

Albian ammonite biostratigraphy in Northwest Bulgaria

Marin Ivanov

Geological Institute, Bulgarian Academy of Sciences, 1113 Sofia

(Received 06.04.1990; accepted in revised form 03.07.1990)

М. Иванов — Аммонитовая биостратиграфия альбского яруса в Северо-Западной Болгарии. Альбский ярус в Северо-Западной Болгарии в сравнении с другими ярусами нижнемеловой серии имеет ограниченное распространение. Он сложен мергелями с прослоями глинистых известняков и реже песчаников (Сумерская свита), а также глауконитовых песчаников, алевролитов и мергелей (Малопештенская свита). Ярус представлен осадками значительной мощности, без перерывов и конденсаций в разрезе. Альбские породы содержат разнообразную макрофауну, среди которой преобладают аммониты. Описаны литологические и аммонитовые последовательности в 15 разрезах яруса. Альбский ярус рассматривается в объеме с зоны *L. (L.) tardefurcata* до зоны *S. dispar*. В рассматриваемой области охарактеризованы три подъяруса. Установлены новые факты для альбских аммонитовых последовательностей в Северо-Западной Болгарии. Это позволило детализировать и дополнить зональную схему яруса, введенную предыдущими исследователями. В некоторых зонах, там, где возможно, выделены подзоны. Охарактеризованы следующие биостратиграфические единицы (снизу вверх): зона *L. (L.) tardefurcata* с подзонами *L. (L.) tenuicostata* и *L. (N.) regularis*; зона *D. mammillatum* с подзоной *P. (I.) steinmanni*; зона *H. dentatus* с подзонами *L. lyelli* и *H. spathi*; зона *E. loricatus* с подзоной *A. intermedius*; зона *E. lautus*; зона *M. (M.) inflatum* с подзонами *H. orbignyi*, *H. varicosum* и *C. auritus*; зона *S. dispar*. Сделана попытка корреляции описанных единиц с уже установленными в других регионах Средиземноморской области.

Abstract. The Albian Stage in Northwest Bulgaria is of more restricted occurrence compared to the other Lower Cretaceous Stages. It consists of marls interbedded by clayey limestones and by less common sandstones (Sumer Formation) and glauconitic sandstones, siltstones and marls (Malo Peštene Formation). The Albian sediments are of considerable thickness without any hiatuses and condensations in the sections. The deposits contain diverse macrofaunas dominated by ammonites. This paper describes the ammonite and lithological successions in 15 Albian sections. The Albian is considered here to include the *L. (L.) tardefurcata* Zone from its base up to the *S. dispar* Zone. The three Albian substages are characterized and new evidence is reported on the Albian ammonite successions in Northwest Bulgaria. It has made it possible to supplement and to further subdivide the zonations proposed by previous authors. Part of the zones where possible, have been subdivided into subzones. The following biostratigraphic units are characterized in ascending order: *L. (L.) tardefurcata* Zone with *L. (L.) tenuicostata* Subzone and *L. (N.) regularis* Subzone; *D. mammillatum* Zone with *P. (I.) steinmanni* Subzone; *H. dentatus* Zone with *L. lyelli* Subzone and *H. spathi* Subzone; *E. loricatus* Zone with *A. intermedius* Subzone; *E. lautus* Zone; *M. (M.) inflatum* Zone with *H. orbignyi* Subzone, *H. varicosum* Subzone and *C. auritus* Subzone; *S. dispar* Zone. An attempt is made to correlate them with units already established in other parts of the Mediterranean Region.

Introduction

The Albian Stage in Bulgaria is exposed most extensively in the northwestern parts of this country. Compared to the other Lower Cretaceous Stages in that region, the Albian is of quite restricted occurrence. Its sections, however, provide lithological sequences of thickness ranging from 100 m to 600 m without inner gaps and condensations. The Albian sediments are rich in ammonite faunas of relatively uniform distribution across the sections. These objective conditions attracted the interest of a number of researchers to study the stage. The Albian stratigraphy and ammonites in Northwest Bulgaria have been

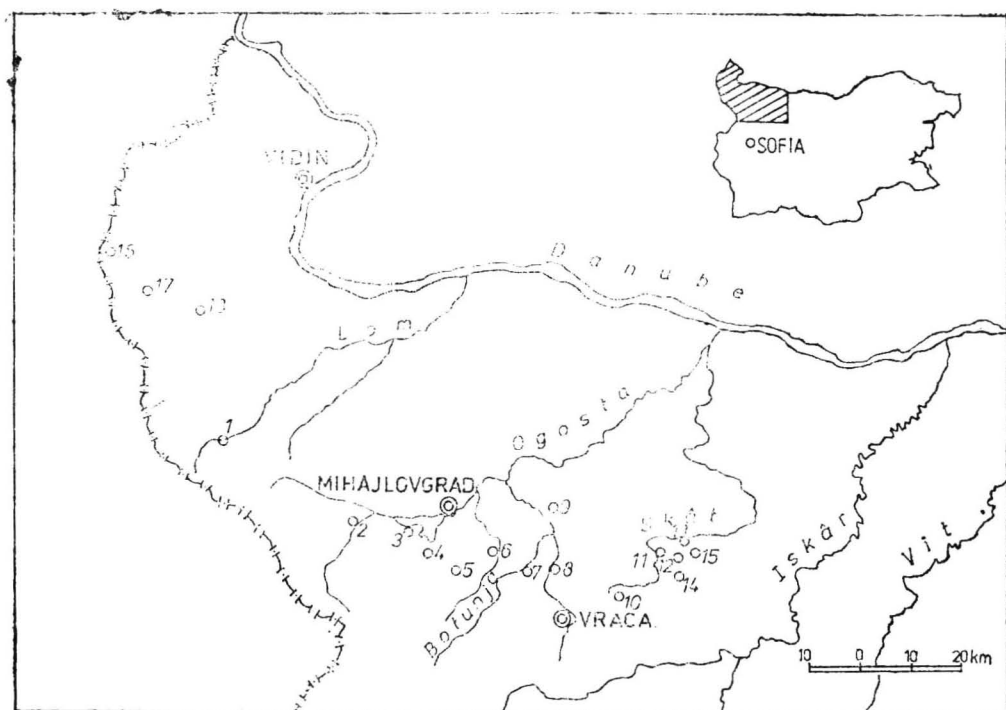


Fig. 1. Sketch-map of Northwest Bulgaria showing position of the Albian localities and sections mentioned in the text:

1 — Čuprene; 2 — G. Damjanovo; 3 — Kalimanica; 4 — Borovci; 5 — Zamfirovo; 6 — Sumer; 7 — Kravoder; 8 — Vlasatica; 9 — Dobruša; 10 — Rečka; 11 — M. Peštene; 12 — Kutela; 13 — Nivjanin; 14 — Virovsko; 15 — Bukovec; 16 — Vrška Čuka; 17 — Rakovica; 18 — Rabiška Mogila

the subject of more than 20 papers most of which are now only of historical interest. The progress in the concepts of the Albian stratigraphy is briefly presented below.

Толла (1881) and Златарски (1907), the first authors to study the Lower Cretaceous Series in that region, reported Albian ammonite species listed together with Barremian and Hauterivian ammonites without defining the Albian Stage.

Бончев, Каменов (1932) were the first to prove the Albian on the basis of ammonite fauna.

In a series of papers, e.g. Бончев, Каменов (1934); Бончев (1935) and Бончев (1955), Bončev referred the sediments studied by him to the Middle Albian. That author suggested the presence of a Middle Albian transgression in the region.

Захарева-Ковачева (1957) established the presence of the three substages of the Albian on the basis of abundant and well-documented paleontological material. Although it has a number of shortcomings, her study has remained the most comprehensive paleontological treatise of the Albian fossils faunas in Bulgaria so far.

Since 1960 a number of authors have published their results gained during an extensive geological research in Northwest Bulgaria. Part of the works dealt with the regional geology with only brief reference to the Albian stratigraphy, e.g. Манолов (1962); Йорданов et al. (1962); Врблянски, Чумаченко (1962) and Моноу, Йовчева (1970). Most papers, however, represent specialized stratigraphical and paleontological studies of the Lower Cretaceous with special emphasis on the Albian and are important contributions to the Albian stratigraphy, mainly the results of T. Nikolov and N. Dimitrova.

Димитрова in Цанков et al. (1960); Димитрова et al. (1961); Цанков (1963); Николов, Хрисчев (1965) and Tzankov, Yovtsheva (1965) established and characterized the Albian in the central and western parts of north-west Bulgaria.

Димитрова et al. (1961) were the first to introduce an ammonite-based zonation of the Albian in Bulgaria without defining any zones, however. Цанков et al. (1963) and Бресковски, Димитрова (1968) have accepted this zonal scheme.

Nikolov (1965, 1969) has proposed an ammonite zonation which is very similar to the currently adopted zonation of the Mediterranean Region.

The lower boundary of the Albian Stage had been a matter of discussion reflecting the different opinions then existing in the stratigraphic practice worldwide. Many authors, including Димитрова et al. (1961); Манолов (1962); Йорданов et al. (1962); Връблянски, Чумаченко (1962); Цанков et al. (1963); Димитрова (1967); Бресковски, Димитрова (1968) referred the Clansesian sediments to the Albian Stage. Nikolov (1965, 1969) and Николов, Хрисчев (1965) assigned them to the Aptian. These authors placed the lower boundary of the Albian to coincide with the base of the *L. (L.) tardefurcata* Zone. In a special paper Николов (1970) has systematized the arguments in favour of this scheme. Since 1970 it has been adopted by all Bulgarian stratigraphers.

Николов et al. (1972); Монов, Николов (1991) have proposed and defined formal lithostratigraphic units of Albian age.

Retrospection shows an increased interest in the problems of Albian stratigraphy during the period 1960-1972. Since 1972 the Albian has been only briefly discussed by Николов (1980, 1983); Николов, Рускова (1984) and Nikolov (1987). Some preliminary results of the present author have also been published (Иванов, 1981).

The present knowledge of the Albian stratigraphy in Northwest Bulgaria includes the following:

- all outcrops of the stage are regionally studied and formal lithostratigraphic units are defined;

- a subdivision of the Albian into three substages is adopted and the stage boundaries are generally characterized;

- different ammonite-based zonations are proposed; Nikolov's (1965, 1969) zonal scheme is accepted as a standard ammonite zonation;

- the already defined ammonite zones are not referred to specific sections and/or intervals within the sections, the boundaries of the stage and its substages has not been drawn in the sections;

- the paleontological material on which the stratigraphical conclusions were based has been collected before 1965 and it had been neither taxonomically revised nor its specific position in the sections had been reported.

The present work represents the results gained during the period 1978-1988. Part of them, obtained until 1984, have been summarized in the author's Ph. D. Thesis but they are not yet published. Since 1984 the study of Albian has been extended on additional outcrops, too. That has led to an improved ammonite zonation of the stage.

The purposes of this investigation were:

- to further subdivide the ammonite zonation on the base of the present-day knowledge of ammonite taxa distribution patterns in the Mediterranean Region;

- to specify and characterize the extent and boundaries of the ammonite zones, to define their distribution in detail and to correlate the sections between each other;

- to specify the boundaries of the Albian and its substages in the study area.

In order to reach these purposes the lithological and ammonite successions were studied in selected instructive sections. A total of more than 3000 ammonite specimens were collected. They are held at the Museum of Paleontology, Sofia University. Collections of previous authors have also been used and revised.

This study has provided some new evidence on the ammonite content and biostratigra-

phy of the Albian Stage in Northwest Bulgaria. The paper presents only the biostratigraphic findings. A series of taxonomical articles will follow in which the paleontological material will be described.

Lithostratigraphic units of Albian age in Northwest Bulgaria

In Northwest Bulgaria the Albian deposits occur as two types of facies which form the basis of the adopted lithostratigraphic scheme.

Sumer Formation

This formation was introduced by Николов et al. (1972, p. 347). It is named after the village of Sumer, District of Mihajlovgrad. The type section is located near Sumer, along the valley of the Šugavica River and it has not been described until now. In the present paper we describe only that part of the type section which belongs to part of the Upper Aptian and to Lower Albian. This formation as originally defined included also sediments which are now considered to represent another unit, the so-called Malo Peštene Formation.

The Sumer Formation comprises mainly grey to dark grey marls of various carbonate content. Interbeds of grey to dark grey clayey and microcrystalline limestones as well as fine grained sandstones and siltstones occur.

The formation extends in the Fore-Balkan region from the village of Čuprene as far as the valley of the Iskâr River. The major outcrops are situated along the river valleys. Throughout the study area the formation has been crosscut by numerous boreholes (Монов, Йовчева, 1970; Николов, 1987). Its thickness ranges from 600 m at the outcrops to 1000 m in the borehole sections.

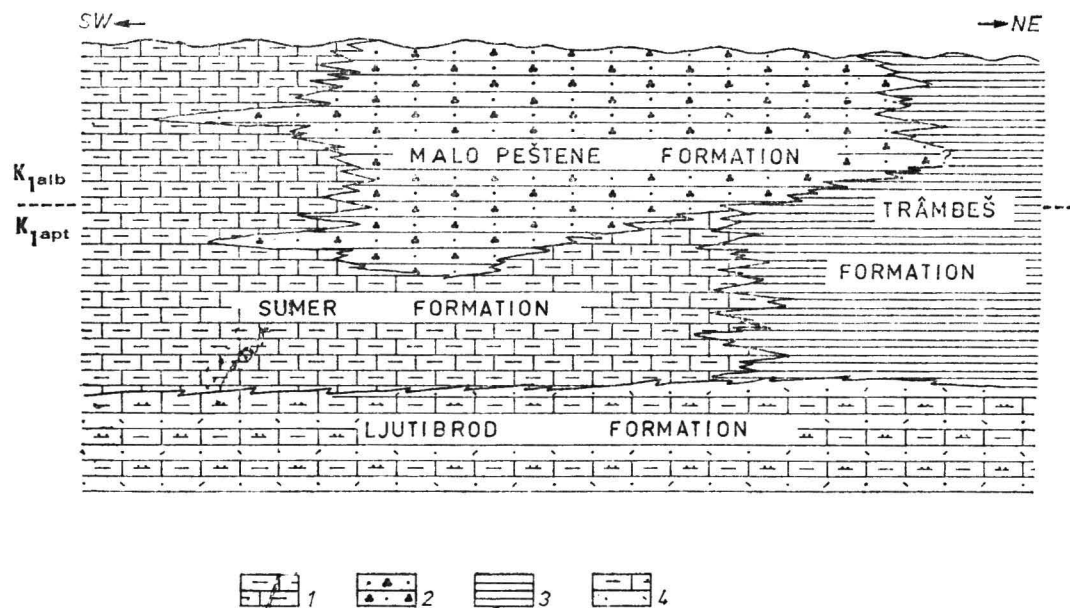


Fig. 2. Diagrammatic section through northwest Bulgaria showing relationship of the Albian and underlying formations (after Николов, 1987, completed): 1 — marls interbedded by clayey limestones and by sandstones; 2 — glauconitic sandstones, siltstones and marls; 3 — marls and mixed deposits; 4 — sandstones, siltstones and sandy limestones

A stability of the lithological features also outside the type area is characteristic of the Sumer Formation. The lithology is relatively variable in the eastern part of the area and at the lateral junction to the Roman Formation. Eastwards the amount of terrigenous component increases and the marls become silty and locally glauconitic. Calcareous shales and minor mixed terrigenous-carbonate sediments occur to the east of the Skât River. Near the town of Vraca the sandstone interbeds tend to be thicker and more common in the sections.

The spatial-temporal relationships between the Sumer Formation and the adjacent lithological units are complex. Northwards and northeastwards the formation passes rapidly into the marls and mixed rocks of the Trâmbeș Formation. To the east of the valley of the Botunja River, the Sumer Formation passes laterally into the Malo Peštene Formation. In the south and southeast (towards the Iskâr Valley and in the Vraca region) the transition to the Roman Formation is observed. The Sumer Formation is underlain by the Ljutibrod Formation with distinct lithological transition or, where the last-named formation is absent, by the Čerepiš Formation. Near the villages of Botunja and Beli Izvor the Sumer Formation overlies the Čerepiš Formation transgressively. To the east of the valley of the Botunja River glauconitic sandstones belonging to the Malo Peštene Formation wedge into the Sumer Formation. The former overlies the latter with a distinct lithological transition to the east of the Skât River. In the northern part of the Fore-Balkan near the village of Dobruša the Sumer Formation is overlain by the Sanadinovo Formation (Cenomanian) with a rapid lithological transition.

The Sumer Formation is of Upper Aptian and Albian age. The sections in the extreme west (near Čuprene) and in the northern part of the study area cover the whole time range whereas to the east of the Skât River the formation is entirely of Upper Aptian age.

Malo Peštene Formation

The formation was informally referred to as the "Glauconitic Sandstones Series" by Николов (1983, p. 33). The Malo Peštene Sandstones (Николов, 1983, p. 37) and the Malo Peštene Formation (Nikolov, 1987, p. 54, fig. 6) were used in the Bulgarian lithostratigraphic literature as 'nomen nudum'. Моноу, Николов (1991) re-introduced the name and defined the formation along with its type section near the village of Malo Peštene. The lithological and faunal successions in the type section are described in detail below. Until defining the Malo Peštene Formation as a separate unit, these sediments were considered to form part of Моноу's (1972) 'Marls and Sandstone Series' and of the Sumer Formation sensu Николов et al. (1972).

The Malo Peštene Formation consists of alternating glauconitic sandstones, marls and siltstones. The sandstones are fine to coarse grained, cross-bedded at some horizons, highly glauconitic. In some localities glauconite is a rock-forming mineral (its content reaches up to 60-70%) and the sediments themselves are glauconitites (Алексиев, 1958). The marls are grey or beige, mainly silty, more or less glauconitic. The siltstones are relatively uncommon. The sandstones and marls form packets of variable thickness. The marls are more common in the lower and upper parts of the formation, and the sandstones in its middle part.

The Malo Peštene Formation is exposed as a narrow band at the foot of the Veslec Hill, to the north of Vraca and near the villages of Malo Peštene, Nivjanin, Bukovec and Tlačene. In the west some wedges of the formation reach the villages of Beli Izvor and Vlasatica, and the Botunja Valley, near the village of Kravoder. In the east the formation was crosscut by boreholes near the village of Bârdarski Geren (Николов, 1983). Its thickness ranges from 3 m to 90 m. The small thickness is due to the wedging out of the formation.

On a regional scale, the abundance of coarse-clastic and highly glauconitic deposits increases eastwards and southeastwards. In the section at the village of Virovsko a bed of concretionary phosphorite is locally developed.

The Malo Peštene Formation is underlain conformably with distinct lithological transition by the Sumer Formation in the central part of the study area and by the Trâmbeș Formation in the eastern part. To the west the Malo Peštene Formation passes laterally into the Sumer Formation, and to the east and probably to the north the former wedges into the Trâmbeș Formation. The upper boundary of the Malo Peštene Formation is unconformable. The formation is overlain transgressively by the Upper Cretaceous sediments belonging to the Novačene Formation (Campanian) and the Dârmanci Formation (Maast-richtian).

The whole range of the Malo Peštene Formation covers part of the Upper Aptian and the Albian only in the type section, however. In all other localities its range is shorter due to lateral transitions and to the depth of the post-Albian denudation.

Description of the principal sections

The Albian sections are described consecutively from the west to the east and from the south to the north. They are more or less incomplete due to the degree of exposure and to the intensity of the post-Albian erosional processes. The Albian sediments are of considerable thickness (from 100 m to 600 m) decreasing to the east. The rich ammonite and other fossil faunas are relatively uniformly distributed across the sections. Condensations and mixed faunas are rare. Such phenomena have been found only at separate levels in the central part of the area. They are locally developed over short time intervals.

The new evidence on the lithological and ammonite successions has required some redescription of sections previously published by Захаријева - Ковачева (1957) and Иванов (1981). The sections at the villages of Kravoder, Malo Peštene, Bukovec and Dobruša are redescribed in this paper. The main part of the ammonites and bivalves were collected and identified by the present author. The cases of using and/or revising other authors' identifications, e. g. Захаријева - Ковачева (1957), Калчева - Илиева (1967) and Димитрова (1967), are specially noted in the text.

The Čuprene Section

The section is located on the left bank of the Čuprenska River. It extends from some 1.5 km north of the village of Čuprene to its western end. The sediments of the Sumer Formation are exposed. The Lower Albian, the Middle Albian and the Upper Albian are established. Neither the lowest part of the Albian nor the Aptian—Albian boundary have been proved. The contact between the Sumer Formation and the "Sandstone Series" (packet 7) is indistinct because continuous outcrops are lacking. Similar sandstones in nearby sections have been referred to the Aptian by previous authors (Цанков et al., 1960). That suggests the presence of a tectonic contact.

"Sandstone Series" (No. 7) (more than 30 m) (probably Aptian)

7. (more than 30 m)

Alternation of beige, fine to medium grained sandstones and beige to grey siltstones. Both the sandstones and siltstones are thinly bedded and their alternation resembles rhythmic sedimentation. No fossils were found.

----- no outcrops 40 m probably tectonic contact -----

Sumer Formation (No. 6—1) (232 m) (Albian, in part)

6. (32 m)

Marls — grey to dark-grey, thinly bedded with beige spots at some places. More calcareous and more clayey interbeds occur and beds of beige highly silty marls are less common. The marls are strongly cleaved and the fossils recovered from them are poorly preserved. The fossils recorded are: from 28 m

to 30 m — *Hamites* (*Stomohamites*) cf. *funatus* Brongniart, *Kossmatella* (*Kossmatella*) *schindewolfi* Wiedmann & Dieni; from 10 m to 12 m — *K. (K.)* cf. *muhlenbecki* (Fallot); from 4 m to 6 m — *H. (S.) virgulatus* Brongniart, *H. (S.) subvirgulatus* Spath, *H. (S.) duplicatus* Pictet & Campiche, *Idiohamites turgidus* (J. Sowerby), *I. turgidus robustus* Spath, *Anisoceras* sp. indet., *K. (K.)* cf. *muhlenbecki* (Fallot), *Hysterocheras* cf. *orbignyi* (Spath), *Puzosia provincialis* (Parona & Bonarelli), *P. mayoriana* (d'Orbigny), *Inoceramus concentricus* Parkinson.

5. (18 m)

Marls — beige to greenish, thinly bedded, highly silty, containing much mica. No fossils were recorded.

4. (15 m)

Marls — grey and beige, thinly bedded. At some horizons rounded calcareous concretions occur of size up to 30 cm. The marls yielded: *K. (K.)* cf. *muhlenbecki* (Fallot), *K. (K.) romana* Wiedmann, *Inoceramus concentricus* Parkinson.

3. (110 m)

Alternation of grey to dark-grey and beige marls. The marls are thinly bedded or indistinctly bedded generally strongly cleaved obliquely to the bedding. Among them at almost equal intervals more calcareous interbeds occur. The marls are often highly silty and contain much mica. Quite rarely beds of clayey marls occur. The fossils are sparse, poorly preserved and hardly determinable. This packet yielded: from 53 to 56 m — *Anahoplites planus gracilis* Spath, *Hamites* (*Hamites*) *tenuicostatus* Spath, *Inoceramus concentricus* Parkinson; from 34 m to 36 m — *Protanisoceras* (*Heteroclinus*) *nodosum* (J. Sow.), *P. (P.)* cf. *moreanum* (Buvignier), *P. (P.)* sp. indet., *H. (H.) attenuatus* J. Sowerby, *Inoceramus concentricus* Parkinson; at 18 m — *Douvilleiceras mamillatum mamillatum* (Schlotheim); from 4 m to 6 m — *Inoceramus salomoni* (d'Orbigny).

2. (34 m)

Marls — grey, indistinctly bedded, highly glauconitic at some levels. No fossils were found.

1. (23 m)

Marls — grey to dark-grey, thinly bedded, highly cleaved, with rare more calcareous interbeds. The marls contain scarce, poorly preserved, indeterminate ammonites.

The G. Damjanovo section

The section extends from 400 m north of the village of G. Damjanovo along the right bank of the Lopusanska Ogosta River to some 300 m south of the village of G. Genova. The lower part of the Sumer Formation is exposed. The Upper Aptian and the Lower Albian are present. Some 80 m of the base of Sumer Formation are not described here because only the Albian is the subject of investigation. In the section folds and dislocations have been found which result in repeating of certain stratigraphic intervals.

Sumer Formation (No. 4 — 1) (106 m) (Upper Aptian, Lower Albian, in part)

4. (16 m)

Marls — grey, clayey, dense, thinly bedded. The fossils recorded are: *Leymeriella* (*Neoleymeriella*) *andrussovi* Glasunova, *L. (N.)* cf. *bogdanovitchi bogdanovitchi* Glasunova, *L. (N.)* cf. *pseudoregularis pseudoregularis* Seitz. Well preserved uncommon aptychuses occur.

3. (12 m)

Marls — beige, clayey, indistinctly bedded, alternating with spotted grey marls and more calcareous interbeds. The rocks yielded: *Leymeriella* (*Neoleymeriella*) *consueta* Casey, *L. (N.) renacensis* Seitz, *L. (N.) pseudoregularis pseudoregularis* Seitz, *L. (N.) pseudoregularis spinosa* Saveliev, *L. (N.) diabolus* Casey, *L. (N.) regularis* (Bruguere) d'Orbigny, *L. (N.) aff. intermedia* Spath, *L. (N.) aff. diabolus* Casey, *Douvilleiceras* sp. aff. *alternans* Casey, *Puzosia quenstedti* (Parona & Bonarelli), *Puzosia* sp. indet., *Anapuzosia* sp. indet., *Ptychoceras* sp. indet.

2. (20 m)

Marls — grey, dense, interbedded by silty limestones. The marls are not homogenous, dominated by clayey interbeds but containing more calcareous interbeds, too. The limestones are grey, due to the

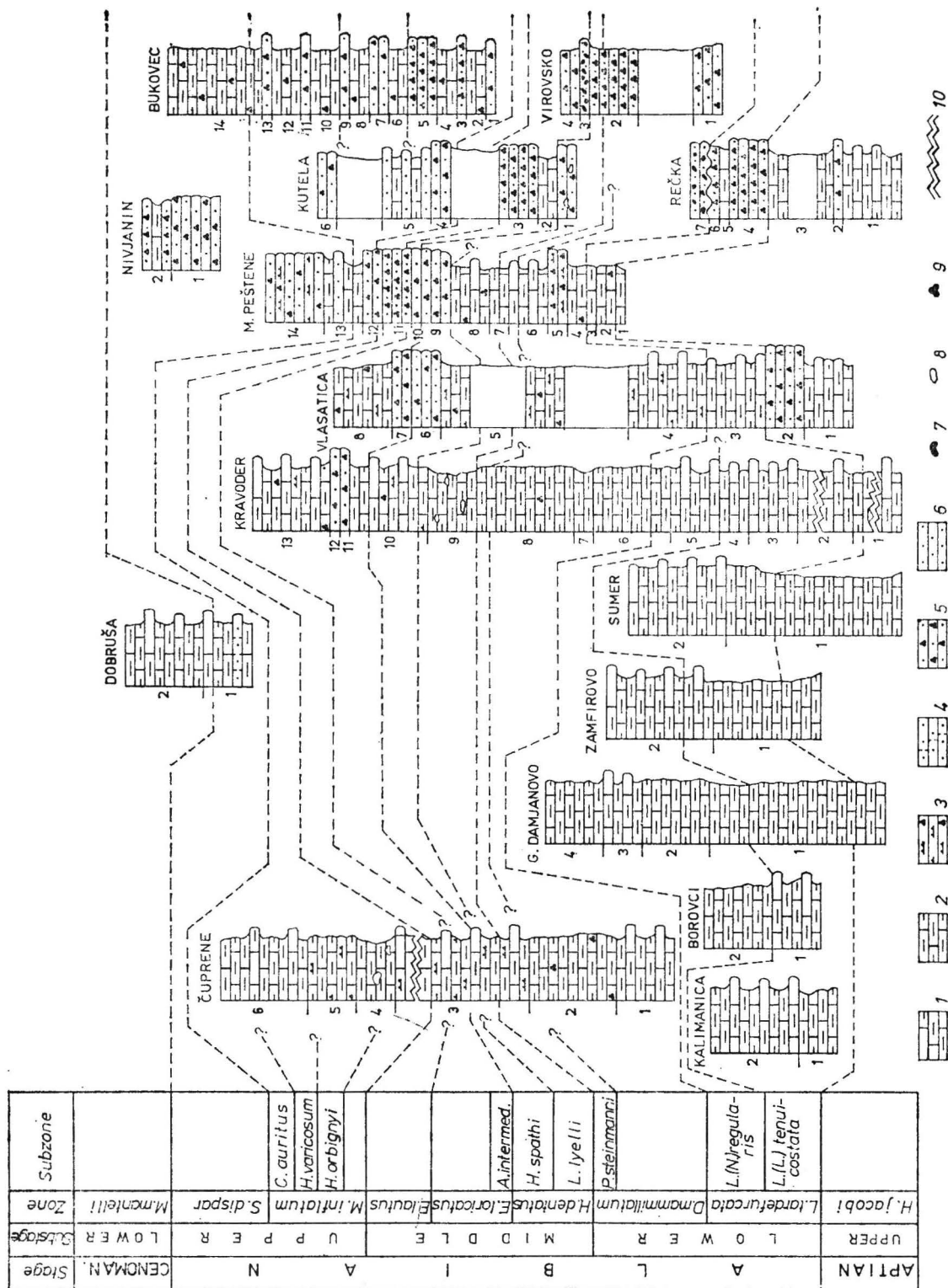


Fig. 3. Correlation of the Albian sections in northwest Bulgaria: 1 — clayey limestones; 2 — marls; 3 — glauconitic siltstones; 4 — calcareous sandstones; 5 — glauconitic sandstones; 6 — sandstones; 7 — phosphatic nodules; 8 — calcareous nodules; 9 — glauconite; 10 — interruption in the lithological column

weathering changing to beige and rust-coloured. They are thinly bedded (the layers are from 0,3 m to 0,5 m thick) and uncommon occurring at each 5 m across the section. The fossils recovered are: from 18 m to 20 m — *L. (N.) pervulata* Saveliev, *L. (N.) cf. intermedia intermedia* Spath; from 15 m to 17 m — *Eogaudryceras (Eotetragonites) gainesi* (Anderson), *Rossalites* sp. indet. as well as unknown heteromorph ammonites, displaying certain similarity to genus *Metahamites* Spath; from 12 m to 14 m — *Leymeriella (Neoleymeriella) intermedia* Spath, *L. (N.)* sp. indet., *Douvilleicer* sp. indet., *Puzosia quenstedti* (Parona & Bonarelli); the lower part of this packet from 0 to 10 m yielded no fossils.

1. (58 m)

Marls — grey, dense, indistinctly bedded, of various clayey and calcareous component. They are extremely rich in fossils: from 53 m to 56 m — *L. (L.) rencurelensis* Jacob, *L. (N.) bogdanovitchi bogdanovitchi* Glasunova, *L. (N.) intermedia intermedia* Spath, *L. (N.) andrussovi* Glasunova, *L. (N.) regularis regularis* (Bruguiere) d'Orbigny, *L. (N.) consueta* Casey, *L. (N.) renacensis* Seitz, *Douvilleicer* sp. aff. *alternans* Casey, *Puzosia quenstedti* (Parona & Bonarelli), *Beudanticeras* sp. indet., *Eogaudryceras (Eogaudryceras) shimizui shimizui* Breistroffer, *E. (E.) cf. numidum* (Coquand); from 47 m to 51 m — *L. (N.) consueta* Casey, *L. (N.) pseudoregularis pseudoregularis* Seitz, *L. (N.) pseudoregularis spinosa* Saveliev, *L. (N.) aff. pseudoregularis spinosa* Saveliev, *L. (N.) crassa* Spath, *L. (N.) renacensis* Seitz, *L. (N.) pervulata* Saveliev, *L. (N.) bogdanovitchi angustumbilicata* Glasunova, *L. (N.)* sp. aff. *diabolus* Casey, *L. (N.) regularis insulsa* Saveliev, *Puzosia quenstedti* (Parona & Bonarelli), *Anapuzosia* sp., *Anapuzosia* sp. indet., *Beudanticeras* sp. indet.; from 43 m to 45 m — *L. (N.) bogdanovitchi bogdanovitchi* Glasunova, *L. (N.) andrussovi* Glasunova, *L. (N.) regularis* (Bruguiere) d'Orbigny, *L. (N.) pseudoregularis pseudoregularis* Seitz, *L. (N.) cf. consueta* Casey, *L. (N.) pervulata* Saveliev, *L. (N.) regularis insulsa* Saveliev, *L. (N.) intermedia intermedia* Spath, *Eogaudryceras (Eotetragonites)* sp. indet., *Puzosia* sp. indet., *Anagaudryceras* sp. indet., *Phylloceras (Hypophylloceras) velledae* Michelin; from 39 m to 42 m — *Leymeriella (Leymeriella) densicostata* Spath, *L. (L.) rencurelensis* Jacob, *L. (N.) disposita* Saveliev, *L. (N.) bogdanovitchi angustumbilicata* Glasunova, *L. (N.)* sp. aff. *renacensis* Seitz; from 29 m to 34 m — *L. (L.) tardefurcata* (Leymerie) d'Orbigny, *L. (L.) tenuicostata tenuicostata* Saveliev, *L. (L.) tenuicostata ornata* Saveliev, *L. (L.) rencurelensis* Jacob, *L. (L.) densicostata* Spath, *L. (N.) intermedia* Spath, *L. (N.) disposita* Saveliev, *Tetragonites rectangularis rectangularis* Wiedmann, *Eogaudryceras (Eotetragonites) gainesi* (Anderson), *E. (E.) umbilicostriatus* Collignon, *Puzosia quenstedti* (Parona & Bonarelli), *Inoceramus coptensis* Casey; from 25 m to 28 m — *L. (L.) tardefurcata* (Leymerie) d'Orbigny, *L. (L.) densicostata* Spath, *Inoceramus coptensis* Casey; from 15 m to 18 m — *L. (L.) tardefurcata* (Leymerie) d'Orbigny, *L. (L.) astrica* Glasunova, *L. (L.) densicostata* Spath, *L. (L.) tenuicostata tenuicostata* Saveliev; from 0 to 12 m — *Phylloceras (Hypophylloceras) velledae* Michelin, *Hypacanthoplites* cf. *clavatus* (Fritel), *Neosilesites nepos nepos* (Douville), *Hypacanthoplites* sp. indet.

The Kalimanica section

The section extends from some 1,2 km southwest of the village in the lower part of the Širokija Dol ravine to the highest part of the ravine some 1,5 km east of Bistrilica. The sediments of the Sumer Formation are exposed. Part of the Lower Albian is present. The section of the Sumer Formation is incomplete. Neither underlying sediments are seen nor overlying sediments are known (Fig. 3).

Sumer Formation (No. 2 — 1) (42 m) (Lower Albian, in part)

2. (14 m)

Marls — grey, dense, with interbeds of clayey limestones. The marls are thinly bedded to indistinctly bedded, clayey or more calcareous. The limestones are made up by thin beds from 10 cm to 30 cm thick. They are grey, slightly silty, beige due to the weathering, and occur across the section at approximately each 4–5 m. The marls yielded: from 7 m to 14 m — *Leymeriella (Leymeriella) tardefurcata* (Leym.) d'Orbigny, *L. (L.) astrica* Glasunova; from 0 to 5 m — *L. (L.) tardefurcata* (Leymerie) d'Orbigny, *L. (L.) tenuicostata tenuicostata* Saveliev.

1. (28 m)

Marls — dark grey, dense, of various clayey component. The clayey marls are dominant and the indistinctly bedded more calcareous interbeds are less common. The packet yielded: from 15 m to 25 m — *Leymeriella (Leymeriella) astrica* Glasunova, *L. (L.) tardefurcata* (Leymerie) d'Orbigny, *L. (L.) tenuicostata tenuicostata* Saveliev, *L. (L.) tenuicostata ornata* Saveliev, *Phylloce-*

ras (*Hypophylloceras*) *velledae* Michelin; from 0 to 10 m — *L. (L.) tardefurcata* (Leymerie) d'Orbigny, *L. (L.) astrica* Glasunova, *L. (L.) tenuicostata ornata* Saveliev.

The Borovci section

The section is found some 1 km east of that village and to the north of the Bârnovec Peak. The outcrops extend along the road to the village of Zamfirovo and at the gullies on the right side of the road. The sediments of the Sumer Formation are present. They are referred to the Lower Albian. The section of the Sumer Formation is incomplete, neither the underlying nor the overlying sediments are seen.

Sumer Formation (No. 2 — 1) (32 m) (Lower Albian, in part)

2. (16 m)

Marls — beige to grey, clayey, indistinctly bedded. The fossils recorded are: *Leymeriella* (*Neoleymeriella*) *intermedia* Spath, *L. (N.) bogdanovitchi undulatocostata* Kalcheva—Ilieva.

1. (18 m)

Marls — grey, spotted at some places, clayey, thinly bedded. More calcareous interbeds are common among them. The fossils found are: *Leymeriella* (*Leymeriella*) *tardefurcata* (Leymerie) d'Orbigny, *L. (L.) astrica* Glasunova.

The Zamfirovo section

The section is found some 200 m northwest of the village along the ravine above the artificial lake. The Sumer Formation sediments are exposed. The Upper Aptian (Clanseyian) and part of the Lower Albian are present. The outcrops are located along the central ravine as well as in the laterally situated gullies. The stratigraphic succession is not continuous. The sediments underlying the Sumer Formation are not seen. The section of this formation is incomplete, the overlying sediments are not known.

Sumer Formation (No. 2 — 1) (62 m) (Upper Aptian — Lower Albian)

2. (30 m)

Marls — grey to beige, interbedded by clayey limestones. The beige, indistinctly bedded, clayey marls alternate with grey, striped, thinly bedded marls, containing uncommon ammonites. The limestones are grey, slightly silty, changing to rust-coloured due to the weathering. The layers occur in the section at approximately each 8-10 m, their thickness ranging from 0.2 m to 0.4 m. This packet yielded: from 21 m to 30 m — *Leymeriella* (*Neoleymeriella*) *pseudoregularis spinosa* Saveliev, *L. (N.) intermedia* Spath, *L. (N.) bogdanovitchi angustumbilicata* Glasunova; from 11 m to 20 m — *L. (N.) consueta* Casey, *L. (N.) regularis regularis* (Bruguiere) d'Orbigny, *L. (N.) cf. diabolus* Casey, *Ammonoceratites* (*Argonauticeras*) *besairiei* Collignon, *Douvilleiceras* sp. indet., *Puzosia quenstedti* (Parona & Bonarelli) as well as unknown heteromorph ammonites; from 2 m to 10 m — *Leymeriella* (*Leymeriella*) cf. *tardefurcata* (Leymerie) d'Orbigny, *L. (L.) rencurelensis* Jacob; from 0 to 2 m — *Epileymeriella* (*Revilites*) *revili* (Jacob), *Ammonoceratites* (*Argonauticeras*) *besairiei* Collignon.

1. (32 m)

Marls — grey and thinly bedded at the base, becoming upwards more clayey with interbeds of beige marls. The fossils recorded are: from 30 m to 33 m — *Phylloceras* (*Hypophylloceras*) *velledae* Michelin, *Anagaudryceras aurarium* (Anderson), *L. (L.) densicostata* Spath, *L. (L.) tardefurcata* (Leymerie) d'Orbigny, *L. (L.) astrica* Glasunova, *Hypacanthoplites bifrons* Saveliev; from 25 m to 27 m — *L. (L.) astrica* Glasunova, *L. (L.) tardefurcata* (Leymerie) d'Orbigny, *L. (L.) tenuicostata tenuicostata* Saveliev; from 22 m to 24 m — *L. (L.) tardefurcata* (Leymerie) d'Orbigny, *L. (L.) rencurelensis* Jacob, *L. (L.) tenuicostata tenuicostata* Saveliev, *Rossalites* sp. indet.; from 14 m to 18 m — *L. (L.) tardefurcata* (Leymerie) d'Orbigny, *L. (L.) astrica* Glasunova, *L. (L.) cf. rencurelensis* Jacob; from 0 to 14 m — *Acanthoplites* sp. indet., *Aucellina caucasica* (v. Buch), *A. stukenbergi* Pavlow, *A. aptiensis* Pompecki.

The Sumer section

The section is found along the Šugavica valley and extends from the bridge at the centre of Sumer to some 2 km south of the village. This section has been designated as a type section of the Sumer Formation but it is not yet described. Only the upper part of the formation is described below. Information concerning the lower parts is to be found in Stoykova's (1990) work. The Upper Aptian and part of the Lower Albian are present.

Sumer Formation (No. 2 — 1) (98 m) (Upper Aptian — Lower Albian, in part)

Marls — grey, dense, alternating with beds of clayey limestones. The marls are clayey, thinly or indistinctly bedded. Slightly silty marls occur. The limestones are grey and form thin beds thick from 0.2 m to 0.4 m. Due to the weathering they become beige to rust-coloured. The limestones are relatively common occurring at each 7–10 m across the section. The marls at 18 m yielded: *Leymeriella* (*Leymeriella*) *tardefurcata* (Leymerie) d'Orbigny, *L. (L.) densicostata* Spath.

1. (64 m)

Marls — grey, mostly clayey, indistinctly or thinly bedded. Single beds of grey clayey or slightly silty limestones occur, their thickness ranging from 0.1 m to 0.4 m. The marls are highly fossiliferous: from 58 m to 62 m — *Leymeriella* (*Leymeriella*) *tenuicostata tenuicostata* Saveliev, *L. (L.) tardefurcata* (Leymerie) d'Orbigny, *L. (L.) cf. recticostata* Saveliev, *L. (L.) astrica* Glasunova, *Rossallites* sp.; from 52 m to 55 m — *L. (L.) astrica* Glasunova, *L. (L.) tardefurcata* (Leymerie) d'Orbigny, *L. (L.) tenuicostata tenuicostata* Saveliev; from 46 m to 48 m — *Phylloceras* (*Hypophylloceras*) *velledae* Michelin, *L. (L.) tardefurcata* (Leymerie) d'Orbigny, *L. (L.) astrica* Glasunova, *L. (L.) cf. tenuicostata tenuicostata* Saveliev, *Inoceramus coptensis* Casey; from 42 m to 44 m — *L. (L.) tardefurcata* (Leymerie) d'Orbigny, *L. (L.) astrica* Glasunova; from 0 to 42 m — *Acanthohoplites trautscholdi* (Sim. Bac. & Sorokin), *Hypacanthoplites elegans* (Fritel), *Eogaudryceras* (*Eotetragonites*) *heterosulcatus* (Anthula), *Neosilesites nepos nepos* (Douville), *N. nepos multifurcatus* Dimitrova, *Acanthohoplites* sp. indet., *Chelonicerias* (*Epichelonicerias*) sp. indet., *Phylloceras* (*Hypophylloceras*) *velledae* Michelin, *Aucellina aptiensis* Pompeckii, *A. pompeckii* Pavlow, *A. caucasica* (v. Buch), *A. stukenbergi* Pavlow.

The Kravoder section

The section extends from some 1 km south of Botun'ia along the Botun'ia River to reach northward the site of Šumaka to the east of Kravoder. That section would be better called 'section between Botun'ia and Kravoder' but for convenience a single name is given. The sediments of the Sumer Formation are exposed. The outcrops are found along the Botun'ia valley as well as in the gullies to the east. The Upper Aptian, the Lower Albian and the Middle Albian are present. The Sumer Formation is underlain by the limestones of the Čerepiš Formation. The boundary is unconformable, abrupt. The basal beds of the Sumer Formation are not here described. The section of the Albian Stage is incomplete, the overlying sediments are not known.

Sumer Formation (No. 13) (35 m) (Middle Albian, in part)

13. (35 m)

Marls — beige, slightly silty with thin more calcareous interbeds up to 0.3–0.4 m thick which are relatively common in the section. The content of glauconite is very low. The marls are poor in fossils. This packet yielded: *Hamites* (*Hamites*) *maximus* J. Sowerby, *H. (H.) tenuis* J. Sowerby, *H. (H.) compressus* J. Sowerby, *H. (H.) cf. gibbosus* J. Sowerby, *Puzosia* sp. indet.

— rapid lithological transition —

Malo Peštene Formation (No. 12 — 11) (6.5 m) (Middle Albian, in part)

12. (4 m)

Sandstones — beige, fine grained, highly glauconitic, containing numerous nuclei of hoplitids. The basal bed resembles an "ammonite breccia". The fossils recorded are: *Hoplites danubiensis* Patruilus,

H. escragnolesensis Spath, *Hoplites* sp., *Anahoplites praecox* Spath, *A. intermedius* Spath, *A. evolutus* Spath, *A. mantelli* Spath, *A. cf. asiaticus* Glasunova, *A. alternans* (Woodward), *Anahoplites* sp., *Heteroclinus nodosus* (J. Sowerby).

11. (2.5 m)

Sandstones — grey, medium grained, glauconitic. They yielded: *H. danubiensis* Patruilius, *A. praecox* Spath, *A. sp.*

— distinct lithological boundary —

Sumer Formation (No. 10 — 1) (394 m) (Middle Albian — Upper Albian)

10. (34 m)

Marls — beige, silty, slightly glauconitic. Some interbeds are more calcareous. The sediments yielded: from 25 m to 34 m — *H. dentatus densicostatus* Spath, *H. escragnolesensis* Spath, *H. danubiensis* Patruilius, *A. praecox* Spath, *A. intermedius* Spath, *A. evolutus* Spath, *A. mantelli* Spath, *A. cf. asiaticus* Glasunova, *Anahoplites* sp., *Pictetia astieriana* (d'Orbigny); from 10 m to 20 m — *H. dentatus dentatus* (J. Sowerby), *H. dentatus densicostatus* Spath, *H. spathi* Breistr., *A. praecox*, *A. evolutus* Spath.

9. (22 m)

Marls — beige to grey, clayey, scarcely containing glauconite. At some levels calcareous concretions occur of ranging size up to 50 cm. The marls yielded a fairly abundant and diverse ammonite fauna: from 17 m to 22 m — *H. dentatus dentatus* (J. Sowerby), *H. dentatus robustus* Spath, *H. deviensensis* Spath, *H. pseudodeluci* Spath, *Douvilleiceras cf. mammillatum aequinodum* (Quenstedt), *D. scarbosum* Casey, *D. cf. inaequinodum* (Quenstedt), *Protanisoceras* (*Protanisoceras*) *alternotuberculatum* (Buvignier), *P. (P.) moreanum* (Buvignier), *P. (P.) sp.*, from 8 m to 12 m — *Hoplites* sp. indet., *Heteroclinus nodosus* (J. Sowerby), *Puzosia* sp. indet., *Beudanticeras* sp. indet.

8. (44 m)

Marls — grey to light grey, silty, indistinctly bedded, locally glauconitic. They are extremely rich in fossils: from 42 m to 44 m — *Pseudosonneratia* (*Isohoplites*) *steinmanni* (Jacob), *D. mammillatum aequinodum* (Quenstedt); from 33 m to 41 m — *D. mammillatum aequinodum* (Quenstedt), *D. mammillatum praecox* Casey, *D. alternans* Casey, *D. leightonense leightonense* Casey, *Puzosia quenstedti* (Parona & Bonarelli), *Beudanticeras dupinianum* (d'Orbigny), *Protanisoceras* (*Protanisoceras*) sp.; from 11 m to 17 m — *D. mammillatum mammillatum* (Schlotheim), *D. cf. mammillatum aequinodum* (Quenstedt), *D. cf. leightonense leightonense* Casey, *Beudanticeras newtoni* Casey, *B. arduenense* Breistroffer, *B. dupinianum* (d'Orbigny), *B. albense* Breistroffer, *Puzosia quenstedti* (Parona & Bonarelli), *Anapuzosia* sp. indet., *Kossmatella* (*Kossmatella*) *ventrocineta gignouxi* Breistroffer, *Anadesmoceras baylei* (Spath), *Protanisoceras* (*Protanisoceras*) *vaucherianum* (Pictet), *P. (P.) blancheti* (Pictet & Campiche), *Hamites* (*Hamites*) *hybridus* Casey, *Phylloceras* (*Hypophylloceras*) *velledae* Michelin, *Inoceramus salomoni* d'Orbigny; at this horizon abundant unknown anisoceratids are present again; from 5 m to 10 m — *D. mammillatum aequinodum* (Quenstedt), *D. cf. scarbosum* Casey, *D. cf. leightonense* Casey, *D. mammillatum praecox* Casey, *Protanisoceras* (*Protanisoceras*) sp. indet., *Kossmatella* (*Kossmatella*) *cf. ventrocineta gignouxi* Breistroffer, *B. newtoni* Casey, *Tetragonites rectangularis rectangularis* Wiedmann, *Puzosia quenstedti* (Parona & Bonarelli).

7. (8 m)

Marls — dark grey, clayey, thinly bedded. The fossils recovered are: *D. mammillatum mammillatum* (Schlotheim), *D. orbignyi* Hyatt, *Protanisoceras* (*Protanisoceras*) *lardyi* (Pictet & Campiche), *P. (P.) raulinianum* (d'Orbigny), *P. (P.) sp.*, *P. (Torquistylus) mareranense* Collignon, *Rossalites* sp. indet., *Beudanticeras newtoni* Casey, *B. arduenense* Breistroffer, *B. cf. laevigatum* (J. Sowerby), *Puzosia quenstedti* (Parona & Bonarelli), *Hamites* (*Hamites*) aff. *pseudoattenuatus* Casey, *Silesitoides escragnolesensis* (Jacob), *Silesitoides* sp., *Ammonoceratites* (*Ammonoceratites*) *mahadeva* (Stoliczka), *Aucellina* sp.

6. (35 m)

Marls — grey, thickly bedded, indistinctly bedded and dense. They yielded: from 28 m to 32 m — *D. leightonense pringlei* Casey, *B. newtoni* Casey, *P. quenstedti* (Parona & Bonarelli); from 20 m to 25 m — *Douvilleiceras* sp. indet., *Kossmatella* (*Kossmatella*) *agassiziana* (Pictet), *Beudanticeras newtoni* Casey, *Ammonoceratites* (*Ammonoceratites*) *mahadeva* (Stoliczka), in this interval unknown anisoceratids with crioceratid coiling appear which are abundant; from 11 m to 15 m — *A. (A.) mahadeva* (Stoliczka), *K. (K.) agassiziana* (Pictet), *P. quenstedti* (Parona & Bonarelli), *Inoceramus salomoni* d'Orbigny; from 0 to 10 m — this level yielded only poorly pre-

served smooth or finely ornamented very involute ammonites which presumably belong to genus *Anadsmoceras* Casey.

5. (26 m)

Marls — grey to dark grey, clayey, slightly silty, indistinctly bedded, alternating with thin beds of clayey limestones. The marls are rich in fossils: from 16 m to 26 m — *Douvilleiceras* sp. indet., *Leymeriella* (*Neoleymeriella*) sp. indet.; from 0 to 15 m — *Leymeriella* (*Neoleymeriella*) *consueta* Casey, L. (N.) *regularis* (Bruguier) d'Orbigny, L. (N.) *pseudoregularis pseudoregularis* Seitz, L. (N.) *pseudoregularis spinosa* Saveliev, L. (N.) aff. *pseudoregularis spinosa* Saveliev, L. (N.) *renacensis* Seitz, L. (N.) *pervulata* Saveliev.

4. (18 m)

Marls — beige to grey, thinly bedded, alternating with more calcareous interbeds. The marls yielded: from 3 m to 13 m — *L. (L.) densicostata* Spath, L. (L.) *tenuicostata tenuicostata* Saveliev, L. (L.) *astrica* Glasunova, L. (L.) *tardefurcata* (Leymerie) d'Orbigny.

3. (32 m)

Marls — grey, thinly bedded, alternating with thin beds of grey clayey limestones, which become rust-coloured due to the weathering. The fossils recovered from the marls are: from 27 m to 30 m — *L. (L.) tardefurcata* (Leymerie) d'Orbigny; from 0 to 20 m — *L. (L.) tardefurcata* (Leymerie) d'Orbigny, L. (L.) *astrica* Glasunova, *Epileymeriella* (*Revlites*) *revili* (Jacob), L. (L.) cf. *rencurelensis* Jacob, *Phylloceras* (*Hypophylloceras*) *velledae* Michelin.

2. (92 m)

Marls — grey, thinly bedded, with interbeds of dense clayey limestone up to 0,3 m thick which are relatively rare. Both the clayey and calcareous components in the marls are of varying amounts. The fossils recorded are: from 82 m to 92 m — *L. (L.) tardefurcata* (Leymerie) d'Orbigny, L. (L.) *astrica* Glasunova; from 60 m to 65 m — *L. (L.) tardefurcata* (Leymerie) d'Orbigny; from 0 to 20 m — *L. (L.) tenuicostata tenuicostata* Saveliev, L. (L.) *tardefurcata* (Leymerie) d'Orbigny, *Hypacanthoplites sigmoidalis* Casey, *H. bifrons* Saveliev, *Aucellina caucasica* (v. Buch), *A. pompeckii* Pavlov.

1. (83 m)

Marls — grey, thinly bedded. At the base marls and clayey limestones alternate. In the upper part the limestones are sparse. This packet yielded: from 71 m to 83 m — *L. (L.) tardefurcata* (Leymerie) d'Orbigny, L. (L.) sp. indet., *Hypacanthoplites milletioides* Casey, *Puzosia* cf. *quenstedti* (Parona & Bonarelli), *Puzosia* sp. indet., *Phylloceras* (*Hypophylloceras*) *velledae* Michelin, *Ptychoceras* sp. indet., *Beudanticeras* sp. indet.; from 0 to 70 m — *Neosilesites nepos nepos* (Douville), *N. nepos multifurcatus* Dimitrova, N. sp., *Aucellina aptiensis* Pompeckii, *A. pompeckii* Pavlov, *A. caucasica* (v. Buch), *A. stukenbergi* Pavlov; *Acanthoplites trautscholdi* (Sim., Bac. & Sorokin) figured by Манолов (1962, Fig. 5, 3) is to be associated with this interval.

The Vlasatica section

The section extends from 1,5 km north of the village at the artificial lake to 500 m southwest of the Vlasatica railway station. The sediments of the Sumer Formation and the Malo Peštene Formation are exposed. In this section wedges of these two formations alternate because they pass into each other in the area. A part of the Upper Aptian, the Lower Albian and a part of the Middle Albian are present. Neither underlying nor overlying the Sumer Formation sediments are seen.

Sumer Formation (No. 8) (17 m) (Middle Albian, in part)

8. (17 m)

Marls — beige, clayey, slightly glauconitic, silty at some levels. *Hamites* (*Hymites*) cf. *compressus* J. Sowerby is recorded.

—rapid lithological transition—

Malo Peštene Formation (No. 7 — 6) (8,5 m) (Middle Albian, in part)

7. (3.5 m)

Sandstones — beige to green, more or less glauconitic. They are coarse grained, quartz bearing and more glauconitic at the base. Upwards they become fine grained, the glauconite is not uniformly distributed. The highest part is fairly rich in fossils and biotritus: *Hoplites danubiensis* Patrušius, *H. dentatus robustus* Spath, *H. dentatus densicostatus* Spath, *Hoplites* sp., *Anahoplites praecox* Spath, *A. evolutus* Spath, *A. asiaticus* Glasunova, *A. mantelli* Spath, *A. intermedius* Spath, *A. grimsdalei* Owen, *A. cf. planus planus* (Mantell), *Anahoplites* sp., *Hamites* (*Hamites*) *tenuicostatus* Spath, *Metahamites* sp., *Brancoceras cricki* Spath, *Inoceramus concentricus* Parkinson.

6. (5 m)

Sandstones — beige, medium grained, slightly glauconitic. They contain relatively poorly preserved fossils: *A. praecox* Spath, *A. evolutus* Spath, *Hoplites* sp. indet.

Sumer Formation (No. 5 — 3) (more than 100 m) (Lower Albian)

5. (47 m)

Marls — beige, silty, slightly glauconitic, the glauconite being relatively uniformly distributed. The upper part of this packet yielded: *A. intermedius* Spath, *A. praecox* Spath, *A. evolutus* Spath, *A. cf. mantelli* Spath, *Inoceramus concentricus* Parkinson.

no outcrops some 35 m
In the lower part of the packet the following fossils are recorded: *Protanisoceras* (*Protanisoceras*) *blancheti* (Pict. & Camp.), *P. (P.)* sp., *I. salomoni* d'Orbigny.

no outcrops some 88 m

4. (25 m)

Marls — grey, silty, indistinctly bedded. Among them, beds of clayey limestones and clayey marls occur albeit rarely. The ammonites are sparse and poorly preserved: *Beudanticeras newtoni* Casey, *Beudanticeras* sp. indet., *Anadismoceras* sp. indet.

no outcrops some 110 m

3. (18 m)

Marls — beige, clayey, thinly bedded, alternating at each 3—4 m with more calcareous interbeds. The fossils recovered are: *Leymeriella* (*Leymeriella*) *tenuicostata tenuicostata* Saveliev, *L. (L.)* sp. indet., *Hypacanthoplites* cf. *trivialis* Breistroffer, *H. cf. clavatus* (Fritel), *H.* sp. indet., *Puzosia* cf. *quenstedti* (Parona & Bonarelli), *Ptychoceras* sp. indet.

distinct lithological boundary

Malo Peštene Formation (No. 2) (12 m) (probably Upper Aptian)

2. (12 m)

Sandstones — fine to coarse grained, quartz bearing, glauconitic, grey or green depending on the content of glauconite. It is uniformly distributed in the fine grained sandstones, the coarse grained are striped. Single bivalves are recorded: *Aucellina* cf. *aptiensis* Pompeckii.

distinct lithological boundary

Sumer Formation (No. 1) (16 m) (Upper Aptian, in part)

1. (16 m)

Marls — grey, clayey, thinly bedded. The calcareous component varies and more calcareous layers also occur. The marls yielded: *Acanthohoplites* sp. indet., *Eogaudryceras* (*Eotetragonites*) *duvalianum* (d'Orbigny), *Neosilesites nepos multifurcatus* Dimitrova, *A. aptiensis* Pompeckii, *A. pompeckii* Pavlow, *A. caucasica* (v. Buch)

The Dobruša section

The section is located in the site of the Kâsija Del to the east of Dobruša. The sediments of the Sumer Formation are present. Parts of the Upper Albian and of the Lower Cenomanian are exposed. The sediments underlying the Sumer Formation are not seen.

Sanadinovo Formation (No. 2) (15 m) (Cenomanian, in part)

2. (15 m)

Marls — dark grey to black, clayey, thinly bedded, fissile due to the weathering. These marls alternate with thin beds of lighter in colour and more calcareous sandy marls. Цанков et al. (1969) have reported from this packet the following fossils: *Puzosia* ex. gr. *planulata* (Sowerby), *Inoceramus crispus* Mantell, *I. pictus* (Sowerby), *Rotalipora reicheli* Morné, *Anomalina cenomanica* (Brotzen).

—rapid lithological transition—

Sumer Formation (No. 1) (23 m) (Upper Albian, in part — probably Lower Cenomanian in part)

1. (23 m)

Marls — light grey, indistinctly bedded, alternating with thin beds thick from 0,2 m to 0,4 m of silty limestones or calcareous sandstones. The marls are clayey or silty, locally slightly glauconitic. The limestones are grey, beige due to the weathering and occur at approximately each 4—5 m. Ammonites are present mainly in the calcareous interbeds and rarely in the marls. The foraminiferal fauna has been recovered only from the marl beds. The fossils recorded are*: from 20 m to 23 m — abundant *Rotalipora appeninica* (Renz) as well as single specimens of *Arenobulimina macfadyeni* Cushman, *Eggerellina mariae* Ten Dam, *Gavelinella ammonoides* (Reuss), *Marssonella oxycona* (Reuss), *Nodosaria paupercula* Reuss, *Dentalina legumen* (Reuss); from 16 m to 18 m — single *R. appeninica* (Renz), *E. mariae* Ten Dam; from 13 m to 15 m — *Stoliczkaia* (*Stoliczkaia*) *dispar* (d'Orbigny), *Lechites gaudini* (Pictet & Campiche), *Puzosia provincialis* (Parona & Bonarelli); from 10 m to 12 m — *S. (S.)* cf. *dispar* (d'Orbigny), *S. (S.) notha* (Seeley), *Mariella* (*Mariella*) *miliaris* (Pictet & Campiche), *Idiohamites* cf. *dorsetensis* Spath, *Eogaudryceras* (*Eogaudryceras*) *italicum* Wiedmann & Dieni, *Leptoplites* cf. *falcoides* Spath, *P. provincialis* (Parona & Bonarelli), *P. communis* Spath, *Lechites* sp. indet., *Salaziceras* sp. indet.; from 6 m to 9 m — *S. (S.) dispar* (d'Orbigny), *S. (S.)* cf. *notha* (Seeley), *M. (M.) bergeri bergeri* (Brongniart), *Anisoceras pseudoelegans* Pictet & Campiche, *L. gaudini* (Pictet & Campiche), *L. morreti* Breistroffer, *Hamites* (*Stomohamites*) *subvirgulatus* Spath; from 0 to 2 m — *M. (M.) bergeri bergeri* (Brongniart), *M. (M.) miliaris* (Pictet & Campiche), *M. (M.)* cf. *nobilis* (Jukes-Browne), *L. gaudini* (Pictet & Campiche), *L.* cf. *moreti* Breistroffer, *P. provincialis* (Parona & Bonarelli).

The section in the site of Rečka at the village of Veslec

The section is found to the south of Veslec. It extends from 250-300 m below the karst spring just next to it. The Sumer Formation and the Malo Peštene Formation are present. The Upper Aptian and part of the Lower Albian are established. Only the highest 54 m of the Sumer Formation are here described. The section of the Albian Stage is incomplete.

Dâimanci Formation (No. 7) (4 m) (Maastrichtian)

7. (4 m)

Medium grained to coarse grained, beige quartz bearing sandstones, containing phosphoritic concretions. The sandstones are rust-coloured due to the weathering. No fossils were found.

—transgressive boundary—

Malo Peštene Formation (No. 6 — 4) (17 m) (Lower Albian, in part)

6. (1,5 m)

Sandstones — fine to medium grained, glauconitic. The glauconite is not uniformly distributed in the beds, which look striped because of that. Only indeterminable ammonite fragments were found.

5. (1,5 m)

Marls — beige, silty, slightly glauconitic. They contain phosphoritic concretions albeit rarely. This packet yielded: *Leymeriella* (*Leymeriella*) *tenuicostata tenuicostata* Saveliev, *L. (L.) tardefurcata* (Leym.) d'Orb., *L. (N.) intermedia* Spath, *L. (N.) pseudoregularis* Seitz.

* The foraminifera have been determined by T. Kovatcheva

4. (14 m)

Sandstones — fine to coarse grained, quartz bearing, glauconitic. The glauconite is not uniformly distributed, its content is higher in the coarse grained sandstones. In some beds the glauconite is dominant and rock-forming mineral. The fossils are quite sparse, poorly preserved and indeterminable. *Rossalites* sp. indet. is found in the interval from 4 m to 6 m.
distinct lithological boundary

Sumer Formation (No. 3 — 1 (54 m) (Upper Aptian, in part)

3. (34 m)

Marls — grey, clayey, indistinctly bedded. The middle part of the packet (some 20 m) is not exposed. No fossils were found.

2. (2 m)

Sandstones — fine grained, glauconitic. A poorly preserved fragment was found identified as *Hypacantholites* sp. indet.

1. (18 m)

Marls — grey, clayey, indistinctly bedded, with interbeds thick from 0,3 m to 0,4 m of clayey limestones which are relatively uncommon in the section. In the middle part of the packet (from 8 m to 10 m) *Hypacantholites* cf. *jacobi* (Collet) was recorded.

The Malo Peštene section

The section extends from some 150 m away of M. Peštene at the jaws of the Padinata ravine to some 200 m southwest of the village. The section has been designated as a type section of the Malo Peštene Formation (Моноу, Николов, 1991). The sediments of the Sumer Formation and the Malo Peštene Formation are exposed. The Upper Aptian (in part), Lower Albian, Middle Albian and Upper Albian are established. The Malo Peštene Formation is underlain by the Sumer Formation and is overlain by Upper Cretaceous sediments. The contact with the limestones of the Dârmanci Formation is not seen.

Malo Peštene Formation (No. 14 — 2) (90 m) (Upper Aptian, in part — Albian)

14. (12 m)

Sandstones and siltstones — beige, indistinctly bedded, slightly glauconitic. The sandstones are medium to coarse grained, the terrigenous component being mostly of quartz. No fossils were found.

13. (10 m)

Marls with two interbeds of calcareous sandstones; the thickness of sandstones ranges from 0,5 m to 0,8 m. The marls are beige, sandy-silty. The fossils recorded are: from 8 m to 10 m — *Hamites* (*Stomohamites*) sp. indet.; from 0 to 4 m — *Anisoceras pseudoelegans* Pictet & Campiche, *A.* cf. *saussoreanum* (Pictet), *A.* aff. *campichei* Spath, *Hamites* (*Stomohamites*) *venetianus* Pictet & Campiche.

12. (5,5 m)

Sandstones — grey to beige, in some beds green, more or less glauconitic, fine to coarse grained. In the upper part of the packet the sandstones are striped and cross-bedded. The fossils are poorly preserved and not uniformly distributed. This packet yielded: *Anisoceras armatum* (J. Sowerby), *A. campichei* Spath, *A. jacobi* Breistr., *A. subarcuatum* Spath, *Anisoceras* sp., *Idiohamites tuberculatus* (J. Sow.), *I. subspiniger* Spath, *I.* cf. *turgidus* (J. Sowerby), *I. dorsetensis* Spath, *Hamites* (*Hamites*) *intermedius* J. Sowerby, *H.* (*H.*) sp. indet., *H.* (*Stomohamites*) cf. *ibex* Spath, *H.* (*S.*) sp. indet., *Pseudohelicoceras* cf. *pseudoelegans* Spath, *P.* cf. *perelegans* Spath, *Lechites* cf. *gaudini* (Pictet & Campiche), *Mortoniceras* (*Pervinquieria*) *killiani* (Lasswitz), *M.* (*Deiradoceras*) cf. *cunningtoni* Spath, *Puzosia* (*Anapuzosia*) *provincialis* (Par. & Bonarelli), *Beudanticeras beudanti* (Brongniart), *K.* (*K.*) *romana* Wiedmann from the upper part; from the lower part — *Anahoplites* sp. aff. *aequilus* Glasunova, *A. planus discoideus* Spath, *Inoceramus concentricus* Park.

11. (8 m)

Sandstones — green to dark-green and grey, striped, coarse grained, highly glauconitic. The fossils occur sporadically: from 3 m to 5 m — *Anahoplites splendens* (Sowerby), *A. planus planus* (Mantell), *A. planus gracilis* Spath, *A. cf. daviesi* Spath, *Pseudohelicoceras cf. subcatenatum* Spath; *Dimorphoplites niobe* Spath and *D. pinax* Spath reported by Захариева-Ковачева from this interval have not been correctly identified.

10. (2 m)

Sandstones — beige to green, fine grained, glauconitic. The glauconite is not uniformly distributed in the rock. The sandstones are quite rich in fossils: *Hoplites dentatus robustus* Spath, *H. dentatus densicostatus* Spath, *H. danubiensis* Patruilus, *H. sp.*, *Anahoplites intermedius* Spath, *A. mantelli* Spath, *A. cf. asiaticus* Glasunova, *A. evolutus* Spath, *A. planus discoideus* Spath, *A. sp.*, *Hamites (Hamites) attenuatus* J. Sowerby.

9. (7 m)

Sandstones — grey, fine grained, glauconitic. The glauconite is relatively uniformly distributed. The psammitic component is mostly of quartz. The fossils recorded are: *H. dentatus dentatus* (J. Sowerby), *A. praecox* Spath, *A. evolutus* Spath, *Inoceramus concentricus* Park.

8. (11 m)

Marls — beige, silty, glauconitic, indistinctly bedded. More calcareous interbeds, occur. The fossils recovered are: *H. baylei* Spath, *H. devisensis* Spath, *H. pseudodeluci* Spath, *H. aff. pseudodeluci* Spath, *H. dentatus dentatus* (J. Sowerby), *H. dentatus densicostatus* Spath, *Lyelliceras lyelli* (d'Orbigny), *L. sp. indet.*, *Brancoceras (Brancoceras) senegueri* (d'Orbigny), *Hamites (Hamites) aff. tenuicostatus* Spath, *Protanisoceras sp. indet.*

7. (6 m)

Marls — grey, clayey, slightly silty, indistinctly bedded. No fossils were found.

6. (12 m)

Marls — beige to grey, indistinctly bedded, slightly silty. More calcareous interbeds occur, too. This packet yielded: from 10 m to 12 m — *Douvilleiceras leightonense pringlei* Casey, *D. cf. clementium* (d'Orbigny), *D. inaequodum* (Quenstedt), *H. pseudodeluci* Spath, *Pseudosonneratis (Isohoplites) sp. indet.*, *Protanisoceras (Protanisoceras) sp.*, *Beudanticeras cf. newtoni* Casey; from 5 m to 7 m — *Otoboplites cf. elegans* Spath, *Beudanticeras cf. dupinianum* (d'Orbigny); from 0 to 4 m — *D. mammillatum mammillatum* (Schlotheim), *D. mammillatum aequodum* (Quenstedt), *D. mammillatum praecox* Casey, *D. leightonense pringlei* Casey, *D. cf. scarbosum* Casey, *Protanisoceras (Protanisoceras) cantianum* Spath, *P. (P.) largyi* (Pictet & Campiche), *P. (P.) raulinianum* (d'Orbigny), *P. (Heteroclinus) sp.*, *P. (H.) sp. indet.*, *Beudanticeras cf. dupinianum* (d'Orbigny), *Inoceramus sp. indet.*

5. (4,5 m)

Siltstones — grey, glauconitic. The glauconite is relatively uniformly distributed. The fossils recorded are: *D. mammillatum mammillatum* (Schlotheim), *D. sp. indet.*, *Kossmatella (Kossmatella) ventrocineta gignouxii* Breistroffer, *Inoceramus salomoni* (d'Orbigny).

4. (6 m)

Marls — beige to grey and green, silty, indistinctly bedded, glauconitic, locally calcareous. They yielded: *Protanisoceras (Protanisoceras) blancheti* (Pictet & Campiche), *P. (P.) vaucheyranum* (Pictet), *Hamites (Hamites) sp. indet.*, *I. salomoni* (d'Orbigny) as well as unknown anisoceratids.

3. (2,5 m)

Marls — grey, clayey, indistinctly bedded, slightly silty. Fossils occur sporadically: *Anadesmoceras tenue* Casey, *Anadesmoceras sp. indet.*

2. (3,5 m)

Marls — slightly silty, glauconitic, indistinctly bedded, in the basal part more glauconitic. At 1 m above the base a purely glauconitic bed occurs thick from 0,3 m to 0,4 m. Upwards the glauconite is not uniformly distributed and its content progressively decreases. The fossils recorded are: *Pictetia depressa* (Pictet & Campiche), *P. sp. indet.*, *Rossalites superbus* (Collignon), *R. sp. indet.*, *L. tardefurcata* = *Leymeriella (Leymeriella) astrica* Glasunova described by Захариева-Ковачева (1957, p. 226, pl. 8, fig. 2) is presumably associated with this level; from 0 to 1 m — *Neo-*

Sumer Formation (No. 1) (more than 2 m) (Upper Aptian, in part)

1. (more than 2 m)

Marls — grey, clayey. They yielded: *Acanthohoplites* sp. indet., *Ptychoceras* sp. indet., *Aucellina aptiensis* Pompecki, *Aucellina* spp.

The Nivjanin section

The section is situated some 2 km south of the village in the right coast of the artificial lake. The Malo Peštene Formation is present. The underlying sediments are not seen. The Malo Peštene Formation is overlain by the limestones of the Dârmanci Formation (Maastrichtian). A part of the Upper Albian is established.

Malo Peštene Formation (No. 2 — 1) (22 m) (Upper Albian, in part)

2. (8 m)

Sandstones — green, highly glauconitic, thickly bedded, alternating with beige, silty, glauconitic marls. The sandstones yielded: *Anisoceras* cf. *saussoreanum* (Pictet), *A. pseudoelegans* Pictet & Camphiche, *Hamites* (*Stomohamites*) sp. indet.

1. (14 m)

Sandstones — green to beige, more or less glauconitic. No fossils were found.

The section in the site of Kutela (between M. Peštene and Bukovec)

The section is located in the depression 2 km west of Bukovec and 3 km east of M. Peštene. The Albian sediments are exposed in the ravine above the artificial lake. The Malo Peštene Formation is present in this section. Neither underlying nor overlaying sediments are seen. The Middle Albian and the Upper Albian are established.

Malo Peštene Formation (No. 6 — 1) (49 m) (Middle Albian — Upper Albian)

6. (6 m)

Sandstones — fine grained, glauconitic, thickly bedded. The glauconite is not uniformly distributed. *Anisoceras armatum* (J. Sowerby) was found.

no outcrops some 25 m

5. (16 m)

Sandstones — beige, fine grained, indistinctly bedded, alternating with beige silty marls. The sandstones are dominant, being calcareous at some levels. The content of glauconite is low. The sandstones yielded *Metaclavites* aff. *trifidus* (Spath).

4. (7 m)

Sandstones — green, fine grained, glauconitic. *Idiohamites* cf. *tuberculatus* (J. Sowerby) was recorded

no outcrops some 22 m

3. (12 m)

Sandstones — dark green, medium to coarse grained, highly glauconitic. The content of glauconite reaches up to 60% and it gives the aspect of the rock (Алексиев, 1958). Some intervals in the sandstones are rich in fossils: *Hoplites* sp., *Anahoplites intermedius* Spath, *A. evolutus* Spath, *A. praecox* Spath, *Protanisoceras* (*Protasnioceras*) sp., *Hamites* (*Hamites*) sp. indet.

2. (3,5 m)

Marls — green, slightly silty, glauconitic, thinly bedded. They yielded: *Protanisoceras* (*Heteroclinus*) cf. *no dosum* (J. Sowerby), *P. (H.) flexuosum* (d'Orb.), *P. (P.)* cf. *halleri* (Pict. & Camp.)

1. (4 m)

Sandstones — green to grey, fine grained, glauconitic, with calcareous concretions containing fossils. The ammonites recorded are: *Hoplites dentatus dentatus* (J. Sowerby), *H. sp. indet.*, *Anahoplites praecox* Spath.

The section to the northeast of Virovsko

The section is found at 3 km northeast of the village along the road to Tlačene. The outcrop is situated in the southern slope of the Usoeto Hill and extends in the left road cutting. The sediments of the Malo Peštene Formation are present. The Middle Albian (in part) is established. Neither underlaying nor overlaying sediments are seen.

Malo Peštene Formation (No. 4 — 1) (more than 22 m) (Middle Albian, in part)

4. (1,5 m)

Sandstones — green to beige, fine grained, glauconitic. The glauconite is not uniformly distributed in the rock. No fossils were found.

3. (0,5 m)

Phosphorites — consisting of concretions, which give a conglomerate-like aspect of the bed. The matrix is calcareous-sandy with glauconite. The size of concretions ranges from 1 cm to 5 cm. Part of them represents phosphatized fossils. The ammonites recorded are: *Anahoplites praecox* Spath, *A. intermedius* Spath, *A. sp. indet.*, *Hamites (Hamites)* sp. indet.

2. (12 m)

Sandstones — dark green, medium to coarse grained, highly glauconitic. The glauconite is a rock-forming mineral and its content in the rock is very high. The sandstones contain calcareous concretions which yielded: *Kosmatella (Kosmatella) ventrocineta gignouxi* Breistroffer, *Beudanticeras cf. newtoni* Casey, *B. arduense* Breistroffer, *Protanisoceras (Protanisoceras)* sp. indet., *Desmoceras* sp. indet. as well as numerous bivalves and gasteropodes.

no outcrops some 20 m

1. (8 m)

Sandstones — green, fine grained, glauconitic. The glauconite is not uniformly distributed. Poorly preserved indeterminable ammonites occur.

The Bukovec section

The section is located to the west of the village, along the Bukovska Bara River and in the right coast of the artificial lake, westward of the Motanova Mogila hill. The Malo Peštene Formation is present. A part of the Upper Albian is established. The sediments underlaying the Malo Peštene Formation are not exposed.

Overlaying unit — Novačene Formation (Lower Campanien)

transgressive boundary

Malo Peštene Formation (No. 14 — 1) (67 m) (Upper Albian)

14. (16 m)

Marls — grey and glauconitic at the base passing upwards into beige, silty and slightly glauconitic marls. The fossils recorded are: from 12 m to 14 m — *Mortoniceras (Cantabrigites)* sp. indet., *Hamites (Stomohamites) charpentieri* Pictet, *Lechites gaudini* (Pictet & Campiche), *L. aff. moreti* Breistroffer, *Scaphites simplex* Jukes-Browne, *Puzosia* sp. indet.; from 8 m to 10 m — *Stoliczkaia blancheti* (Pictet & Campiche), *S. sp. indet.*, *H. (S.) cf. duplicatus* Pictet & Campiche, *L. gaudini* (Pictet & Campiche); from 0 to 2 m — *Mortoniceras (Mortoniceras)* cf. *killiani* (Lasswitz), *M. (Cantabrigites) cantabrigense cantabrigense* Spath, *M. (C.) cantabrigense gracilis* Spath, *M. (C.) subsimplex* Spath, *Hysterocheras orbigny* (Spath), *H. carinatum* Spath, *H. cf. bucklandi* (Spath), *Prohysterocheras (Goodhallites)* aff. *besakatrense* Collognon, *P. (N.) hugardianum* (d'Orbigny), *P. (N.) cf. irregulare* Spath, *Callihoplites cf. leptus leavis* Spath, *Eogaudryceras (Eogaudryceras)* sp. indet., *Scaphites simplex* Jukes-Browne, *Anisoceras cf. saussoreanum* (Pictet).

13. (1,5 m)

Sandstones — fine grained, grey-green, glauconitic. They are richly fossiliferous: *Hysterocheras orbignyi* (Spath), *H. bucklandi* (Spath), *H. carinatum* Spath, *P. (G.) candolium* (Pictet), *P. (G.) besakatense* Collignon, *P. (Neoharpoceras) hugardianum* (d'Orbigny), *P. (N.) irregulare* Spath, *P. (N.)* sp., *M. (M.) fissicostatum* Spath, *M. (Deiradoceras) praerostratum* (Spath), *M. (D.) cunningtoni* Spath, *M. (C.) cantabrigense* Spath, *Callihoplites auritus* (J. Sowerby), *Anisoceras armatum* (J. Sowerby), *A. saussoreanum* (Pictet), *H. (S.) virgulatus* (Brongniart) Pictet & Campiche, *H. (S.) subvirgulatus* Spath, *H. (S.) parkinsoni* (Fleming), *H. (S.) charpentieri* Pictet, *Scaphites* sp. indet.

12 (5,5 m)

Marls — grey-green, silty, glauconitic, indistinctly bedded. They yielded: *H. carinatum* Spath, *H. bucklandi* (Spath), *H.* sp. indet., *P. (G.)* cf. *candolium* (Pictet), *P. (G.) goodhalli* (J. Sowerby), *P. (N.) hugardianum* (d'Orbigny), *P. (N.) irregulare* Spath, *P. (N.)* sp., *M. (M.)* cf. *aequatorialis* (Kossmat), *H. (S.) virgulatus* (Brongniart) Pictet & Campiche, *H. (S.) charpentieri* Pictet, *H. (H.)* cf. *intermedius* J. Sowerby, *A. armatum* (J. Sowerby), *A.* cf. *perarmatum* Pictet & Campiche, *A. saussoreanum* (Pictet).

11. (2,5 m)

Sandstones — green, fine grained, indistinctly bedded, glauconitic. The fossils found are: *H. orbignyi* (Spath), *H. bucklandi* (Spath), *H.* aff. *bucklandi* (Spath), *H. carinatum* Spath, *H.* cf. *symmetricum* (J. Sowerby), *H.* sp., *M. (M.) commune* Spath, *M. (M.)* aff. *pricei* (Spath), *M. (M.)* sp., *M. (M.)* sp. indet., *Hamites (Stomohamites) virgulatus* (Brongniart) Pictet & Campiche, *H. (S.) parkinsoni* (Fleming), *Puzosia* cf. *provincialis* (Parona & Bonarelli).

10. (6 m)

Marls — beige to grey, silty, slightly glauconitic, alternating with thin beds thick up to 30-40 cm of fine grained beige sandstones. Fossils occur in both the marls and sandstones: *A. saussoreanum* (Pictet), *A. armatum* (J. Sowerby), *H. (S.) parkinsoni* (Fleming), *H. (S.) virgulatus* (Brongniart) Pictet & Campiche, *H. (H.) intermedius* J. Sowerby, *Hysterocheras orbignyi* (Spath), *H. bucklandi* (Spath), *M. (Deiradoceras) praerostratum* (Spath).

9. (2,5 m)

Sandstones — grey-green, fine grained, glauconitic. The fossils recorded are: *H. carinatum* Spath, *H. orbignyi* (Spath), *H. bucklandi* (Spath), *M. (D.)* cf. *devonense* Spath.

8. (4,5 m)

Marls — beige, slightly glauconitic, silty, with interbeds of sandstone. Fossils occur rarely: *A.* cf. *armatum* (J. Sowerby), *A. perarmatum* Pictet & Campiche.

7. (3,5 m)

Sandstones — grey-green, fine grained, slightly glauconitic, locally calcareous. The fossils are sparse: *Anisoceras* sp. indet., *M. (M.) inflatum* (J. Sowerby).

6. (4 m)

Marls — beige, thinly bedded, clayey to slightly silty, slightly glauconitic. The marls are richly fossiliferous: *Hysterocheras orbignyi* (Spath), *H. varicosum* (J. Sowerby), *H. binum* (J. Sowerby), *H. subbinum* Spath, *H. carinatum* Spath, *H. bucklandi* (Spath), *H.* cf. *pseudocornutum* Spath, *H.* aff. *symmetricum* (J. Sowerby), *H.* aff. *choffati* Spath, *H.* sp., *Prohysterocheras* cf. *pseudobolbiense* Spath, *P. (G.) goodhalli* (J. Sowerby), *P. (G.)* sp. indet., *Diploceras* cf. *bouchardianum* (d'Orbigny), *Mortoniceras (Mortoniceras) inflatum* (J. Sowerby), *M. (M.) pricei* (Spath), *M. (M.) pricei intermedius* Spath, *M. (M.)* aff. *recticostatum* (Spath), *M. (M.) nanoides* Wiedmann & Dieni, *M. (Deiradoceras)* cf. *devonense* Spath, *M. (D.)* cf. *albense* Spath, *Anisoceras subarcuatum* Spath, *A. armatum* (J. Sowerby), *A.* cf. *perarmatum* Pictet & Campiche, *A. saussoreanum* (Pictet), *Idiohamites spiniger* (L. Sowerby), *I. favrinus* (Pictet), *I.* cf. *subspiniger* Spath, *Hamites (Hamites) incurvatus* Browne, *H. (Stomohamites) duplicatus* Pictet & Campiche, *H. (S.) charpentieri* Pictet, *H. (S.) parkinsoni* (Fleming), *H. (S.) subvirgulatus* Spath, *Puzosia mayorianae* (d'Orbigny), *P. provincialis* (Parona & Bonarelli), *Scaphites hugardianus* d'Orbigny, *S. simplex* Jukes-Browne.

5. (8,8 m)

Sandstones — coarse grained, glauconitic, green, fairly rich in glauconite, which is not uniformly dis-

tributed and forms accumulations in the rock. The fossils are extremely scarce: *Prohysterocheras* (*Goodhallites*) *goodhalli* (J. Sowerby).

4. (3,5 m)

Marls — beige, sandy, with glauconite, which is relatively uniformly distributed; phosphatic concretions are uncommon. The fossils recorded are: *Anisoceras armatum* (J. Sowerby), *A. aff. armatum* (J. Sowerby), *Idiohamites spiniger* (J. Sowerby), *I. subspiniger* Spath, *I. sp. indet.*, *Hamites* (*Hamites*) *intermedius* J. Sowerby, *H. (Stomohamites) venetianus* Pictet, *H. (S.) duplicatus* Pictet & Campiche, *H. (S.) virgulatus* Pictet & Campiche, *H. (S.) subvirgulatus* Spath, *Hysterocheras binum* (J. Sowerby), *H. subbinum* Spath, *Prohysterocheras* (*Neoharpoceras*) *cop-tense* Spath, *Mortonicerias* (*Mortonicerias*) *sp. indet.*

3. (1,2 m)

Sandstones — quartz bearing, hard, highly glauconitic. The glauconite is uniformly distributed in the rock. This bed yielded: *Anisoceras cf. jacobi* Breistroffer, *Idiohamites turgidus* (J. Sowerby), *I. tuberculatus* (J. Sowerby), *I. sp.*, *Hysterocheras orbignyi* (Spath), *Puzosia mayoriana* (d'Orbigny), *P. sp.*

2. (5 m)

Marls — beige, sandy, slightly glauconitic. The fossils found are: *Idiohamites turgidus* (J. Sowerby), *I. cf. spinolosus* (J. Sowerby), *I. sp. aff. androivensis* Collignon, *Metaclavites cf. compressus* (Parona & Bonarelli), *Hysterocheras binum* (J. Sowerby), *Mortonicerias* (*Mortonicerias*) *sp. indet.*, *Prohysterocheras* (*Goodhallites*) *sp. indet.*

1. (2,5 m)

Sandstones — indistinctly bedded, glauconitic. The fossils recorded are: *Hysterocheras pseudocornutum* Spath, *M. (Deiradoceras) cf. albense* Spath, *Anisoceras armatum* (J. Sowerby), *Idiohamites* *sp. indet.*

Substages, ammonite zones and subzones in the Albian Stage in Northwest Bulgaria

Current subdivision into substages and zonation

As it is now accepted worldwide, the Albian Stage is divided into three substages — Lower Albian, Middle Albian and Upper Albian. The detailed zonations proposed by Spath (1923, 1941), Breistroffer (1947) and Casey (1961) serve as a basis of the modern zonal subdivisions of the Albian. These zonal schemes have been introduced in Western Europe (Anglo — Paris Basin). Since 1970 new and revising investigations have been carried out concerning the Albian biostratigraphy in England, France, Poland, Switzerland, Austria, Romania and the Soviet Union. The results gained by Owen (1971, 1975, 1988); Савельев (1974, 1976, 1981); Kennedy, Hancock (1978); Destombes (1979); Друщиц, Горбатчик (1979) and Амедро (1980) are to be shown up. Николов (1987) made an attempt to introduce equalized criteria of the Albian zonation in the whole of the Mediterranean Region. In spite of the evident efforts to create an equalized widely usable biostratigraphic subdivisions, the differences between the zonations are inevitable. It is easily explicable with the objective conditions and the specific characters of the ammonite successions in each region. The current zonations of the Albian Stage in the Mediterranean Region are highly detailed, the units are clearly and precisely defined.

Following the practice worldwide, in Bulgaria the triple subdivision of the Albian Stage is used. The term "Vraconian" has been employed only by Тзанков, Ювтовска (1965) without determining a rank of substage.

Бончев (1935) was the first to introduce a zonation of the Albian in Bulgaria. Страшимиров, Стоянова (1958) divided the Upper Albian Substage in the region of Nikopol into two zones — *M. inflatum* and *S. dispar*, without defining them, however. Димитрова et al. (1961) proposed a first zonation to cover the whole of

STAGE	SUBSTAGE	Бончев (1935)	Страшимиров, Стоянов (1958)	Димитрова и др. (1961)	Nikolov (1965, 1969)	Бресковски, Димитрова (1963)	Иванов (1981)	Ivanov (in this work)	
		Zone	Zone	Zone	Zone	Zone	Zone	Zone	Subzone
ALBIA N	UPPER		S. dispar	H. orbigny?	S. dispar	S. dispar	S. dispar	S. dispar	
			M. inflatum		M. inflatum	H. orbigny?	M.(P) inflatum	M.(M) inflatum	C. auritus H. varicosum H. orbigny?
	MIDDLE	A. intermedius			unnamed zone	H. dentatus	E. laevis	E. laevis	
		H. dentatus, H. bennettianus		H. dentatus	H. dentatus		H.(H) dentatus	E. loricatus	A. intermedius H. spathi L. lyelli
								H. dentatus	P.(L) steinmanni
	LOWER				D. mammillatum	D. mammillatum	D. mammillatum	D. mammillatum	
				L. tardefurcata	L. tardefurcata	L. tardefurcata	L.(L) tardefurcata	L.(L) tardefurcata	L.(N) regularia L.(L) tenuicostata
	UPPER			Ch. bigoureti	D. nodoso-costatum	H. jacobii	D. nodoso-costatum	H. jacobii	

Fig. 4. Development in the concepts of the Albian zonation in Bulgaria

the Albian. Later that subdivision was modified by Бресковски, Димитрова (1968).

T. Nikolov reported at the Lyon Colloquium a new zonal subdivision of the Albian in Bulgaria (Nikolov, 1965) which is more detailed and enables correlation with other regions in the world. It is essentially the same as the currently adopted standard ammonite zonation of the Mediterranean Region. The development in the conceptions and knowledge of the Bulgarian authors about Albian zonation is shown in Fig. 4.

The zonal schemes proposed in Bulgaria so far are not highly detailed although they are usable. Neither the criteria to indicate the boundaries, nor the characterization of ammonite zones are clearly and completely defined in them.

Nikolov's (1965, 1969) zonation underlies the subdivision adopted in the present work. The former has already been partly completed by this author (Иванов, 1981). Now, based on revising and new investigations of the ammonite successions, the zonation of the Albian Stage in Northwest Bulgaria has been detailed. Besides, the modern achievements and trends in the Albian zonal stratigraphy of the Mediterranean Region have been taken into account. The characteristic features of both the taxonomic content and character of the ammonite successions determine the degree of subdivision in detail, as well as the peculiarity of the zonation in Northwest Bulgaria. Several kinds of biostratigraphic units have been used — Opel-zones, Range-zones, Concurrent-Range-zones and Interval-zones.

The lower boundary of the Albian Stage in the study area

The Albian in Northwest Bulgaria follows directly upon the Aptian. There is no lithological differences between the sediments of these two stages across the boundary interval. Both the Upper Aptian and Lower Albian consist of thick deposits forming lithological continuity without hiatuses and condensations. The lower boundary of the Albian has been established in the sections at G. Damianovo, Zamfirovo, Sumer, Kravoder, Vlasatica and M. Peštene and in the site of Rečka. This boundary coincides with the base of the *L. (L.) tardefurcata* Zone. Its specific position in the sections is shown in Fig. 3 as well as in the definition of last-named zone. The Upper Aptian and Lower Albian se-

diments yielded fairly abundant and diverse ammonites. It facilitates drawing the boundary in the sections. The lower boundary of the Albian Stage is defined by the following biostratigraphic criteria: the disappearance of the species of *Acanthohoplites*, *Chelonicer* (*Epicheloniceras*), *Eodouvilleceras* and *Neosilesites*; the appearance and the abundant presence of *Leymeriella*; the significant change in species belonging to *Hypacanthoplites* (*H. milletioides* is amongst the characteristic Lower Albian species).

Hypacanthoplites, *Eogaudryceras*, *Ptychoceras* and *Phylloceras* (*Hypophylloceras*) range from the Aptian into the Lower Albian with restricted number of species. In Bulgaria no species of *Proleymeriella* and *Farnhamia* have yet been found. Those of *Anadesmoceras* appear quite later.

The Lower Albian Substage

Compared to the other two substages, the Lower Albian is of most widespread occurrence. In the western parts of the area it has been established in the region of Belogradčik at Vraška Čuka (И. Цанков, 1963) and along the valley of Čuprenska River. To the east of the Lopusanska Ogosta River the Lower Albian is largely exposed. In that region, it consists of marls of various clayey and calcareous components. The marls are often silty, sometimes slightly glauconitic, alternating with thin beds of clayey limestones, sandstones and/or siltstones (the Sumer Formation).

At the foot of the Veslec Hill near Veslec and Malo Peštene the Lower Albian comprises fine to coarse grained glauconitic sandstones, siltstones and marls. The marls are often silty and more or less glauconitic (the Malo Peštene Formation). The thickness of the substage in the area studied ranges from 20 m to 270 m.

The Lower Albian sediments are rich in ammonites dominated by the characteristic genera *Leymeriella*, *Hypacanthoplites*, *Douvilleceras* and *Protanisoceras*. A few specimens of *Epileymeriella* (*Revilites*), *Anadesmoceras*, *Rossalites*, *Silesitoides* and *Pseudosonneratia* (*Isohoplites*) have been found. Some genera range also lower into the Upper Aptian or higher into the Middle Albian.

The absence of the distinctive Lower Albian species of *Farnhamia*, *Proleymeriella*, *Belidiscus*, *Vnigrice* (*Vnigrice*), *Cleoniceras*, *Sonneratia*, *Pseudosonneratia* (*Pseudosonneratia*) and *Protohoplites* in Bulgaria restricts the possibilities to subdivide the substage into zones and subzones in greater detail.

Leymeriella (Leymeriella) tardefurcata Zone

Nomenclature. *Leymeriella (Leymeriella) tardefurcata* (Leymerie) d'Orbigny, 1841 is the zonal index. The species range is restricted only in the lower parts of the zone.

The zone was introduced by Jacob (1907). In Bulgaria it was proposed by Димитрова et al. (1961).

Stratigraphy. The zone coincides with the *Leymeriella* Range-Zone. The lower boundary has already been defined as lower boundary of the Albian Stage. In Bulgaria *Epileymeriella*, *Puzosia*, *Beudanticeras*, *Tetragonites*, *Anagaudryceras* and *Rossalites* appear at the base of the zone, and *Douvilleceras*, *Anadesmoceras*, as well as unknown anisoceratids in its upper part. The latest species of *Hypacanthoplites* and *Eogaudryceras* (*Eotetragonites*) have been recorded within the zone.

Analysis of the ammonite sequences in some sections permits to divide the zone into two subzones — *L. (L.) tenuicostata* Subzone and *L. (N.) regularis* Subzone. The bulk of the distinctive faunal elements of these two subzonal ammonite associations are mutually incompatible. The zonal association is composed of the subzonal associations.

Distribution in the area. The zone is established in the section at G. Damianovo (No. 1 — from 15 m to 58 m; No. 2—4); section Kalimnica (No. 1—2); section Borovci (No. 1—2); section Zamfirovo (No. 1 — from 14 m to 32 m; No. 2); sec-

tion Sumer (No. 1 — from 42 m to 64 m; No. 2); section Kravoder (No. 1 — from 71 m to 83 m; No. 2—5; No. 6 — from 0 to 10 m); section Vlasatica (No. 3); section Rečka (No. 4—5); section M. Peštene (No. 2 — from 1 m to 2,5 m; No. 3). The zone was indicated at Vrška Čuka (И. Цанков, 1963).

Correlation. The zone is well correlated with the same unit in England, France, West Germany, Austria, Romania, the southern parts of the Soviet Union, Mangyschlag, Turkmenia and Iran. In Bulgaria the genera *Farnhamia* and *Proleymeriella* do not occur, the species *H. milletioides* Casey coexists with *Leymeriella*. These circumstances do not enable to define equivalent units to the *F. farnhamensis* Subzone and *H. milletioides* Subzone known from England, as well as to the *P. schrameni* Subzone from West Germany and Northern Caucasus. Further finding of new evidence is needed to elucidate this problem which is here not considered to be completely solved.

Leymeriella (*Leymeriella*) *tenuicostata* Subzone

Nomenclature. *Leymeriella* (*Leymeriella*) *tenuicostata* Saveliev, 1973 is the index fossil. This species is proposed here for the first time in order to avoiding homonymy with the zone. This unit has already been defined in such extent as "*L. (L.) tardefurcata* Zone" or "*L. (L.) tardefurcata* Subzone". In Bulgaria the subzone is introduced in the present paper.

Stratigraphy. The lower boundary of the subzone has already been characterized as lower boundary of the Albien. The subzone is defined on the base of the Concurrent-Range-Zones of the following species of *Leymeriella* (*Leymeriella*): *L. (L.) tardefurcata* (Leymerie) d'Orbigny, *L. (L.) tenuicostata tenuicostata* Saveliev, *L. (L.) tenuicostata ornata* Saveliev, *L. (L.) densicostata* Spath, *L. (L.) astrica* Glasunova and *L. (L.) recticostata* Saveliev. The subzone coincides with the abundant presence of *Leymerilla* (*Leymeriella*), only the species *L. (L.) rencurelensis* Jacob ranging higher into the overlaying subzone. *Epileymeriella* (*Revilites*) *revili* (Jacob) and *Hypacanthoplites milletioides* Casey are confined to this unit. In the upper part of the subzone the first species of *Leymeriella* (*Neoleymerilla*) appear. These are species belonging to the *L. (N.) intermedia* Spath group which represents the phylogenetic transition between the two genera. Some of them have a restricted range and disappear at the top of the subzone; others, as for instance, *L. (N.) intermedia intermedia* Spath and *L. (N.) bogdanovitchi angustumbilicata* Glasunova, range higher into the following *L. (N.) regularis* Subzone. Together with the characteristic ammonites of the *L. (L.) tenuicostata* Subzone mentioned above, single species of *Puzosia*, *Anapuzosia*, *Eogaudryceras*, *Anagaudryceras*, *Tetragonites*, *Ammonoceras*, *Rossalites*, *Ptychoceras* and *Phylloceras* (*Hypophylloceras*) also occur but they are longer ranging forms.

Distribution in the area. The subzone is established in the section at G. Damjanovo (No. 1 — from 15 m to 42 m); section Kalimanica (No. 1—2); section Borovci (No. 1); section Zamfirovo (No. 1 — from 14 m to 32 m; No. 2 — from 2 m to 10 m); section Sumer (No. 1 — from 42 m to 64 m; No. 2); section Kravoder (No. 1 — from 71 m to 83 m; No. 2—4); section Vlasatica (No. 3); section Rečka (No. 4 and No. 5 — in part); section M. Peštene (No. 2 — from 1 m to 2,5 m). The presence of the unit was also indicated at Vrška Čuka (И. Цанков, 1963).

Correlation. The subzone is correlated with the *L. tardefurcata* Zone or Subzone in West Germany, Romania, the southern parts of the Soviet Union, Mangyschlag and Turkmenia. The *H. milletioides*, *L. acuticostata* and *L. (N.) regularis* Subzones in England, France and West Germany are equated to parts of the *L. (L.) tenuicostata* Subzone in Bulgaria.

Leymeriella (*Neoleymerilla*) *regularis* Subzone

Nomenclature. *Leymeriella* (*Neoleymerilla*) *regularis* (Bruguiere) d'Orbigny, 1841 is the subzonal index. This unit was introduced by Stolley (1908) in Ger-

many as '*Hoplites regularis* and *Belemnites strombecki* Zone'. In Bulgaria the subzone is proposed in the present paper.

Stratigraphy. The lower boundary is taken to coincide with the disappearance of *L. (L.) tardefurcata* (Leymerie) d'Orbigny, *L. (L.) tenuicostata* Saveliev, *L. (L.) astrica* Glasunova and *L. (N.) disposita* Saveliev and the appearance of the characteristic species of *Leymeriella* (*Neoleymeriella*), e. g. *L. (N.) consueta* Casey, *L. (N.) regularis* (Bruguere) d'Orbigny and *L. (N.) pseudoregularis* Seitz. The subzone coincides with the abundant occurrence of species of *Leymeriella* (*Neoleymeriella*). It is also defined by the coexistence of *L. (N.) regularis* (Bruguere) d'Orbigny, *L. (N.) renacensis* Seitz, *L. (N.) pervulata* Saveliev, *L. (N.) consueta* Casey, *L. (N.) pseudoregularis* Seitz, *L. (N.) intermedia* Spath, *L. (N.) bogdanovitchi* Glas., *L. (N.) andrussovi* Glas., etc. First species of *Douvilleiceras*, *Anadesmoceras*, as well as unknown heteromorph ammonites appear within this unit. Single representatives of *Puzosia*, *Eogaudryceras* (*Eotetragonites*), *Anagaudryceras*, *Tetragonites* and *Phylloceras* (*Hypophylloceras*) also occur. They are not characteristic of the subzone but complete the ammonite association.

Distribution in the area. Section G. Damianovo (No. 1 — from 43 m to 58 m; No. 2—4); section Borovci (No. 2); section Zamfirovo (No. 2 — from 11 m to 30 m); section Kravoder (No. 5 and No. 6 — from 0 to 10 m); section Rečka (No. 4 — in part); section M. Peštene (probably No. 3).

Correlation. The subzone is well correlated with the same unit in England, France, West Germany, Austria, the southern parts of the Soviet Union, Mangyschak and Turkmenia. It has also been denoted in Iran. In some regions of Western Europe (England, France, Switzerland), as well as in Georgia the condensation of sediments does not permit distinguishing this subzone from the underlying subzone and/or the overlying *D. mammillatum* Zone.

Douvilleiceras mammillatum Zone

Nomenclature. *Douvilleiceras mammillatum* (Schlotheim, 1813) is the index ammonite. The zone was introduced in 1875 by Barrois (P. Destombes et J.-P. Destombes, 1965). Савельев (1974) and later Destombes (1979) and Owen (1988) have raised its rank in superzone. In Bulgaria the zone has been proposed by Nikolov (1965).

Stratigraphy. The lower boundary of the zone is taken to coincide with the total disappearance of *Leymeriella* and *Eogaudryceras* (*Eotetragonites*) and the abundant presence of *Douvilleiceras*, *Protanisoceras*, *Beudanticeras* and *Kossmatella*. The zone corresponds to the *Douvilleiceras* and *Protanisoceras* Acme-Zones. In the lower part *Hamites* (*Hamites*) and *Kossmatella* appear, and in the upper part — *Otohoplites*, *Pseudosonneratia* (*Isohoplites*) and *Heteroclinus*. The species of *Silesitoides* are confined to the unit. *Rossalites* disappears within the zone.

The zonal ammonite association consists of *D. mammillatum mammillatum* (Schlotheim), *D. mammillatum praecox* Casey, *D. orbignyi* Hyatt, *D. alternans* Casey, *D. leightonense leightonense* Casey, *Pseudosonneratia* (*Isohoplites*) *steinmanni* (Jacob), *Hamites* (*Hamites*) *hybridus* Casey, *Protanisoceras* (*Protanisoceras*) *raulinianum* (d'Orbigny), *P. (P.) lardyi* (Pictet & Campiche), *P. (P.) vaucherianum* (Pictet), *P. (P.) blancheti* (Pictet & Campiche), *Protanisoceras* (*Torquistylus*) *mareranense* Collignon, *Beudanticeras newtoni* Casey, *B. arduenense* Breistroffer, *Otohoplites elegans* (Spath) and *Silesitoides escragnolensis* (Jacob).

The ammonite fauna recorded is completed by species of *Puzosia*, *Kossmatella*, *Anadesmoceras*, *Tetragonites*, *Rossalites*, *Ammonoceratites*, as well as by unknown heteromorphic ammonites.

In Bulgaria no species of *Sonneratia*, *Pseudosonneratia* (*Pseudosonneratia*), *Protohoplites*, *Cleoniceras* and *Tegoceras* have been recorded. Those of *Otohoplites* and *Pseu-*

dosonneratia (*Isohoplites*) are extremely sparse. As it is well known, the detailed biostratigraphic subdivisions of this stratigraphic interval in Western Europe and the Soviet Union (Mangyschlag) are based on vertical ranges of species belonging to these genera. These species are used as index fossils or defining elements of the zones and subzones (Савельев, 1974, 1981; Destombes, 1979; Owen, 1988). The absence of hoplites from the lower and middle parts, as well as the scarce specimens found in the upper part have made it practically impossible to divide the whole of the zone. In the highest part only, the *Pseudosonneratia* (*Isohoplites*) *steinmanni* Subzone has been recognized. In this paper, Owen's (1988) arguments are adopted, who reasonably assigned this subzone to the Lower Albian.

Distribution in the area. Section Čuprene (No. 3 — from 0 to 18 m); section Kravoder (No. 6 — from 11 m to 35 m; No. 7—8); section Vlasatica (No. 4 and No. 5 — lower part); section M. Peštene (No. 4—6); section Virovsko (probably No. 2).

Correlation. The zone correlates with the same unit in Western Europe (England, France, etc.), the southern parts of the Soviet Union (Crimea, Caucasus), Transcaspia and Turkmenia. In Mangyschlag the zone is correlated with the *Cleoniceras mangyschlagense* Superzone.

Pseudosonneratia (*Isohoplites*) *steinmanni* Subzone

Nomenclature. *Pseudosonneratia* (*Isohoplites*) *steinmanni* (Jacob, 1907) is the subzonal index. Spath (1923) defined it as '*D. inaequinodum* Subzone'. Casey (1961) proposed *H. (I.) eodentatus* as an index fossil. Owen (1988) established that Casey's species is indistinguishable from *P. (I.) steinmanni*, the latter being previously founded. In Bulgaria the subzone is first proposed in the present work.

Stratigraphy. The lower boundary of the subzone is taken to coincide with the disappearance of *D. mammillatum mammillatum* (Schlotheim), *D. alternans* Casey, *P. (P.) cantianum* Spath and *P. (P.) raulinianum* (d'Orbigny) and the appearance of *Pseudosonneratia* (*Isohoplites*) and *D. inaequinodum* (Quenstedt). The subzone corresponds to the *Pseudosonneratia* (*Isohoplites*) Range—Zone. *Douvilleiceras* and *Protanisoceras* are represented by restricted number of species within the subzone. *P. (I.) steinmanni* (Jacob) and *D. inaequinodum* (Quenstedt) are characteristic of the subzone. Some species belonging to *Douvilleiceras*, as well as to *Beudanticeras* and *Protanisoceras* also occur. No species of *Lyelliceras*, *Otohoplites*, *Tegoceras* and *Brancoceras* have yet been recorded.

Distribution in the area. Section Kravoder (No. 8 — from 42 m to 44 m); section M. Peštene (No. 6 — from 10 m to 12 m).

Correlation. The subzone is correlated with the same unit in England and Mangyschlag (Owen, 1988; Савельев, 1981). It has been named *H. (I.) eodentatus* by some English stratigraphers as well as in France, West Germany and Poland.

The Middle Albian Substage

The Middle Albian is of relatively confined occurrence. In the western part of the area it has been indicated near the villages of Rakovica (И. Ианков, 1963) and Čuprene. The substage comprises marls interbedded by clayey limestones (the Sumer Formation). After a long-distant obscurity the substage is exposed again to the east of Botunja Valley near Kravoder, Pudrija and Vlasatica. In that region it consists of clayey, silty, locally slightly glauconitic marls and thin beds of clayey limestones (the Sumer Formation) and glauconitic sandstones and siltstones (the Malo Peštene Formation). To the east of the Skăt River the substage is established near Malo Peštene and Bukovec where glauconitic sandstones, siltstones and marls belonging to the Malo Peštene Formation are present in the sections. The thickness of the Middle Albian in the area ranges from 30 m to 100 m.

The sediments in the lower parts of the Middle Albian yielded rich ammonite and other

faunas whereas those in the upper part only rare and badly preserved ammonites. The species of *Hoplites* and *Anahoplites* are dominant. Representatives of *Protanisoceras*, *Lyelliceras*, *Heteroclinus*, *Hamites*, *Metahamites*, *Pictetia*, *Pseudhelicoceras*, *Puzosia*, *Beudanticeras* and *Brancoceras* also occur but are less common. In Northwest Bulgaria no *Euhoplites*, *Dimorphoplites*, *Oxytropidoceras* and *Mojsisovicsia* have yet been found.

The lower boundary of the Middle Albian in the area is taken to coincide with the disappearance of *Pseudosonneratia* (*Isohoplites*) and the appearance and abundant presence of *Hoplites*, *Lyelliceras* and *Brancoceras* (the species *H. dentatus* (J. Sowerby), *H. devisensis* Spath, *L. lyelli* (Leymerie) d'Orbigny, etc.)

The Middle Albian is divided into three zones — the *H. dentatus*, *E. loricatus* and *E. lautus* Zones.

Hoplites dentatus Zone

Nomenclature. *Hoplites dentatus* (J. Sowerby, 1821) is the zonal index. The zone was first defined in 1875 by Barrois in France as '*A. interruptus* Zone'. In Bulgaria the unit was mentioned for the first time in Бончев's (1935) account. Nikolov (1965) gave the correct name and characterized the zone. In this paper, it is considered in its shorter extent defined by Owen (1971, 1988).

Stratigraphy. The lower boundary of the zone has already been characterized as lower boundary of the Middle Albian. The zone coincides with the *Hoplites* Acme-Zone and the Range-Zone of *H. dentatus* (J. Sowerby), the index species. *Lyelliceras*, *Brancoceras*, *Douvilleiceras* and *Protanisoceras* are confined to the lower part of the zone only. In the upper part the first species of *Anahoplites* appear. The ammonite zonal association is completed by representatives of *Hamites*, *Pictetia*, *Heteroclinus*, *Puzosia* and *Beudanticeras*.

There are different opinions in the stratigraphic literature concerning the extent of the zone. Part of the authors, including Савельев (1974, 1981); Kennedy, Hancock (1978); Destombes (1979) and Amedro (1980) assigned to this zone the Subzone of *H. (I.) eodentatus* (= *P. (P.) steinmanni*). The writer's idea about it has been expressed above. Another group, e.g. Spath (1941); Breistroffer (1947) and Destombes (1979) included into this zone the *A. intermedius* Subzone. In this paper, Owen's (1971, 1975); Савельев's (1976, 1981) and Kennedy and Hancock's (1978) concept is adopted and the *A. intermedius* Subzone is referred to the overlaying zone. Thus, the restricted zonal extent comprises the *L. lyelli* and *H. spathi* Subzones only.

Distribution in the area. Section Čuprene (No. 3 — from 34 m to 36 m); section Kravoder (No. 9 and No. 10 — from 10 m to 20 m); section Vlasatica (No. 5 — upper part and No. 6); section M. Peštene (No. 8—9); section Kutela (No. 1—2).

Correlation. In the light of the specifying made above this zone correlates with parts of the same unit in England, France, Poland, Austria, Romania, the southern parts of the Soviet Union, Mangyschlak and Turkmenia.

Lyelliceras lyelli Subzone

Nomenclature. *Lyelliceras lyelli* (Leymerie) d'Orbigny, 1841 is the index ammonite. The subzone was introduced by Spath (1923) as '*H. benettianus* Subzone'. The index species *L. lyelli* and the subzonal definition were proposed by P. et J.-P. Destombes (1965). In Bulgaria the subzone is first established and introduced in the present paper.

Stratigraphy. The subzonal extent is defined by the *Douvilleiceras* and *Hoplites* Concurrent-Range-Zone and by the coexistence of the species *H. devisensis* Spath, *H. baylei* Spath, *H. pseudodeluci* Spath, *L. lyelli* (Leymerie) d'Orbigny, etc. It coincides with the *Lyelliceras* Acme-Zone. *Douvilleiceras*, *Protanisoceras* and *Lyelliceras* disappear within the subzone.

The characteristic ammonite association is composed of *Lyelliceras lyelli* (Leymerie) d'Orbigny, *H. devisensis* Spath, *H. pseudodeluci* Spath, *H. baylei* Spath, *P. (P.) alternotuberculatum* (Buvignier), *P. (P.) moreanum* (Buvignier) and *Brancoceras (Brancoceras) senequieri* (d'Orbigny).

H. dentatus dentatus (J. Sowerby), *H. dentatus densicostatus* Spath and *H. dentatus robustus* Spath complete the association. They appear within the subzone and range higher into the following subzone.

Distribution in the area. Section Čuprene (probably No. 3 — from 34 m to 36 m); section Kravoder (No. 9); section M. Peštene (No. 8).

Correlation. This biostratigraphic unit is correlated with the same subzone in England, France, East Germany, the southern parts of the Soviet Union and Mangyschlag. The following subzones correlate also with the subzone: *H. benettianus* Subzone sensu Spath (1923, 1941), Casey (1961) and Соколов (1963, 1966); *H. benettianus* Subzone and *H. pseudodeluci* Subzone sensu Breistroffer (1947) and *H. benettianus* Subzone (pro parte) in Turkmenia.

Hoplites spathi Subzone

Nomenclature. *Hoplites spathi* Breistroffer, 1947 is the index ammonite. The subzone was introduced by Spath (1923) as '*H. dentatus* Subzone'. Breistroffer (1947) gave the double name *H. dentatus* — *H. spathi*, Owen (1971) proposed only *H. spathi* as an index. In Bulgaria the subzone is introduced in this work.

Stratigraphy. The lower boundary of the subzone is taken to coincide with the disappearance of *Lyelliceras*, *Douvilleiceras*, *Protanisoceras*, *H. devisensis* Spath, *H. pseudodeluci* Spath and the appearance of *H. spathi* Breistroffer, as well as of the first representatives of *Anahoplites*, e.g. *A. evolutus* Spath and *A. praecox* Spath. The subzone corresponds to the *H. spathi* Breistroffer Range-Zone and to the *H. dentatus dentatus* (J. Sowerby), *A. praecox* Spath and *A. evolutus* Concurrent-Range-Zones. This subzone is clearly defined as an interval between the disappearance of the characteristic genera and species of the *L. lyelli* Subzone listed above and the appearance of *Anahoplites intermedius* Spath and *A. asiaticus* Glasunova.

The subzonal ammonite association is composed mainly by species of *Hoplites* and *Anahoplites*, e.g. *H. spathi* Breistroffer, *H. dentatus dentatus* (J. Sowerby), *H. dentatus densicostatus* Spath, *H. dentatus robustus* Spath, *A. praecox* Spath and *A. evolutus* Spath.

Distribution in the area. Section Kravoder (No. 10 — from 10 m to 20 m); section Vlasatica (No. 5 — upper part; No. 6); section M. Peštene (No. 9); section Kutela (No. 1).

Correlation. The unit is correlated with the same subzone in England and Mangyschlag, as well as with the *H. dentatus* — *H. spathi* Subzone in France and *H. dentatus* Subzone (pro parte) in the southern parts of the Soviet Union and Turkmenia.

Euhoplites loricatus Zone

Nomenclature. *Euhoplites loricatus* Spath, 1930 is the zonal index. The zone was first defined by Owen (1971). It corresponds partly to the *E. lautus* Zone sensu Spath (1941). In Bulgaria it has been introduced by Иванов, Стойкова (1990) in central Northern Bulgaria.

Stratigraphy. The lower boundary of the zone is taken to coincide with the disappearance of *H. dentatus dentatus* (J. Sowerby) and the appearance of *A. intermedius* Spath, *A. asiaticus* Glasunova and *A. mantelli* Spath. In Northwest Bulgaria only the lower parts of the zone yielded ammonite faunas. In the upper parts ammonites do not occur and the boundary with the overlaying *E. lautus* Zone is not quite distinct. The absence of fossils is probably related to the unfavorable influence of

the taphonomic factors. Besides, in the area no species of *Dimorphoplites*, *Euhoplites* and *Mojsisovicsia* have been recorded which form the basis of the subzonal scheme. The genus *Anahoplites* is represented by relatively low number of species. Because of these objective conditions in the area, the ammonite faunas recorded prove the presence of the lower part of the zone only, the *A. intermedius* Subzone in particular.

Distribution in the area. Section Kravoder (No. 10 — from 25 m to 34 m; No. 11, 12 and probably 13 — lower part); section Vlasatica (No. 7 and probably part of No. 8); section M. Peštene (No. 10); section Kutela (No. 2—3); section Virovsko (No. 3).

Correlation. The whole of the zone is impossible to be correlated with the same unit in Western Europe. Its lower parts are comparable with the corresponding intervals in England, France, Romania and the southern parts of the Soviet Union. Outside the study area the zone has been established and well characterized in Central-Northern Bulgaria (Иванов, Стойкова, in press). The zone corresponds to the lower part of the *E. lautus* Zone sensu Иванов (1981), Иванов et al. (1982).

Anahoplites intermedius Subzone

Nomenclature. *Anahoplites intermedius* Spath, 1925 is the index species. Spath (1923) defined the subzone for the first time and later specified its extent (Spath, 1941). In Bulgaria it is introduced in the present paper.

Stratigraphy. The lower boundary of the subzone has already been defined in the description of the zone. The subzone is characterized by the concurrent ranges of *A. intermedius* Spath, *A. asiaticus* Glasunova, *A. mantelli* Spath, *A. grimsdalei* Owen, *A. sp.*, *Hoplites danubiensis* Patruilus, *P. (Heteroclinus) nodosus* (J. Sowerby), *P. (H.) flexuosum* (d'Orbigny) and *Eubrancoceras (Eubrancoceras) cricki* Spath.

The ammonite association includes also *H. dentatus robustus* Spath, *A. praecox* Spath, *A. evolutus* Spath, *A. planus planus* (Mantell), *H. (Hamites) tenuicostatus* Spath, *H. (H.) attenuatus* J. Sowerby, *Metahamites* sp., *Kossmatella (Kossmatella) agassiziana* (Pictet), *Pictetia asteriana* (d'Orbigny), etc. Single representatives of *Kossmatella*, *Hamites*, *Metahamites* and *Pictetia* have been recorded. *Euhoplites* and *Dimorphoplites* are absent from the subzone.

Distribution in the area. Section Kravoder (No. 10 — from 25 m to 34 m; No. 11—12); section Vlasatica (No. 7); section M. Peštene (No. 10); section Kutela (No. 2—3); section Virovsko (No. 3).

Correlation. The subzonal ammonite association is similar and well correlated with those from the same zone or subzone in England, Romania, the southern parts of the Soviet Union, Mangyschlag and Turkmenia (Owen, 1971; Destombes, 1979; Chiriac, 1981; Савельев, 1976, 1981; Котетъшвили, 1986).

Euhoplites lautus Zone

Nomenclature. *Euhoplites lautus* (J. Sowerby, 1821) is the index species. The zone was introduced by Spath (1923) as "*Anahoplitan*". Spath (1941) proposed *E. lautus* as an index ammonite, Owen (1971) changed and confined the zonal extent. In Bulgaria it has been recognized as an interval (unnamed zone) by Nikolov (1965). Иванов (1981), Иванов et al. (1982) considered this zone sensu Spath (1941). In its extent defined by Owen (1971) the zone is proposed by Иванов, Стойкова (1990), as well as in the present work.

Stratigraphy. It is difficult to draw the lower boundary of the zone in the sections because this interval yielded sparse and poorly preserved ammonites. The boundary is placed at the appearance of *A. planus gracilis* Spath and *H. (H.) maximus* J. Sowerby. The zone is characterized by the concurrent ranges of *A. cf. daviesi* Spath,

H. (H.) tenuis J. Sowerby, *H. (H.) maximus* J. Sowerby and *A. planus gracilis* Spath.

The ammonite association recorded in the zone includes also *A. planus planus* (Mantell), *A. splendens* (J. Sowerby), *A. planus discoides* Spath, *A. sp. aff. aequilosus* Glasunova, *H. (H.) compressus* J. Sowerby, *H. (H.) gibbosus* J. Sowerby, *H. (H.) tenuicostatus* Spath, etc.

Of note is the almost total absence of species of *Euhoplites* and *Dimorphoplites*. That makes it difficult distinguishing the zone in the sections and impossible its dividing in detail.

Distribution in the area. Section Čuprene (No. 3 — from 53 m to 56 m); section Kravoder (No. 13 — upper part); section M. Peštene (No. 11 — from 3 m to 8 m and No. 12 — lower part).

Correlation. This biostratigraphic unit is correlated with the same zone in France, England and Romania (Owen, 1971; Destombes, 1973; Chiriac, 1981). In the southern parts of the Soviet Union, Mangyschak and Turkmenia the zone is equated to the *A. daviesi* Zone and part of the *A. intermedius* Zone, the *A. daghestanensis* Zone and the *H. perarmatus* Zone (Соколов, 1963, 1966; Друщиц, Михайлова, 1966; Савельев, 1973, 1976, 1981; Друщиц, Горбатчик, 1979; Котеишвили, 1986). In Bulgaria the zone has been established and more completely characterized by fossils in central Northern Bulgaria (Иванов, Стойкова, 1990).

The Upper Albian Substage

The substage is of quite restricted occurrence in the area. In the western parts it is exposed in the region of Belogradčik near the Rabiška Mogila Hill (Димитрова in Цанков et al., 1960; Цанков, 1963) and near Čuprene. The Upper Albian comprises marls with interbeds of clayey limestones (the Sumer Formation). In the northern parts of the Fore-Balkan near Dobruša the highest parts of the substage are revealed. In this region it is represented by similar deposits. To the east of the Skät River the substage has been established near M. Peštene, Nivianin and Bukovec. It consists of fine to coarse grained glauconitic sandstones, siltstones and silty glauconitic marls (the Malo Peštene Formation). The thickness of the substage in the area ranges from 20 m to 65 m. In the sections studied the Upper Albian is not completely present.

The deposits of this substage contain diverse ammonite fauna. The genera of Acanthocerataceae, Anisoceratidae and Hamitidae, e.g. *Mortoniceras*, *Prohysterocheras*, *Hysterocheras*, *Stoliczkaia*, *Anisoceras*, *Idiohamites*, *Hamites*, etc. are dominant. The hoplitids occur sporadically. Single specimens of *Callihoplites*, *Metoclavites* and *Lepthoplites* have been found. *Mariella* is the unique genus recorded amongst the ammonites with turrilitid coiling. Species of *Puzosia*, *Beudanticeras*, *Kossmatella*, *Scaphites*, *Pseudohelicoceras* and *Eogaudryceras* complete the ammonite association.

The Upper Albian is divided into two zones — the *M. (M.) inflatum* and *S. dispar* Zones. The beds across the Middle Albian — Upper Albian boundary are not exposed or contain no ammonites. The lowest Upper Albian, i.e. the *D. cristatum* Subzone has not yet been proved by fossils. The Middle Albian — Upper Albian boundary is placed tentatively in the sections.

Mortoniceras (Mortoniceras) inflatum Zone

Nomenclature. *Mortoniceras (Mortoniceras) inflatum* (J. Sowerby, 1818) is the index ammonite. Barrois in 1875 introduced the zone (J. et J.-P. Destombes, 1965). Spath (1923, 1941) gave its precise definition. In Bulgaria it has been first proposed by Страшимиров, Стоянова (1958).

Stratigraphy. The lower boundary of the zone is placed at the appearance and abundant presence of *Mortoniceras*, *Hysterocheras* and *Metoclavites*. The zone coincides

with the *Prohysterocheras*, *Hysterocheras*, *Metaclavites* and *Mortonicerases* (*Deiradocerases*) Range-Zones and with the Acme-Zones of *Mortonicerases* (*Mortonicerases*), *Idiohamites*, etc. *Diplocerases* is characteristic of the lower part, and *Callihoplites*, *Lechites* and *Mortonicerases* (*Cantabrigites*) of the upper part of the zone. The first species of *Anisocerases* and *Hamites* (*Stomohamites*) appear within the zone. Representatives of *Kossmatella*, *Pseudohelicocerases*, *Beudanticerases*, *Puzosia* and *Scaphites* also occur, some of them being characteristic of the unit.

The ammonite fauna recorded in the zone in Northwest Bulgaria has its specific features. The hoplitides are extremely sparse and the genera *Anahoplites*, *Euhoplites*, *Epihoplites* and *Dimorphoplites* are absent. *Hamites* (*Stomohamites*), as well as some species of *Anisocerases* appear within the zone in Bulgaria. In other localities of the Mediterranean Region these taxa are known to occur only within the *S. dispar* Zone. *Prohysterocheras* (*Neoharpocerases*) appears also earlier. This evidence has been established in a section providing continuous ammonite successions and lacking condensations. In spite of these differences, the ammonite successions are similar to those in England (Spath, 1941; Owen, 1975; Kennedy & Hancock, 1978) and France. The *M. (M.) inflatum* Zone in Northwest Bulgaria is divided into the following subzones: *H. orbignyi* Subzone, *H. varicosum* Subzone and *C. auritus* Subzone (there is no proof of the presence of *D. cristatum* Subzone).

Distribution in the area. Section Čuprene (No. 4—6); section M. Peštene (No. 12 — upper part); section Kutela (No. 4—6); section Bukovec (No. 1—13 and No. 14 — from 0 to 2 m). The zone was indicated at Rabiška Mogila Hill in the region of Belogradčik (Димитрова и Цанков et al., 1960; Цанков, 1963).

Correlation. The zone corresponds to the same unit in Western Europe, Austria and Romania. In the southern parts of the Soviet Union this interval is divided into two or three zones. The following zones are correlated with parts of the *M. (M.) inflatum* Zone: *H. orbignyi*, *M. inflatum*, *A. rossicus*, *D. cristatum*, *S. uhligi*, *S. michalskii* and *H. orbignyi* — *M. inflatum* Zones — Друщиц, Михайлова (1966), Савельев (1973, 1981), Друщиц, Горбатчик (1979), Котетишвили (1986).

Outside the study area the zone has been established in Central Northern Bulgaria (Иванов et al., 1982; Иванов, Стойкова, 1990).

Hysterocheras orbignyi Subzone

Nomenclature. *Hysterocheras orbignyi* (Spath, 1922) is the index species. The subzone was introduced by Spath (1923). In Bulgaria it is first proposed in this paper.

Stratigraphy. The lower boundary is placed at the appearance of *Mortonicerases* (*Deiradocerases*), *Idiohamites* and *Prohysterocherases* (*Goodhallites*) and the abundant presence of *M. (Mortonicerases)* and *Hysterocherases*. The boundary coincides with the appearance of the following species: *Hysterocherases binum* (J. Sowerby), *H. subbinum* Spath, *H. carinatum* Spath, *M. (Deiradocerases) albense* Spath, *Idiohamites tuberculatus* (J. Sowerby), *I. spiniger* (J. Sowerby) and *I. subspiniger* Spath. In the upper part the first *Hamites* (*Stomohamites*) appear. Almost all ammonite species occurring within the subzone range higher into the overlaying.

The subzonal ammonite association recorded is composed of *M. (D.) albense* Spath, *Hysterocherases orbignyi* (Spath), *H. pseudocornutum* Spath, *H. binum* (J. Sowerby), *H. subbinum* Spath, *P. (G.) goodhalli* (J. Sowerby), *I. tuberculatus* (J. Sowerby), *I. spiniger* (J. Sowerby), *I. subspiniger* Spath, *H. (H.) intermedius* J. Sowerby, *H. (S.) virgulatus* Pictet & Campiche, *H. (S.) subvirgulatus* Spath, *A. armatum* (J. Sowerby), *Metaclavites trifidus* (Spath) and *M. compressus* (Parona & Bonarelli).

Distribution in the area. Section Bukovec (No. 1—3; probably No. 4—5).

Correlation. The subzone is correlated with the same unit in Western Europe (Spath, 1923, 1941; Owen, 1975; Destombes, 1979; Amedro, 1980). It is

equated to the Subzones or Zones of *H. orbignyi*, *M. inflatum* — *H. orbignyi* (pro parte), *P. inflata* and *A. uhligi* in the southern parts of the Soviet Union, Mangyschak and Turkmenia (Соколов, 1966; Друщиц, Горбатчик, 1979; Савельев, 1981; Алиев et al., 1985; Котетшвили, 1986).

Hysterocheras varicosum Subzone

Nomenclature. *Hysterocheras varicosum* (J., C. Sowerby, 1824) is the index species. Spath (1923) introduced the subzone. In Bulgaria it is first proposed in the present paper.

Stratigraphy. The lower boundary is placed at the appearance of *M. (M.) inflatum* (J. Sowerby), *H. bucklandi* (Spath) and *H. carinatum* Spath. The subzone corresponds to the Concurrent-Range-Zone of *M. (M.) inflatum* (J. Sowerby), *M. (M.) binum* (J. Sowerby) and *H. varicosum* (J. Sowerby).

The subzonal ammonite association recorded consists of *M. (M.) pricei* (Spath), *M. (M.) pricei intermedius* Spath, *M. (M.) inflatum* (J. Sowerby), *M. (D.) devonense* Spath, *M. (D.) albense* Spath, *H. orbignyi* (Spath), *H. varicosum* (J. Sowerby), *H. binum* (J. Sowerby), *H. subbinum* Spath, *H. carinatum* Spath, *I. spiniger* (J. Sowerby), *I. subspiniger* Spath, *I. favrinus* (Pictet), *H. (S.) duplicatus* Pictet & Campiche, *H. (S.) subvirgatus* Spath, *H. (S.) charpentieri* Pictet, *A. armatum* (J. Sowerby) and *A. saussoreanum* (Pictet). Species of *Prohysterocheras*, *Puzosia* and *Scaphites* also occur.

Distribution in the area. Section Bukovec (No. 6—9).

Correlation. The unit is correlated with the same subzone in Western Europe (Spath, 1923, 1941; Owen, 1975; Kennedy and Hancock, 1978). In the southern parts of the Soviet Union (Crimea, Caucasus, Mangyschak and Turkmenia) the subzone has not been established. It correlates with parts of the *M. inflatum* (or *P. inflata*) Subzone as described by Соколов (1966), Друщиц, Горбатчик (1979), Савельев (1981), Алиев et al. (1985) and Котетшвили (1986).

Callihoplites auritus Subzone

Nomenclature. *Callihoplites auritus* (J. Sowerby, 1816) is the index species. The subzone was first defined by Spath (1923). In Bulgaria it is introduced in this work.

Stratigraphy. The lowest boundary is taken to coincide with the disappearance of *H. varicosum* (J. Sowerby) and *H. binum* (J. Sowerby) and the appearance of *M. (D.) praerostratum* (Spath), *M. (M.) commune* Spath, *C. auritus* (J. Sowerby), *P. (N.) hugardianum* (d'Orbigny), etc. The subzonal extent is defined by the concurrent ranges of *P. (G.) besakatrese* Collignon, *P. (N.) hugardianum* (d'Orbigny), *P. (N.) irregulare* Spath, *M. (M.) commune* Spath, *M. (M.) fissicostatum* Spath, *M. (D.) praerostratum* (Spath) and *C. auritus* (J. Sowerby). *Callihoplites* appears and *Prohysterocheras* (*Neoharpoceras*) is fairly abundant at the base of the subzone and first species of *Lechites* and *Mortoniceras* (*Cantabrigites*), e.g. *M. (C.) cantabrigense* Spath and *M. (C.) subsimplex* Spath appear in its upper part. *Hysterocheras*, *P. (Neoharpoceras)* and *M. (Deiradoceras)* are not known to occur above the subzone.

The ammonite association recorded is completed by species of *Anisoceras*, *H. (Stomohamites)*, *Scaphites* and *Puzosia*, as well as of sparse *H. (Hamites)* and *E. (Eogaudryceras)*. *M. (M.) cf. aequatorialis* (Kossmat) and *M. (M.) cf. killiani* (Lasswitz) also occur. Thus, the subzone there includes also strata corresponding to the *M. aequatorialis* Subzone and the *M. altonense* Subzone in England and France (Spath, 1923, 1941; Breistroffer, 1947).

Distribution in the area. Section Bukovec (No. 10—13 and No. 14 — from 0 to 2 m); section M. Peštene (probably No. 12 — upper part).

Correlation. The subzone is correlated with the same unit in Western Europe (Spath, 1923, 1941; Owen, 1975; Kennedy and Hancock, 1978). It is equated to parts of the *M. inflatum* (*P. inflata*) Subzone or Zone in the southern parts of the Soviet Union (Друщиц, Горбатчик (1979), Савельев (1981), Алиев et al. (1985) and Котетишвили (1986). The *C. catillus* Zone sensu Соколов (1966) is to be considered to correlate with the *C. auritus* Subzone, too.

Stoliczkaia dispar Zone

Nomenclature. *Stoliczkaia* (*S.*) *dispar* (d'Orbigny, 1841) is the index species. Spath (1923) introduced the zone as 'Pleurohoplitan' and later designated *S. dispar* as a zonal index (Spath, 1941). In Bulgaria the zone has been proposed by Страшимиров, Стоянова (1958).

Stratigraphy. The lower boundary is taken to coincide with the disappearance of *Hysterocheras*, *Prohysterocheras*, *M. (Deiradoceras)* and some species of *M. (Mortonicerias)*, the appearance of *Stoliczkaia* and the abundant presence of *Mariella*, *Lechites* and *M. (Cantabrigense)*. The zonal extent is defined by the *S. (Stoliczkaia)* Range-Rone and the Concurrent-Range-Zones of *M. (M.) bergeri* (Brongniart), *M. (M.) miliaris* (Pictet & Campiche), *L. gaudini* (Pictet & Campiche), *S. (S.) dispar* (d'Orbigny), *S. (S.) notha* (Seeley) and *S. blancheti* (Pictet & Campiche).

The following species are also recovered: *A. pseudoelegans* Pictet & Campiche, *A. saussoreanum* (Pictet), *I. dorsetensis* Spath, *H. (S.) duplicatus* Pictet & Campiche, *H. (S.) charpentieri* Pictet, *H. (S.) subvirgulatus* Spath, *M. cf. nobilis* (Jukes-Browne), *L. cf. morreti* Breistroffer, *Scaphites simplex* Jukes-Browne, *Leptoplites cf. falcoides* Spath, *E. (Eogaudryceras) italicum* Wiedmann & Dieni, *Puzosia provincialis* (Parona & Bonaielli), *P. communis* Spath and *Salasiceras* sp. indet. No species of *Mortonicerias* and *Ostlingoceras* have been found. Nearly total absence of hoplitids is characteristic of the zone.

The upper boundary of the zone will be characterized below as upper boundary of the Albian Stage. The ammonite successions recorded within this stratigraphical interval do not permit to divide the zone into subzones.

Distribution in the area. Section Dobruša (No. 1 — from 0 to 20 m); section M. Peštenc (probably No. 13—14); section Bukovec (No. 14 — from 3 m to 16 m); probably section Nivjanin (No. 1—2).

Correlation. The *S. dispar* Zone is correlated with the same unit in Western Europe (Owen, 1975; Kennedy and Hancock, 1978; Destombes, 1979; Troger, 1981), Poland (Marcinowski and Wiedman, 1985), Hungary (Schelz, 1979) and Romania (Chiriac, 1981). In the southern parts of the Soviet Union (Crimea, Caucasus and Middle Asia) it correlates also with the Zones of *L. cantabrigensis*, *M. rostratum* — *Cantabrigites*, *S. dispar* — *Leptoplites*, *S. dispar* — *M. rostratum* and *S. dispar* — *L. falcoides* (Котетишвили, 1977, 1986; Друщиц, Горбатчик, 1979; Савельев, 1981; Алиев et al., 1985). Outside the area studied it has been established in Central Northern Bulgaria (Страшимиров, Стоянова, 1958; Иванов et al., 1982; Иванов, Стойкова, 1990).

The Upper boundary of the Albian Stage

In the southern parts of the area the Albian stage is overlain transgressively by Campanian and Maastrichtian deposits (Димитрова et al., 1961; Йолкичев, Вапцарова, 1969; Йолкичев, 1989). The Albian sections are more or less incomplete.

In the north, in the Belogradčik and Vraca regions the Cenomanian follows directly upon the Albian (Цанков, 1963; Цанков et al., 1969; Йолкичев, 1986; Йолкичев, 1989). Both the upper parts of Albian and the base of Cenomanian yielded relatively uncommon macrofaunas. It has made it difficult to draw the Albian—Cenomanian

boundary in the sections. It is placed there at the disappearance of the characteristic Albian taxa, e.g. *S. (Stoliczkaia)*, *Lechites*, *M. (M.) bergeri* (Brongniart), *M. (M.) miliaris* (Pictet & Campiche) and *A. pseudoelegans* Pict. & Camp. and the appearance of *Puzosia* ex gr. *planulata* (J. Sowerby), *Inoceramus crispus* Mentel and *I. pictus* (J. Sowerby) reported by Цанков (1963) and Цанков et al. (1969). In the section at Dobruša, unpublished data of T. Kovatcheva indicate that the boundary is marked by the abundant presence of *Rotalipora appenninica* (Renzi).

Further work is needed to characterize more completely and precisely the Albian—Cenomanian boundary in both the area and Bulgaria on the basis of the changes in successions of different fossil groups.

Conclusions

The Albian Stage in Northwest Bulgaria occurs as two types of facies represented by marls with interbeds of clayey limestones (the Sumér Formation) and glauconitic sandstones, siltstones and marls (the Malo Peštene Formation). Both the amount of terrigenous component and presence of clastic deposits increase eastwards. The Albian sediments are considerably thick, continuous and uncondensed.

The ammonite successions are studied in 15 previously and newly described sections. Part of the ammonite genera and species have been found in Bulgaria and Eastern Europe for the first time. Some of them, as for example, *Pseudosonneratia (Isohoplites)*, *Lyelliceras* and *Prohysteroceras (Neoharpoceras)*, are of particular interest of the Albian zonation.

The following biostratigraphic units are established and described in ascending order: *L. (L.) tardefurcata* Zone with *L. (L.) tenuicostata* and *L. (N.) regularis* Subzones; *D. mammillatum* Zone with *P. (I.) steimanni* Subzone; *H. dentatus* Zone with *L. lyelli* and *H. spathi* Subzones; *E. loricatus* Zone with *A. intermedius* Subzone; *E. lautus* Zone; *M. (M.) inflatum* Zone with *H. orbignyi*, *H. varicosum* and *C. auritus* Subzones; *S. dispar* Zone. The Albian zonation is supplemented and further subdivided by introduction of subzones for the first time in Bulgaria. The boundaries and ammonite associations of the zones and subzones, as well as the boundaries of Albian and its substages are characterized. The Albian sections in Northwest Bulgaria are correlated between each other on the basis of the zones and subzones established.

Taking into account the specific characters of the Albian ammonite faunas in Bulgaria, the biostratigraphic units described have been correlated with those from other parts of the Mediterranean Region. The zonation accepted in the present paper is very similar to the current zonal schemes in Western Europe and is essentially different from that in the southern parts of the Soviet Union and Middle Asia.

Acknowledgements. I am much indebted to Prof. T. Nikolov, Chair of Paleontology, Sofia University, for suggesting me to study the Albian Stage and its ammonite faunas in Bulgaria. I thank him for his advices and help during the first years of my work. Dr T. Kovatcheva, Geological Institute, Bulgarian Academy of Sciences, is thanked for providing unpublished results on foraminifers. Mr I. Iliev and Mr B. Zablenski are thanked for printing the photographs. Particular thanks are due to Dr K. Stojkova for the fruitful joint fieldwork, for making suggestions and critically reading the manuscripts.

References

- Amedro, F. 1980. In: Robaszynski, F., Amedro, F., Foucher, J. C., Magniez-Jannin, F., Manivit, H., Sornay, J. Synthèse biostratigraphique de l'Aptien au Santonien du Boulonnais à partir de sept groupes paléontologiques: Foraminifères, Nannoplacton, Dinoflagellés et Macrofaunes. — *Revue Micropaleont.*, Paris, 22; 195—321, pls. 1-20.
- Breistroffer, M. 1947. Sur les Zones d'Ammonites dans l'Albien de France et d'Angleterre. — *Trav. Lab. Geol. Univ. Grenoble*, 26; 17-104.

- Breistroffer, M. 1965. Vues sur les Zones d'Ammonites de l'Albien. — *Mem. Bur. Rech. geol. miner.*, Paris, 34; 311-312.
- Casey, R. 1957. The Cretaceous ammonite genus (*Leymeriella*) with a systematic account of its British occurrences. — *Palaeontology*, 1; 28-59, pls 7-10.
- Casey, R. 1960—1980. *A Monograph of the Ammonoidea of the Lower Greensand*. Parts I—IX. *Palaeontogr. Soc. (Monogr.)*, London; 1-660, pls 1-112.
- Casey, R. 1961. The stratigraphical palaeontology of the Lower Greensand. — *Palaeontology*, 3; 487-621, pls 77-84.
- Chiriac, M. 1981. *Amoniti Cretacici din Dobrogea de sud. Studiu biostratigrafic*. Bucuresti, Edit. Acad. Rep. Soc. Romania, 143 p., 33 pls.
- Collignon, M. 1963. *Atlas des fossiles caracteristiques de Madagascar (Ammonites), X (Albien)*. Serv. geol. Malgache, Tananarive, 183 p., pls 241—317.
- Destombes, P. 1973. Hoplitidae et zonation nouvelle de l'Albien inferieur de Bully — Saint-Martin (Bray occidentale). — *C. r. hebd. Seanc. Acad. Sci.*, Paris, D277; 2145—2148, pl. 1.
- Destombes, P. 1979. Les Ammonites de l'Albien inferieur et moyen dans le stratotype de l'Albien: Gisements, paleontologie, biozonation. In: Rat, P., Magniez-Janin, F., Chateau-neuf, J.-J., Damotte, R., Destombes, P., Fauconnier, D., Feuillée, P., Manivit, H., Mongin, D., Odin, G. *L'Albien de l'Aube. Les Stratotypes Francais 5*. Paris. CNRS; 51-194, pls. 4.1-4.27.
- Destombes, P. & Destombes, J.-P. 1965. Distribution Zonale des Ammonites dans l'Albien du Bassin de Paris. — *Mem. Bur. Rech. geol. miner.*, 34; 255-270.
- Jacob, C. 1907. Etudes paleontologique et stratigraphique de la partie moyenne des terrains Cretaces dans les Alpes Francaises et regions voisines. — *Trav. Lab. Geol. Univ. Grenoble*, 8; 280—590, pls 1-6.
- Kemper, E. 1975. Die Cephalopoden aus dem Unter-Alb (Zone der *Leymeriella tardefurcata*) von Altwarmbuchen. — *Ber. Naturhist. Ges. Hannover*, 119; 87-111, pls 1-3.
- Kemper, E., Zimmerle, W. 1978. Der Grenz-Tuff Apt/Alb von Vohrum. — *Geol. Jahrb. Hannover*, A 45; 125-143, pls 1-3.
- Kennedy, W. 1985. Integrated macrobiostratigraphy of the Albian to basal Santonian. In: Reymont, R. & Bengtson, P. (compilers). *Mid-Cretaceous Events: report on results obtained 1974-1983 by IGCP Project 58*. Uppsala. Publ. Palaeontol. Inst. Univ. Uppsala, spec. vol. 5; 98-108.
- Kennedy, W., Hancock, J. 1978. The mid-Cretaceous of the United Kingdom. — *Ann. Mus. Hist-nat. Nice*, 4; vi—v72, pls 1-30.
- Marcinowski, R., Wiedmann, J. 1985. The Albian ammonite fauna of Poland and its paleogeographical significance. — *Acta geol. Pol.*, 35; 199-219.
- Nikolov, T. 1965. Étages, sous-étages et zones d'ammonites du Crétacé inférieur en Bulgarie. — *Mem. Bur. Rech. geol. miner.*, 34; 803-817.
- Nikolov, T. 1969. Le Crétacé inférieur en Bulgarie. — *Bull. Soc. Geol. France*, (7), 11; 56-68.
- Nikolov, T. 1987. *The Mediterranean Lower Cretaceous*. Sofia. Publ. Bulg. Acad. Sci. 268 p.
- Orbigny, A. d'. 1840—1842. *Paleontologie française. Terrains cretaces. 1. Cephalopodes*. Paris. 662 p., 148 pls.
- Owen, H. 1971. Middle Albian stratigraphy in the Anglo-Paris Basin. London. *Bull. Brit. Mus. nat. Hist. (Geol.) Suppl.*, 8; 164 p., 3 pls.
- Owen, H. 1975. The stratigraphy of the Gault and Upper Greensand of the Weald. — *Proc. geol. Assoc.*, 86; 4, 475-498.
- Owen, H. 1988. The ammonite zonal sequence and ammonite taxonomy in the *Douvilleiceras mammillatum* Superzone (Lower Albian) in Europe. — *Bull. Br. Mus. nat. Hist. (Geol.)*, 44, 3; 177-231, figs. 1-55.
- Pictet, F., Campiche, G. 1861. *Materiaux pour la Paleontologie Suisse. Description des fossiles du terrain Cretace des environs de Sainte-Croix*. Geneve. 3, 2; 752 p.
- Sowerby, J. 1812-1822. *The mineral Conchology of Great Britain*. London. 1—4 (part), pls 1-383.
- Spath, L. 1923-1943. *A monograph of the Ammonoidea of the Gault*. *Palaeontogr. Soc. (Monogr.)*; 75-97, 787 p., 72 pls.
- Stolley, E. 1908. Die Gliederung der norddeutschen untern Kreide. 2 Mittel und Ober Gault. — *Zentralbl. Miner. Geol. Palaont.*, 4-8; 242-250.
- Stoykova, K. 1990. Ammonites from Subfamily Venzuelinac Kvantalani, 1980 (Lower Cretaceous, Aptian) in Bulgaria. — *Geologica Balc.*, 20.1; 19-28, 2 pls.
- Toula, F. 1881. Grundlinien der Geology des Westlichen Balkan besonders. — *Denkschr. k. Akad. Wiss. math.-nat. Cl.*, 44; 1-56.
- Tröger, K. 1981. German Democratic Republic. — In: *Aspects of mid-Cretaceous Regional Geology*. London, Acad. Press, 327 p.
- Tzankov, V., Michailova-Iovtcheva, P. 1965. Sur la presence du vraconien de la Bulgarie du Nord. — *Carp.-Balk. Geol. Assoc. 7 Congr.*, 2, 1; 145-147.
- Wiedmann, J., Dieni, I. 1968. Die Kreide Sardiniens und ihre Cephalopoden. — *Paleontogr. Italica*, 64; 171 p., 18 pls.
- Алексиев, Б. 1958. Глаусинът от албанските отложения при Мало Пешене Врачанско. — *Изв. Геол. и-т БАН*, 6; 175—191.
- Алиев, М. М., Друшиц, В. В., Крылов, Н. А., Алексеева, Л. В., Богданова, Т. Н., Коротков, В. А., Прозоровский, В. А., Мирзоев, Г. Г., Андреев, Ю. Н., Нехрикова, Н. И., Горбачик, Т. Н., Михайлова, И. А., Янин, Б. Т., Каменец-

- кий, А. Е., Ткачук, Г. А., Глумаков, П. В., Чернышев, С. М. 1985. *Нижний мел юга СССР*. М., Наука; 224 р.
- Бончев, Е. 1935. Върху стратиграфията на аптиенската серия в Северна България. — *Геол. Балканите*, 1, 2; 57—77.
- Бончев, Е. 1955. *Геология на България*. С., Наука и изк., 1; 264 р.
- Бончев, Е., Каменов, Б. 1932. Предварително съобщение за първата находка на албиен в България. С.; 4 р.
- Бончев, Е., Каменов, Б. 1934. Сенонът между реките Искър и Огоста. — *Сп. Бълг. геол. д-во*, 6, 2; 69—103.
- Бресковски, С., Димитрова, Н. 1968. Долна креда. — В: *Стратиграфия на България*. С., Наука и изк.; 217—251.
- Връблянски, Б., Чумаченко, П. 1962. Геология на областта между р. Лопушанска Огоста и с. Драганица (Северозападна България). — *Год. управ. геол. проуч.*, А, 12; 229—274.
- Глазунова, А. 1953. *Аммонити апта и алба Копет-Дага, Малого и Большого Балханов и Мангышлака*. М., Госгеолиздат; 156 р., 27 pls.
- Димитрова, Н. 1967. *Фосилиите на България. Долна креда. 4. Главоноги (Nautilioidea и Ammonoidea)*. С., Изд. БАН; 424 р., 93 pls.
- Димитрова, Н., Чемберски, Х., Попов, Н., Додекова, Л. 1961. Стратиграфия на апта и алба във Врачанско. — *Год. управ. геол. проуч.*, А, 11; 79—99.
- Друшиц, В., Горбачик, Т. 1979. Зональное расчленение нижнего мела юга СССР по аммонитам и фораминиферам. — *Изв. АН СССР, Геол.*, 12; 95—105.
- Друшиц, В., Михайлова, И. 1966. *Биостратиграфия нижнего мела Северного Кавказа*. М., Изд. МГУ; 190 р.
- Захариева-Ковачева, К. 1957. Палеофаунистични и стратиграфски изследвания на албиена в България. — *Год. Соф. у-тет, Биол.-геол.-геогр. фак.*, Геол., 50, 2; 209—286, pls. 1—37.
- Златарски, Г. 1907. Еокретацейската или долнокредната серия в България. — *Период. сп. Бълг. книж. д-во*, 68; 35—114.
- Иванов, М. 1981. Бележки върху стратиграфията на албския етаж между реките Ботуня и Искър. — *Сп. Бълг. геол. д-во*, 42, 3; 352—360.
- Иванов, М., Стойкова, К. 1990. Стратиграфия аптского и альбского ярусов в центральной части Мизийской платформы. — *Geologica Balc.*, 20, 5, 45—70, 4, pls.
- Иванов, М., Стойкова, К., Николов, Т. 1982. Биостратиграфски изследвания на албския етаж в северната част на Плевенско. — *Год. Соф. у-тет, Геол.-геогр. фак.*, 72, 1; 79—87.
- Йолкичев, Н. 1986. Литостратиграфски единици, свързани с горнокредната серия в Западния и Централния Предбалкан. — *Сп. Бълг. геол. д-во*, 47, 3; 49—60.
- Йолкичев, Н. 1987. Литостратиграфски единици, свързани с горнокредната серия в централните части на Мизийската плоча. — *Сп. Бълг. геол. д-во*, 48, 2; 25—37.
- Йолкичев, Н. 1989. *Стратиграфия на епиконтиненталния тип горна креда в България*. С., Унив. изд. „Кл. Охридски“; 184 р.
- Йолкичев, Н., Вацарова, Я. 1969. Върху присъствието на кампанския етаж в Предбалкана между реките Скът и Катунецка. — *Год. Соф. у-тет, Геол.-геогр. фак.*, 61, 1; 81—104.
- Йорданов, М., Попов, Н., Мандов, Г., Недялкова, С., Бецов, М., Христанов, М. 1962. Върху геологията на Предбалкана между Огоста и Веслец. — *Год. Соф. у-тет, Биол.-геол.-геогр. фак.*, 55, 2, 47—74.
- Калчева-Илиева, К. 1967. Представители на род *Leymeriella* от долния алб на Северозападна България. — *Сп. Бълг. геол. д-во*, 28, 1; 23—34.
- Котетишвили, Э. 1977. *Альбская фауна Грузии (Аммониты и двустворчатые)*. Тбилиси, Мецниереба; 97 р., 40 pls.
- Котетишвили, Э. 1986. *Зональная стратиграфия нижнемеловых отложений Грузии и палеозоогеография раннемеловых бассейнов Средиземноморской области*. Тбилиси, Мецниереба; 160 р.
- Манолов, Ж. 1962. Бележки върху стратиграфията на долната креда в Салашката синклинала. — *Труд. геол. България, страт. и тект.*, 6; 95—116.
- Монов, Б. 1972. Основни черти на геоложкия строеж и нефтегазоносната перспективност на Западния Предбалкан. — *Сп. Бълг. геол. д-во*, 33, 1; 13—28.
- Монов, Б., Михайлова-Йовчева, П., Атанасов, А. 1970. Бележки за стратиграфията на долната креда в сондажите около селата Главаци, Бели извор и северно от Враца. — *Сп. Бълг. геол. д-во*, 31, 1; 23—32.
- Монов, Б., Николов, Т. 1991. Литостратиграфия на долнокредните седименти в Западния Предбалкан. — *Сп. Бълг. геол. д-во*, 52, 1; 32—41.
- Николов, Т. 1970. О граници между аптским и альбским ярусам. — *Изв. Геол. и-т БАН, страт. и тект.*, 19; 61—78.
- Николов, Т. 1980. Долнокредна серия. — В: *Нефтегазоносност на Предбалкана (между реките Огоста и Янтра)* (ред. А. Атанасов). С., Техника; 15—18.
- Николов, Т. 1983. Долна кредна серия. — В: *Геология и нефтегазоносна перспективност на Мизийската платформа в Централната Северна България* (ред. А. Атанасов и П. Боков). С., Техника; 28—37.
- Николов, Т., Христчев, Х. 1965. Основи на стратиграфията и литологията на долната креда в Предбалкана. — *Тр. геол. Бълг., страт. и тект.*, 6; 77—173.

- Николов, Т., Монов, Б., Митов, П., Петков, К. 1972. Литостратиграфия на Врачанската ургонска група. — *Сп. Бълг. геол. д-во*, 33, 3; 337—348.
- Рускова, Н., Николов, Т. 1984. Литофации и эволюция обстановок осадконакопления в раннемеловую эпоху Болгарии. — *Geologica Balc.*, 14, 3; 3—22.
- Савельев, А. А. 1973. *Стратиграфия и аммониты нижнего альба Мангышлака (зоны Leymeriella tardefurcata и Leymeriella regularis)*. Л., Недра; 339 р., 44 pls.
- Савельев, А. А. 1974. Новая зональная схема стратиграфии нижнего альба Мангышлака. — *Тр. ВНИГРИ*, 350; 116—122.
- Савельев, А. А. 1976. Новая зональная схема стратиграфии среднего альба Мангышлака. — *Тр. ВНИГРИ*, 388; 119—129.
- Савельев, А. А. 1981. О зональном делении альбского яруса Мангышлака по аммонитам. В: *Эволюция организмов и биостратиграфия середины мелового периода* (ред. Д. П. Найдин, В. А. Красилов). Владивосток, ДВНЦ АН СССР; 41—46.
- Соколов, М. И. 1963. Об объеме альбского яруса и зональном сопоставлении отложений Туркмении и Мангышлака с разрезами стратотипов Англии и Франции. — *Бюлл. Моск. о-ва испыт. прир., геол.*, 38; 148—149.
- Соколов, М. И. 1966. Зональное расчленение и фации альбских и верхнемеловых отложений Закаспия. — *Бюлл. Моск. о-ва испыт. прир., геол.*, 41, 4; 56—72.
- Страшимиров, Б., Стоянова, М. 1958. Албиенска фауна от Никополско и Свищовско. — *Год. ВМГИ*, 4; 1—2, 21—46.
- Цанков, В., Димитрова, Н., Стефанов, Ю., Връблянски, Б. 1960. Стратиграфски изследвания на юрата и кредата в Северозападна България. — *Тр. Геол. Бълг., страт. и тект.*, 1; 203—247.
- Цанков, В., Памукчиев, А., Мотекова, Н. 1969. Бележки върху стратиграфията на горната креда при с. Добруша, Врачанско. — *Год. Соб. у-тет, Геол.-геогр. фак.*, 61, 1; 27—32.
- Цанков, В., Чешитев, Г., Димитрова, Н. 1963. Современные познания о стратиграфии мела Северной Болгарии. — *Карп. Балк. геол. асоц.*, 5 конгр., 3/2 стратигр., 221—244.
- Цанков, Ц. 1963. Стратиграфия карпатского типа мела в районе Кулы (Северо-Западная Болгария). — *Карп. Балк. геол. асоц.*, 5 конгр., 3/2 стратигр., 207—219.

EXPLANATIONS TO THE PLATES

PLATE I

1. *Leymeriella (Neoleymeriella) regularis* (Brug.) d'Orbigny. Section at G. Damjanovo Village, Mihajlovgrad area. Sumer Formation, No 3; Lower Albian Substage, *L. (L.) tardefurcata* Zone, *L. (N.) regularis* Subzone, PM-US K₁ 10131 (×1)
2. *Pseudosonneratia (Isohoplites) steinmanni* (Jacob). Section at Kravoder Village, Vraca area. Sumer Formation, No 8, m. 42-44; Lower Albian Substage, *D. mamillatum* Zone, *P. (I.) steinmanni* Subzone, PM-US K₁ 10193 (×1)
3. *Leymeriella (Neoleymeriella) consueta* Casey. Section at G. Damjanovo Village, Mihajlovgrad area. Sumer Formation, No 1, m. 48-50; Lower Albian Substage, *L. (L.) tardefurcata* Zone, *L. (N.) regularis* Subzone, PM-US K₁ 10134 (×1)
4. *Leymeriella (Leymeriella) tenuicostata tenuicostata* Saveliev. Section at G. Damjanovo Village, Mihajlovgrad area. Sumer Formation, No 1, m. 27; Lower Albian Substage, *L. (L.) tardefurcata* Zone, *L. (L.) tenuicostata* Subzone, PM-US K₁ 10132 (×1)
5. *Leymeriella (Leymeriella) tardefurcata* (Leym.) d'Orbigny. Section at Sumer Village, Mihajlovgrad area. Sumer Formation, No 1, m. 46-48; Lower Albian Substage, *L. (L.) tardefurcata* Zone, *L. (L.) tenuicostata* Subzone, PM-US K₁ 10133 (×1)
6. *Douvilleiceras mamillatum mamillatum* (Schlotheim). Section at Kravoder Village, Vraca area. Sumer Formation, No 7; Lower Albian Substage, *D. mamillatum* Zone, PM-US K₁ 10192 (×1)
7. *Leymeriella (Neoleymeriella) pseudoregularis spinosa* Saveliev. Section at G. Damjanovo Village, Mihajlovgrad area. Sumer Formation, No 1, m. 48-50; Lower Albian Substage, *L. (L.) tardefurcata* Zone, *L. (N.) regularis* Subzone, PM-US K₁ 10190 (×1)
8. *Douvilleiceras mamillatum aequinodum* (Quenstedt). Section at Kravoder Village, Vraca area. Sumer Formation, No 8, m. 35-37; Lower Albian Substage, *D. mamillatum* Zone, PM-US K₁ 10191 (×1)

*Palaeontological Museum, University of Sofia (PM-US)

PLATE II

1. *Hoplites dentatus dentatus* (J. Sowerby). Section at Kravoder Village, Vraca area. Sumer Formation, No 9, m. 17-19; Middle Albian Substage, *H. dentatus* Zone, *L. lyelli* Subzone, PM-US K₁ 10194 (×1)
- 2, 3. *Anahoplites intermedius* Spath. Section at Kravoder Village, Vraca area. Sumer Formation, No 10, m. 27-32; Middle Albian Substage, *E. loricatus* Zone, *A. intermedius* Subzone; 2 — PM-US K₁ 10195, 3 — PM-US K₁ 10196 (×1)
4. *Anahoplites praecox* Spath. Section at Kravoder Village, Vraca area. Malo Peštene Formation, No 12, Middle Albian Substage, *E. loricatus* Zone, *A. intermedius* Subzone, PM-US K₁ 10197 (×1)
5. *Hoplites spathi* Breistroffer. Section at Kravoder Village, Vraca area. Sumer Formation, No 10, m. 15-17; Middle Albian Substage, *H. dentatus* Zone, *H. spathi* Subzone, PM-US K₁ 10198 (×1)
6. *Lyelliceras lyelli* (d'Orbigny). Section at Malo Peštene Village, Vraca area. Malo Peštene Formation, No 8; Middle Albian Substage, *H. dentatus* Zone, *L. lyelli* Subzone, PM-US K₁ 10199 (×2)

PLATE III

1. *Anahoplites splendens* (J. Sowerby). Section at Malo Peštene Village, Vraca, area. Malo Peštene Formation, No 11, m. 3-5; Middle Albian Substage, *E. lautus* Zone, PM-US K₁ 10200 (×1)
2. *Anahoplites planus gracilis* Spath. Section at Čuprene Village, Vidin area. Sumer Formation, No 3, m. 53-56; Middle Albian Substage, *E. lautus* Zone, PM-US K₁ 10201 (×1)
3. *Hamites* (*Hamites*) *maximus* J. Sowerby. Section at Kravoder Village, Vraca area. Sumer Formation, No 13 (upper part); Middle Albian Substage, *E. lautus* Zone, PM-US K₁ 10202 (×1)
4. *Hysterocheras* cf. *varicosum* (J. Sowerby). Section at Bukovec Village, Vraca area. Malo Peštene Formation, No 6; Upper Albian Substage, *M. (M.) inflatum* Zone, *H. varicosum* Subzone, PM-US K₁ 10203 (×1)
5. *Mortoniceras* (*Mortoniceras*) *inflatum* (J. Sowerby). Section at Bukovec Village, Vraca area. Malo Peštene Formation, No 7; Upper Albian Substage, *M. (M.) inflatum* Zone, *H. varicosum* Subzone, PM-US K₁ 10204 (×1)
- 6, 7. *Hysterocheras orbignyi* (Spath). Section at Bukovec Village, Vraca area. Malo Peštene Formation, No 6; Upper Albian Substage, *M. (M.) inflatum* Zone, *H. varicosum* Subzone; 6 — PM-US K₁ 10205, 7 — PM-US K₁ 10206 (×1)
- 8, 9. *Callihoplites auritus* (J. Sowerby). Section at Bukovec Village, Vraca area. Malo Peštene Formation, No 13; Upper Albian Substage, *M. (M.) inflatum* Zone, *C. auritus* Subzone; 8 — plaster-cast, PM-US K₁ 10207 (×1)

PLATE IV

1. *Hysterocheras carinatum* Spath. Section at Bukovec Village, Vraca area. Malo Peštene Formation, No 11; Upper Albian Substage, *M. (M.) inflatum* Zone, *C. auritus* Subzone, PM-US K₁ 10208 (×1)
2. *Hysterocheras subbinum* Spath. Section at Bukovec Village, Vraca area. Malo Peštene Formation, No 6; Upper Albian Substage, *M. (M.) inflatum* Zone, *H. varicosum* Subzone, PM-US K₁ 10212 (×1)
3. *Hysterocheras binum* (J. Sowerby). Ibid., PM-US K₁ 10209 (×1)
4. *Hysterocheras orbignyi* (Spath). Section at Bukovec Village, Vraca area. Malo Peštene Formation, No 3; Upper Albian Substage, *M. (M.) inflatum* Zone, *H. orbignyi* Subzone, PM-US K₁ 10210 (×1)
5. *Hysterocheras* aff. *bucklandi* (Spath). Section at Bukovec Village, Vraca area. Malo Peštene Formation, No 10; Upper Albian Substage, *M. (M.) inflatum* Zone, *C. auritus* Subzone, PM-US K₁ 10214 (×1)
6. *Hysterocheras bucklandi* (Spath). Section at Bukovec Village, Vraca area. Malo Peštene Formation, No 11; Upper Albian Substage, *M. (M.) inflatum* Zone, *C. auritus* Subzone, PM-US K₁ 10211 (×1)
7. *Hysterocheras orbignyi* (Spath). Section at Bukovec Village, Vraca area. Malo Peštene Formation, No 6; Upper Albian Substage, *M. (M.) inflatum* Zone, *H. varicosum* Subzone, PM-US K₁ 10213 (×1)
8. *Mariella* (*Mariella*) *bergeri bergeri* (Brongniart). Section at Dobruša Village, Vraca area. Sumer Formation, No 1, m. 6-9; Upper Albian Substage, *S. dispar* Zone, PM-US K₁ 10216 (×1)
9. *Stoliczkaia* (*Stoliczkaia*) sp. juv. aff. *dispar* (d'Orbigny). Ibid., PM-US K₁ 10217 (×2)
10. *Prohysterocheras* (*Neoharpoceras*) *irregulare* Spath. Section at Bukovec Village, Vraca area. Malo Peštene Formation, No 13; Upper Albian Substage, *M. (M.) inflatum* Zone, *C. auritus* Subzone, PM-US K₁ 10215 (×1)
11. *Lechites gaudini* (Pictet & Campiche). Section at Dobruša Village, Vraca area. Sumer Formation, No 1, m. 6-9; Upper Albian Substage, *S. dispar* Zone, PM-US K₁ 10218 (×1)
12. *Mariella* (*Mariella*) *miliaris* (Pictet & Campiche). Section at Dobruša Village, Vraca area. Sumer Formation, No 1, m. 0-2; Upper Albian Substage, *S. dispar* Zone, PM-US K₁ 10219 (×1)
13. *Stoliczkaia* (*Stoliczkaia*) *dispar* (d'Orbigny). Section at Dobruša Village, Vraca area, Sumer Formation, No 1, m. 13-15; Upper Albian Substage, *S. dispar* Zone, PM-US K₁ 10220 (×1)

