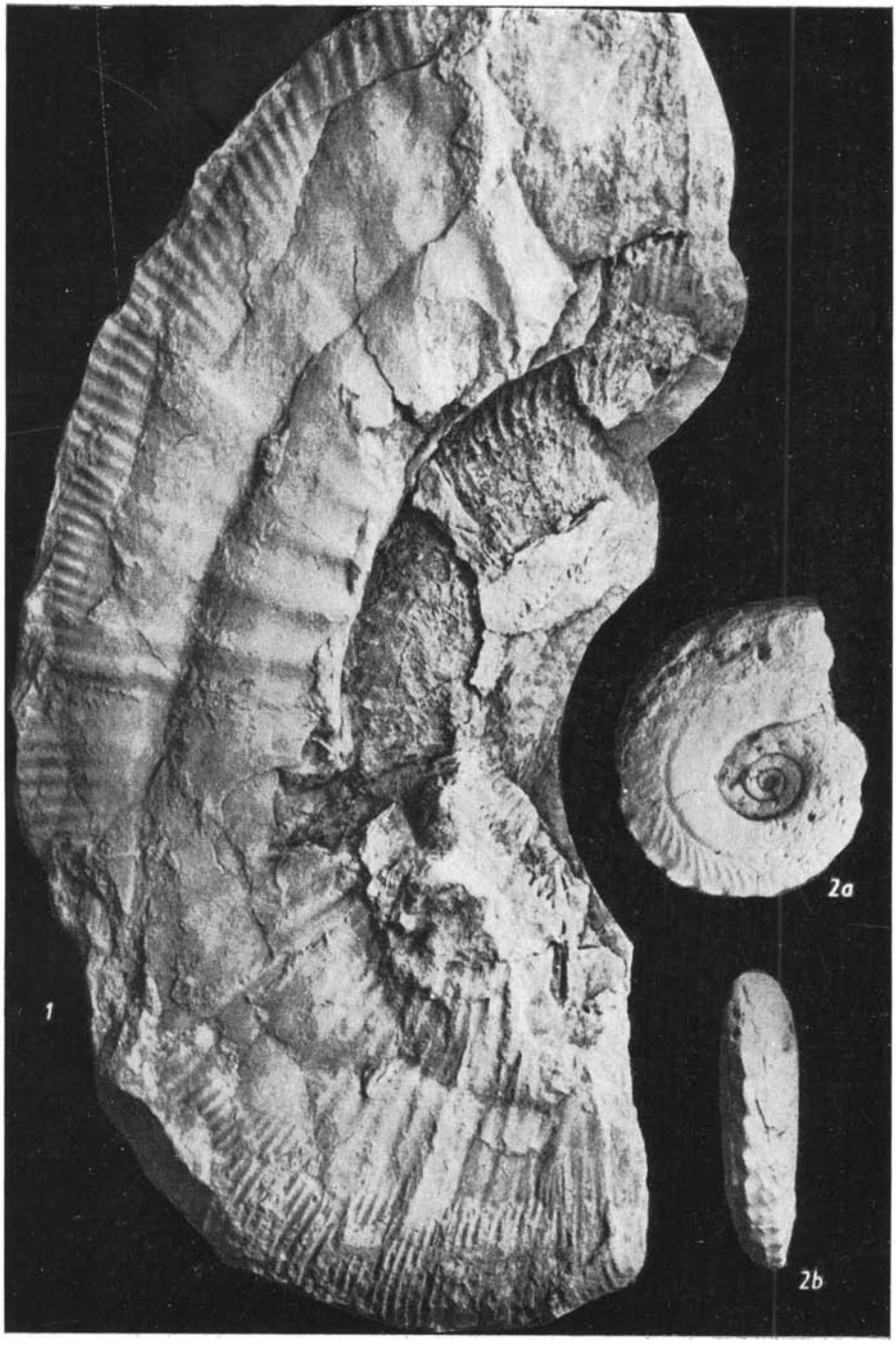
EXPLANATION OF PLATE III

(Early Tithonian ammonites)

Fig. 1. *Franconites pseudojubatus* (D o n z e & E n a y, 1961). Section in the valley of Agălnica River, area of Elena, District of Veliko Tărnovo (East Forebalkan). Agălnica Formation, No. 4, probably from the upper half (S a p u n o v, 1976a, p. 37); Lower Tithonian, *Franconites vimineus* Zone, *Franconites pseudojubatus* Subzone. Pal. Mus. Univ. Sofia, J126/49—4. × 1.0

Figs. 2a, b. *Glochiceras (Paralingulaticeras) lithographicum* (O p p e l, 1863). Localit- near the village of Smolča, area of Godeč, District of Sofia (West Balkan). Ginci Fory mation, probably from the middle part (S a p u n o v, 1976a, p. 32); Lower Tithonian, *Hybonoticeras hybonotum* Zone. Pal. Mus. Univ. Sofia, J141/49—5. × 1.0

PLATE III



EXPLANATION OF PLATE IV

(Early & Middle Tithonian ammonites)

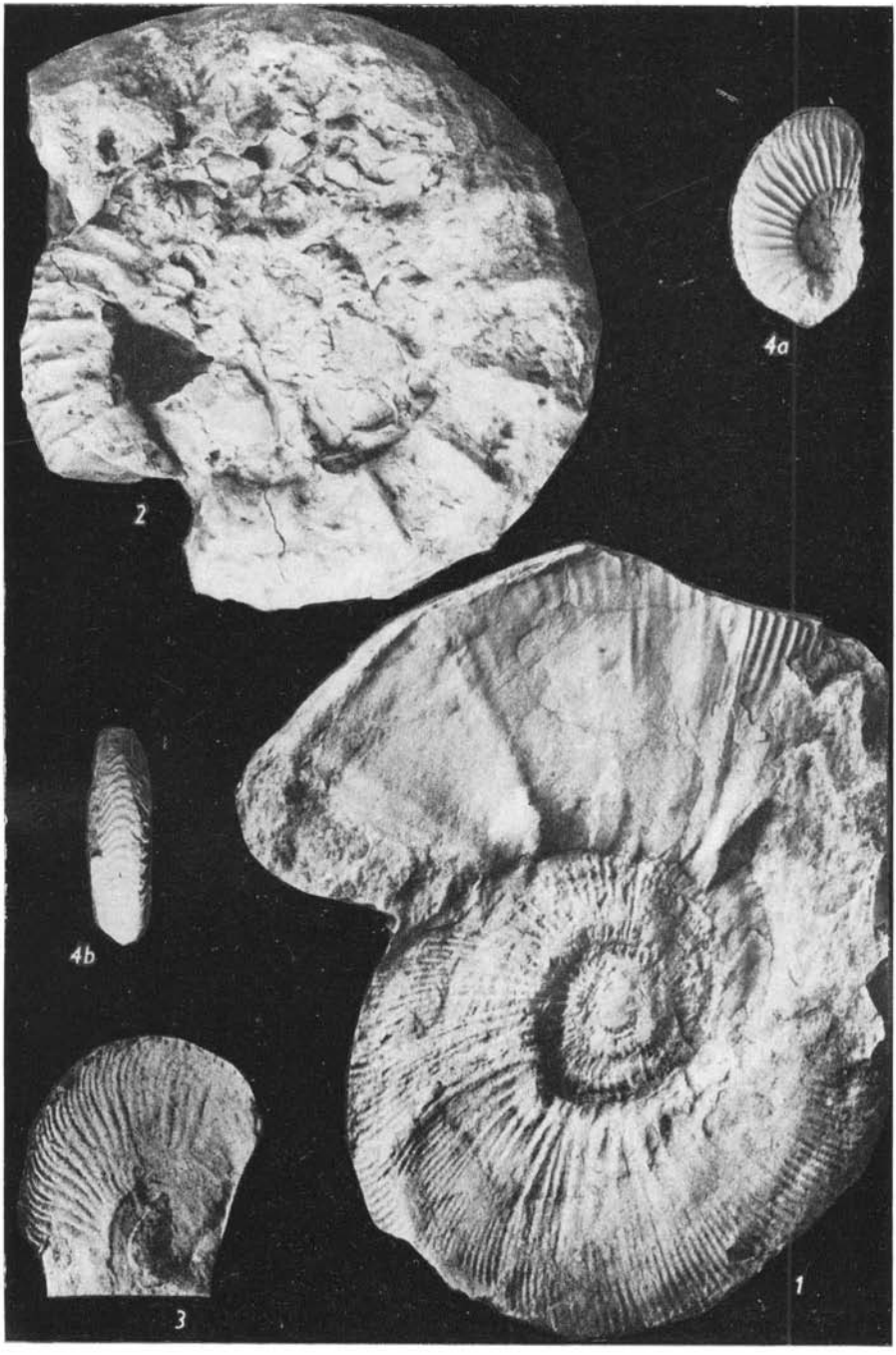
Fig. 1. *Franconites vimineus* (S c h n e i d, 1915). Locality near the hamlet of Todorčeta, to the west of Gabrovo (Central Balkan). Zlatarica Formation, lower half, from the middle part (S a p u n o v, 1976a, p. 34); Lower Tithonian, *Franconites vimineus* Zone. Pal. Mus. Univ. Sofia. J124/49—6. × 1.0

Fig. 2. *Virgatosimoceras rothpletzi* (S c h n e i d, 1915). Section near the village of Ginci, District of Sofia (West Balkan). Ginci Formation, No. 7, from the upper 9 m (S a p u n o v, 1976a, p. 34); Middle Tithonian, *Virgatosimoceras rothpletzi* Zone. Specimen of S a p u n o v & Z i e g l e r (1976, pl. 2, fig. 7), figured as "*Virgatosimoceras rothpletzi* (S c h n e i d) mittleres Tithon". Pal. Mus. Univ. Sofia, J120/46—6 (old number J5093). × 1.0

Fig. 3. *Richterella richteri* (O p p e l, 1865). Locality near the village Bojkovec (Ravna), to the west of Etropole, District of Sofia (Central Balkan). Černiosăm Formation, the exact position is unknown (S a p u n o v, 1976a, p. 34); Middle Tithonian, *Virgatosimoceras rothpletzi* Zone. Speci men of К а м е н о в (1936, p. 112), described as „*Perisphinctes richteri*, O p p e l — Tithonian". Pal. Mus. Univ. Sofia, J16/13—3. × 1.0

Figs. 4a, b. *Richterella patruliusi* (A v r a m, 1974). Locality near Červen Peak, to the north of Televen, District of Loveč (Central Forebalkan). Ginci Formation, in the interval between 15th—30th m (S a p u n o v, 1976a, p. 36); Middle Tithonian, *Virgatosimoceras rothpletzi* Zone. Pal. Mus. Univ. Sofia, J136/49—7. × 1.0

PLATE IV



EXPLANATION OF PLATE V

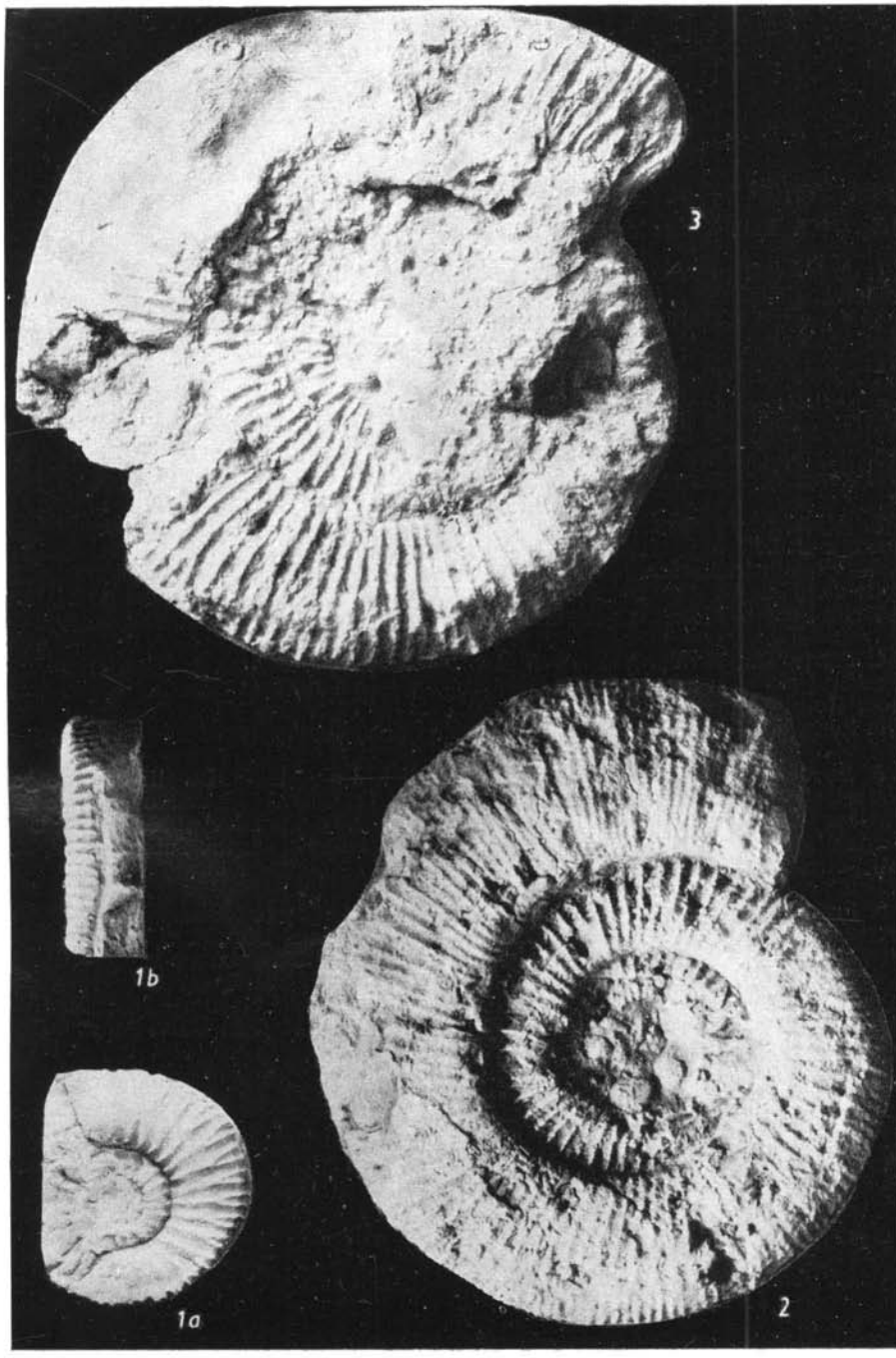
(Middle & Late Tithonian ammonites)

Figs. 1a, b. *Parapallasiceras praecox* (S c h n e i d, 1915). Locality to the north of the hamlet of Jankovo, area of Breznik, District of Pernik (Region of Kraište). Zlatarica Formation, from the middle part (S a p u n o v, 1976a, p. 33); Middle Tithonian, *Parapallasiceras* spp. Zone. Pal. Mus. Univ. Sofia, J115/49—8. × 1.0

Fig. 2. *Paraulacosphinctes transitorius* (O p p e l, 1865). Section near the village of Komštica area of Godeč, District of Sofia (West Balkan). Gložene Formation, Ogosta Member, No. 15, from the lower half (S a p u n o v, 1976a, p. 31); Upper Tithonian, *Paraulacosphinctes transitorius* Zone. Pal. Mus. Univ. Sofia, J65/49—9. × 1.0

Fig. 3. *Himalayites (Micracanthoceras) microcanthus* (O p p e l, 1865). Section near the village of Komštica, area of Godeč, District of Sofia (West Balkan). Gložene Formation, Ogosta Member, No. 15, the lower half, from the lower part (S a p u n o v, 1976a, p. 31); Upper Tithonian, *Paraulacosphinctes transitorius* Zone, *Himalayites (Micracanthoceras) microcanthus* Subzone. Pal. Mus. Univ. Sofia, J57/49—10. × 1.0

PLATE V



EXPLANATION OF PLATE VI

(Middle (?) & Late Tithonian ammonites)

Fig. 1. *Aulacosphinctes linoptychus* (U h l i g, 1910). Locality to the north of the village of Sredorek, District of Kjustendil (Region of Kraište). Kostel Formation, from the upper part (S a p u n o v, 1976a, p. 33); ?Middle Tithonian, *Parapallasiceras* spp. Zone — ?Upper Tithonian, *Paraulacosphinctes transitorius* Zone, *Himalayites (Micracanthoceras) microcanthus* Suqzone, lower part. Pal. Mus. Univ. Sofia, J59/49—11. × 1.0

Fig. 2. *Malbosiceras chaperi* (P i c t e t, 1868). Locality near the hamlet of Katilska, area of Trojan, District of Loveč (Central Balkan). Černiosăm Formation, lower half, from the upper part (S a p u n o v, 1976a, p. 34); Upper Tithonian, *Paraulacosphinctes transitorius* Zone, *Malbosiceras chaperi* Subzone. Pal. Mus. Univ. Sofia, J36/49—12. × 1.0

Fig. 3. *Malbosiceras asper* (M a z e n o t, 1939). Locality between the villages Malka Željazna and Lesi ren, area of Teteven, District of Loveč (Central Forebalkan). Černiosăm — Gložene formation, lower half, from the upper part [S a p u n o v, 1976a, p. 36;] wrongly cited as *M. aizyensis* (M a z e n o t, 1939)]; Upper Tithonian, *Paraulacosphinctes transitorius* Zone, *Malbosiceras chaperi* Subzone. Pal. Mus. Univ. Sofia, J32/49—13. × 1.0

Fig. 4. *Berriasella (Berriasella) moreti* M a z e n o t, 1939. Section in the Straža Gorge, to the south of the village of Straža, District of Tărgovište (East Forebalkan). Tiča Formation, No. 4 (S a p u n o v, 1976a, p. 38). Upper Tithonian, *Paraulacosphinctes transitorius* Zone, *Malbosiceras chaperi* Subzone. Pal. Mus. Univ. Sofia, J9/49—14. × 1.0

Fig. 5. *Berriasella (Delphinella)* cf. *delphinensis* (K i l i a n, 1889). Locality in the gorge of Zlatarica River, to the north of the town of Elena, District of Veliko Tărnovo (East Forebalkan). Zlatarica Formation, from the lower half (S a p u n o v, 1976a, p. 37); Upper Tithonian, *Paraulacosphinctes transitorius* Zone, *Malbosiceras chaperi* Subzone. Pal. Mus. Univ. Sofia, J38/49—15. × 1.0

Fig. 6. *Proniceras simplex* (D j a n é l i d z é, 1922). Locality to the north of Černa Reka river, near the village of Kostel, area of the town of Elena, District of Veliko Tărnovo (East Forebalkan). Kostel Formation, from the lower half (S a p u n o v, 1976a, p. 37); Upper Tithonian, *Paraulacosphinctes transitorius* Zone, *Malbosiceras chaperi* Subzone. Specimen of Д и м и т р о в а (1967, p. 87, pl. 43, fig. 1), described and figured as "*Proniceras simplex* D j a n é l i d z é, 1922 — Berriasian?". Pal. Mus. Univ. Sofia, $Cr_1$1842/40—3. × 1.0

PLATE VI