

## THE GENUS *KOSMOCERAS* IN BULGARIA

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### I. INTRODUCTION

During field work in the last few years three specimens of the boreal genus *Kosmoceras* were found in the Western and Central Balkan Mountains. These are the first representatives of the genus on the territory of Bulgaria and also in the Balkan Peninsula, and although they do not mark its southernmost known extent, they are still found in a rather southerly area, in which such ammonites were not known up to the present. The *Kosmoceras* in question are here described. The stratigraphy — discussion on the mediterranean Callovian, description of the sections and discussion of the relationships between the Balkanian Jurassic and the North-west European Province — were written by J. Stephanov of the Geological Institute at the Bulgarian Academy of Sciences, Sofia, and the taxonomy — description of the specimens and comparisons with other areas — were written by M. K. Howarth of the British Museum (Natural History), London.

The specimens described are kept in the Museum of the Geological Institute at the Bulgarian Academy of Sciences (Coll. BAN), or in the Museum of the Department of Paleontology at Sofia University (Coll. SU).

### II. THE CALLOVIAN STAGE AND ITS SUBDIVISION IN THE MEDITERRANEAN JURASSIC AMMONITE PROVINCE

The presence of ammonites of the genus *Kosmoceras*, and in particular of both *K. compressum* (Quenstedt) and *K. spinosum* (J. de C. Sowerby), attribute an Upper Callovian age to the layers in which they were found. But let us, first of all, see what is the Upper Callovian (and in addition Lower and Middle Callovian) in the Mediterranean Jurassic Ammonite Province.

Two kinds of units of the International Stratigraphical Scheme (i.e. chronostratigraphical units) can be distinguished according to their definitions: 1 — nominal units (with both typological and hierarchical definitions), and 2 — potential units (with hierarchical definition only). The terms typological and hierarchical definitions were introduced by J. Callomon (1962), while the terms nominal and potential were introduced by J. Stephanov (in Nachev, Sapunov & J. Stephanov, 1963, pp. 110—111, 141, 144—145) for distinguishing two kinds of substages, but here this nomenclature is distributed over all chronostratigraphical units.

A Mesozoic stage is an obligatory nominal one and has (or must have) both typological and hierarchical definitions, although the principles of the two ways of defining are now widely discussed and many subjective and objective difficulties exist at present. The substage in the Mesozoic is recommended to be potential, i. e. its volume has to be defined by, and to be equal to the sum of the volumes of those zones, which it wholly includes. But since some generally accepted substages have been created in the past as stages with typological definition and later on were lowered in rank, we have now in existence in our schemes nominal substages, too.

Discussion of the typological and hierarchical definitions of the Callovian Stage in its type-province can be found in J. Callomon (1962). From the same paper one can take the hierarchical definitions of the Lower, Middle and Upper Callovian in the Northwest European Province. The ammonite zonal standard of the Callovian of this Province, however, as was mentioned elsewhere (Nachev, Sapunov & J. Stephanov, 1963, pp. 110 141, 144), is inapplicable for the Callovian of the Mediterranean Province. For the latter such a standard must be made in the future. But how many zones it shall encompass, how they shall be classified in the further three mediterranean potential Callovian substages and up to what degree they shall be comparable with zones of other Callovian provinces — all this is a matter for further investigations. At present it is possible to say only that the mediterranean Lower Callovian can be recognized by the predominance of *Macrocephalites* in the fossil assemblages of its layers; the mediterranean

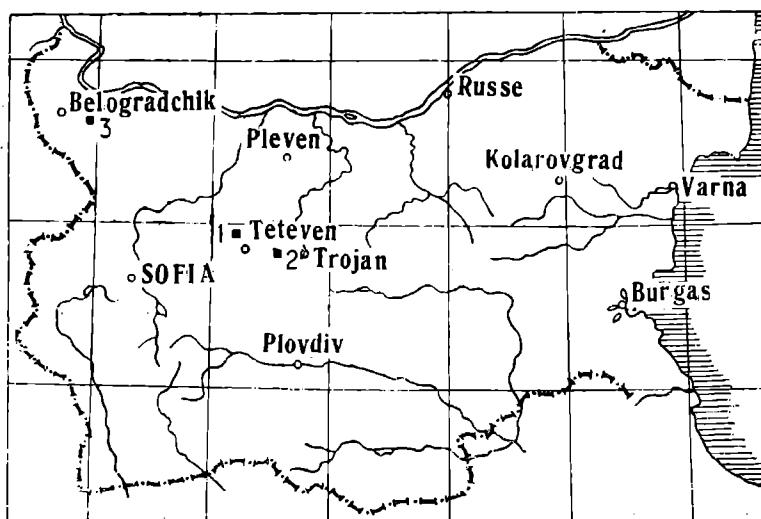


Figure 1. Bulgaria, with the three *Kosmoceras* localities shown

1 — at Polaten village, Teteven district; 2 — near Shipkovo village, Trojan district;  
3 — near Belotintzi village, Belogradchik district

Middle Callovian by the predominance of *Hecticoceras*, and the Mediterranean Upper Callovian (usually difficult to recognize because of poverty of ammonites) can be indicated by early *Aspidoceratidae*. The *Kosmoceras* in the Upper Callovian of the Mediterranean Province must be con-

sidered as emigrants from the north and therefore cannot be taken as a basis for its zoning, while, on the other hand, they give a good opportunity for correlation of mediterranean with boreal fossil assemblages. Probably the index species for the mediterranean ammonite zonal standard must be selected among the representatives of the genera *Macrocephalites* and *Hecticoceras*, as well as among the early *Aspidoceratidae*. For the present time, however, as this standard is not yet made, the mediterranean substages of the Callovian cannot be considered as potential ones. It seems they have to be characterized as insufficiently defined stratigraphical units, whose contents are known, but not the volume and the exact boundaries between them.

### III. STRATIGRAPHY

Two of the three Bulgarian *Kosmoceras* (BAN J997 and J998) described below, were extracted by one of the authors from the rock and their position in the sections is fixed exactly. The third one (SU J01246) had fallen to the base of a low cliff together with other Callovian ammonites and was found recently by the Algerian student-geologist at Sofia University Mr. O. Merabet during his diploma's field work and mapping. Later on, after the suggestion of Dr. J. Callomon of University College, London, he described this specimen in his diploma-work as *Kosmoceras* sp. Thus, while the first two Bulgarian *Kosmoceras* have, besides their other significances, great stratigraphical value, indicating exactly the Upper Callovian in two important sections of the Balkanian Jurassic, — the third one, unfortunately, is interesting as a paleontological fact only.

The important parts of the sections, which yielded the Callovian *Kosmoceras* in question, are briefly described below. However, since almost no formational names are in existence for the Bulgarian Jurassic, and such are not introduced here, only rocks are described in the present paper. They are characterized on the ground of their macroscopical features only, i. e. as they are easily seen and established in the field.

#### 1. The Bathonian-Callovian section at Polaten village, Teteven district

The locality. The village Polaten is situated in the western part of the Central Prebalkan at the river Vitt, 6 km. W. N. W. of the town of Teteven and about 80 km. E. N. E. of Sofia. The locality is in the village, on the left bank of the river by the village bridge. This is an exposure showing well the boundary between the Bathonian and Callovian in this region, but the sediments of remaining Jurassic stages do not outcrop in this section.

The section (see Table 1). In the upper part of a thick formation of dark crystalline crinoidal limestones with quartz grains (0.5 cm. or even 1 cm. thick) several Upper Bathonian Opeleids of the genera *Otoxyites* (*Prohecticoceras*) and *Oecotraustes* (specimens of two subgenera) are found. These fossils are collected in the highest 10 cm. of the formation. Above the latter there are transgressive gray microcrystalline limestones, which are fossiliferous at the very base — the lowest 10 cm. *K. spinosum* (BAN J998) was found here, together with several Phylloceratids, *Hecticoceras* (species of different subgenera), as well as *Grossouvria* and *Choffatia*. Above follow unfossiliferous limestones.


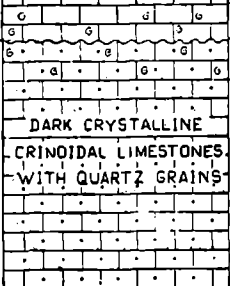
Stages	Substages	Rocks Lithology	Thickness in m	Fauna Ammonites
Callovian	Upper Callovian	 GREY MICROCRYSTALLINE LIMESTONES	0.1	<i>Hecticoceras</i> (subgenera) spp. & others <i>Kosmoceras compressum</i> (Quenstedt) <i>Oecalraustes</i> ( <i>Paroecalraustes</i> ) spp <i>Olozyites</i> ( <i>Prohecticoceras</i> ) spp
		 DARK CRYSTALLINE CRINOIDAL LIMESTONES WITH QUARTZ GRAINS		
Bathonian	Upper Bathonian			

Table 1. The Bathonian-Callovian section at Polaten village, Teteven district

The fossiliferous limestone layer in question, situated transgressively over Upper Bathonian rocks belongs to the Upper Callovian because of the presence of *K. spinosum*. The lower boundary of this substage is clear in the section because of the transgressive disposition of its sediments. However, its upper boundary (i. e. that between the Callovian and Oxfordian Stages) cannot be drawn here because of the entire absence of ammonites or other macrofossils in the section.

## 2. The locality near Shipkovo village, Trojan district

The locality. The village Shipkovo is situated in the central part of the Central Prebalkan, 20 km. W. of the town of Trojan and about 100 km. E. N. E. of Sofia. The locality is north-west of the village, high in the mountain, but the specimen of *K. compressum* (SU J01246), as was mentioned above, was not extracted from the rocks itself and its exact position in the section is unknown.

Remarks on the Callovian transgression in Teteven and Trojan district (Jurassic outcrops in Teteven Anticlinorium). It was recently established (unpublished data of Nachev, Sapunov & J. Stephanov) that the Callovian limestones forming part of the Mesozoic mantle of the Teteven Anticlinorium are transgressively situated over Bathonian sediments. Up to the present this transgression was thought to have occurred entirely during the Middle Callovian, on the ground of an insufficiently studied fauna of widely distributed (Middle-Upper Callovian) *Hecticoceras*, as well as on the grounds of comparisons with neighbouring regions. The new evidence, however, makes us abandon this idea. It seems that the transgression in

question has taken place during the Upper Callovian, but this must be proved in more than one Jurassic section of the Teteven and Trojan regions. Of course, a more complicated paleogeographical situation can be expected, resulting in transgression during both Middle and Upper Callovian. The solving of this problem depends of further detailed investigations of many sections. However, it must be emphasized that the Upper Callovian transgression near the village Polaten is a well established fact.

### 3. The Callovian-Oxfordian section near Belotinzi village, Belogradchik district

The locality. The village Belotinzi is situated in the central part of the Western Prebalkan, 20 km. W. S. W. of the town of Belogradchik, and about 100 km. N. N. W. of Sofia. The locality is at the junction of the rivulets Belotinska Bara and Nechinska Bara. These are steep cliffs, embracing a part of the Upper Bathonian, the whole Callovian and the Lower Oxfordian. The remaining part of the Jurassic section is also well exposed, but does not occur in the cliffs. This is one of the most instructive and complete Jurassic sections in Bulgaria, but ammonites (in some beds in great abundance) are found only in the beds between the Middle Bathonian and the Lower Tithonian.

The section (see Table 2). The Callovian Stage is fully represented by gray-yellowish or bluish clayey limestones with different crushed *Macrocephalites* spp. (Lower Callovian), slightly clayey limestones with *Hecticoceras* spp. (Middle Callovian), and light gray nodular limestones with *Kosmoceras* sp. indet. (Upper Callovian).

The exact position of *Kosmoceras* sp. indet. (BAN J997) in this section (see Table 2) is 20 cm. above the upper surface of one very characteristic reddish layer of limestone, easily recognizable because of its colour; 1.6 m. below the lower surface of a characteristic 0.4 m. thick layer of white limestone (see below); and 6 m. below of an exceptionally characteristic fossiliferous bed with *Creniceras crenatum* (Bruguère). *Kosmoceras* sp. indet. indicates an Upper Callovian age for the layers in which it was found.

The lower boundary of the Callovian Stage in this section is drawn at the appearance of the first ammonites of the genus *Macrocephalites*. Lithologically this coincides with a thick layer of clayey limestone, lying with a sharp lower lithological boundary over Upper Bathonian marls. The boundary between the Callovian and Oxfordian in this section is drawn at the appearance of the first ammonites of the genus *Parawedekindia*. Lithologically this probably coincides with the base of the above mentioned 0.4 m. thick layer of white limestone. Two meters above its upper surface are found well preserved *Parawedekindia* spp. and *Peltomorphites* spp., and 0.6 m. below the latter ones are found some *Parawedekindia* (nuclei). Ammonites of the last genus can be expected even lower in the next 1.8 m., but such have not been found up to the present. In this way the Callovian-Oxfordian boundary ought to be drawn somewhere in the interval of 3.4 m. of limestones, between the layer with *Kosmoceras* sp. indet. and *Parawedekindia* (nuclei).

The subdivision of the Callovian into the above substages can be done successfully in this section, but drawing the exact boundaries between them is difficult because of the considerable gaps of the ammonite succession here (see also Chapter II).

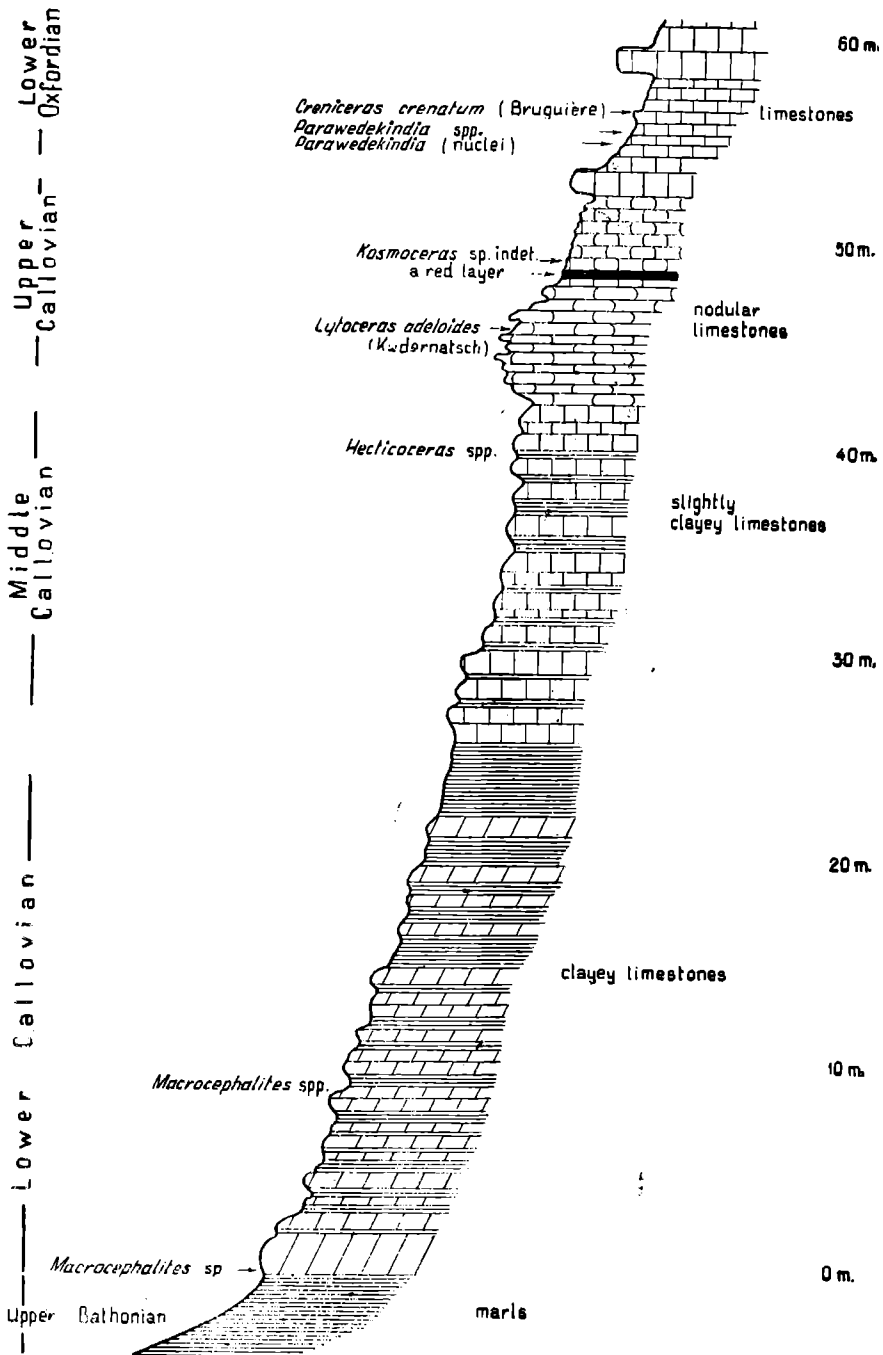


Table 2. The Callovian-Oxfordian section near Belotinzi village, Belogradchik district

#### IV. RELATIONSHIPS BETWEEN THE BALKANIAN JURASSIC WITH THOSE OF NORTH-WEST EUROPEAN PROVINCE

The finding of ammonites of the genus *Kosmoceras* suggests interesting connections between the Balkan Mountains and the regions of the Central and North-west Europe during the Jurassic Period. It has been already pointed out (Sapunov & J. Stephanov, 1962), that during the Lower and Middle Jurassic from the Pliensbachian (older sediments *in situ* in Bulgaria are almost entirely lacking in macrofossils) up to the Lower Bathonian — i. e. Jamesoni-Zigzag<sup>1</sup> Zones incl. — close relationships were established between the Bulgarian ammonite faunas and those of the North-west European Province. During that time not only the ammonite families and genera, but also most of the species are the same for both territories. Some of the published Bulgarian Jurassic ammonite faunas illustrates this well (see Sapunov, 1961, 1963a, 1963b, 1964; J. Stephanov, 1960, 1961a, 1961b, 1963). During Progracilis-Macrocephalus Zones the close connections are retained, but a slight differentiation is noticed — almost the same genera, but less common species. However, an active faunal exchange between the Balkans and the territories of the North-west European Province existed during the Jamesoni to Macrocephalus Zones.

After the Macrocephalus Zone, however, the faunal exchange was quickly interrupted, although not entirely stopped, and the territories of the Balkans became more-or-less part of the Mediterranean Jurassic Ammonite Province. Thus, in the Balkanian post Macrocephalus-Zone Callovian there are no early representatives of the boreal families *Kosmoceratidae* and *Cardioceratidae*, which suddenly appear in the North-west European Calloviense Zone and persist there up to the Upper Callovian and — *Cardioceratidae* — even up to the late Oxfordian. In the Balkans their place was taken by various groups of *Hecticoceratinae* which flourished. It seems that the Perisphinctids are in a neutral position, but *Grossouvria* is probably a southern genus. The remaining families (with the exception of those of *Phylloceratina* and *Lytooceratina*) are of less importance for this review. The two different faunas meet in Central Europe and the south-eastern part of European Russia, making this large territory favourable for their correlation. As already mentioned, the single specimens of *Kosmoceras* in the Balkanian Upper Callovian must be considered as emigrants from the north and perhaps as a beginning of that late Middle and early Upper Jurassic expansion of boreal faunas towards the south, about which H. Termier & G. Termier (1952) and Arkell (1956) wrote. In the Balkanian Jurassic, however, the expansion in question is noticed best in the Lower Oxfordian, in which was found recently a rich fauna of *Parawedekindia*, *Peltomorphites*, *Creniceras*, and, of course, *Euaspidoceras*, *Taramelliceras* and many Perisphinctids — all known to be familiar in the Central and even North-west European Lower Oxfordian. But later on, during the Upper Oxfordian-Tithonian the relationships with North-west European Province are quickly interrupted and the territory of the Balkanids was once again part of the Mediterranean Jurassic Ammonite Province.

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<sup>1</sup> I am indebted to Mr. H. S. Torrens of the University, Leicester, for discussing some details of the relationships during the Bathonian (J. Stephanov).

V. SYSTEMATIC DESCRIPTIONS

Family *KOSMOCERATIDAE* HAUG, 1887

Genus *Kosmoceras* Waagen, 1869

*Kosmoceras compressum* (Quenstedt)

Plate I, figs. 1a, b

1847. *Ammonites duncani* J. Sowerby; d'Orbigny, p. 451, pl. 162, figs. 5—8 only.  
 1849. *Ammonites ornatus compressus* Quenstedt, p. 133, pl. 9, fig. 18.  
 1858. *Ammonites ornatus compressus* Quenstedt, p. 529, pl. 70, fig. 7.  
 1896. *Cosmoceras duncani* (J. Sowerby); Brasil, p. 44, pl. 4, figs. 3—5.  
 1901. *Cosmoceras duncani* (J. Sowerby) var.; Raspail, p. 197, pl. 11, fig. 6.  
 1911. *Cosmoceras modestum* Rollier, p. 295.  
 1915. *Cosmoceras duncani* (J. Sowerby); R. Douvillé, p. 55, pl. 16, figs. 1—3, 5—8;  
 pl. 17, figs. 1—3, 6; pl. 18, figs. 1—6.  
 1939. *Kosmoceras compressum* (Quenstedt); Arkell, p. 191.

Material. One specimen from Shipkovo village, Trojan district about 100 km. E. N. E. of Sofia (Coll. SU J01246).

Description. The specimen consists of two septate whorls ending at a diameter of 50 mm., followed by half a whorl of body chamber up to the broken aperture at a maximum size of 67 mm. diameter. The outer whorl is moderately well preserved, but the inner one and a half whorls are much worn and the ornament hardly visible. The whorl section is compressed, and has a rounded umbilical edge, flat sides that taper towards the ventro-lateral angles, and a flat venter. Dimension of the Balkan specimen are given below, together with those of the holotype and one of R. Douvillé's specimens for comparison.

	D.	Wh.	Wb.	U.
SU J01246. Shipkovo village, Trojan district.	64.5;	24.5(0.37),	20.0(0.31),	23.2(0.36).
Holotype. Quenstedt, 1849, pl. 9, fig. 18.	49.2;	20.8(0.42),	—	15.0(0.31).
R. Douvillé, 1915, pl. 18, fig. 1.	61.4;	24.3(0.39),	—	22.4(0.36).

D=diameter, Wh=whorl height, Wb=whorl thickness (breadth), U=width of umbilicus.

The ornament consists of straight primary ribs that are inclined slightly forwards of radial, and intercalated secondary ribs that commence just ventral of the mid point of the side of the whorl. At the beginning of the last whorl in places where the shell is preserved the primaries can be seen to bifurcate to form the secondaries, but on the remainder of the last whorl most of the secondaries are intercalated and do not show connections with the primary ribs. Both primary and secondary ribs pass over the venter with a slight swing forwards and without diminishing in strength. There are no umbilical tubercles on the last whorl. Very small lateral tubercles can be seen in some places at the point of bifurcation, and at the ventro-lateral edges the ribs are surmounted by small tubercles that form two regular rows bordering the flat venter.

Details of the suture-lines cannot be seen, but the last 3 or 4 sutures appear to be crowded together, suggesting that the specimen is adult.

Remarks. The identification of *Kosmoceras compressum* (Quenstedt) has been discussed by Arkell (1939, pp. 191—192). Substantially the same species was discussed by Brinkmann (1929, pp. 90—94, non pl. 1, figs. 7—8) under the wrong name *K. duncani*, but Brinkmann's species was



defined too widely and many of the items in his synonymy should be excluded. The variability in whorl dimensions and strength of ornament in this species is seen well in the 20 specimens from the Lamberti Zone, Upper Callovian, of Normandy figured photographically by Brasil, Raspail and R. Douvillé (listed in synonymy above). Two further Normandy specimens were figured by d'Orbigny (1847, pl. 162, fig. 5—8) for which Rollier (1911, p. 295) proposed the name *K. modestum*, which is a synonym of *K. compressum*. Recently several specimens were referred by Amanniazov (1962, p. 57, pl. 4, figs. 3—4) to this species, but they, as well as those referred by him (ibid., p. 69, pl. 7, figs. 2—3) to *K. spinosum* (described below), have rather bad photographs that are difficult to interpret.

The Bulgarian specimen appears to be one of the more evolute examples of *K. compressum* and it agrees exactly with R. Douvillé's plate 18, fig. 1. The relatively evolute final half whorls of both these specimens may be due to their approach to the adult shell. Quenstedt's holotype (1849, pl. 9, fig. 18) is slightly more involute, though there is little or no difference between it and the Bulgarian specimen when they are compared at the same size. More involute examples are R. Douvillé's plate 17, fig. 3 and plate 18, fig. 2, but all are connected by many intermediates and are clearly conspecific. The small, regular, ventro-lateral tubercles and very small lateral tubercles of the Bulgarian specimen are just as in the Normandy topotypes, and its rib density agrees with approximately the middle of the range of variation of the latter.

*K. compressum* (Quenstedt) is one of the most weakly tuberculate species of Upper Callovian *Kosmoceras*. It is only likely to be confused with *K. duncani* (J. Sowerby) and *K. rowlstonense* (Young & Bird). *K. duncani* has a narrow, smooth venter and distinctive large ventro-lateral tubercles on at least the smaller whorls (neotype Arkell, 1939, pl. 11, fig. 6). *K. rowlstonense* is closer to *K. compressum*, but it is more involute and has dense ribs and long, fine secondary ribs.

### ***Kosmoceras spinosum* (J. de C. Sowerby)**

Plate I, figs. 2a, b

1826. *Ammonites spinosus* J. de C. Sowerby, p. 78, pl. 540, fig. 2.  
 1831. *Ammonites decoratus* Zieten, p. 18, pl. 13, fig. 5.  
 1849. *Ammonites ornatus rotundus* Quenstedt, p. 133, pl. 9, fig. 19.  
 1880. *Ammonites gemmatus* Phillips; Damon, pl. 18, fig. 6.  
 1881. *Cosmoceras ornatum* (Schlotheim); Nikitin, p. 72, pl. 4, fig. 34.  
 1887. *Ammonites ornatus rotundus* Quenstedt, p. 725, pl. 84, figs. 6, 7, 11.  
 1890. *Cosmoceras grewingkii* Siemiradzki, p. 63, pl. 3, figs. 1, 2, 8.  
 1901. *Cosmoceras duncani* (J. Sowerby); Raspail, p. 197, pl. 10, fig. 7.  
 1908. *Cosmoceras* cf. *ornatum* (Schlotheim); Borissjak, p. 37, pl. 3, fig. 16.  
 1915. *Cosmoceras ornatum* (Schlotheim); R. Douvillé, p. 48 (pars), pl. 19, figs. 22—42; pl. 20, figs. 1, 3, 6, 7, 9; pl. 21, figs. 1—4; pls. 22—24.  
 1915. *Cosmoceras duncani* (J. Sowerby); R. Douvillé, p. 55 (pars), pl. 19, figs. 2—23.  
 1929. *Kosmoceras spinosum* (J. de C. Sowerby); Brinkmann, p. 102 (pars).  
 1939. *Kosmoceras* (*Kosmoceras*) *spinosum* (J. de C. Sowerby); Arkell, p. 187, pl. 11, fig. 1.  
 1952. *Cosmoceras* (*Cosmoceras*) *spinosum* (J. de C. Sowerby); Makowski, p. 35, pl. 3, figs. 6, 7; pl. 8, fig. 2.  
 1962. *Cosmoceras spinosum* (J. de C. Sowerby); Makowski, p. 69, pl. 3, fig. 1; pl. 4; pl. 5, fig. 1.

**Material.** One specimen from Polaten village, Teteven district; about 80 km. E. N. E. of Sofia (Coll. BAN J998).

**Description.** The specimen consists of septate whorls up to 67 mm. diameter, followed by a quarter of a whorl of body chamber ending in an obliquely broken aperture at a maximum size of 79 mm. diameter. It is not crushed or distorted except for the displacement of a small portion just before the aperture caused by a calcite vein, but the preservation is generally rough. All whorls consist of an internal mould except for a very small part of the shell preserved at the beginning of the body chamber. It is noticeable that the ribs are tall and thick and the tubercles pronounced on the shell, but the ribs are low and thin and the tubercles much smaller on the internal mould. The whorl section is generally rounded, with marked tapering towards a narrow flat venter. The ribs are strong and unbroken between umbilicus and ventral edge; they are straight and radial on the side of the whorl and curve slightly forwards just before the ventro-lateral edge. The ribs are continuous across the venter on the final whorl of the specimen, but the venter is smooth on the small inner whorls. Each primary rib bifurcates at the mid lateral point, and a prominent lateral tubercle occurs on roughly half the primary ribs at this point. A third intercalated secondary rib occurs occasionally. Every secondary rib ends in a tubercle at the edge of the flat venter. There are no umbilical tubercles.

**Remarks.** *K. spinosum* occurs in large numbers in the Upper Cretaceous of many localities in North and North-west Europe. Two series of beautifully preserved specimens from Normandy and Luków, Poland, have been figured by R. Douvillé and Makowski (see synonymy), and the interpretation of the species has been discussed by Arkell (1939, pp. 187—188). As in *K. compressum* there is some variation in density of ribs, strength of tubercles and whorl dimensions, but the species is characterized by having evolute whorls and ribs that are continuous from the umbilicus to the venter with a lateral tubercle occurring only on every second rib or less frequently. On inner whorls such as those figured by Arkell (1939, pl. 11, fig. 1) the lateral and ventro-lateral tubercles are relatively more prominent, but there are still many ribs bearing no lateral tubercles. The Bulgarian specimen shows approximately average characters for the species and agrees closely with one of the largest specimens figured by R. Douvillé (1915, pl. 24) and by Makowski (1962, pl. 5, figs. 1b, 1c).

*K. annulatum* (Quenstedt) (see Arkell, 1939, p. 190, pl. 11, fig. 5) was interpreted by Makowski (1962, pp. 18, 21, 69, text-pl. 1, fig. 4; pl. 2, fig. 3; pl. 3, figs. 2, 3; pl. 5, figs. 2, 3) as the male of the species of which *K. spinosum* was the female. The Bulgarian specimen is a true *K. spinosum* and is female according to this view.

### *Kosmoceras* sp. indet.

**Material.** One specimen from Belotinzi village, Belogradchik district, about 100 km. N. N. W. of Sofia (Coll. BAN J997).

**Description.** BAN J997 from Belotinzi is poorly preserved and worn. It has a maximum size of 51 mm. diameter. At the beginning of the final whorl at a diameter of about 28 mm. a short portion of the whorl is sufficiently well preserved to show that the whorl section is moderately thick at the centre and narrows markedly to a narrow venter. There are well marked lateral tubercles, with fine ribs between them, and well marked

ventro-lateral tubercles that border the narrow smooth venter. At larger sizes the whorl seems to become more compressed and the ribs become continuous across the venter. This specimen probably belongs to *K. prionae* Teisseyre (1884, p. 557, pl. 3, figs. 15—18), or to one of the forms figured as *K. prionaeduncani* by Krenkel (1915, p. 262, pl. 21, figs. 2—19) that are intermediate between *K. prionae*, *K. compressum* and *K. transitionis* Nikitin (1881, p. 73, pl. 4, fig. 35). These forms are all characteristic of the Athleta Zone, Upper Callovian. The Bulgarian specimen is not sufficiently well preserved, however, for a definite identification to be made.

## VI. COMPARISONS WITH OTHER AREAS

In Britain, France and Germany *K. spinosum* and *K. compressum* are species characterizing the Upper Callovian. *K. spinosum* occurs in both the Lamberti and Athleta Zones, while *K. compressum* appears to be confined to the Lamberti Zone. The best summary for this area can be found in Arkell (1939, pp. 196—210). The age of the three Bulgarian *Kosmoceras* is undoubtedly Upper Callovian, but it cannot be narrowed down further.

The nearest record of *Kosmoceras* to Bulgaria is from Valea Lupului, near Rucar, Transylvanian Alps, which is 175—200 km. north of the Balkan Mountains. From this locality Simionescu (1899, p. 25, pl. 2, fig. 1) described and figured *Kosmoceras mrazeci*, a species that is very close to and perhaps conspecific with *Kosmoceras duncani* (J. Sowerby) and indicates an Upper Callovian age. A Middle Callovian fauna of *Kosmoceras* is known from Villany, 425 km. north-west of the Balkans (Till, 1911, p. 23; Loczy, 1915, p. 354). In the Krakow area of Southern Poland and again at Luców, east of Warsaw, there occurs an Upper Callovian fauna of species of *Kosmoceras*, including the ubiquitous *K. spinosum*, that rivals the finely preserved faunas of Normandy (Neumayr, 1871; Makowski, 1952).

East of the Balkan, an Upper Callovian species of *Kosmoceras* has been figured from the Donetz basin, north of the Crimea, by Borissjak (1908, p. 37, pl. 3, fig. 16). *Kosmoceras* does not occur in the Crimea itself, but there are Middle and Upper Callovian species of the genus in Trans-Caspia (Semenov, 1896, pp. 76, 97—104; de Tsytovitich, 1912, p. 192, pl. 2, figs. 3—15) and the Caucasus (Kazansky, 1909, p. 104, pl. 1, figs. 1—4; Nikshick, 1915, p. 521; Khimshiasvilli, 1957, p. 68; 1961, pp. 165—170, pl. 2, figs. 3—6; pl. 4, figs. 1—2, 7). Further north in Russia, Upper Callovian species of *Kosmoceras* appear in force again in the Volga basin (Nikitin, 1881; Teisseyre, 1884).

The new find of *Kosmoceras* in Bulgaria is not the southernmost extent of the species, for the genus has been recorded (unfortunately without specific names or figures) from the Coast Range, south side of the Sea of Marmara, Turkey (Altinli, 1943, pp. 91—93), and from the Elburz Mountains in northern Persia (Fischer, 1915, p. 234). Both of these records are considerably further south than the Balkan Mountains and they mark the southernmost known extent of this characteristically boreal genus. Fischer's record from the Elburz Mountains is only slightly further south than the rich faunas of Middle and Upper Callovian species of *Kosmoceras* described recently by Amanniazov (1962, pp. 51—6) from Tuarkyr on the east side of the Caspian Sea (just east of the Gulf of Karabugas).

## REFERENCES

- Altınlı, F. 1943. Étude géologique de la chaîne côtière entre Bandırma-Gemlik. *Rev. Fac. Sci. Univ. Istanbul*, vol. 8, séries B, pp. 76—139.
- Amanniazov, K. 1962. Stratigraphy and ammonites of the Upper Jurassic deposits of Tuarkyr. *Inst. Geol. Acad. Nauk Turkmenskaya SSR*, Ashkabad, 110 pp., 28 pls.
- Arkell, W. J. 1939. The ammonite succession at the Woodham Brick Company's pit, Akeman Street Station, Buckinghamshire, and its bearing on the classification of the Oxford Clay. *Quart. J. Geol. Soc. Lond.*, vol. 95, pp. 135—222, pls. 8—11.
- Arkell, W. J. 1956. *Jurassic geology of the World*. XV+806 pp., 46 pls., 27 tables, 102 figs., Edinburgh & London.
- Borissjak, A. 1908. Die Fauna des Donetz-Jura. 1, Cephalopoda. *Mém. Com. Géol. St. Petersbourg*, (NS) vol. 37, VI+94 pp., pls. 1—10.
- Brasil, L. 1896. Les genres *Peltoceras* et *Cosmoceras* dans les couches de Dives et de Villers-sur-Mer. *Bull. Soc. Géol. Normandie*, vol. 17, pp. 36—49, pls. 3, 4.
- Brinkmann, R. 1929. Monographie der Gattung *Kosmoceras*. *Abh. Ges. Wiss. Göttingen, Math.-Phys. Kl.*, (NF) vol. 13(4), VII+123 pp., 1 pl.
- Callomon, J. 1962. *Notes on the Callovian and Oxfordian Stages*. Manuscript for the Luxembourg's meeting in 1962.
- Damon, R. 1880. *A supplement to the handbook to the geology of Weymouth and the Isle of Portland*. Second edition (of the supplement). 18 pls. London.
- Douvillé, R. 1915. Études sur les Cosmocératidés des collections de l'École Nationale supérieure des Mines et de quelques autres collections publiques ou privées. *Mém. Carte géol. France*, 75 pp., 24 pls.
- Fischer, E. 1915. Jura- und Kreideversteinerungen aus Persien. *Beitr. Pal. Öst. Ung.*, vol. 27, pp. 207—273, pl. 19—21.
- Kazansky, P. 1909. Matériaux pour la connaissance de la faune jurassique du Daghestan. *Tomsk. Tech. Inst. Izvestia*, vol. 16 (4), pp. 102—116, pls. 1—3.
- Khimshiasvilli, N. G. 1957. Upper Jurassic fauna from Georgia. *Acad. Nauk Georg. SSR*, Tbilisi, 313 pp., 31 pls.
- Khimshiasvilli, N. G. 1961. Relationships between Upper Jurassic molluscan faunas of Georgia with those of North Caucasus. *Acad. Nauk Georg. SSR, Trudy Inst. Paleobiol.*, vol. 6, pp. 123—212, 13 pls.
- Krenkel, E. 1915. Monographie der Kelloway-Fauna von Popilani in Westrußland. *Palaeontographica*, vol. 61, pp. 191—363, pl. 19—28.
- Lóczy, L. 1915. Monographie der Villányer Callovien — Ammoniten. *Geologica Hungarica*, vol. 1, fasc. 3, 4, pp. 225—502, 14 pls.
- Makowski, H. 1952. La faune callovienne de Łuków en Pologne. *Pal. Polonica*, no. 4, X+64 pp., 9 pls.
- Makowski, H. 1962. Problem of sexual dimorphism in ammonites. *Pal. Polonica*, no. 12, VIII+92 pp., 20 pls.
- Nachev, I., Sapunov, I. & Stephanov, J. 1963. Stratigraphy and lithology of the Jurassic System between Gorno Ozirovo and Prevala villages (North-west Bulgaria). *Travaux sur la géol. de Bulg., série stratigr. et tect.*, vol. 5, pp. 99—146.
- Neumayr, M. 1871. Die Cephalopoden-Fauna der Oolithe von Balin bei Krakau. *Abh. k. k. Geol. Reichsanst.*, vol. 5(2), pp. 19—54, pls. 9—15.
- Nikitin, S. 1881. Die Jura-ablagerungen zwischen Rybinsk, Mologa und Myschkin an der oberen Wolga. *Mém. Acad. Imp. Sci. St. Petersbourg*, vol. 28(5), 98 pp., 7 pls.
- Nikshick, J. 1915. Dépôts jurassiques dans le bassin de la rivière Biélaïa (versant Nord du Caucase). *Bull. Com. Géol. St. Petersbourg*, vol. 34, pp. 503—533, pl. 18.
- Orbigny, A. d'. 1812—1851. *Paléontologie française*. Terrains Jurassiques. 1, Céphalopodes, 642 pp., 234 pls. Paris.
- Quenstedt, F. A. 1815—1859. *Petrefactenkunde Deutschlands*. Die Cephalopoden. 580 pp., 36 pls. Tübingen.
- Quenstedt, F. A. 1855—1859. *Der Jura*. 842 pp., 100 pls. Tübingen.
- Quenstedt, F. A. 1833—1833. *Die Ammoniten des Schwäbischen Jura*. 1140 pp., 126 pls. Tübingen.
- Raspail, J. 1901. Contribution à l'étude de la falaise jurassique de Villers-sur-Mer. *Feuille jeunes Nat.*, vol. 31, nos. 365—368.
- Rollier, L. 1911. Les faciès du Dogger ou Oolithique dans le Jura et les régions voisines. *Mém. Fond. Schnyder von Wartensee*, pp. V+352, Zürich.
- Sapunov, I. 1961. Ammonites from the Liassic family *Liparoceratidae* in Bulgaria. *Travaux sur la géol. de Bulg., série paléont.*, vol. 3, pp. 49—83, 7 pls.

- Sapunov, I. 1963a. Toarclan ammonites of the family *Dactylioceratidae* from Western Bulgaria, *Ibid.*, vol. 5, pp. 109—147, 6 pls.
- Sapunov, I. 1963b. The ammonites of the Bajocian genus *Protoecotraustes* Spath (*Haploceratidae*). *Ibid.*, vol. 5, pp. 149—165, 1 pl.
- Sapunov, I. 1964. A revision of several Bajocian ammonites from the ironbearing Jurassic in Troyan region (Central Balkan range). *Ibid.* vol. 6, pp. 249—277, 5 pls.
- Sapunov, I. & Stephanov, J. 1962. *The stages, substages, ammonite zones and sub-zones of the Lower and Middle Jurassic in the Western and Central Balkan range (Bulgaria) in 1962*. Manuscript for the Luxembourg's meeting in 1962.
- Semenov, B. 1896. Faune des dépôts jurassiques de Mangyçhlak et de Tour Kyr. *Trav. Soc. Nat. St. Petersburg, Sect. Géol. Min.* vol. 24, pp. 29—140, pls. 1—3.
- Siemiradzki, J. 1890. O młeczakach głównogich brunatnego jura w Popielanach na Zmudzi (z czterema tablicami). *Pam. Acad. Umiej. Krakowie*, vol. 17, pp. 46—72, pls. 1—4.
- Simionescu, I. 1899. Fauna calloviana din Valea Lupului (Rucar). *Pub. Fond. V. Adamaci, Acad. Romana*, vol. 1, no. 3, pp. 1—42, pls. 1—3.
- Sowerby, J. & Sowerby, J. de C. 1812—1846. *The Mineral Conchology of Great Britain*, vols. 1—7. London.
- Stephanov, J. 1960. Representatives of the family *Amaltheidae* in Bulgaria. *Travaux sur la géol. de Bulg., série paléont.*, vol. 2, pp. 265—293, 3 pls.
- Stephanov, J. 1961a. The Bathonian in the section of the Belogradçik — Gara Oreshets road (North-west Bulgaria). *Bull. of the Inst. of Geol. BAN*, vol. 9, pp. 337—369, 7 pls.
- Stephanov, J. 1961b. The *serrigerus* problem in the Jurassic ammonoid family *Oppeliidae* Bonarelli, 1894. *Comptes rendus de l'Acad. Bulg. des Sci.*, vol. 14, no. 8, pp. 827—830, 2 text-figs.
- Stephanov, J. 1963. Bathonian ammonites of the superfamily *Stephanocerataceae* in Bulgaria. *Travaux sur la géol. de Bulg., série paléont.*, vol. 5, pp. 167—209, 6 pls.
- Teisseyre, L. 1884. Ein Beitrag zur Kenntniss der Cephalopodenfauna der Ornatenthone in Gouvernement Rjäsan (Rußland). *Sitz. Akad. Wiss. Wien*, vol. 88 (1), pp. 538—628, 8 pls.
- Termier, H. & Termier, G. 1952. *Histoire géologique de la biosphère*. IV+721 pp., 8 pls., 35 maps. Paris.
- Till, A. 1910—1911. Die Ammonitenfauna des Kelloway von Villány (Ungarn). *Beitr. Pal. Öst. Ung.*, vol. 23, pp. 175—199. 251—272; vol. 24, pp. 1—49.
- Tsytovitich, X. de 1912. Sur quelques ammonites calloviens de la Crimée et du Mangyçhlak. *Ann. géol. min. Russie*, vol. 14, pp. 189—199, pl. 2.
- Zieten, C. H. von 1830—1833. *Die Versteinerungen Württembergs*. 102 pp., 72 pls. Stuttgart.

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PLATE I

1a, b. *Kosmoceras compressum* (Q u e n s t e d t); Upper Callovian; Shipkovo village, Trojan district; Coll. SU J01246.

2a, b. *Kosmoceras spinosum* (J. de C. S o w e r b y); Upper Callovian; Polaten village, Te-teven district; Coll. BAN J998.

All photos natural size;  
both specimens were whitened with Ammonium chloride ( $\text{NH}_4\text{Cl}$ ) before photographing; the photographs were made at the British Museum (Natural History), London.



1a



1b



2a



2b