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Jurassic/Cretaceous boundary in the Río Argos succession (Caravaca, SE Spain)

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Abstract

An integrated biostratigraphic investigation has been performed of section Z of the Río Argos successions. Section Z is situated along the Barranco de Tollo, a left tributary of the Río Argos three kilometres west of the city of Caravaca, Province of Murcia, SE Spain. The sediments of section Z form part of the External Subbetic Zone of the Betic Cordillera.

Section Z comprises the Jacobi Zone and the Subalpina Subzone, which is the lower part of the Occitanica Zone. The base of the Jacobi Zone, i.e. the base of bed Z1, conformably overlies beds in ammonitico rosso facies yielding ammonites of the *Durangites vulgaris* Zone. Sequence boundary Be1 is situated on top of bed Z4. The top of the Jacobi Zone (major sequence boundary Be3) is situated in a continuously deposited succession. The Jacobi zone can be divided into two parts, which are separated by sequence boundary Be2. *Berriasella (Hegaratella) jacobi* can still function as the index species for the lower part (equivalent to depositional sequence Be1). Instead of the appearance of *Pseudosubplanites grandis* in bed Z139, a more obvious and natural boundary between the ammonite faunas of the lower and upper part of the Jacobi Zone is formed by sequence boundary Be2. However for this upper part (equivalent to depositional sequence Be2) no index species could be indicated yet. However, *Subthurmannia floquinensis* is provisionally used as index species for the upper part of the Jacobi Zone.

Hitherto the base of the Cretaceous System was defined by ammonites. The base of the Jacobi ammonite Zone is the base of the Berriasian Stage, which is the lowest stage of the Cretaceous. Bed Z1 yielded the first *Berriasella* (*Hegaratella*) *jacobi* (Wiedmann in Allemann *et al.*, 1975). In the sections of Puerto Escaño (S. Spain) and Le Chouet SE France) the base of the Jacobi Zone is virtually situated at the same level as the base of polarity chron M19n, but it is not known how large the lacuna is at the major sequence boundary Be1.

The belemnites from section Z are not well-preserved, and difficult to identify. The belemnite fauna mainly consists of species that have traditionally been recognized as indicative for the Late Jurassic (Tithonian Belemnite Association IV) and that were previously unknown from the earliest Cretaceous. The first "typical" Cretaceous belemnite, which is related to the *Duvalia lata* group, appears in bed Z131. The ranges of the species encountered in section Z should be considered with a certain reservation.

As to the calpionellid zones, section Z covers the upper part of the Crassicolaria Zone, viz. the upper part of the Intermedia Subzone and the Colomi Subzone, and the lower part of the Calpionella Zone, viz. the Alpina (with the bloom of *Calpionella alpina* at its base), Ferasini, and Elliptica subzones. For specialists in calpionellids the bloom of *Calpionella alpina* at the base of the Calpionella Zone, which is also the base of the Alpina Zone, is considered the base of the Cretaceous. This base was demonstrated at the base of bed Z40.

Calcareous nannofossil biostratigraphy was achieved on a total of 56 samples from section Z. Several primary and secondary bio-horizons were detected, allowing us to recognize three zones and two subzones in section Z, viz. the upper part of NJT-17a Subzone, the NJT-17b Subzone, the NKT and NK-1 zones, and a part of NK-2 Zone. Three (on a total of four) bio-horizons selected by the Berriasian Working Group as useful in locating the Jurassic/Cretaceous boundary were recognized. The first appearances of important nannoplankton species are marked in the lithological column.

It appeared that, because of a nearby volcanic heat source, all non-calcareous dinoflagellate cysts of section Z are carbonized and that the rocks were totally remagnetized during the Miocene, so that magnetostratigraphy was not possible (Hoedemaker *et al.*, 1998). However, sequence stratigraphy was quite clear and three sequences could be distinguished bounded by three sequence boundaries: Be1, Be2, and Be3.

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Contents

1. GENERAL INTRODUCTION

The purpose of this article is to contribute essential data as to the determination of the stratigraphic position of the lower boundary of the *Berriasella* (*Hegaratella*) *jacobi* ammonite zone (henceforth Jacobi Zone) and to describe its fossil fauna and flora and of the overlying *Tirnovella subalpina* ammonite subzone (henceforth Subalpina Subzone) in one and the same section (section Z) along the Barranco de Tollo, a left bank tributary of the Río Argos three kilometres west of Caravaca, Province of Murcia, South-eastern Spain (Fig. 1). The Jacobi Zone along the Barranco de Tollo is 70 m thick and probably the thickest Jacobi Zone in Europe. The Subalpina Subzone is 18 m thick. Bed Z1, the basal bed of section Z, is considered the base of the Jacobi Zone, because Wiedmann (in Allemann *et al*., 1975) reported *Berriasella jacobi* from this bed. Bed Z1 is a graded mudflow deposit, which lies, without any sign of emergence, conformably upon ammonite bearing beds of the *Durangites vulgaris* Zone. Sequence boundary Be1 is interpreted as being situated at the top of bed Z4. The name Vulgaris Zone has been proposed by Carlo Sarti (1988, p. 473) to replace the Durangites Zone of Tavera (1985), the uppermost ammonite zone of the Jurassic System. The name Vulgaris Zone was used for instance by Geyer (1993) and Zeiss (2001, 2003). The Andreaei Zone of Bulot (in Wimbledon *et al.,* 2013) is a junior synonym.

Section Z forms part of the Río Argos Succession, which covers, with a few minor observational gaps, the totality of the Lower Cretaceous. The Río Argos Succession consists of 26 sections (A-Z) over a distance of about seven kilometres along the borders of the Río Argos. The sediments of section Z form part of the Gavilan Unit in the External Subbetic Zone of the Betic Cordillera. It consists of a more or less rhythmic succession of pelagic micritic limestone-marlstone couplets. The sediments of section Z are considered to be deposited in the middle part of the shelf. They lack benthic macrofossils except for some pygopids (brachiopods) and echinoids in the first three beds of section Z; only fossils of nektonic and planktonic organisms were reported.

Unfortunately the non-calcareous dinoflagellate cysts of section Z are carbonized; this is a local phenomenon, because 200 m to the south and in the outcrops along the Río Argos non-calcareous dinocysts are abundantly present (Leereveld, 1997). The source of heating is local and probably of volcanic origin. The nearest outcrop of volcanic rock (intrusion of Verite), is 10 kilometres to the north-east in the Sierra de la Puerta, which is rather close. Magneto-stratigraphy also failed in section Z because of strong remagnetisation of the rocks during the Miocene orogenesis (Hoedemaeker *et al.,* 1998). However, it should be mentioned that in the other outcrops of Lower Cretaceous rocks along the Río Argos, dinocysts are abundantly present (Leereveld, 1997), while the rocks are still strongly remagnetised. This is also a local phenomenon, because the Lower Cretaceous rocks two kilometres south of Caravaca are not remagnetized (Ogg *et al.,* 1988).

New insights (personal communication: G. W. van Veen, 2008. Strike-slip Fault in the Subbetic near Caravaca, SE Spain. Unpublished manuscript) have lead to attributing the remagnetization of the Río Argos succession to an important, still active, southwest-northeast trending, left-lateral strike-slip fault in the basement below the Río Argos. The Caravaca earthquakes of 1941 and 1948 had their epicentres along this fault (Rey Pastor, 1949).

However, sequence stratigraphy appears quite evident in section Z and enables a worldwide correlation of the Jacobi Zone. The use of sequence stratigraphy requires a thorough sedimentological training. The sequence stratigraphy of the whole Argos succession was analysed in the field by Hoedemaeker together with Prof. Dr Peter R. Vail (Houston, Texas) in 1989, 1990 and 1991. In section Z three sequence boundaries were determined: Be1, Be2 and Be3 (Hoedemaeker & Leereveld, 1995; Hoedemaeker, 1998). The author dissociates himself from his former sequence boundary Be1' (Hoedemaeker, 1998), which is now interpreted as a parasequence boundary; sequence boundary Be4 is probably situated at a younger level than the one indicated by Hoedemaeker (1998). The Jacobi Zone is bounded by two major

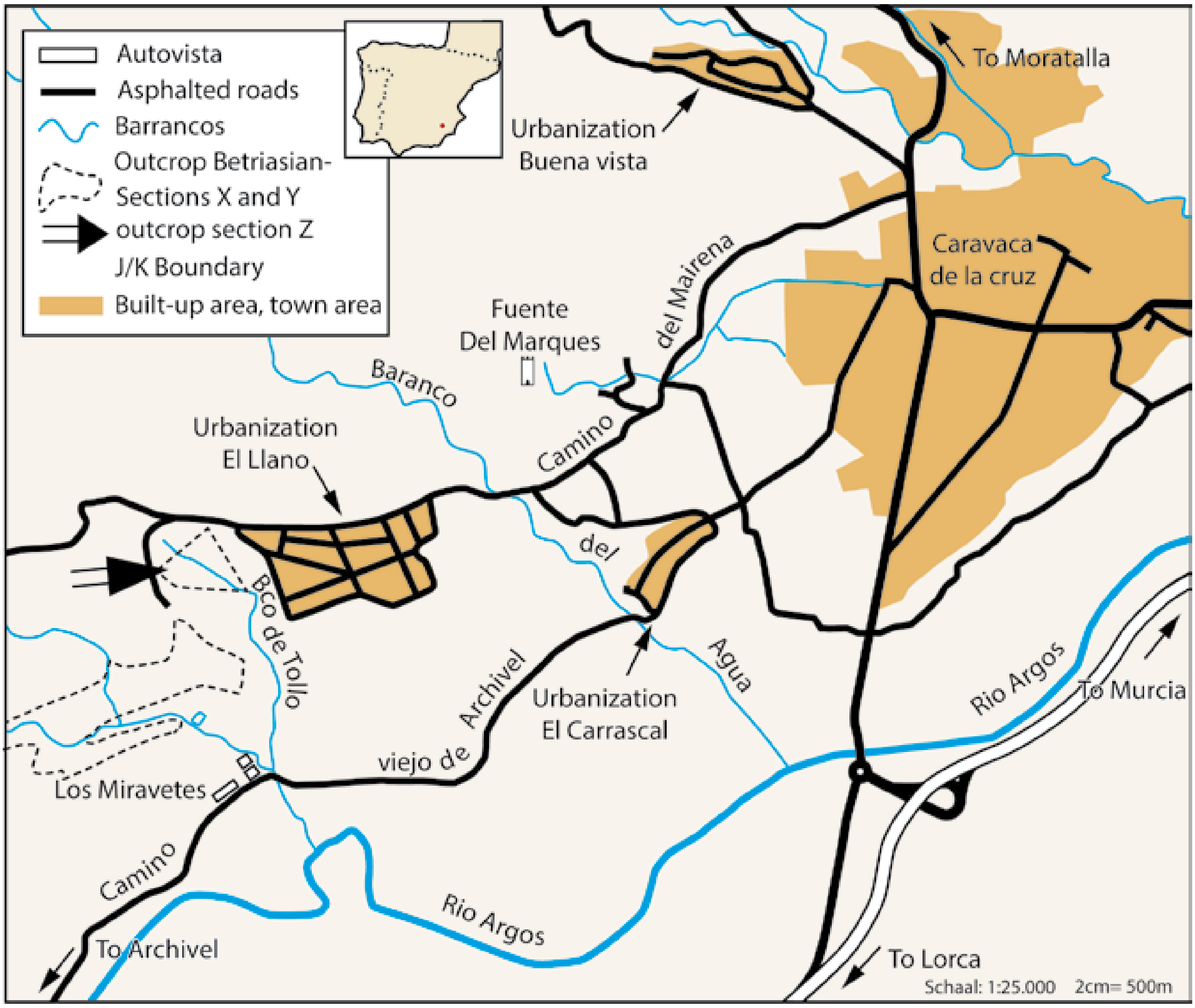


Fig. 1: Map of Caravaca de la Cruz (Province of Murcia, SE Spain) and its western outskirts. The arrow indicates the outcrop of section Z about three kilometres west of Caravaca.

sequence boundaries, Be1 at the base and Be3 at the top; it is therefore a depositional sequence of the second order. Minor sequence boundary Be2 divides the Jacobi Zone in two sequences of the third order.

The faunal change at sequence boundary Be2 is conspicuous and this boundary therefore forms an obvious natural zonal boundary between the two parts in which the Jacobi Zone can be divided. It marks the end of the acme of genus *Pseudosubplanites*. Each depositional sequence has its own ammonite fauna.

The six authors of this paper (four of them are members of the Berriasian Working Group of the ICS) investigated the ammonites (Philip Hoedemaeker), the belemnites (Nico Janssen), the calpionellids (Daniela Reháková, Miroslava Jamrichová), the calcareous dinocysts (Daniela Reháková, Miroslava Jamrichová) and the calcareous nannoplankton (Cristina E. Casellato, Silvia Gardin) of section Z. The non-calcareous cysts of dinoflagellates are carbonized due to a source of heat close by. The ranges of the species of these fossil groups were plotted along the lithological column of 90 m thickness. Microfacies analyses were made; all 253 limestone beds of section Z were sampled, and from most samples thin sections were made and analysed on calpionellids and nannoplankton.

The studied ammonites are not well preserved. Sixty-five ammonite species were described and figured, among which 16 are new; two of the new species are defined by syntypes and two are introduced with only their type specimens and a diagnosis. In addition a new subgenus is introduced. Two subzones were distinguished within the Jacobi Zone of which the lower retains the name *Berriasella* (*Hegaratella*) *jacobi* Subzone. No index species can yet be indicated for the upper subzone, which is equal to the upper part of the former "Grandis"

Zone. The lower part of the former "Grandis" Zone is equivalent to the upper quarter of the *B.* (*H.*) *jacobi* Subzone. However, *Subthurmannia floquinensis* was chosen as provisional index species. The ammonites of the *Tirnovella subalpina* Subzone (= basal subzone of the Occitanica Zone) are also described.

Twelve belemnite species are described and figured among which several species previously not or sporadically known from earliest Cretaceous sediments such as *Conobelus conophorus, Conobelus strangulatus, Duvalia apenninica, Duvalia esba* and *"Pseudobelus" fischeri.* The upper Tithonian Belemnitida Zone IV (TiBaIV *sensu* Főzy *et al*., 2011) also comprises the lower part of the *Berriasella* (*Hegaratella*) *jacobi* ammonite zone. The first "typically" Cretaceous belemnite, which is related to the *Duvalia lata* group, was sampled in bed Z131.

Twenty-two calpionellid species were encountered and figured. Two calpionellid zones and five subzones were distinguished: the Crassicolaria Zone with the Intermedia and Colomi subzones, and the Calpionella Zone with the Alpina, Ferasini and Elliptica subzones. The Alpina Subzone starts in bed Z40 with the acme of *Calpionella alpina*.

Seventy two calcareous nannoplankton species were identified and five subzones distinguished, viz. the upper part of NJT-17a, the NJT-17b Subzone, the NKT and NK-1 zones and a part of NK-1 Zone. The first appearance datums of the species that are important for correlation, are marked along the lithological column (Fig. 6).

For ammonitologists the base of the Lower Berriasian ammonite zone of *Berriasella* (*Hegaratella*) *jacobi* has hitherto been accepted as the base of the Berriasian Stage, and therefore the base of the Cretaceous. This base is 1.5 m below sequence boundary Be1. The first belemnite with Cretaceous affinities was sampled in bed Z131, about halfway through the Jacobi Zone; for belemnitologists the base of the Cretaceous also remains for the time being the first appearance of *B.* (*H.*) *jacobi* at the base of the Jacobi Zone.

Specialists in calpionellids prefer to locate the base of the Cretaceous at the base of the Calpionella Zone, i.e. the base of the *C. alpina* Subzone (which was determined in bed Z40). This boundary is defined by the sudden marked bloom of small rounded *Calpionella alpina*, which occurs about 321 thousand years later than the base of the Jacobi Zone.

For specialists in calcareous nannoplankton, four events are proposed as useful in approximating the base of the Cretaceous: the first occurrences of either *Nannoconus wintereri* and/or *Cruciellipsis cuvillieri*, or the first occurrences of *Nannoconus steinmannii minor* and/or *Nannoconus kamptneri minor* (Wimbledon *et al.,* 2011).

2. AMMONITES (Ph. J. Hoedemaeker)

2.1. Introduction

The ammonites of the Jacobi Zone and Subalpina Subzone from section Z along the Barranco de Tollo (a left tributary of the Río Argos) and from section M along the 'Barranco de las Oicas' (the latter name is invented herein to denote the only other investigated tributary seven kilometres more to the west, which discharges into the Río Argos facing the Cortijo de Las Oicas de Enmedio), are not well-preserved, but nevertheless most of them are identifiable. In descriptions of faunas complete lists of synonyms are not necessary. The classification of the ammonites adopted is strictly morphotypic; variation within species is recognized if transitions between the morphotypes can be indicated. The ammonites of section Z were collected in 1973, those of section M in 1974. A second sampling of section Z occurred in 1996.

Two zones and three subzones were distinguished. The zones are the *Berriasella* (*Hegaratella*) *jacobi* Zone and the *Tirnovella occitanica* Zone. The Jacobi Zone clearly falls apart into two subzones. The differences between the ammonite faunal compositions of the subzones are conspicuous, for it marks the end of the acme of genus *Pseudosubplanites* (eight species become extinct). For the lower subzone *Berriasella* (*Hegaratella*) *jacobi* could be used as index species (Jacobi Subzone). However, for the upper subzone no index species could be indicated. *Pseudosubplanites grandis* cannot be the index species for the upper zone, because this species appears to be restricted to the upper part of the Jacobi Subzone (See paragraph 2.3.1.). The author provisionally indicated *Subthurmannia floquinensis* as index species for the upper subzone (henceforth Floquinensis Subzone), which is equal to the upper part of the former "Grandis" Zone. Only the lowest Zone of the Occitanica Zone is present in section Z, which has *Tirnovella subalpina* as index species (Subalpina Subzone).

The base of bed Z1 is the base of the Jacobi Zone (1.5 m below sequence boundary Be1). Wiedmann (in Allemann *et al.,* 1975) reported the first *Berriasella jacobi* from this bed. Directly below the base of section Z the ammonite bearing beds of the *Durangites vulgaris* Zone are present. It turns out that the marked changes of the ammonite faunas, which led to the distinction of the subzones, coincide with sequence boundaries, so that every subzone of the Jacobi Zone appears to be a separate depositional sequence.

2.2. Ammonite fauna of the Jacobi Zone and Subalpina subzone in section Z

Subclass Ammonoidea Zittel, 1884
Order Ammonitida Agassis, 1847
Suborder Perisphinctina Steinmann, 1890
Superfamily Perisphinctoidea Steinmann, 1890
Family Ataxioceratidae Buckman, 1921
Subfamily Lithacoceratinae Zeiss, 1968

2.2.1. Genus *Pseudosubplanites* Le Hégarat, 1973

Type species: *Pseudosubplanites berriasensis* Le Hégarat, 1973.

Systematic position: The systematic position of *Pseudosubplanites* has been debated since its introduction and subsequent discussion by Callomon (1981). Le Hégarat (1973) classifies this genus in the Perisphinctidae Steinmann, 1890, that means outside the Neocomitidae Salfeld, 1921 and the Berriasellinae Spath, 1922, because all ribs cross the venter without interruption (also on the inner whorls), and because of the presence of subvirgatotomous ribs, which is a perisphinctoid feature, not a berriasellid one. Callomon (1981) included this genus in the Ataxioceratidae Buckman, 1921 and Lithacoceratinae Zeiss, 1968 (followed herein).

On the other hand, Nikolov & Sapunov (1977) regarded genus *Pseudosubplanites* as the type genus of the subfamily Pseudosubplanitinae Nikolov & Sapunov, 1977, characterized by the absence of a mid-ventral furrow; nevertheless they included this subfamily in the Neocomitidae, species of which are characterized by the presence of a mid-ventral furrow. They subdivided the genus *Pseudosubplanites* into two subgenera, viz. *P*. (*Pseudosubplanites*) and *P*. (*Hegaratella*) Nikolov & Sapunov, 1977. Finally, Tavera (1985) included the generic groups *Pseudosubplanites* and *Hegaratella* as subgenera within the genus *Berriasella* and therefore in the Berriasellinae and Neocomitidae. Since the Berriasellinae are characterized by the presence (at least on the inner whorls) of a mid-ventral furrow, a mid-ventral smooth band, or mid-ventral row of notches in the ribs, and by the absence of subvirgatotomous ribs, the author prefers to consider *Pseudosubplanites* to belong to the Ataxioceratidae following the idea of Callomon (1981).

Berriasella (*Hegaratella*) *paramacilenta* (Mazenot, 1939), the type species of *Berriasella* (*Hegaratella*), was included by Mazenot (1939) in the 'section of *Berriasella* without siphonal furrow.' Because of the absence of a clear siphonal furrow, this whole section of Mazenot was included in *Pseudosubplanites* by Nikolov (1982). For the same reason he also included *Berriasella jauberti* Mazenot, 1939, in *Pseudosubplanites.* However, Mazenot (1939) showed in his text (p. 128) and drawing (pl. 20, figs 2b, 4b and pl. 21, fig. 7b) that the ribs of *B.* (*H.*) *paramacilenta* and *B.* (*B.*) *jauberti* have mid-ventral notches ('encoches siphonales'), which form a special kind of ventral furrow in the same way as the weakening of the ribs at mid-venter. From this point of view there is no essential difference between *B.* (*H.*) *paramacilenta* and the other species of *Berriasella* of the Jacobi Zone. Therefore, it is not possible to include *B.* (*H.*) *paramacilenta* and *B.* (*B.*) *jauberti* in the genus *Pseudosubplanites,* which lack any sign of siphonal notches or rib weakening.

Consequently, the name *Hegaratella* became available as a subgeneric name for all the species of *Berriasella* of the Jacobi Zone. Hoedemaeker, 1982 emended the scope of *Berriasella* (*Hegaratella*) Nikolov & Sapunov, 1977, by including in it all the species of *Berriasella sensu* Le Hégarat (1973) that occur in the Jacobi Zone.

Le Hégarat (1973), Hoedemaeker (1982, and herein), Tavera Benitez (1985), Wright *et al.* (1996), and Bogdanova & Arkadiev (2005) considered *Hegaratella* a subgenus of *Berriasella*. The representatives of *Berriasella* (*Hegaratella*) *sensu* Hoedemaeker (1982) of the Jacobi Zone differ from those of *Berriasella* (*Berriasella*) *sensu* Hoedemaeker (1982) of the Occitanica and Boissieri zones, in having straight, prorsiradiate to radial ribs, which are only more or less projected (or not) on the upper part of the flank. This is a common aspect of all species of *Berriasella* in the Jacobi zone. The representatives of *Berriasella* (*Berriasella*) differ from those of *Berriasella* (*Hegaratella*) mainly in the convexity of the ribs at mid-flank especially on the last whorl. The lower part of the ribs can be prorsiradiate to radial, and the upper part radial to rursiradiate, and both parts are connected by a convex curve. The convexity at mid-flank can be more or less pronounced like a knee. *Berriasella* (*Hegaratella*) is considered to be ancestral to *Berriasella* (*Berriasella*), which is restricted to the Occitanica and Boissieri zones of the Mediterranean region.

The subgenus *Berriasella* (*Hegaratella*) is closely related to the contemporary *Parodontoceras* Spath, 1923, which occurs in the 'upper Tithonian' *Substeueroceras*-*Parodontoceras* beds of South and North America, which can be correlated with the Jacobi Zone (Hoedemaeker, 1987 and herein).

Macroconchs of *Pseudosubplanites*: Le Hégarat (1973) grouped four macroconchs and two microconchs in *Pseudosubplanites*. The macroconchs are *P. ponticus* (Retowski, 1894), *P. grandis* (Mazenot, 1939), *P. berriasensis* Le Hégarat, 1973 and *P. combesi* Le Hégarat, 1973. The latter two were mainly distinguished by the abundance or rarity of subvirgatotomous ribs respectively. In 2005 Bogdanova & Arkadiev introduced a fifth macroconch, *P. crymensis*. Herein the author introduces a sixth and seventh macroconch, namely *P. paracombesi* sp. nov. (= paratype of *P. combesi* Le Hégarat, 1973, only pl. 37, fig. 1) and *P. hegarati* sp. nov. Moreover, in this article the author will demonstate that *Pseudosubplnites lorioli* is a macroconch and not a microconch as is generally assumed.

The systematic position of *P. subrichteri* is not clear. It has been grouped in *Kossmatia* (Uhlig, 1907), in *Berriasella* (Mazenot, 1939), in *Richterella* (Avram, 1973), or in *Pseudosubplanites (Hegaratella)* (Nikolov & Sapunov, 1977). Bogdanova & Arkadiev (2005) studied the lectotype (Retowski, 1894, pl. 10, fig. 8) and they reported that it has no ventral furrow. They included this species in *Pseudosubplanites* and this is followed by the author.

Microconchs of *Pseudosubplanites*: On account of their smallness or of the presence of lappets, the representatives of *P. lorioli* (Zittel, 1868) and *P. euxinus* (Retowski, 1894) were considered microconchs. Merely on account of the rarity or the frequency of subvirgatotomous ribs, Le Hégarat (1973) considered the representatives of *P. lorioli* to be the possible antidimorphs of those of *P. combesi,* and the representatives of *P. euxinus* the microconchs of those of *P. berriasensis*. This distinction appears to be too simple. The more so as the representatives of *P. lorioli* appear to be macroconchs (see below). Bogdanova & Arkadiev introduced a third microconch species, *P. fasciculatus* Bogdanova & Arkadiev, 2005. As every macroconch species should have its proper antidimorph, we may expect to find at least eight different microconch species. However, if the lappets are not preserved, it is impossible to decide whether small specimens of *Pseudosubplanites* are microconchs or young macroconch species. Along the Barranco de Tollo the author found at least two more microconch species: *P. tolloensis*, and the microconch of *P. lorioli*.

***Pseudosubplanites euxinus* (Retowski, 1894)**

Pl. I. figs 1-3

**pars* 1894. *Perisphinctes euxinus* n. sp. Retowski, p. 254, pl. 10, fig. 7, non fig. 5 (= *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005). non fig. 6 [= *Berriasella* (*Hegaratella*) *paramacilenta*?].

non 1939. *Berriasella euxina* (Retow.).– Mazenot, p. 125, pl. 20, fig. 5a, b [= *Pseudosubplanites lorioli* (Zittel, 1868)].

1960. *Berriasella euxina* Retowski.– Drushchits, p. 277, pl. 20, fig. 4.

non 1961. *Berriasella* cf. *euxina*.– Eristavi, p. 90, pl. 3, fig. 4 (= Olcostephanidae).

non 1973. *Pseudosubplanites euxinus* (Retowski).– Le Hégarat, p. 37, pl. 2, fig. 2; pl. 37, fig. 4-6 (= *Pseudosubplanites tolloensis* sp. nov.).

pars? 1973. *Pseudosubplanites lorioli* (Zittel).– Le Hégarat, p. 40, pl. 37, fig. 3?, non figs 7, 8 (= *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005).

non 1979. *Pseudosubplanites* (*Pseudosubplanites*) *euxinus* (Retowski 1893).– Sapunov, p. 188, pl. 40, fig. 3 (= *Pseudosubplanites tolloensis* sp. nov.)

non 1982. *Pseudosubplanites* (*Pseudosubplanites*) *euxinus* (Retowski, 1893).– Nikolov, p. 36, pl. 2, fig. 4 (= *Pseudosubplanites tolloensis* sp. nov.), non pl. 5, fig. 1 (= *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005), non fig. 2 (= *Pseudosubplanites* sp. indet.).

pars 1999. *Pseudosubplanites* cf. *euxinus* (Retowski).– Kvantaliani, p. 101, pl. 13, figs 4, 5, 6, non fig. 3 (= *Pseudosubplanites*?).

pars 2003. *Pseudosubplanites lorioli* (Zittel).– Arkadiev, p. 33, pl. 1, fig. 5a, b, non fig. 6 (=*Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005).

non 2005. *Pseudosubplanites* cf. *euxinus* (Ret.).– Kvantaliani, p. 314, pl. 58, fig. 4 (= *Pseudosubplanites* sp.?).

pars 2005. *Pseudosubplanites lorioli* (Zittel).– Bogdanova & Arkadiev, p. 493, fig. 5D, fig. 6A, figs 7A- 7C, non figs 5C, 6B, 7D-7I (= *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005).

pars 2012. *Pseudosubplanites lorioli* (Zittel, 1868).– Arkadiev *et al.,* p. 168, pl. 12, figs 3, 4a, b, non figs 5, 6a, b, 7 (= *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005).

2012. *Pseudosubplanites* cf. *euxinus* (Retowski).– Guzhikov *et al.,* p. 19, pl. 2, fig. 6a, b.

Lectotype: The specimen depicted by Retowski (1894), on pl. 10, fig. 7 under the name *Perisphinctes euxinus*, derived from the Upper Tithonian of Feodosia, The Crimea, deposited in the CNIGR Museum, St. Petersburg, Retowski collection No. 28/10916. Designated by Mazenot, 1939.

Material: Six not well-preserved, but well-identifiable specimens from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain: RGM 160 362 (bed Z 115), RGM 160 370 (bed Z150), RGM 160 363 (bed Z136), RGM 617 860 (bed Z137), RGM 160 354 (bed Z118, loose), RGM 160 379 (bed Z115).

Description: Small, moderately evolute planulates; lappets are present on all specimens. The flanks are flattened and the umbilicus is shallow. The umbilicus is eccentric, i.e. the percentage of the umbilical width in relation to the diameter becomes greater with growth. The umbilicus is equal to the whorl height at a diameter of 27 mm; below this diameter it is smaller than the whorl height, above this diameter wider.

The ornamentation consists of sharp, straight to slightly flexuous ribs, which start at the umbilical seam and are somewhat projected on the upper part of the flanks. The ribs generally bifurcate, but the lectotype has three subvirgatotomous ribs and one fascicule on the last whorl. The preserved part of specimen RGM 160 362 has two subvirgatotomous ribs, the preserved part of specimen RGM 160 363 only one, and RGM 160 370 exhibits only one short intercalated rib; so this feature is rather variable. RGM 160 370 has, like the lectotype, 20 ribs on half a whorl, RGM 160 363 has 22. The lectotype has 37 ribs on the entire last whorl. The ventral sides and suture lines of the specimens from the Barranco de Tollo are not preserved. At a diameter of 27 mm the whorl height is equal to the umbilical width.

Measurements: See Table I.

Table I: Measurements *Pseudosubplanites euxinus* (Retowski, 1894).

RGM 160 370	D = ± 42	Wh = 13 (31.0)	U = 17 (40.5)	(with lappets)
RGM 160 363	D = 39.0	Wh = 12 (30.7)	U = 15.4 (38.5)	(with lappets)
RGM 160 362a	D = ± 38	Wh = 13.6 (35.8)	U = 14.7 (38.7)	(with lappets)
RGM 617 860	D = 30.4	Wh = 10 (32.9)	U = 12.0 (39.5)	(with lappets)
Lectotype photo	D = 36.0	Wh = 12 (33.3)	U = 15 (41.6)	(with lappets)

Meaning of abbreviations (for all tables):
D = Diameter, Wh = Whorl height, U = umbilical width, wh = whorl height at 180^0, Wt = Whorl thickness, N = number of ribs on the last whorl, ½N = number of ribs on half a whorl.
Numbers in brackets denote the percentages of the diameter of the ammonite.

Remarks: Retowski (1894) figured two specimens under the name *Hoplites euxinus*, which differ from each other in several aspects. In both specimens the lappets are preserved. The smaller specimen figured on pl. 10, fig. 7, has a wider umbilicus and a smaller whorl height than the specimen of fig. 5, has three subvirgatotomous ribs on one whorl, and exhibits one fascicule of two ribs [the other fascicule mentioned by Bogdanova & Arkadiev (2005) is not a true fascicule], while Retowski's larger specimen on pl. 10, fig. 5 has a smaller umbilicus, a larger whorl height and only two subvirgatotomous ribs. The interspaces of the smaller specimen are a little wider (37 ribs on the last whorl) than those of the larger specimen (43 ribs on the whorl at the same diameter as the smaller specimen).
Mazenot (1939) designated the smaller specimen of pl. 10, fig. 7 as the lectotype of *P. euxinus*. According to Retowski (1894) fig. 6 would represent the ventral side of the specimen of fig. 7, but it is larger than the specimen of fig. 7. Kvantaliani (1999) considered it to be the ventral side of *Berriasella* (*Hegaratella*) *paramacilenta* (Mazenot, 1939) and not of *P. euxinus*. Bogdanova & Arkadiev (2005) found a distinct mid-ventral break of the ribs.
Bogdanova & Arkadiev (2005) erroneously put the specimen of fig. 7 in synonymy with their *Pseudosubplanites fasciculatus*, on account of the additional presence of fascicules among the ribs. Firstly, fascicules are also present on many other specimens of *Pseudosubplanites* and cannot be considered a diagnostic characteristic of one certain species. Secondly, they considered *P. euxinus* (Retowski, 1894) as a junior synonym of *P. fasciculatus* Bogdanova & Arkadiev, 2005. This conceptual error does not invalidate their species.
Geographic distribution: Spain, France, Bulgaria, Ukraine (The Crimea).

Pseudosubplanites fasciculatus Bogdanova & Arkadiev, 2005
Pl. I, figs 4-9

pars 1894. *Perisphinctes euxinus* n. sp. Retowski, p. 254, pl. 10, fig. 5, *non* fig. 7 [= *Pseudosubplanites euxinus* (Retowski, 1894)], *non* fig. 6 [= *Berriasella* (*Hegaratella*) sp.].
pars 1939. *Berriasella Richteri* (Opp. *in* Zitt.).– Mazenot, p. 129, pl. 21, fig. 3a, b, *non* figs 2, 4, 5 [= *Richterella richteri* (Zittel, 1868)].
1973. *Pseudosubplanites lorioli* (Zittel, 1868).– Le Hégarat, p. 40, pl. 37, figs 3, 7, 8.
pars 1976. *Pseudosubplanites ponticus* (Retowski).– Patrulius & Avram, p. 171, pl. 7, fig. 6, *non* fig. 5.
pars 1982. *Pseudosubplanites lorioli* (Zittel, 1868).– Nikolov, p. 42, pl. 5, fig. 6, *non* fig. 5 (= *Pseudosubplanites lorioli* microconch), *non* fig. 7 (= *Pseudosubplanites Jacobi* Mazenot, 1939), *non* fig. 8 [= *Berriasella* (*Hegaratella*) *oppeli* (Kilian, 1889)], *non* pl. 2, fig. 2 (= *Pseudosubplanites crymensis* Bogdanova & Arkadiev, 2005), *non* fig. 3 [= *Pseudosubplanites lorioli* (Zittel, 1868)].
1982. *Pseudosubplanites euxinus* (Retowski).– Hoedemaeker, p. 10, pl. 1, fig. 1.
pars 2003. *Pseudosuplanites lorioli* (Zittel).– Arkadiev, p. 33, fig. 6, *non* fig. 5a, b [= *Pseudosubplanites euxinus* (Retowski, 1894)].
**pars* 2005. *Pseudosubplanites fasciculatus* sp. nov.– Bogdanova & Arkadiev, p. 499, figs 6G, 9A-9E (figs 9D, 9E = dense ribbed variety or a new species), *non* fig. 5D [= *Pseudosubplanites euxinus* (Retowski, 1894)].
pars 2005. *Pseudosubplanites lorioli* (Zittel, 1868).– Bogdanova & Arkadiev, p. 493, figs 5C, 6B, 7E-7I, *non* figs 6A, 7A-D [= *Pseudosubplanites euxinus* (Retowski, 1894)].
pars 2012. *Pseudosubplanites lorioli* (Zittel, 1868).– Arkadiev *et al.,* p. 168, pl. 12, figs 5, 6a, b, 7.
pars? 2012. *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev 2005.– Arkadiev *et al.,* p. 178, pl. 14, fig. 2a, b (figs 3a, b, 4 = dense ribbed variety or new species).

Lectotype: The specimen depicted by Bogdanova & Arkadiev (2005) in figs 9A, 9B, under the name *Pseudosubplanites fasciculatus* sp. nov., deposited in the CNIGR Museum, St. Petersburg, No. 61/13077.
Diagnosis: Microconch of *Pseudosubplanites* with

eccentric umbilicus; umbilical width smaller than the whorl height. Only at a diameter of 42 mm it is equal to the whorlheight. Fourty-three thin, slightly flexuous, bifurcating ribs; a few ribs are subvirgatotomous. All ribs cross the venter without diminishing in height. Long slender lappets are present.

Material: Ten specimens from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain. RGM 160 231 (bed Z124), RGM 160 308 (bed Z106-117), RGM 160 346 (bed Z115-133), RGM 160 365 (bed Z140), RGM 160 367 (bed Z143), RGM 160 368 bed (Z143), RGM 160 369 (bed Z143), RGM 160 373 (bed Z150-153), RGM 617 861 (bed Z140-143), RGM 160 364 (bed Z140).

Description: Small, moderately involute planulates with a shallow umbilicus. The relative umbilical width becomes greater with growth and becomes as wide as the whorl height at a diameter of c. 42 mm; below this diameter it is smaller than the whorl height, and above this diameter wider. The specimens collected along the Barranco de Tollo are diagenetically flattened, but still shows slightly rounded flanks. The ribs are thin and sharp, slightly flexuous or straight and radiate to slightly prorsiradiate. The number of ribs on the last whorl is 43. The ribs are generally bifurcate and split around mid-flank. The number of subvirgatotomous ribs varies from six to two or three on the last whorl. Three specimens have a fascicule of two ribs.

The author found two specimens with long narrow lappets: one at a diameter of 33 mm and the other at a diameter of 24 mm. They have the same number of sharp ribs on the last whorl, same measurements but for the smaller diameter, and are at least 22.7% and 43.8% smaller than the holotype. The author provisionally interpreted it as a small variety of *P. fasciculatus* sp. nov., but it may well be a separate species. They differ from *P. euxinus* in the smaller diameter.

Measurements: See Table II.

Remarks: Bogdanova & Arkadiev (2005) synonymized the larger specimen of the two that Retowski (1894, pl. 10, fig. 5) named *euxinus* with *P. lorioli* (Zittel, 1868). However, this specimen cannot be conspecific with *P. lorioli* just because it has only a few subvirgatotomous ribs, but primarily because its ribs are much more closely spaced (43 ribs on one whorl up to D = 34 mm) than in *P. lorioli* (33 on one whorl up to D = 34 mm). This is a significant difference of 21% less ribs; the interspaces are wider than in *P. fasciculatus*. The holotype of *P. lorioli* and the two specimens of *P. lorioli* depicted by Le Hégarat, 1973 (on pl. 1, figs 4 and 5) also have two subvirgatotomous ribs. The author considers Retowski's specimen of pl. 10, fig. 5 conspecific with *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005, because it has the same measurements and the same number of sharp ribs (44) per whorl. The specimen depicted by Bogdanova & Arkadiev (2005) on fig. 9D and 9E under the name *P. fasciculatus* may be a new species, because it has 58 ribs on the last whorl, which is 32% more ribs than the type.

Geographic distribution: Ukraine (The Crimea), Spain, France, Southern Germany, Romania, Bulgaria.

***Pseudosubplanites tolloensis* sp. nov.**

Plate II, figs 1-12

1973. *Pseudosubplanites euxinus* (Retowski).– Le Hégarat, p. 37, pl. 2, fig. 2, pl. 37, figs 4-6.

1979. *Pseudosubplanites* (*Pseudosubplanites*) *euxinus* (Retowski, 1893).– Sapunov, p. 188, pl. 40, fig. 3.

pars 1982. *Pseudosubplanites euxinus* (Retowski, 1893).– Nikolov, p. 36, pl. 2, fig. 4, *non* pl. 5, figs 1, 2 (= *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005).

Holotype: Specimen RGM 160 350 (Pl. II, fig. 7) from the Jacobi Zone along the Barranco de Tollo, Caravaca, Murcia, Spain; deposited in the geological collection of Naturalis Biodiversity Centre, Leiden, The Netherlands. It is the only full-grown microconch that probably shows the beginning of a lappet.

Derivatio nominis: Named after the Barranco de Tollo, a northern tributary of the Río Argos, 3 kilometres west of Caravaca (SE Spain).

Diagnosis: Small microconch with an eccentric umbilicus, which is smaller than the whorl height at diameters smaller than 40 mm and wider at larger diameters. The holotype shows the beginning of a lappet at a diameter of 50 mm. The ribs are thin and slightly prorsiradiate; most of them bifurcate around mid-flank. Characteristic is the presence of many intervals with one to three short intercalated ribs between two groups of the

Table II: Measurements *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005.

RGM 160 367	D = 45.	Wh = 16 (35.6)	U = 17 (37.8)	(with lappets)
Holotype	D = 45.	Wh = 16.2 (35.6)	U = 16.0 (35.6)	Wh = U at D = 42
RGM 160 346	D = 41.2	Wh = 15.6 (37.9)	U = 14.3 (34.7)	
RGM 160 368	D = 37	Wh = 15 (40.5)	U = 13.1 (35.4)	
RGM 160 231	D = 33	Wh = 13 (39.4)	U = 12.7 (38.5)	(with lappets)
RGM 160 364	D = 24	Wh = 9 (37.5)	U = 8 (33.3)	(with lappets)

secondary ribs, or of intervals in which the secondaries do not touch the main ribs. In the ribbing of the adult, the number of intercalated ribs is small.

Material: Eleven small specimens from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain: RGM 160 350 (bed Z143), RGM 160 347 (bed Z140), RGM 160 355 (bed Z150), RGM 617.873 (bed Z153), RGM 617.871 (bed Z141), RGM 617.874 (bed Z151), RGM 160 352 (Z150-153) (2x), RGM 160 357 (bed Z140), RGM 160 342 (Z 140), RGM 160 372 (bed Z150-153), RGM 160 383 (bed Z151).

Description: Planulates with shallow umbilicus and slightly rounded flanks. In the last quarter of the last whorl, the whorl height is slightly smaller than the umbilical width. At a diameter of 40 mm the whorl height is equal to the umbilical width. At lesser diameters the umbilicus is smaller than the whorl height. One quarter of the height of the penultimate whorl is covered by the last whorl. The venter is not preserved. The ornamentation of the inner whorls consists of closely spaced, fine, sharp, straight, bifurcate ribs, which are slightly prorsiradiate. They are slightly projected on the upper part of the flanks. From a diameter of 15 mm (but in some specimens much earlier) the sharp ribs become more widely spaced and may be subvirgatotomous or bifurcate; they are often separated by one or two short intercalated ribs of the same size as the secondary ribs; some ribs remain simple and are only flanked by two or three short intercalated ribs; one specimen has three short intercalaries between several bifurcate ribs. From a diameter of 30 mm on the holotype there are only rather strong bifurcate ribs of which only four are separated by an extra intercalated rib. The combination of a bifurcate rib and a short intercalated rib is analogous to a subvirgatotomous rib, which is a characteristic feature of the genus *Pseudosubplanites*. At the aperture of the holotype, the sharp curvature of the last rib indicates the possible presence of a lappet, which itself is not preserved.

Measurements: See Table III.

Remarks: All specimens of this species are small except the holotype, which has a diameter of 50 mm. None of them show lappets except perhaps the holotype, of which the last two ribs are appreciably curved. If this indicates the presence of a lappet, then *P. tolloensis* is a microconch of the about the same size as *P. fasciculatus*. The author cannot indicate a suitable macroconch.

Geographic distribution: Spain, France, Bulgaria.

***Pseudosubplanites lorioli* (Zittel, 1868)**

Pl. II, figs 12-17 (m), Pl. III, figs 1-9 (M)

**pars* 1868. *Ammonites Lorioli* n. sp. Zittel, p. 103, figs 6a-c, *non* figs 7-8 (= unidentifiable ammonite).

? 1880. *Ammonites* (*Phylloceras*) *Lorioli*, Zittel.– Favre, p. 33, pl. 3, figs 1, 2.

? 1889. *Perisphinctes Lorioli* Zit.– Kilian, p. 652, pl. 28, fig. 3a, b.

non 1890. *Perisphinctes Lorioli* Zittel sp.– Toucas, p. 589, pl. 16, fig. 2a, b (= *Pseudosubplanites* sp?).

1939. *Berriasella euxina* (Retowski).– Mazenot, p. 125, pl. 20, fig. 5a, b.

1939. *Berriasella Lorioli* (Zittel).– Mazenot, p. 125, pl. 19, figs 3-7.

non 1960. *Berriasella lorioli* (Zittel).– Nikolov, p. 166, pl. 3, fig. 4 [= *Berriasella* (*Hegaratella*) *jacobi* (Mazenot, 1939)].

non 1967. *Berriasella lorioli* (Zittel).– Dimitrova, p. 103, pl. 48, fig. 3 [= *Berriasella* (*Hegaratella*) *jacobi* (Mazenot 1939)].

pars 1973. *Pseudosubplanites lorioli* (Zittel).– Le Hégarat, p. 40, pl. 1, figs 3, 4, 5, *non* pl. 37, figs 7, 8 (= *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005), *non* pl. 37, fig. 3 (= *Pseudosubplanites euxinus*? Retowski, 1894).

non 1976. *Pseudosubplanites* cf. *lorioli* (Zittel).– Patrulius & Avram, p. 171, pl. 7, fig. 6 (= *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005), *non* pl. 7, fig. 5 (= *Hegaratella* sp.).

non 1976. *Pseudosubplanites lorioli* (Zittel).– Khimshiashvili, p. 77, pl. 16, figs 1, 2 (= *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005), *non* fig. 3 (= *Pseudosubplanites euxinus* Retowski, 1894).

non 1979. (*Pseudosubplanites*) *lorioli* (Zittel, 1868).– Sapunov, p. 189, pl. 40, fig. 4 [= *Berriasella* (*Hegaratella*) *jacobi* (Mazenot, 1939)], *non* fig. 5 [= *Berriasella* (*Hegaratella*) *oppeli* Kilian, 1889].

pars 1982. *Pseudosubplanites lorioli* (Zittel, 1868).– Nikolov, p. 42, pl. 2, fig. 3 (Macroconch), pl. 5, fig. 5 (microconch.), *non* pl. 2, fig. 2 [= *Berriasella* (*Hegaratella*) *crymensis* Bogdanova & Arkadiev,

Table III: Measurements *Pseudosubplanites tolloensis* sp. nov.

RGM 160 350	D = 50	Wh = 17	(34.0)	U = 20	(40.0)
RGM 160 347	D = 33	Wh = 12.8	(38.8)	U = 11	(33.3)
RGM 167 874	D = 32	Wh = 12	(37.5)	U = 10.5	(32.8)
RGM 617 873	D = 30.3	Wh = 11.5	(38.0)	U = 8.6)	(28.4)
RGM 160 355	D = 29	Wh = 11.6	(40.0)	U = 8.8	(30.3)
RGM 160 353	D = 28	Wh = 10.6	(37.9)	U = 9.2	(32.9)
RGM 160 352	D = 26	Wh = 10	(38.5)	U = 8	(30.8)
RGM 617 872	D = 21.4	Wh = 8.3	(38.8)	U = 7	(32.7)

2005], *non* pl. 5, fig. 6 (= *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005), *non* pl. 5, fig. 7 [= *Berriasella* (*Hegaratella*) *jacobi* (Mazenot, 1939)], *non* pl. 5, fig. 8 [= *Berriasella* (*Hegaratella*) *oppeli* Kilian, 1889].

1985. *Berriasella* (*Pseudosubplanites*) *lorioli* (Zittel).– Tavera Benitez, p. 261, fig. 20/1, pl. 36, fig. 10.

non 1986. *Pseudosubplanites lorioli* (Zittel).– Clavel *et al.,* p. 324, pl. 1, figs 1, 2, 3. (= *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005).

non 2001. *Pseudosubplanites lorioli* (Zittel).– Wippich, p. 80, pl. 20, figs 3, 4, 5. [= *Berriasella* (*Hegaratella*) *paramacilenta* (Mazenot, 1939?)].

non 2003. *Pseudosubplanites lorioli* (Zittel).– Arkadiev, p. 33, pl. 1, figs 5a, b [= *Pseudosubplanites euxinus* (Retowski, 1894)], *non* fig. 6 (= *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005).

non 2005. *Pseudosubplanites lorioli* (Zittel, 1868).– Bogdanova & Arkadiev, p. 493, figs 6A, 7A-7C [= *Pseudosubplanites euxinus* (Retowski, 1894)], *non* figs 7D-7I (= *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005).

non 2012. *Pseudosubplanites lorioli* (Zittel, 1868).– Arkadiev *et al.,* p. 168, pl. 12, figs 3, 4a, b [= *Pseudosubplanites euxinus* (Retowski, 1894)], *non* figs 5, 6a, b, 7 (= *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005).

Lectotype: The specimen figured in Zittel, 1868, on pl. 20, figs 6a-c under the name *Ammonites Lorioli* n. sp., derived from the Upper Tithonian of Koniakau and deposited in the Staatliche Sammlung für Paläontologie und historischen Geologie, Münich, No. AS III 90.

Material: Fifteen macroconchs from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Mucia, Spain: RGM 160 359 (bed Z156), RGM 160 404 (bed M50?), RGM 617 863 (bed Z203), RGM 617 894 (bed Z11), RGM 617 867 (bed Z202), RGM 160 401 (bed Z202), RGM 160 400 (bed Z202), RGM 160 398 (bed Z202), RGM 617 900 (bed Z202), RGM 160 384 (bed Z193), RGM 160 371 (bed Z152), RGM 617 865 (bed Z199), RGM 617 866 (bed Z150-153), RGM 160 396 (bed Z202), RGM 617 887 (bed Z150), and six small fragments: RGM 160 391-394, RGM 160 386, RGM 160 388, and six badly preserved, but well identifiable microconchs: RGM 160 387 (Z202), RGM 160 389 (bed Z202), RGM 617 868 (Z202), RGM 160 390 (bed Z202), RGM 617 869 (Z203), RGM 617 870 (Z196).

Description of Macroconchs: Planulates with subrectangular whorl section and a shallow umbilicus. The flanks and venter are somewhat rounded, but the whorl section is subrectangular. The umbilicus is shallow, and the percentage of the width of its diameter increases with growth.

The ornamentation of *P. lorioli* consists of sharp, straight to slightly flexuous, bifurcate ribs; the holotype has two subvirgatotomous ribs (Le Hégarat, 1973, pl. 1, fig. 3), and the two other specimens depicted by Le Hégarat (1973, pl. 4, 5) also have two subvirgatotomous ribs. The characteristic feature of the ornamentation is the large distance of the ribs, not the rarity of the subvirgatotomous ribs. The holotype has 33 ribs on the last whorl, which ends at a diameter of 34 mm. The two additional species of Le Hégarat (1973, pl. 1, figs 4, 5) with diameters of 41 and 37 mm have 36 and 35 ribs on their last whorls respectively. In one bed of the Jacobi Zone along the Barranco de Tollo (bed Z202) four specimens were found with very projected ribs.

Measurements: See Table IV.

Remarks: The ribs of *P. fasciculatus* are more closely spaced (43 ribs on one whorl up to D = 34 mm) than those of *P. lorioli* (33 on one whorl up to D = 34 mm). This is a significant difference of 21% less ribs. They cannot be conspecific.

Pseudosubplanites lorioli (Zittel, 1868) has generally been considered a microconch, although lappets have never been figured from specimens that the author considers to belong to *P. lorioli,* neither in the literature, nor in his material. Only Patrulius & Avram (1976, pl. 7, fig. 6) mention lappets, but they are not visible on the photograph and the closeness of the bifurcated ribs rather suggests this specimen to be *P. fasciculatus* sp. nov. Patrulius & Avram's specimen figured on pl. 7, fig. 5 shows mid-ventral notches on the ribs and cannot be a *P. lorioli*. The largest specimen known (Le Hégarat, 1973, pl. 1, fig. 4) has a diameter of 41 mm and still does not show lappets.

In the Jacobi Zone along the Barranco de Tollo the acme of *P. lorioli* sharply peaks in the same bed, Z202, as the small specimens which strikingly resemble *P. lorioli*, and which the author initially regarded as a separate species. However, this coincidence of sharply peaking acmes in the same bed compelled the author to regard the small lappeted specimens as the microconchs of *P. lorioli*; the latter must be considered a macroconch.

Zittel (1868), Favre (1880), Kilian (1889) and Nikolov (1982) figured large specimens with diameters that are normally reached by macroconchs of *Pseudosubplanites* under the name *P. lorioli*. Nikolov's specimen (pl. 2, fig. 2) can now be identified as *Pseudosubplanites crymensis* Bogdanova & Arkadiev, 2005, but whether those depicted by Zittel, Favre, and Kilian are large specimens of *P. lorioli* remains uncertain.

Description of microconchs: Very small planulates with rather rounded flanks and shallow umbilicus. The inner whorls are more rounded than the later whorls. The shallow umbilicus is slightly narrower than, or as wide as, the whorl height. The ventral side is not preserved. They show lappeted apertures at diameters of 25-27 mm. The sculpture consists of rather widely spaced, bifurcate ribs, which start at the umbilical seam, are rursiradiate on the umbilical wall, but become radial to slightly prorsiradiate on the flanks. They are straight to slightly flexuous and become more or less projected near the venter. Forking occurs at various flank heights, but not below mid-flank. Two specimens exhibit fascicules of two ribs and two specimens show a group of two simple ribs separated by a short intercalated rib; only one specimen shows a subvirgatotomous rib. The number of ribs on the last whorl is 33. The ribbing becomes gradually denser and finer towards the apex, but not as fine as in *P. lorioli*, its antidimorph.

Measurements: See Table V.

Remarks: Only once a microconch of *Pseudosubplanites* of such a small size was figured in literature (Nikolov, 1982, pl. 5, fig. 5). These specimens look like very small *P. lorioli*. As it turned out that the acme of these small specimens exactly peaks (four specimens) in the same bed (Z202) in which *P. lorioli* (six specimens) has his acme, the author drew the conclusion that these small specimens should be the microconchs of *P. lorioli* and that *P. lorioli* must be a macroconch. The microconchs are about 40% smaller than the macroconchs of *P. lorioli*. The microconchs show only the adult ornamentation of *P. lorioli*; the fine ribbing on the inner whorls of *P. lorioli* has disappeared owing to acceleration [see also under *Neocosmoceras sayni* (m)].

Geographic distribution: Spain, France, Bulgaria, Ukraine (the Crimea), Romania.

Pseudosubplanites crymensis
Bogdanova & Arkadiev, 2005
Pl. III, figs 10-14

1899. *Hoplites ponticus* Ret.– Simionescu, p. 477, pl. 1, fig. 1.

pars 1973. *Pseudosubplanites grandis* (Mazenot, 1939).– Le Hégarat, p. 38, pl. 37, fig. 9, *non* pl. 2, figs 3, 4 [= *Pseudosubplanites grandis* (Mazenot, 1939)].

pars 1982. *Pseudosubplanites lorioli* (Zittel, 1868).– Nikolov, p. 42, pl. 2, only fig. 2, *non* pl. 2, fig. 4 (= *Pseudosubplanites tolloensis* sp. nov.), *non* pl. 2, fig. 3a, b, pl. 5, fig. 5, [= *Pseudosubplanites lorioli* Zittel, 1868)], *non* fig. 6 (= *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005), *non* fig. 7 [= *Berriasella* (*Hegaratella*) *jacobi* Mazenot, 1939], *non* fig. 8 [= *Berriasella* (*Hegaratella*) *oppeli* (Kilian, 1889)].

* 2005. *Pseudosubplanites crymensis* sp. nov.– Bogdanova & Arkadiev, p. 500, figs 8F-8K.

2012. *Pseudosubplanites crymensis* sp. nov. Bogdanova & Arkadiev, 2005.– Arkadiev *et al.*, p. 179, pl. 13, figs 11, 12a, b, 13a, b, pl. 14, fig. 1.

Holotype: The specimen figured in Bogdanova & Arkadiev (2005) on figs 8G, 8H under the name *Pseudosubplanites (Pseudosubplanites) crymensis* sp. nov., derived from the Jacobi Zone of St. Elias Cape, Feodosiya, eastern Crimea, Ukraine; deposited in the CNIGR Museum, St. Petersburg, Russia, under number 70/13077.

Material: Ten specimens from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain. RGM 160 345 (bed Z140), RGM 160 299 (bed Z15), RGM 160 337 (bed Z66), RGM 160 282 (bed Z168-Z170), RGM 160 283 (bed Z152), RGM 160 290 (bed Z66), RGM 617 862 (bed Z202), RGM 160 232 (bed Z102-108), RGM 617 876 (bed Z171), RGM 160 289 (bed Z151-157).

Description: Large planulates with a rather small shallow excentric umbilicus (Wh = U at D = 56 mm, which means that at diameters larger than 56 mm the umbilicus is larger than the whorl height and at smaller diameters smaller). They may reach a diameter of 122 mm, for instance the specimen of *Pseudosubplanites grandis* (Mazenot) in Le Hégarat, 1973, pl. 37, fig. 9. The flanks are rounded. The involution is about 1/3. The ornamentation consists of rather dense, straight to slightly flexuous, somewhat prorsiradiate ribs, which start near the umbilical seam. Nearly all ribs are bifurcate; subvirgatotomous ribs are rare; the author found only one. The ribs are thin and only slowly increase in thickness. The ribs are somewhat projected near the venter and cross it without interruption. Only one rib starts a little above the umbilical rim.

Measurements: See Table VI.

Remarks: The specimen depicted by Le Hégarat (1973) on pl. 37, fig. 9 with the name *Pseudosubplanites grandis* (Mazenot) is herein considered not to belong to

Table IV: Measurements *Pseudosubplanites lorioli* (macroconch) (Zittel, 1868).

Lectotype	D = 34	Wh = 12.6 (37)	U = 12.0 (35.3)	N = 33
RGM 160 404	D = ±23	Wh = 10.0 (43.5)	U = 7.6 (33.0)	½N = 17
RGM 617 900	D = 46.1	Wh = 17.7 (38.4)	U = 16.0 (34.7)	

Table V: Measurements *Pseudosubplanites lorioli* (microconch) (Zittel, 1868).

RGM 617 870	D = 28	Wh = 11.2 (40)	U = 10 (35.7)	(with lappets)
RGM 617 868	D = ±25	Wh = ±8.8 (35.2)	U = 8.8 (35.2)	(with lappets)
RGM 160 389	D = ±25	Wh = ±7.5 (30)	U = 7.6 (30.4)	(with lappets)
RGM 160 387	D = ±24	Wh = 8.8 (36.7)	U = 8.5 (35.4)	(with lappets)
RGM 160 390	D = 21	Wh = 8.0 (38.1)	U = 7.0 (33.3)	(no lappets)

Table VI: Measurements *Pseudosubplanites crymensis* Bogdanova & Arkadiev, 2005.

RGM 160 290	D = 72	Wh = 28 (38.9)	U = 28 (38.9)
RGM 160 299	D = 71	Wh = 27 (38)	U = 26 (36.6)
RGM 160 345	D = 64.3	Wh = 23.6 (36.7)	U = 24 (37.3)

P. grandis. *P. grandis* has a smaller excentric umbilicus (Wh = U at D = 113 mm). The measurements are similar to *P. crymensis* Bogdanova & Arkadiev, 2005, and the specimen was reidentified accordingly. Specimen RGM 160 345 (Pl. III, fig. 11) from the Barranco de Tollo resembles *P. grandis* Le Hégarat, 1973, *non* Mazenot most, only the ribs on the last whorl of Le Hégarat's specimen are slightly wider apart. The holotype of *P. crymensis* cannot be distinguished from *P. ponticus* (Simionescu, 1899, *non* Retowski, 1894); both have the same relative dimensions and the same shape and number of ribs (26 on half a whorl). *P. crymensis* differs from *P. subrichteri* (Retowski, 1894) in the smaller number of ribs per whorl; the latter has 60 ribs per whorl, the former 53.
Geographical distribution: Spain, Ukraine (The Crimea), France, Romania, Bulgaria.

***Pseudosubplanites ponticus* (Retowski, 1894)**
Pl. IV, figs 1-7

* 1894. *Perisphinctes ponticus* n. sp.– Retowski, p. 256, pl. 10, fig. 9.
non 1899. *Hoplites ponticus* Ret.– Simionescu, p. 477, pl. 1, fig. 1 (= *Pseudosubplanites crymensis* Bogdanova & Arkadiev, 2005).
1938. *Berriasella pontica* Retowski.– Roman, p. 325, pl. 32, fig. 307.
non 1939. *Berriasella pontica* (Retowski, 1894).– Mazenot, p. 131, pl. 21, fig. 9a, b (= *Delphinella* sp.?).
non 1960. *Berriasella pontica* (Retowski).– Nikolov, p. 167, pl. 8, fig. 4, pl. 9, fig. 1 [= *ambo Berriasella* (*Hegaratella*) *oppeli* (Kilian, 1889)], *non* pl. 9, figs 2, 3 [= *Berriasella* (*Berriasella*) *callisto* (d'Orbigny, 1847)].
1960. *Berriasella pontica* Retowski.– Drushchits, p. 277, pl. 21, fig. 2 (= holotype).
1973. *Pseudosubplanites ponticus* (Retowski).– Le Hégarat, p. 42, pl. 1, figs 6, 7, pl. 38, fig. 1.
non 1976. *Pseudosubplanites ponticus* (Retowski).– Patrulius & Avram, p. 171, pl. 7, figs 7-9 [= *Pseudosubplanites subrichteri* (Retowski, 1894)].
non 1979. *Pseudosubplanites* (*Pseudosubplanites*) *ponticus* (Retowski, 1893).– Sapunov, p. 190, pl. 40, fig. 6a, b [= *Berriasella* (*Hegaratella*) *paramacilenta* (Mazenot, 1939)].
pars 1982. *Pseudosubplanites* (*Pseudosubplanites*) *ponticus* Retowski, 1893.– Nikolov, p. 42, pl. 6 figs 1, 2, *non* pl. 2, fig. 6 [= *Pseudosubplanites grandis* (Mazenot, 1939)].
2005. *Pseudosubplanites ponticus* (Retowski, 1893).– Bogdanova & Arkadiev, p. 491, figs 5A, 6E, fig. 7L-7N.
2012. *Pseudosubplanites ponticus* (Retowski, 1893).– Arkadiev *et al.,* p. 172, pl. 13, figs 1-4, 6, 7, *non* fig. 5 (= possibly dense ribbed variety of *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005).

Holotype: By monotypy, the specimen depicted by Retowski (1894) on pl. 10, fig. 9, under the name *Perisphinctes ponticus* n. sp, derived from the Tithonian (*Hegaratella jacobi* Zone) near Feodosia, eastern Crimea (Ukraine); deposited in the CNIGR Museum, St. Petersburg, Retowski collection under number 30/10916.
Material: Sixteen moderately preserved specimens; the largest ones (up to 111 mm) are interpreted as macroconchs, the six smallest ones, smaller than 25 mm, may be small macroconchs or microconchs; they do not show lappets; all derived from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain: RGM 160 310 (bed Z153-157), RGM 160 312 (bed Z172), RGM 160 305 (bed Z66), RGM 617 879 (bed Z157), RGM 617 882 (bed Z151), RGM 617 878 (bed Z151), RGM 617 885 (bed Z 150), RGM 160 311 (bed Z161), RGM 160 340 (bed Z133-140), RGM 617 877 (bed Z170), RGM 617 880 (bed Z141), RGM 617 886 (bed Z167), RGM 617 884 (bed Z135), RGM 160 304 (bed Z60-84), RGM 160 313 (bed Z183); *Pseudosubplanites* cf. *ponticus*: RGM 160 341 (bed Z168B).
Description: The shell has the shape of a flat platycone with a small shallow umbilicus; it may reach a diameter of 111 mm. The flanks of the whorls are slightly rounded. The last whorl overlaps the foregoing whorl for 1/3 of the flank height.
The ribs are fine, sharp, and prorsiradiate, but on the sloping umbilical wall rectiradiate; they are slightly S-shaped and closely spaced. They commonly split into two secondaries; the angle between the secondaries is only a few degrees; the points of forking are generally situated around two thirds of the flank height, but rarely much lower. On the inner whorls the sculpture consists of very fine, dense ribs. In the holotype the distance between the ribs gradually and regularly increases with growth, and the ribs gradually grow in thickness, but remain slender; subvirgatotomous ribs or short intercalated ribs are rare.
However, this regularity in the ornamentation is not the rule. A secondary rib is considered to be in contact with the primary, but if it is loose, it should be called a short intercalary rib, and the primary becomes a simple rib. There are intervals with bifurcate ribs separated by one short intercalary rib. But often there are two or

three intercalated ribs between two simple ribs. So, the breadth of interspaces between the primary ribs may change, depending on the number of intercalated ribs; the interspaces are therefore not always regularly increasing with growth. On the venter the number of secondaries and short intercalated ribs within an interval (cord), which is equal to the whorl height, remains the same, *viz*. 13. So, if there are, for instance, three intercalated ribs, the primary ribs are farther apart than if there is only one or no intercalary. Intercalated ribs are generally more frequent on the inner whorls than on later whorls.

Measurements: See Table VII.

Remarks: *P. ponticus* resembles *Hegaratella paramacilenta* Mazenot, 1939 a great deal. The shells of both species are rather strongly compressed. Both have a regular ribbing of rather close-spaced, slender bifurcate ribs, which may be slightly flexuous and describe a small concave curvature at the umbilical rim. Both species exhibit very fine dense ribbing on the inner whorls and lack a mid-ventral furrow. However, the fine ribbing of *P. ponticus* shows often intervals with many intercalary riblets, and the gradation into the less closely spaced ribbing of the adult stage is very slow; some subvirgatotomous ribs are present. The points of splitting often shift from mid-flank to two thirds of the flank height. On the other hand, in *H. paramacilenta* the fine ribbing is restricted to the more inner whorls and grade more rapidly into the normal adult rib distance; subvirgatotomous ribs are absent and the points of splitting are all at the same flank height.

Geographic distribution: Ukraine (The Crimea), Spain, France, Bulgaria.

***Pseudosubplanites paracombesi* sp. nov.**

Pl. V, figs 1-4

* 1973. *Pseudosubplanites combesi* n. sp. paratype.– Le Hégarat, p. 36, pl. 37, fig. 1.

1982. *Pseudosubplanites* (*Pseudosubplanites*) *combesi* Le Hégarat, 1973.– Nikolov, p. 38, pl. 4, fig. 2, pl. 5, fig. 3, *non* fig. 4 (= *Pseudosubplanites grandis* Mazenot, 1939).

Holotype: The specimen figured by Le Hégarat (1973) on pl. 37, fig. 1 under the name *Pseudosubplanites combesi*, paratype, derived from the Jacobi Zone of Les Combes (near Glandage, Drôme), deposited in the Le Hégarat collection, Claude Bernard University of Lyon, Département de Géologie, No. FSL129441.

Derivatio nominis: Contraction of the words *para* (= besides, near) and *combesi*.

Material: Two specimens: one well-preserved imprint (and plaster cast), RGM 160 291 (bed Z148), and a smaller specimen, RGM 617 888 (Z160), both derived from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain.

Diagnosis: Large planulate with a moderately wide umbilicus, which is approximately as wide as the whorl height, and with thick, rather distantly spaced, straight, bifurcate ribs, which are slightly projected; simple and subvirgatotomous ribs are rare. On the inner whorls the ribs are closely spaced. The flanks are slight rounded. The number of ribs on the last whorl is 45-46, on the penultimate whorl 37-38.

Description: The plastercast made of the imprint are almost copies of the figure of the paratype of *P. combesi* in Le Hégarat (1973). The diameter of the Barranco de Tollo specimen is more than 100 mm and the shell is diagenetically flattened. The flanks are slightly convex and the eccentric umbilicus is shallow. The umbilicus becomes wider than the whorl height only at a diameter of 86 mm. The ornamentation consists of straight to slightly flexuous, radial to slightly prorsiradiate, strong, bifurcate ribs, with wide interspaces; the splitting of the ribs is situated at mid-flank or just above it. They arise at the umbilical seam and are slightly rursiradiate on the umbilical wall. The ribs are straight to slightly projected approaching the venter. The innermost whorls have thin, closely spaced ribs, like *P. ponticus* and *P. lorioli*. The number of subvirgatotomous ribs varies from zero to two. The Barranco de Tollo specimens have no subvirgatotomous ribs. The whorl height of the last whorl is at every diameter almost equal to the umbilical width. The French holotype of *P. paracombesi* and the specimens from the Barranco de Tollo have fine, straight, radiate ribs on the innermost whorls, 37-38 radiate ribs

Table VII: Measurements *Pseudosubplanites ponticus* (Retowski, 1894).

RGM 160 312	D = 111	Wh = 37.5 (33.8)	U = 42 (37.8)
RGM 160 305	D = 90	Wh = 32 (35.5)	U = 34 (37.8)
RGM 617 879	D = 56.5	Wh = 21 (37.2)	U = 17.5 (31.0)
RGM 617 880	D = 46	Wh = 18.5 (40.2)	U = 14.2 (30.8)
RGM 617 878	D = 40.7	Wh = 16.6 (40.8)	U = 12.5 (30.7)
RGM 160 310	D = 25.5	Wh = 12 (47.1)	U = 7.3 (28.6)
RGM 617 880	D = 21.5	Wh = 8.5 (39.5)	U = 6.5 (30.2)
RGM 617 882	D = 18.4	Wh = 8.0 (43.5)	U = 6.0 (32.6)

on the penultimate whorl and 45-46 radiate ones on the last whorl.
Measurements: See Table VIII.
Remarks: The holotype of *P. combesi* has several subvirgatotomous ribs, three on the outer whorl and four on the penultimate whorl. Its paratype has only two subvirgatotomous ribs on the last whorl. The main difference between *P. combesi* and *P. paracombesi* is the much smaller umbilicus and the more rapid growth of the whorl height of the latter. The only common feature between the holotype and the paratype is the number of ribs on the last whorl; the holotype of *P. combesi* has 43 ribs on the last whorl, the paratype 45. The author considers the paratype of *P. combesi* to be a different species and proposes to give it another name, *Pseudosubplanites paracombesi* sp. nov.
Geographic distribution: France, Spain, Bulgaria.

Pseudosubplanites berriasensis Le Hegarat, 1973
Pl. VI, figs 2-4

* 1973. *Pseudosubplanites berriasensis* n. sp. Le Hégarat, p. 33, pl. 1, fig. 1, pl. 37, fig. 2.
non 1979. *Pseudosubplanites* cf. *berriasensis* Le Hégarat, 1971.– Sapunov, p. 188, pl. 40, fig. 2 (= *Pseudosubplanites hegarati* sp. nov.).
1982. *Pseudosubplanites* (*Pseudosubplanites*) *berriasensis* Le Hégarat, 1971.– Nikolov, p. 34, pl. 2, fig. 1, *non* pl. 1, fig. 1 (= *Pseudosubplanites hegarati* sp. nov.).

Holotype: The specimen depicted by Le Hégarat (1973) on pl. 37, fig. 2 under the name *Pseudosubplanites berriasensis* n. sp. from the Grandis Zone of Les Combes (Drôme, France), deposited in the University of Claude Bernard in Lyon, Department of Geology, Le Hégarat collection No. FSL 128788.
Material: Two small specimens from the Jacobi Zone along the Barranco de Tollo: RGM 160 353 (bed Z153) and RGM 617 875 (bed Z141).
Description: The author collected two small diagenetically flattened specimens with planulate shells in which the shallow umbilicus is smaller than the whorl height. The ribs are widely spaced, high and sharp. The ribs are slightly prorsiradiate, bifurcate or trifurcate and the secondary ribs are projected. The third secondary of the subvirgatotomous ribs may not be in touch with the primary rib.
Measurements: See Table IX.
Remarks: A larger specimen from the Col du Pin, which could clearly be identified as *P. berriasensis*, helped the author to identify the two specimens from the Jacobi Zone along the Barranco de Tollo. The small specimens did not show lappets and may be either young representatives of *P. berriasensis* or its microconchs. This species is rather rare, because in literature a second specimen has not been figured yet.
Geographical distribution: France, Spain.

Pseudosubplanites hegarati sp. nov.
Pl. VI, figs 1, 5, 6

1979. *Pseudosuplanites* (*Pseudosubplanites*) cf. *berriasensis* (Le Hégarat, 1971).– Sapunov, p. 188, pl. 40, fig. 2.

Holotype: The specimen RGM 160 335 from bed Z131 (Pl. VI, figs 1, 6) of the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain. Deposited in the Naturalis Biodiversity Centre. Leiden, The Netherlands.
Derivatio nominis: Named after Dr. Gerard Le Hégarat (1973), who introduced the genus *Pseudosubplanites* and who did a thorough study of the biostratigraphy and ammonite fauna of the Berriasian in south-eastern France.
Diagnosis: *P. hegarati* is a macroconch with rather small, shallow umbilicus and with strong ribs. Among the rather thin, generally bifurcating ribs many subvigatotomous ribs are present, and most ribs are more or less raised at the point of forking. Simple and fasciculated ribs occur. On the phragmocone the ribs are rather closely spaced; on the body chamber the interspaces are two times wider. The length of the body chamber is half a whorl.
Material: Two specimens: the large holotype, RGM 160 335 (bed Z131), and the smaller paratype, RGM 160 336

Table VIII: Measurements *Pseudosubplanites paracombesi* sp. nov.

Holotype photo	D = 96	Wh = 35 (36.5)	U = 34.5 (36.0)
RGM 160 291	D = 87	Wh = 33.2 (38.2)	U = 33.2 (38.2)
RGM 617 888	D = 84	Wh = 30 (35.7)	U = 33.3 (39.6)

Table IX: Measurements *Pseudosubplanites berriasensis* Le Hegarat, 1973.

RGM 160 353	D = 28.7	Wh = 11.1 (38.7)	U = 9.5 (33.1)
RGM 617 875	D = 25.0	Wh = 9.0 (36.0)	U = 7.8 (31.2)

(bed Z119). Both specimens are preserved as positive and negative.

Description: Diagenetically compressed planulate shells with a rather small, shallow umbilicus. The flanks are slightly rounded. Unfortunately the right side of the holotype has shifted in relation to the left side along a mediane plane; this caused a small difference in measurements between the left and right sides. Ribs are rather thin, straight to slightly concave and are somewhat prorsiradiate; they originate at the umbilical seam. The number of ribs (47) is about the same as in *P. paracombesi* (45); but on the body chamber the ribs are two times wider separated than on the phragmocone. Most ribs bifurcate, two are simple. Remarkable is that on the body chamber most furcation points are heightened, occasionally forming real tubercles. The holotype has nine subvirgatotomous ribs on the last whorl. The "third secondary rib" of a subvirgatotomous rib is often not in touch with the primary rib. Two fascicules were found on the holotype and one on the paratype. The umbilicus is rather small, smaller than the umbilici of *P. combesi*, *P. berriasensis* and *P. paracombesi*.

Measurements: See Table X.

Remarks: The main differences between *P. paracombesi* and *P. hegarati* are the smaller umbilicus, the thinner, more closely spaced ribs, and the rather large number (nine) of subvirgatotomous ribs on the last whorl of the latter; subvirgatotomous ribs are nearly absent in *P. paracombesi*. The points of furcation of most ribs of *P. hegarati* are raised and sometimes show a real tubercle. It differs from *P. berriasensis* in the much smaller umbilicus and in the less distant and less sharp ribbing. The number of subvirgatotomous ribs (nine) is smaller than in the holotype of *P. berriasensis* (13).

Geographic distribution: Southeastern Spain.

***Pseudosubplanites combesi* Le Hégarat, 1973**
Pl. VII, figs 1-4

* 1973. *Pseudosubplanites combesi* n. sp. Le Hegarat, p. 36, pl. 1, fig. 2, *non* pl. 37, fig. 1 (= *Pseudosubplanites paracombesi* n. sp. Le Hégarat, paratype).

non 1982. *Pseudosubplanites* (*Pseudosubplanites*) *combesi* Le Hégarat, 1973.– Nikolov, p. 38, pl. 4, fig. 2 (= *Pseudosubplanites grandis* (Mazenot,1939), pl. 5, fig. 3 (= *Pseudosubplanites paracombesi* sp. nov.), fig. 4 (= *Pseudosubplanites grandis* Mazenot, 1939).

1986. *Pseudosubplanites combesi* Le Hegarat.– Clavel *et al.,* p. 324, pl. 1, figs 4, 5.

non 1999. *Pseudosubplanites* cf *combesi* Le Hégarat.– Kvantaliani, p. 103, pl. 14, fig. 1 (= unidentified ammonite).

non 2005. *Pseudosubplanites combesi* Le Hégarat, 1971.– Bogdanova & Arkadiev, p. 499, figs 6D, 8D, 8E (= perhaps *Subplanites* sp.).

non 2012. *Pseudosubplanites combesi* Le Hégarat, 1973.– Arkadiev *et al.,* p. 177, pl. 13, fig. 8 (= perhaps *Subplanites* sp.).

Holotype: The specimen depicted by Le Hégarat (1973) on pl. 1, fig. 2 under the name *Pseudosubplanites combesi* n. sp., derived from the Jacobi Zone of Les Combes (Drôme, France), deposited in the Université Claude Bernard, Déepartement de Géologie (Collection Le Hégarat) No. FSL129 367.

Material: Five badly preserved specimens from the Jacobi Zone along the Barranco de Tollo three kilometres west of Caravaca, Province of Murcia, Spain: RGM 160 293 (bed Z141-158), RGM 160 294 (bed Z141-142), RGM 160 295 (bed Z141-142), RGM 160 293 (bed Z141-158), RGM 160 300 (bed Z31A).

Description: Large planulates with a large eccentric umbilicus, which is much wider than the whorl height. Two fragments have an umbilicus which is much wider than the whorl height except at diameters smaller than approximately 35 mm. For the other two whorl fragments, a very wide umbilicus can be surmised. The specimens show strong, widely spaced, bifurcating ribs, which originate at the umbilical seam. The ribs cross the venter without interruption. In all specimens there is one short intercalated rib, which has the same length as the secondary ribs. The bifurcation points of the stout ribs are at, or just above, mid-flank.

Measurements: See Table XI.

Remarks: The holotype of *P. combesi* has merely been sketched, not photographed, by Le Hégarat (1973) on plate 1, fig. 2. Le Hégarat's sketch is probably drawn from a photograph of a not well-preserved specimen. The sketch is in conformity with the measurements given in Le Hégarat's text. The first features that strike most are the large umbilicus and the slow growth of the whorl height. The last whorl overlaps the penultimate whorl for about 20 percent. The umbilicus is much wider than the whorl height except at diameters smaller than approximately 35 mm. There is no other macroconch of *Pseudosubplanites* which is so evolute. One may argue whether a holotype without proper photographic illustration is legitimate.

A second specimen has never been figured or drawn in

Table X: Measurements of *Pseudosubplanites hegarati* sp. nov.

RGM 160 335	D = 95	Wh left = 35 (36.8)	U left = 36 (38.0)
Same specimen	D = 95	Wh right = 39 (41)	U right = 34 (36.3)
RGM 160 336	D = 65.5	Wh = 24.5 (37.4)	U = 23.9 (36.5)
Sapunov's spec.	D = 91.7	Wh = 33.2 (36.2)	U = 32.2 (35.1)

Table XI: Measurements *Pseudosubplanites combesi* Le Hégarat, 1973.

RGM 160 293	D = ±64	Wh = 23.5 (36.7)	U = 27.5 (42.9)
Le Hégarat's measurem. holot. *P. combesi*	D = 95	Wh = 31 (32.6)	U = 38 (40.0)
The author's measurem. holot. *P. combesi*	D = 94	Wh = 30 (31.9)	U = 40 (42.5)
The Col du Pin specimen of *P. combesi*	D = 63	Wh = 22 (34.9)	U = ±27 (42.9)

literature, except for the small fragment in Clavel *et al.* (1986, pl. 1, figs 4, 5). For comparison the author figures two specimens of *P. combesi* from the Col du Pin (near St. Nazaire-de-Desert, Drôme. Collection J. Klein, No. JK 44685, Naturalis Center of Biodiversity).
Geographical distribution: France, Spain.

Pseudosubplanites grandis **(Mazenot, 1939)**
Pl. VII, figs 5, 6

- * 1939. *Berriasella grandis* n. sp. Mazenot, p. 133, pl. 22, figs 3a, b, 6a, b.
- 1939. *Berriasella consanguinoides* n. sp. Mazenot, p. 138, pl. 23, fig. 2a, b.
- 1968. *Pseudosubplanites grandis* (Mazenot).– Le Hégarat & Remane, p. 25, pl. 5, figs 6, 7.
- *pars* 1973. *Pseudosubplanites grandis* (Mazenot).– Le Hégarat, p. 38, pl. 2, figs 3, 4, *non* pl. 37, fig. 9 (= *Pseudosubplanites crymensis* Bogdanova & Arkadiev, 2005).
- *pars* 1982. *Pseudosubplanites* (*Pseudosubplanites*) *grandis* Mazenot, 1939.– Nikolov, p. 38, pl. 1, figs 2, 3; pl. 2, fig. 5; pl. 3, fig. 1; pl. 4, fig. 1, *non* pl. 3, fig. 2 (= *Pseudosubplanites crymensis* Bogdanova & Arkadiev, 2005).
- *non* 1982. *Pseudosubplanites grandis* (Mazenot).– Hoedemaeker, p. 16, pl. 1, fig. 5 (= *Pseudosubplanites crymensis* Bogdanova & Arkadiev, 2005).
- 1982. *Pseudosubplanites combesi* Le Hégarat, 1973.– Nikolov, p. 38, pl. 4, fig. 2; pl. 5, fig. 4.
- *pars* 1982. *Pseudosubplanites ponticus* (Retowski, 1893).– Nikolov, p. 42, pl. 2, fig. 6, *non* pl. 6, figs 1, 2 (= *Pseudosubplanites ponticus* Retowski, 1894).
- 2003. *Pseudosubplanites grandis* (Mazenot).– Arkadiev, p. 33, pl. 1, fig. 7a, b.
- 2005. *Pseudosubplanites grandis* (Mazenot).– Bogdanova & Arkadiev, p. 493, figs 6F, 7J, K.
- 2012. *Pseudosubplanites grandis* (Mazenot, 1939).– Arkadiev *et al.*, p. 174, pl. 12, figs 1, 2.

Holotype: The specimen depicted by Mazenot (1939) on plate 22, fig. 6a, b under the name *Berriasella grandis* n. sp., derived from the Jacobi Zone of Le Chevalon, (Isère, France), deposited in the Faculté des Sciences de Grenoble, Institut Dolomieu, No. ID 661.
Material: Three whorl fragments. One whorl fragment of 63 mm long RGM 160 292 (bed Z150-153), one whorl fragment of 80 mm long RGM 791 174 (bed Z161-163) and one whorl fragment of 40 mm long (= cf. *grandis*) RGM 160 303 (bed Z139), all from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain.
Description: The 80 mm long fragment exhibits seven thick bifurcate ribs. The straight primaries are 9 mm apart and are 3 mm broad just below the point of forking; they taper toward the umbilicus. The umbilical rim is not preserved. The ribs are not high. The secondary ribs are also 3 mm broad and are slightly projected. Neither the ventral part nor the umbilical rim is preserved. According to the thickness of the ribs and their interspaces, the fragment must be a part of a very large specimen.
The 63 mm long whorl fragment exhibits one subvirgatotomous rib, and the ribs cross the venter without interruption. The secondaries are 2.5 mm broad, are 6.6 mm apart and slightly projected. The umbilical rim is preserved.
The third whorl fragment (cf. *grandis*) has ribs with the same measurements as the second whorl fragment. The umbilical rim is preserved, but the ribs do not show their total length.
Geographical distribution: France, Spain, Bulgaria, Ukraine (The Crimea).

Family Neocomitidae Salfeld, 1921
Subfamily Berriasellinae Spath, 1922
Genus *Berriasella* Uhlig, 1905

2.2.2. Subgenus *Berriasella* (*Hegaratella*) Nikolov & Sapunov, 1977

Type species: *Berriasella paramacilenta* Mazenot, 1993.

Systematics and emendation: Hoedemaeker (1982, herein) united all the species that Le Hégarat (1973) included in genus *Berriasella* Uhlig, 1905 (type species *Ammonites privasensis* Pictet, 1867) and that occur in the Jacobi Zone, in subgenus *Berriasella* (*Hegaratella*) Nikolov & Sapunov, 1977 (type species *Berriasella paramacilenta* Mazenot, 1939).
Le Hégarat (1973), Hoedemaeker (1982, and herein), Tavera Benitez (1985), Wright *et al.* (1996), and Bogdanova & Arkadiev (2005) considered *Hegaratella* a subgenus of *Berriasella*. The representatives of *Berriasella* (*Hegaratella*) *sensu* Hoedemaeker (1982) of the Jacobi Zone collectively differ in several aspects from those of *Berriasella* (*Berriasella*) *sensu* Hoedemaeker (1982) of the Occitanica and Boissieri zones, in having straight, prorsiradiate to radial ribs, which are only more or less projected (or not) on the upper part

of the flank. This is a common aspect of all species of *Berriasella* in the Jacobi zone. The representatives of *Berriasella* (*Berriasella*) differ from those of *Berriasella* (*Hegaratella*) mainly in the convexity of the ribs at mid-flank especially on the last whorl. The lower part of the ribs can be prorsiradiate to radial, and the upper part radial to rursiradiate, and both parts are connected by a convex curve. The convexity at mid-flank can be more or less pronounced like a knee. *Berriasella* (*Hegaratella*) is here considered ancestral to *Berriasella* (*Berriasella*), which is restricted to the Occitanica and Boissieri zones of the Mediterranean region.

Nikolov (1982) considered *Hegaratella* a subgenus of *Pseudosubplanites*, because the species of *Hegaratella* allegedly lack a mid-ventral furrow, since they were united by Mazenot (1939) into the group of *Berriasella* without a siphonal furrow. However, Mazenot (1939, p. 128, pl. 22, figs 2b, 4b) explicitly mentioned and showed that the ribs of *B. paramacilenta* have mid-ventral notches, especially on the inner whorls. These rows of mid-ventral notches are siphonal lowerings of the ribs, which occur in many Mesozoic ammonites and which should be considered to represent a special kind of siphonal groove. Therefore, *Hegaratella* does not fundamentally differ from all the species of the subgenera *Berriasella* (*Berriasella*) and *Berriasella* (*Picteticeras*) *sensu* Le Hégarat (1973) that occur in the Jacobi Zone. *Berriasella* (*Hegaratella*) cannot be included in *Pseudosubplanites*, because the latter genus does not show mid-ventral notches and is characterized by the presence of subvirgatotomous ribs, which are absent in *Berriasella* (*Hegaratella*).

The author (Hoedemaeker, 1982, and herein) and Tavera, 1985 considered the introduction of *Picteticeras* Le Hégarat, 1973, unjustified and they synonymized *Berriasella* (*Picteticeras*) with *Berriasella* (*Berriasella*) (See paragraph 2.2.4.).

Most species of *B.* (*Hegaratella*) have rather small umbilici except *B.* (*H.*) *elmii* Le Hegarat, 1973, *B.* (*H.*) *enayi* Le Hegarat, 1973 and *B.* (*H.*) *oxycostata* Mazenot, 1939. Most species of *B.* (*Berriasella*) have large umbilici except *B.* (*Berriasella*) *privasensis* (Pictet, 1867) and *B.* (*Berriasella*) *callisto* (d'Orbigny, 1847).

On the other hand, *B.* (*Hegaratella*) shows great similarity with its contemporary and closely related genus *Parodontoceras* of the Pacific Realm (type species *Hoplites callistoides* Behrendsen, 1891). *Parodontoceras* also have small umbilici and straight to projected ribs, but some species differ from *B. (Hegaratella)* in the presence of a few short intercalated ribs on the upper part of the flanks, which are not present in *Berriasella (Hegaratella)*, and in the ribs describing a concave curve at the umbilical rim, which is only present in *B.* (*Hegaratella*) *paramacilenta* (Mazenot, 1939).

***Berriasella* (*Berriasella*) *multicostata* sp. nov.**

In some synonymy lists in this article the author refers to some species as *Berriasella* (*Berriasella*) *multicostata* sp. nov. This is the new name for the following specimens that have been described and depicted in literature under the following names:

1. *Berriasella paramacilenta* Mazenot, 1939, pl. 20, fig. 3a-d, pl. 21, fig. 1.
2. *Berriasella paramacilenta* Mazenot, 1939.– Arnould-Saget, 1953, pl. 6, fig. 2a, b.
3. *Berriasella* (*Picteticeras*) *evoluta* Le Hégarat, 1973, only pl. 8, figs 3, 7, pl. 39, figs 9, 13.
4. *Pseudosubplanites* (*Hegaratella*) *kaffae* (Rousseau in Retowski, 1894).– Nikolov, 1982, pl. 8, fig. 1.
5. *Berriasella* (*Berriasella*) *kaffae* (Rous.).– Kvantaliani, 1999, pl. 11, fig. 5a-c.

Lectotype: The specimen depicted by Mazenot pl. 20, fig. 3a-d with the name *Berriasella paramacilenta,* derived from the Paramimouna Subzone of La Faurie, deposited in the Faculté des Sciences de Grenoble, Institut Dolomieu, No. ID 651.

Diagnosis: compressed planulate with moderately wide umbilicus [Measurement: D = 60.4, Wh = 21.6 (35.8), U = 22 (36.4)]. The thin, prorsiradiate bifurcate ribs are closely spaced (60 ribs on last whorl). They are straight to convex with projected secondaries and near the aperture slightly falcoid. Several simple ribs are present. All ribs cross the venter, but show mid-ventral notches. Aperture with lappets. They occur in the Dalmasi, Paramimounum and Picteti Subzones.

Remarks: *Hoplites calisto* var. *kaffae* Rousseau in Retowski, 1894, is possibly a species of genus *Delphinella* (*Delphinella*). [see under heading *Delphinella (Delphinella) crimensis*] and occurs in the Jacobi Zone.

***Berriasella* (*Hegaratella*) *jacobi* Mazenot, 1939**
Pl. VII, figs 7-10

1890. *Hoplites carpathicus* Zittel sp.– Toucas, p. 602, pl. 17, figs 10a, b, 11.
? 1890. *Hoplites Calisto* d'Orb. sp.– Toucas, p. 600, pl. 17, fig. 3a, b.
*pars 1939. *Berriasella Jacobi* n. sp.– Mazenot, p. 54, figs 1, 2, 4, *non* fig. 3 (= *Lemencia subjacobi* Donze & Enay, 1961).
1953. *Berriasella Jacobi* Mazenot, 1939.– Arnould-Saget, p. 33, pl. 3, fig. 11a-c, pl. 4, fig. 1a-c.
1960. *Berriasella Jacobi* Maz.– Collignon, pl. CLXV, figs 668, 669.
1960. *Berriasella lorioli* (Zittel).– Nikolov, p. 166, pl. 3, fig. 4.
1967. *Berriasella lorioli* (Zittel 1868).– Dimitrova, p. 103, pl. 48, fig. 3.
1968. *Berriasella jacobi* Mazenot.– Le Hégarat & Remane, p. 25, pl. 5, fig. 1, 2.
pars? 1973. *Berriasella (Berriasella) jacobi* Mazenot.– Le Hégarat, p. 56, pl. 6, figs 9-12, pl. 38, figs 3? 6, 7.
1979. *Pseudosubplanites* (*Pseudosubplanites*) *lorioli* (Zittel, 1868).– Sapunov, p. 189, pl. 40, fig. 4.
1982. *Berriasella* (*Hegaratella*) *jacobi* Mazenot.– Hoedemaeker, p. 14, pl. 1, fig. 7.
pars? 1982. *Berriasella* (*Berriasella*) *jacobi* Mazenot, 1939.–

Nikolov, p. 51, pl. 8, figs 4, 6-8, *non* fig. 5 [perhaps *Berriasella (Hegaratella) oppeli* (Kilian)].

pars 1982. *Pseudosubplanites lorioli* (Zittel, 1968).– Nikolov, p. 42, pl. 5, fig. 7, *non* fig. 5 [= *Pseudosubplanites lorioli* (microconch) Zittel, 1868)], *non* fig. 6 (= *Pseudosubplanites fasciculatus* sp. nov.).

1985. *Berriasella* (*Berriasella*) *jacobi* Mazenot.– Tavera Benitez, p. 238, pl. 33, figs 7-11.

pars 1985. *Berriasella* (*Berriasella*) *oppeli* (Kilian, 1889).– Tavera Benitez, p. 252, pl. 35, fig. 5, *non* fig. 3 (= *Berriasella (Hegaratella) elmii* Le Hégarat, 1973), *non* fig. 4 [= *Berriasella (Hegaratella) oppeli* (Kilian, 1889)].

1990. *Berriasella jacobi* (Mazenot, 1939).– Khimshashvili, p. 372, pl. 1, figs 1, 6.

2003. *Berriasella jacobi* Mazenot.– Arkadiev, p. 31, pl. 1, figs 1a, b, 2.

2004. *Berriasella jacobi* Mazenot, 1939.– Arkadiev & Bogdanova, p. 372, pl. 1, figs 1a, b, 2.

pars 2012. *Berriasella jacobi* Mazenot, 1939.– Arkadiev *et al.,* p. 144, pl. 4, figs 4a, b, 5?, 6.

non 2012. *Berriasella* (*Berriasella*) *jacobi* Mazenot, 1939.– Salazar Soto, p. 172, fig. 4.52, a-q (= *Parodontoceras fraudans* Steuer, 1897).

2013. *Berriasella jacobi* (Mazenot, 1939).– Vašíček & Skupien, p. 335. figs 5C, D, G-I.

Holotype: The specimen depicted by Mazenot (1939), pl. 4, fig. 1a, b under the name *Berriasella Jacobi* n. sp., derived from the Jacobi Zone of Chomérac, deposited in the Faculté des sciences de Grenoble, Institut Dolomieu, Collection Gevrey, No. ID 572.

Material: Thirteen specimens: twelve from the Jacobi Zone along the Barranco de Tollo RGM 160 414 (loose upon bed Z115), RGM 160 438 (bed Z196), RGM 160 412 (bed Z 31A), RGM 160 413 (bed Z 31A), RGM 160 234 (bed Z 95), RGM 617 891 (bed Z170), RGM 160 415 (bed Z143), RGM 160 385 (bed Z196), RGM 365 172 (bed Z192), RGM 160 414 (bed Z115), RGM 617 890 (bed Z31), RGM 791 175 (bed Z152), and one from Jacobi Zone along the Barranco de Las Oicas (section M, seven kilometres west) RGM 160 416 (bed M8).

Description: The shape of the shell of *H. jacobi* is planulate and has a small and shallow umbilicus. The whorl height increases rapidly with growth. The flanks are slightly convex. The ornamentation consists of prorsiradiate bifurcate ribs, which split just above mid-flank into two secondary ribs of the same thickness as the primary ribs. The ribs are not too fine and rather close together. There are some simple ribs on the outer whorl (their number may vary from zero to six). All ribs are slightly flexuous and projected on the upper third of the flank.

Measurements: See Table XII.

Remarks: *Berriasella (Hegaratella) jacobi* has the smallest umbilicus of all species in *Berriasella (Hegaratella)* and a rapid increase of the whorl height; it is therefore rather easily identifiable. However, there are also specimens in which the height of the whorl rather slowly increase in height, and in which the umbilical width almost equals the whorl height, for instance the specimen of *B. (H.) jacobi* in Le Hégarat & Remane (1968), pl. 5, fig. 1; Nikolov (1982) pl. 8, fig. 6; Tavera (1985) pl. 33, fig. 11; Arkadiev *et al.* (2012) pl. 4, fig. 5. There are transitional specimens.

The specimen described by Salazar Sato (2012) is not conspecific with *B.* (*H.*) *jacobi*, because its umbilicus is too wide and the whorls too thick and too rounded. He thinks that the holotype of *B.* (*H.*) *jacobi* is a juvenile specimen. If so, then all the specimens hitherto collected in southern Europe and northern Africa are juvéniles, which is hard to proof.

Geographic distribution: France, Spain, Bulgaria, Georgia, Tunisia, Madagascar, Ukraine (The Crimea).

***Berriasella* (*Hegaratella*) *subcallisto* (Toucas, 1890)**
Pl. VIII, figs 1-3

* 1890. *Hoplites Calisto* var. *subcalisto* Toucas, p. 601, pl. 17, fig. 4a, b., *non* fig. 5a, b [= *Berriasella (Hegaratella) oppeli*? Kilian, 1889].

pars 1939. *Berriasella subcallisto* (Toucas).– Mazenot, p. 53, pl. 3, fig. 11a, b; 14a, b, *non* 13a, b [= *Lemencia ciliata* (Schneid, 1914)].

non 1939. *Berriasella* aff. *subcallisto* (Toucas).– Mazenot, p. 54, pl. 3, fig. 12 [= possibly *Berriasella (Hegaratella) oppeli* Kilian, 1889].

non 1953. *Berriasella subcallisto* (Toucas 1890).– Arnould-Saget, p. 32, pl. 3, fig. 9a-c (= *Delphinella berthei* Toucas, 1890).

? 1960. *Berriasella subcallisto* [(Toucas) Gevrey].– Nikolov, p. 159, pl. 4, figs 2, 3.

non 1967. *Berriasella subcallisto* (Toucas, 1890).– Dimitrova, p. 101, pl. 48, fig. 8 [= possibly *Berriasella* (*Hegaratella*) *berthei* (Toucas, 1890)].

Table XII: Measurements *Berriasella* (*Hegaratella*) *jacobi* Mazenot, 1939.

RGM 160 412	D = 43.4	Wh = 18.6 (42.9)	U = 13.6 (31.3)
RGM 617 891	D = 38	Wh = 15.0 (39.5)	U = 10 (26.3)
RGM 160 414	D = 38.5	Wh = 15.5 (40.3)	U = 13.1 (34.0)
RGM 160 385	D = 26.1	Wh = 11.6 (44.4)	U = 6.8 (26.1)
RGM 791 175	D = 38.8	Wh = 14.0 (36.1)	U = 13.0 (33.5)
RGM 160 415	D = 32.4	Wh = 13.4 (41.4)	U = 10.3 (31.8)

1968. *Berriasella subcallisto* (Toucas).– Le Hégarat & Remane, p. 24, pl. 5, fig. 4.

pars 1973. *Berriasella (Berriasella) subcallisto* (Toucas).– Le Hégarat, p. 66, pl. 6, figs 3-6; *non* pl. 39, fig. 2 [= *Berriasella (Hegaratella) vasiceki* sp. nov.].

non 1982. *Berriasella* (*Berriasella*) *subcalisto* (Toucas, 1890).– Nikolov, p. 56, pl. 10, fig. 2 (= *Berriasella* sp. indet.), *non* pl. 11, fig. 1 [= *Berriasella (Hegaratella) vasiceki* sp. nov.].

1985. *Berriasella* (*Berriasella*) *subcallisto* (Toucas).– Tavera, p. 245, pl. 34, fig. 3.

2004. *Berriasella subcallisto* (Toucas, 1890).– Arkadiev & Bogdanova, p. 373, pl. 1, figs 10a, b, 11a, b.

2012. *Berriasella subcallisto* (Toucas, 1890).– Arkadiev *et al.,* p. 146, pl. 5, figs 6a, b, 7a, b.

Lectotype: The specimen depicted by Toucas (1890), on pl. 17, fig. 4a, b under the name *Hoplites Calisto* var. *subcalisto*, derived from the Jacobi Zone of Chomérac, designated by Mazenot, 1939. Unfortunately this lectotype is lost, but Mazenot (1939) produced two nice topotypes on pl. 3, fig. 11a, b, and fig. 14a, b. The former resembles the lectotype most and may function as neotype (designated herein).

Material: Four specimens. Three of them from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain: RGM 160 420 (bed Z134), RGM 160 418 (bed Z150-153), RGM 160 419 (bed Z154), and one from the Subalpina Subzone along the Barranco de las Oicas, 10 kilometres west of Caravaca: RGM 160 422 (beds M58-62).

Description: The shell is an evolute planulate with a shallow umbilicus. The latter has a very low wall, which merges into a rounded rim. The umbilicus is at a diameter of 52 mm equal to the whorl height. At larger diameters it is wider and at smaller diameters narrower than the whorl height. The flanks are only slightly rounded and the venter is sharply rounded and provided with a narrow siphonal furrow. The ornamentation of most specimens of *H. subcallisto* looks like the topotype specimen depicted in Mazenot (1939) on pl. 3, fig. 14, the thin-ribbed variety with an umbilicus, which is wider than the whorl height. On the innermost whorls up to 6 mm diameter the ribs are very fine. On the phragmocone the prorsiradiate ribs are straight, thin and close together. The interspaces are equal. Most ribs bifurcate, but simple ribs also occur. On the low umbilical wall the ribs are rursiradiate. On the body chamber the ribs are slightly flexuous; they are rursiradiate on the low umbilical wall, convex on the lower two thirds of the flank height and projected on the upper third of the flank height. The furcation occurs at mid-flank, but sometimes a little higher.

Measurements: See Table XIII.

Remarks: The specimen of pl. 10 fig. 2 in Nikolov (1982) has some resemblance to *B.* (*H.) subcallisto*, but was found in the Boissieri Zone. Since the representatives of the subgenus *Berriasella* (*Hegaratella*) are vitually restricted to the Jacobi Zone and herein considered the ancestral group of *Berriasella* (*Berriasella*), which are restricted to the Occitanica and Boissieri zones, Nikolov's species probably cannot be identified as such.

The specimen depicted by Le Hégarat (1973) on pl. 39, fig. 2 (FSL 127 348) has thicker, close-spaced ribs, an umbilicus which is smaller than the whorl height, and a whorl which more rapidly increases in height. This specimen is herein regarded as not conspecific with the lectotype and should have another name. The author named it *Berriasella (Hegaratella) vasiceki* sp. nov. The specimens RGM 160 421 and RGM 617 893 (Z243) are identical to Le Hégarat's specimen.

Geographic distribution: France, Spain, Tunisia.

Berriasella (*Hegaratella*) *vasiceki* sp. nov.

Pl. VIII, figs 5, 6

**pars* 1973. *Berriasella* (*Berriasella*) *subcallisto* (Toucas).– Le Hégarat, p. 66, pl. 39, fig. 2, *non* pl. 6, figs 3-6 [= *Berriasella (Hegaratella) subcallisto* (Toucas, 1890)].

1982. *Berriasella* (*Berriasella*) *subcalisto* (Toucas, 1890).– Nikolov, p. 56, pl. 11, fig. 1, *non* pl. 10, fig. 2 (*Berriasella* sp. indet.).

Holotype: The specimen figured in Le Hégarat (1973) on pl. 39, fig. 2, under the name *Berriasella (Berriasella) subcallisto* (Toucas), derived from the Jacobi Zone near St. Germain (in the neighbourhood of Aubenas, Ardèche, France), deposited in the Le Hégarat collection, No. FSL 127 348, at the Université Claude Bernard de Lyon.

Derivatio nominis: After Prof. Dr. Zdenek Vašíček, specialist in Lower Cretaceous ammonites, Ostrava, Czech Republic.

Material: Three specimens in total: two from the Subalpina Zone along the Barranco de Oicas, 10 kilometres west of Caravaca, Province of Murcia, Spain RGM 160 421 (bed M 54-55) and RGM 160 423 (bed M33); one from the Subalpina Zone along the Barranco

Table XIII: Measurements *Berriasella* (*Hegaratella*) *subcallisto* (Toucas, 1890).

RGM 160 422	D = 60.7	Wh = 20.8 (34.3)	U = 22.7 (37.4)	
RGM 160 420	D = 59.5	Wh = 20 (33.6)	U = 24.2 (40.7)	Wh = U at D = 52
Lectotype	D = 54	Wh = 19 (35.2)	U = 21 (38.9)	
RGM 160 418	D = 41.5	Wh = 16.3 (39.3)	U = 15.6 (37.6)	

de Tollo, three kilometres west of Caravaca: RGM 617 893 (bed Z243).

Description: Discoidal planulate with flat flanks, a shallow umbilicus with rounded rims. The umbilicus is smaller than the whorl height. The whorl section is high with parallel flaks and a narrowly rounded venter. The venter has a very narrow furrow. The ribs are not as sharp and thin as in *H. subcallisto* (Toucas), with which it is often confounded, but are slightly thicker and rounded in section. The ribs of the inner whorls are prorsiradiate, a little flexuous, rather close together and normally bifurcate. There are a few simple ribs. The secondary ribs are projected. On the body chamber the ribs are very uniform and calibrated, almost straight. The secondary ribs are hardly deviating and not or hardly projected. They make an angle of ninety degrees with the siphonal furrow.

Measurements: See Table XIV.

Remarks: The specimen that has been identified as *Berriasella (Berriasella) subcallisto* (Toucas) by Le Hégarat (1973) and depicted by him on pl. 39, fig. 2, differs markedly in measurements and ribbing from the lectotype of this species. The umbilicus is markedly smaller, and the whorl height increases more rapidly with growth; the ribs are more distant and thicker. The flanks are flat and not slightly rounded as in *B.* (*H.*) *subcallisto*. Therefore the author was compelled to give this ammonite a new name, viz. *Berriasella (Hegaratella) vasiceki* sp. nov.

Geographic distribution: France, Spain.

***Berriasella* (*Hegaratella*) *oxycostata* Mazenot, 1939**
Pl. VIII, figs 7-9

**pars* 1939. *Berriasella oxycostata* (Jacob) in Breistroffer.– Mazenot, 1939, p. 51, pl. 3, fig. 9a-j, *non* fig. 10 (= *Subthurmannia simplicicostata* Mazenot, 1939).
1953. *Berriasella oxycostata* (Jacob) in Mazenot 1939.– Arnould-Saget, p. 29, pl. 3, figs 5a-c, 6a-c.
non 1953. *Barriasella* cf. *oxycostata* (Jacob) in Mazenot 1939.– Arnould-Saget. p. 31, pl. 3, figs 7a-c, 8a-c (= *Delphinella angustiumbilicata* sp. nov).
1973. *Berriasella (Picteticeras) oxycostata* (Jacob).– Le Hégarat, p. 78, pl. 8, figs 4-6, pl. 40, figs 2-4.
1979. *Berriasella* (*Picteticeras*) *oxycostata* (Mazenot, 1939).– Sapunov, p. 176, pl. 56, figs 3, 4.
1979. *Berriasella* (*Picteticeras*) *chomeracensis* (Toucas, 1890).– Sapunov, p. 175, pl. 56, fig. 3.
1982. *Berriasella* (*Hegaratella*) *oxycostata* (Mazenot, 1939).– Nikolov, p. 70, pl. 15, fig. 2.

Holotype: The specimen depicted in Mazenot (1939) on pl. 3, fig. 9 under the name *Berriasella oxycostata* (Jacob) in Breistroffer, derived from the Jacobi Zone of Aizy (Isère, France), deposited in the Faculté des Sciences de Grenoble, Institut Dolomieu, No. ID 614.

Material: Eight badly preserved specimens: six identifiable specimens from the Jacobi Zone along the Barranco de Tollo (Caravaca, Province of Murcia. Spain): RGM 160 435 (bed Z87), RGM 160 436 (bed Z119), RGM 160 437 (bed Z119), RGM 617 894 (bed Z171), RGM 617 895 (bed Z196), RGM 160 429 (bed Z192-197); and two along the Barranco de Las Oicas 10 kilometres west of Caravaca: RGM 160 433 (bed M8) and RGM 160 434 (bed M8).

Description: Evolute planulate shell with a wide, shallow umbilicus with rounded rims. The umbilicus is wider than the whorl height. The whorls only slowly increase in height. The whorl section is elliptic with rounded flanks and venter. Ribs are slightly prorsiradiate, straight, thin and high and separated by wide interspaces. Apart from the bifurcating ribs there are many simple ribs; the bifurcation points are above mid-flank. On the venter the ribs are interrupted by a prominent furrow. On the ventrolateral shoulders the ribs are raised into small tubercles.

Measurements: See Table XV.

Remarks: *B.* (*H.*) *oxycostata* resembles *B.* (*H.*) *chomeracensis*, but is more evolute, has whorls that slowly grow in height, has a smaller number of simple ribs, and the ribs are further apart.

Geographic distribution: France, Tunisia, Spain.

Table XIV: Measurements *Berriasella* (*Hegaratella*) *vasiceki* sp. nov.

Holotype Photo	D = 65	Wh = 26 (40.0)	U = 21.7 (33.4)
RGM 617 893	D = 49.5	Wh = 19.5 (39.4)	U = 16.5 (33.3)

Table XV: *Berriasella* (*Hegaratella*) *oxycostata* Mazenot, 1939.

RGM 160 433	D = 46	Wh = 15.7 (34.1)	U = 18 (39.1)	Wt = 10.8 (23.5)
RGM 617 894	D = 25.3	Wh = 9.0 (35.6)	U = 9.8 (38.7)	
RGM 160 435	D = 27	Wh = 9.3 (34.4)	U = 10.5 (38.9)	

Berriasella (_Hegaratella_) _paramacilenta_ Mazenot, 1939

Pl. VIII, figs 4, 10-16

*pars 1939. *Berriasella paramacilenta* n. sp. Mazenot, pl. 20, figs 1a, b, 2a, b, 4a, b; *non* fig. 3a-d [= *Berriasella* (*Berriasella*) *multicostata* sp. nov]. [see under Subgenus *Berriasella* (*Hegaratella*) systematics].

non 1953. *Berriasella paramacilenta* Mazenot 1939.– Arnould-Saget, p. 59, pl. 6, fig. 2a, b [= *Berriasella* (*Berriasella*) *multicostata* sp. nov.].

1967. *Berriasella paramacilenta* Mazenot, 1939.– Dimitrova, p. 102, pl. 48, fig. 5 [= *Berriasella privasensis* (Pictet, 1867)].

1968. *Berriasella paramacilenta* Mazenot.– Le Hégarat & Remane, p. 24, pl. 4, fig. 5.

pars 1973. *Berrriasella* (*Berriasella*) *paramacilenta* Mazenot.– Le Hégarat, p. 60, pl. 6, fig. 8, pl. 38, fig. 8, pl. 39, fig. 1, pl. 42, fig. 11.

1976. *Berriasella (Berriasella) paramacilenta* Mazenot, 1939.– Patrulius & Avram, p. 175, pl. 6, fig. 5.

non 1979. *Pseudosubplanites* (*Hegaratella*) *paramacilenta* (Mazenot, 1939).– Sapunov, p. 191, pl. 56, fig. 1 [= *Substeueroceras beneckei* (Mazenot, 1939)].

pars 1982. *Pseudosubplanites* (*Hegaratella*) *paramacilenta* (Mazenot, 1939).– Nikolov, p. 44, pl. 7, fig. 1, 3, *non* fig. 2 (= possibly *Tirnovella berriasensis* Le Hégarat, 1964), pl. 6, fig. 5, *non* fig. 4 (= *Substeueroceras beneckei,* Mazenot, 1939), *non* pl. 8, fig. 9 (= *Delphinella clavicostata* sp. nov.).

1985. *Berriasella* (*Hegaratella*) *paramacilenta* (Mazenot).– Tavera, p. 259, pl. 36, figs 3-9.

non 1999. *Berriasella* (*Berriasella*) *paramacilenta* Mazenot, 1939.– Kvantaliani, p. 91, pl. 11, fig. 3a, b (= *Berriasella* indet.).

non 2005. *Berriasella* (*Hegaratella*) *paramacilenta* (Mazenot, 1939).– Bogdanova & Arkadiev, 502, fig. 9F [= may be the inner whorls of *Berriasella* (*H.*) *grandis*].

non 2012. *Berriasella paramacilenta* Mazenot, 1939.– Arkadiev *et al.,* p. 150, pl. 5, fig. 5 (= may be the inner whorls of *Berriasella* (*H.*) *grandis* Mazenot, 1939).

Holotype: The specimen depicted by Mazenot (1939), on pl. 20, fig. 1a, b under the name *Berriasella paramacilenta* n. sp., derived from the Jacobi Zone near Noyarey, Isère, France, deposited in the Faculté des Sciences de Grenoble, Institut Dolomieu (Gevrey collection) No. ID 515.

Material: Fourteen specimens from the Jacobi Zone and one specimen from the Subalpina Subzone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain: RGM 160 407 (bed Z144), RGM 617 898 (bed Z158), RGM 160 410 (bed Z158), RGM 160 408 (bed Z150), RGM 160 309 (bed Z140-168), RGM 617 897 (bed Z110), RGM 160 307 (bed Z95), RGM 617 896 (bed Z141), RGM 617 899 (Z168-170), RGM 160 405 (bed Z119), RGM 160 464 (bed 168A), RGM 160 465 (bed Z168-170), RGM 617 885 (bed Z161), RGM 617 883 (bed Z166), Subalpina subzone: RGM 791 178 (bed Z242).

Description: Compressed planulates with a shallow umbilicus, which is narrower than the whorl height, but which increases with growth to become as wide as the whorl height at the aperture. The ornamentation consists of straight, slender, slightly prorsiradiate ribs, which bifurcate at mid-flank; they may become flexuous towards the aperture; at the umbilical rim they describe a small concavity. The secondary ribs are slightly projected. On the innermost whorls the ribbing is very fine and dense. The venter is not preserved in the material of the author.

Measurements: See Table XVI.

Remarks: The ribs of *B.* (*H). paramacilenta* are slightly less rigid than in *B.* (*H.*) *oppeli* (Kilian), that is, their relief is less high, they are slightly closer to each other, and without elevation at the point of furcation; the ribs may even be a little flexuous. There is no furrow on the adult venter as in *B.* (*H.*) *oppeli*, but according to Mazenot (1939) the ribs have mid-ventral notches on the inner whorls, which is a special kind of furrow indicating that *B.* (*H.*) *paramacilenta* belongs to the Barriasellidae and not to *Pseudosubplanites*. From mid-flank the ribs begin their projection; the furcation of the primary ribs into secondary ribs is also at mid-flank. In *B.* (*H.*) *oppeli* the furcation of the ribs and their projection begins at two thirds of the flank height. In *B.* (*H.*) *paramacilenta* most ribs describe a small concave curvature at the umbilical rim, which is not present in *B.* (*H.*) *oppeli* (Kilian).

B. (*H.*) *paramacilenta* resembles *Pseudosubplanites ponticus* (Retowski, 1894) in the densely ribbed inner whorls, but it differs from the latter in the more rapid disappearance of the dense ribbing with growth; in *P. ponticus* the dense ribbing also disappears with growth, but much later, slower and more gradual. In *B.* (*H.*) *oppeli* the ribbing on the inner whorls remain rather strong and wide-spaced.

Table XVI: Measurements *Berriasella* (*Hegaratella*) *paramacilenta* Mazenot, 1939.

RGM 160 307	D = 46.6	Wh = 19.2 (41.2)	U = 14.5 (31.1)	
RGM 160 405	D = 43.6	Wh = 16.4 (37.6)	U = 14.6 (33.5)	wh = 12.9 (29.6)
RGM 160 465	D = 45.8	Wh = 16.2 (34.5)	U = 14.3 (31.2)	wh = 14.4 (31.4)
RGM 160 464	D = 54	Wh = 22.0 (40.7)	U = 18.0 (33.3)	wh = 15.0 (27.7)

The author introduced a new name, *Berriasella* (*Berriasella*) *multicostata*, for the specimens depicted by Mazenot (1939) on pl. 20, fig. 3a-d and on pl. 21, fig. 1 (see under Subgenus *Berriasella* (*Hegaratella*) systematics).

Geographic distribution: Spain France, Bulgaria, Ukraine (The Crimea).

Berriasella (*Hegaratella*) *oppeli* (Kilian, 1889)

Pl. IX, figs 1, 2

**pars* 1868. *Ammonites Calisto* d'Orbigny.– Zittel, p. 100, pl. 20, fig. 1-4. *non* fig. 5 (= unidentifiable fragment).

1889. *Perisphinctes Oppeli* Kilian, p. 662.

1889. *Hoplites carpathicus* Zitt. sp.– Kilian, p. 660, pl. 30, fig. 1a, b.

non 1891. *Hoplites Oppeli* Kil. sp.– Behrendsen, p. 403, pl. 23, fig. 2a, b [= *Parodontoceras krantzi* (Leanza, 1945)].

non 1912. *Berriasella* aff. *Oppeli* Kilian sp.– Burckhardt, p. 138, pl. 35, figs 1-3. ("*Berriasella*" *Krantzi* Leanza, 1945).

pars 1939. *Berriasella Oppeli* (Kilian).– Mazenot, p. 49, pl. 3, figs 1-3, 6-8, *non* fig. 4 [= *Berriasella (Hegaratella) elmii* (Le Hégarat, 1973)], *non* fig. 5 [= *Berriasella* (*Berriasella*) *picteti* (Kilian, 1906)].

pars 1960. *Berriasella oppeli* (Kilian).– Nikolov, p. 160, pl. 3, fig. 3, *non* fig. 7 (= *Berriasella* sp.).

1960. *Berriasella oppeli* Kilian.– Drushchits, p. 275, pl. 20, figs 2, 3.

1973 *Berriasella* (*Berriasella*) *oppeli* (Kilian).– Le Hégarat, p. 58, pl. 1, figs 1, 2, pl. 38, figs 4, 5.

non 1976. *Berriasella (Berriasella*) *oppeli* (Kilian).– Patrulius & Avram, p. 172, pl. 4, figs 1a, b, 3a, b [=*Berriasella* (*Berriasella*) *privasensis* (Pictet, 1867)], *non* figs 2, 4 [= *Berriasella* (*Berriasella*) *picteti* (Kilian, 1906)].

1976. *Berriasella* (*Berriasella*?) *paramacilenta* Mazenot, 1939.– Patrulius & Avram, p. 175, pl. 6, fig. 5.

1979. *Pseudosubplanites* (*Pseudosubplanites*) *lorioli* (Zittel, 1868).– Sapunov, p. 189, pl. 40, fig. 5, *non* fig. 4 [= *Berriasella* (*Hegaratella*) *jacobi* (Zittel, 1868)].

1982. *Berriasella* (*Hegaratella*) *oppeli* (Kilian).– Hoedemaeker, p. 16, pl. 1, fig. 6.

pars 1982. *Pseudosubplanites* (*Pseudosubplanites*) *lorioli* Zittel, 1868).– Nikolov, p. 42, pl. 2, fig. 2, pl. 5, fig. 8 *non* pl. 5, fig. 5 [= *Pseudosubplanites lorioli* (microconch)], *non* pl. 2, fig. 2 [= *Berriasella (Hegaratella) oppeli* Kilian, 1889], *non* pl. 5, fig. 6 (= *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005), *non* pl. 5, fig. 7 [= *Berriasella* (*Hegaratella*) *jacobi* (Mazenot, 1939)].

non 1985. *Berriasella* (*Berriasella*) *oppeli* (Kilian).– Tavera, p. 252, pl. 35, fig. 3 [= *Berriasella* (*Hegaratella*) *elmii* Le Hégarat, 1973], *non* fig. 4 [= *Berriasella* (*Hegaratella*) *paramacilenta* Mazenot, 1939], *non* fig. 5 [=*Berriasella* (*Hegaratella*) *jacobi* Mazenot, 1939].

2004. *Berriasella oppeli* (Kilian).– Arkadiev & Bogdanova, p. 375, pl. 1, fig. 3a-d.

2012. *Berriasella oppeli* (Kilian, 1889).– Arkadiev *et al.,* p. 147, pl. 5, fig. 3a-d.

2013. *Berriasella oppeli* (Kilian, 1889).– Vašíček & Skupien, p. 335, figs 5E, F, J.

Holotype: The specimen depicted in Zittel (1868), on pl. 20, fig. 1-4 under the name *Ammonites Calisto* d'Orbigny, from the Upper Tithonian of Koniakau, Silesia. The specimen is lost.

Material: Four specimens from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain: RGM 160 233 (bed Z150-153), RGM 160 381 (bed Z140), RGM 160 439 (bed Z192-197), RGM 160 424 (bed Z119).

Description: Compressed planulate with a shallow umbilicus, which is as wide as the whorl height. Whorl section oval with a truncated venter. The bifurcate ribs are strong, straight and radiate; the ribbing is very regular and the rather wide interspaces slowly increase with growth. All points of forking are at two-thirds of the flank height, and the ribs are elevated at the forking points. The secondary ribs are projected and interrupted at midventer by a furrow.

Measurements: see Table XVII.

Remarks: *B.* (*H.*) *oppeli* resembles *B.* (*H.*) *paramacilenta*, but differs from the latter in the stronger and staighter ribs, the elevated forking points, which are situated above mid-flank, and in the absence of fine, dense ribbing on the inner whorls. On *B.* (*H.*) *paramacilenta* the bifurcate ribs are less strong, prorsiradiate, with smaller interspaces and exhibiting small, concave curvature at the umbilical rim; they split at mid-flank and some of them may be weakly flexuous. *Berriasella* aff. *Oppeli* Burckhardt, 1912 of the upper Portlandian (San Pedro de Gallo, Mexico) has too wide an umbilicus and was identified by Leanza (1945) as *"Berriasella" krantzi*.

Geographic distribution: Spain, France, Bulgaria, Ukraine (The Crimea), Czechia.

Table XVII: Measurements *Berriasella* (*Hegaratella*) *oppeli* (Kilian, 1889).

RGM 160 233	D = 43.4	Wh = 15.0 (34.6)	U = 17 (39.2)
RGM 160 405	D = 44.3	Wh = 16.5 (37.2)	U = 14.5 (32.7)
RGM 160 415	D = 32.2	Wh = 11.6 (36.0)	U = 11 (34.2)
RGM 160 439	D = 28.6	Wh = 10 (35.0)	U = 9.3 (32.5)

Berriasella (*Hegaratella*) *chomeracensis* (Toucas, 1890)
Pl. IX, figs 3, 4

* 1890. *Hoplites Calisto* var. *Chomeracensis* Toucas, p. 601, pl. 17, figs 8a, b, 9.
non 1907. *Thurmannia (Berriasella) chomeracensis* Toucas.– Sayn, p. 53, pl. 3, fig. 22a, b [= *Eristavites* (?) *drumensis* Breistroffer, 1937].
1939. *Berriasella chomeracensis* [(Toucas) Gevrey].– Mazenot, p. 62, pl. 6, figs 1-7.
1953. *Berriasella chomeracensis* (Toucas 1890).– Arnould-Saget, p. 36, pl. 4, fig. 4, pl. 6, fig. 5.
1960. *Berriasella chomeracensis* [(Toucas) Gevrey].– Nikolov, p. 161, pl. 4, figs 4-6.
1982. *Berriasella (Picteticeras) chomeracensis* (Toucas, 1890).– Nikolov, p. 65, pl. 14, figs 1-5.
2003. *Berriasella chomeracensis* (Toucas).– Arkadiev, p. 31, pl. 1, figs 3 (enlarged 4×), 4 (enlarged 1.5×).
2004. *Berriasella chomeracensis* (Toucas).– Arkadiev & Bogdanova, p. 376, pl. 1, figs 4 (enlarged 4×), 5 (enlarged 1.5×).
2012. *Berriasella chomeracensis* (Toucas, 1890).– Arkadiev *et al.,* p. 148, pl. 5, fig. 1 (enlarged 1.5×), fig. 2 (enlarged 3×).

Lectotype: The specimen depicted by Toucas (1890), pl. 17, figs 8a, b under the name *Hoplites Calisto* var. *Chomeracensis*, derived from the Jacobi Zone of Chomérac, deposited in the Université Claude Bernard de Lyon, Geological Department, No FSL 127 334.
Material: Five specimens in total: four from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain: RGM 160 428 (bed Z144), RGM 160 431 (bed Z202), RGM 160 427 (bed Z31-33), RGM 160 432 (bed Z105), one from the Barranco de las Oicas ten kilometers west of Caravaca: RGM 160 426 (bed M8).
Description: Rather small planulates with somewhat inflated whorls and shallow umbilicus. The umbilicus is smaller than the whorl height. The flanks are slightly rounded, the umbilical rim and the venter are rounded. The whorl section is subrectangular with rounded shoulders. The ornamentation consists of strong, high ribs, which bifurcate at, or slightly above, mid-flank, or do not bifurcate. The simple ribs are in great numbers but their number may vary considerably; one specimen (Le Hégarat, 1973, pl. 7, fig. 5) has only seven simple ribs to 33 bifurcate ones, but another specimen (Mazenot, 1939, pl. 6, fig. 6) has 20 simple ribs to 10 bifurcate ribs. The simple ribs are irregularly distributed. On the venter all ribs are interrupted by a mid-ventral furrow.
Remarks: *B.* (*H.*) *chomeracensis* resembles *B.* (*H.*) *oxycostata*, but has a smaller umbilicus and is less evolute; *B.* (*H.*) *chomeracensis* generally has more simple ribs than *B.* (*H.*) *oxycostata*. The ribs of *B.* (*H.*) *oxycostata* are sharper and further apart.
Geographic distribution: France, Tunisia, Spain, The Crimea (Ukraine).

Berriasella (*Hegaratella*) *taverai* sp. nov.
Pl. IX, figs 5-10

* 1939. *Berriasella subrichteri* (Retowski).– Mazenot, p. 130, pl. 21, fig. 10a.
1999. *Berriasella* (*Berriasella*) *subrichteri* (Retowski).– Kvantaliani, p. 90, pl. 11, figs 1, 2.
? 2005. *Berriasella* (*Berriasella*) *subrichteri* (Retowski).– Kvantaliani, p. 313, pl. 58, fig. 2.

Holotype: The specimen depicted in Mazenot (1939) on pl. 21, fig. 10a, b, under the name *Berriasella subrichteri* (Retowski), deposited in the Faculté des Sciences de Grenoble, Institut Dolomieu, No. ID 657.
Derivatio nominis: After Professor Dr José Maria Tavera Benitez of the Universty of Granada, who described (in his dissertation, 1985) the upper Tithonian and Berriasian ammonite fauna of the Betic Cordilleras.
Diagnosis: Flat compressed planulate with an eccentric umbilicus, which is at a diameter of 54.7 mm as wide as the whorl height. Thin, sharp, sigmoidal to falcate, bifurcate ribs. Only a few simple ribs present. There are intervals in which the ribs are only weakly sigmoidal. Ribs cross the venter without interruption, but on the inner whorls the venter shows siphonal notches.
Material: Five fragments from the Jacobi Zone along the Barranco de Tollo (Caravaca, Province of Murcia, Spain); only the inner whorls of this species are preserved; RGM 160 380 (bed Z117-133), RGM 160 694 (bed Z202), RGM 617 901 (bed Z130), RGM 617 902 (bed Z147), RGM 617 903 (bed Z204).
Description: Compressed planulate shells with a slightly eccentric umbilicus, which is smaller than the whorl height, but becomes slightly larger at diameters larger than 54.7 mm. The umbilical wall is perpendicular and the umbilical rim is rounded. The inner whorls are slightly more rounded than those of the later whorls. In the author's material the venter is not preserved, but according to Mazenot (1939) the ribs cross the venter without interruption. However, Mazenot mentions mid-ventral notches on the inner whorls. The ornamentation consists of rather thin, sharp, prorsiradiate, rather closely set, bifurcating ribs, which are markedly sigmoidal to falcate. They originate on the umbilical wall. Many ribs describe a concave curve on the umbilical rim. A few simple ribs are present.
Measurements: See Table XVIII.
Remarks: The specimen depicted by Mazenot (1939) is the only species of *Berriasella (Hegaratella)* of the Jacobi Zone that exhibits pronounced sharp S-shaped and sickle-shaped ribs on the whorls of the younger specimens. This type of ornamentation is unique in the Jacobi Zone. Le Hégarat (1973) synonymized this species with *Berriasella* (*Hegaratella*) *paramacilenta* (Mazenot, 1939), but the strong, sharp, sigmoidal ribs of *B.* (*H.*) *taverai* are a good distinguishing feature.
Geographical distribution: Spain, France, Ukraine (The Crimea).

Berriasella (Hegaratella) enayi Le Hégarat, 1973
Pl. IX, fig. 11

1890. *Perisphinctes eudichotomous* (Zittel).– Toucas, p. 599, pl. 16, fig. 4.
* 1939. *Berriasella praecox* (Schneid).– Mazenot, p. 41, pl. 1, figs 10, 11a-c, 12a, b, *non* fig. 13 (= *Berriasella nitida* Schneid, 1915).
1973. *Berriasella* (*Picteticeras*) *enayi* n. sp.– Le Hégarat, p. 72, pl. 7, figs 10-12.
? 1979. *Berriasella* (*Picteticeras*) *enayi* Le Hégarat, 1973.– Sapunov, p. 176, pl. 56, fig. 2.
pars 1982. *Berriasella* (*Picteticeras*) *enayi* (Le Hégarat, 1973).– Nikolov, p. 65, pl. 14, fig. 6a, b, *non* fig. 7a, b [= *Berriasella* (*Hegaratella*) *elmii* Le Hégarat, 1973].

Holotype: The specimen, depicted by Mazenot (1939) on pl. 1, fig. 12a, b under the name *Berriasella praecox* Schneid, derived from the upper Tithonian of Chomérac, deposited in the faculté des Sciences de Grenoble, Institut Dolomieu, (Collection Gevrey), number ID569.
Material: One specimen from the Jacobi Zone along the Barranco de Tollo, Caravaca, province of Murcia, Spain: RGM 160 409 (bed Z150).
Description: Evolute planulate with an umbilicus which, with growth, becomes wider than the whorl height. The whorls of *B*. (*H*.) *enayi* slowly grow in height and have slightly rounded flanks. Its ornamentation consists of rather widely spaced, straight, radial to slightly prorsiradiate ribs, which bifurcate just above mid-flank. Forty-one ribs on the last whorl.
Measurements: See Table XIX.
Remarks: *Berriasella (Hegaratella) enayi* Le Hégarat, 1973 closely resembles *Berriasella (Hegaratella) elmii* Le Hégarat, 1973, but in contrast with the former species *B*. (*H*.) *elmii* has about 56 more closely spaced, bifurcate ribs on the last whorl instead of 41; they bifurcate at ¾ flank height instead of just above mid-flank. These two representatives of *Berriasella (Hegaratella)* have, like *B*. (*H*.) *oxycostata*, umbilici, which are wider than the whorl height. This is the main distinction of these forms from other representatives of *Berriasella* (*Hegaratella*), which are characterized by umbilici that are smaller than, or equal to, the whorl height.
Geographical distribution: France, Spain.

Berriasella (Hegaratella) kleini sp. nov
Pl. VII, figs 11, 12

* 1889. *Hoplites privasensis* Pictet sp.– Kilian, p. 660, pl. 30, fig. 3a, b.
? 1939. *Berriasella* aff. *privasensis* (Pictet).– Mazenot, p. 46, pl. 2, fig. 5a, b.

Holotype: The specimen depicted by Kilian (1889) on plate 30, fig. 3a, b, with the name *Hoplites privasensis* (Pictet), derived from the upper Tithonian at Fuente de los Frailes near Cabra (Province of Cordoba, southern Spain), deposited in the collections of the 'Mission d'Andalousie' in the laboratoire de géologie of the Sorbonne (Paris).
Derivatio nominis: Named after Jaap Klein, collector of Lower Cretaceous ammonites, which he donated to the Naturalis Diversity Centre, author of Fossilium Catalogus I; Animalia. Lower Cretaceous ammonites.
Diagnosis: Small planulate, with a shallow umbilicus, which is a little smaller than the whorl height. The whorls grow only slowly in height. Sharp bifurcating ribs, slightly prorsiradiate; a few simple ribs present. Narrow siphonal groove. The rib-ends reach the mid-ventral furrow at an angle of about 45 degrees and form a chevronlike pattern.
Material: One specimen: RGM 617 892 (bed Z193).
Description: Small planulate shell with a high compressed whorl section with the thickest part at one quarter flank height. The ventral side is rather narrow. Umbilicus shallow and slightly smaller than the whorl height. Umbilical rim rounded. The ornamentation consists of 21 radial, straight primary ribs on half a whorl; ribs nearly all bifurcate at mid-flank into two secondary ribs; the latter become projected when approaching the venter; nearly all ribs are dichtomous and split into two secondary ribs at mid-flank. A few ribs remain simple. Ribs originate at the umbilical seam and are interrupted at midventer by a narrow furrow. The rib-ends reach the mid-ventral furrow at an angle of about 45 degrees forming a chevron-like pattern.
Measurements: See Table XX.
Remarks:. The specimen depicted by Mazenot (1939) on plate 2, fig. 5a, b with the name *Berriasella* aff. *privasensis* (Pictet) closely resembles *B*.(*H*.) *kleini*, but the ribbing of Mazenot's specimen is coarser.

Table XVIII: Measurements *Berriasella* (*Hegaratella*) *taverai* sp. nov.

RGM 160380	D = ±40	Wh = ±13.5 (33.7)	U = 12.5 (31.2)
Holotype	D = 64	Wh = 22 (34.4)	U = 24.7 (38.6)

Table XIX: Measurements *Berriasella* (*Hegaratella*) *enayi* Le Hégarat, 1973.

RGM 160 409	D = 49	Wh = 17.3 (35.3)	U = 20.6 (42.0)

Table XX: Measurements: *Berriasella* (*Hegaratella*) *kleini* sp. nov.

RGM 617 892	D = 27.5	Wh = 9.5 (34.5)	U = 8.7 (31.6)
Holotype Kilian	D = 40	Wh = 15.5 (38.7)	U = 13.5 (33.7)

Geographical distribution: France (?), Spain.

2.2.3. Genus *Chapericeras* Hoedemaeker, 1982

Type species: *Ammonites Chaperi* Pictet, 1868.

Systematics: The Berriasellinae in the lower Jacobi Zone with lateral and umbilical tubercles are generally included in the genus *Malbosiceras* Grigorieva, 1938 (type species *Ammonites Malbosi* Pictet, 1867), but they differ considerably from its type species in the Paramimounum Subzone (Biossieri Zone). The species of the Jacobi Zone are markedly narrower umbilicated and markedly more compressed; they show, like in the subgenus *Berriasella* (*Hegaratella*), rather thin straight ribs, which are only projected near the venter. A small to large number of intercalated ribs are present, and trifurcation occurs. Only '*Malbosiceras*' *nikolovi* Le Hégarat, 1973, of the Jacobi Zone is very aberrant and probably represents the inner whorls of *Himalayites* (*Pomeliceras*) *breveti* (Pomel, 1889).

The representatives of '*Malbosiceras*' of the Jacobi Zone are quite different from those of the Occitanica and Boissieri zones, which have much thicker whorls, much wider umbilici and a less elegant ornamentation. The author (Hoedemaeker, 1982, and herein) deemed it necessary to rename the group of species of the Jacobi Zone generally referred to as '*Malbosiceras*', and proposed the genus *Chapericeras* for this group (Type species: *Ammonites Chaperi* Pictet). The species of genus *Chapericeras* are, like *Berriasella (Hegaratella)*, compressed and moderately umbilicated with straight ribs, which become projected in the upper part of the flanks; they could be regarded as tuberculated *Berriasella* (*Hegaratella*). The genus *Chapericeras* would be a cladistic offshoot of *Berriasella (Hegaratella) sensu* Hoedemaeker and the genus *Malbosiceras* a cladistic offshoot of *Berriasella* (*Berriasella*) *sensu* Hoedemaeker. The species herein assigned to *Chapericeras* are: *C. aizyensis* (Mazenot, 1939), *C. asper* (Mazenot, 1939), *C. chaperi* (Pictet, 1868), *C. tarini* (Kilian, 1889), and *C. bonti* sp. nov. The latter is the only evolute one. It appears that *Chapericeras* mainly occurs in the lower quarter of the Jacobi Zone.

Diagnosis of the genus *Chapericeras*: Compressed planulates commonly with an umbilicus, which is smaller or as wide as the whorl height, and with a narrow truncated venter. They exhibit straight to weakly flexuous bifurcate ribs, which are projected near the venter. In the adult stage they develop umbilical bullae and lateral tubercles and short intercalary ribs between the secondary ribs; some ribs are trifurcate.

Chapericeras chaperi (Pictet, 1868)

Plate IX, fig. 12

pars 1868. *Ammonites Chaperi*, Pictet, p. 242, pl. 37, figs 1a-c, 2, *non* fig. 3 [= *Chapericeras tarini* (Kilian, 1889)].
1889. *Hoplites Chaperi* Pictet.– Kilian, p. 666, pl. 30, fig. 5, pl. 31, fig. 1.
non 1890. *Hoplites Chaperi* Pictet sp.– Toucas, p. 606, pl. 18, fig. 8 (= *Chapericeras tarini* Kilian, 1889).
1939. *Berriasella Chaperi* (Pictet).– Mazenot, p. 80, pl. 8, figs 5a-c, 6a-c, 7a-c, 8, 9, pl. 9, fig. 1.
pars 1939. *Berriasella* sp. ind. (gr. de *B. Chaperi*).– Mazenot, p. 95, pl. 11, fig. 5a, b, *non* pl. 10. fig. 5a, b [= *Delphinella consanguinea* (Retowski, 1894)], *non* pl. 12, fig. 3.[= *Malbosiceras malbosi* (Pictet, 1867)], *non* pl. 13, fig. 1. (= *Retowskiceras*? sp.).
1973. *Malbosiceras chaperi* (Pictet).– Le Hégarat, p. 86, pl. 9, figs 6, 7.
non 1977. *Malbosiceras chaperi* (Pictet, 1868).– Sapunov, p. 57, pl. 6, fig. 2 (= *Chapericeras aizyensis* Mazenot, 1939).
non 1979. *Malbosiceras chaperi* (Pictet, 1868).– Sapunov, p. 184, pl. 57, figs 1a, b, *non* fig 2 (= *Retowskiceras* sp), *non* figs 3-5 (= *Himalayites* or *Retowskiceras*).
1982. *Malbosiceras chaperi* (Pictet, 1868).– Nikolov, p. 128, pl. 42, figs 5, 6, pl. 43, figs 1, 2.
1985 *Malbosiceras chaperi* (Pictet).– Tavera, p. 271, fig. 20D, pl. 39, fig. 3.
non 2007 *Malbosiceras chaperi* (Pictet, 1868).– Arkadiev, Bogdanova & Lysenko, p. 285, pl. 3, fig. 1 (= *Mazenoticeras* sp.), 2 (= *Malbosiceras* indet.), 3a-c [= possibly *Malbosiceras paramimouna* (?) Mazenot, 1939].
non 2012. *Malbosiceras chaperi* (Pictet, 1868).– Arkadiev *et al.,* p. 184, pl. 17, fig. 1 (= *Mazenoticeras* sp.), 2 (= *Malbosiceras* sp. indet.), 3a-c (= *Malbosiceras* sp. indet.).
2013. *Delphinella consanguinea* (Retowski, 1894).– Vašíček & Skupien, p. 338, figs 50, P.

Lectotype: The specimen depicted in Pictet (1868) on pl. 37, fig. 1a-c, under the name *Ammonites Chaperi*, derived from from the Jacobi Zone near Aizy (Isère, France), designated by Mazenot (1939) and deposited in the Faculté des Sciences de Grenoble, Institut Dolomieu, No. ID 637; refigured by Mazenot, 1939 on pl. 8, fig. 7a-c).

Material: One badly preserved, but well-identifiable specimen derived from the Jacobi Zone along the Barranco de Tollo: RGM 617 911 (Z32-37).

Description: Slightly diagenetically compressed planulate with an umbilicus which is as wide as the whorl height. Umbilical wall rounded. The inner whorls are provided with a siphonal groove. The ornamentation of the inner whorls consists of rather closely spaced, straight, bifurcate ribs in which can be discerned two narrow constrictions accompanied by simple ribs. At a diameter of 35 mm lateral tubercles and small umbilical bullae appear. From this point the ornamentation cannot be studied because of the absence of three quarters of a whorl. But the umbilical tubercles are well visible again from a diameter of 70 mm and are rather distant from each other, and this distance increases gradually. At a diameter of 74 mm the body chamber begins. At a diameter of about 80 mm the ribs become weak and the lateral tubercles less prominent, but the umbilical tubercles remain prominent. The mid-ventral groove has disappeared.
Measurements: See Table XXI.
Remarks: The umbilici of the species of *Chapericeras*, with the exception of *Ch. Bonti* sp. nov., are smaller than those of *Malbosiceras*.
Geographical distribution: Spain, France, Bulgaria, The Crimea (Ukraine).

***Chapericeras bonti* sp. nov.**
Pl. IX, figs 13, 14

Holotype: Specimen RGM 617 912 from bed Z46 (Pl. IX, figs 13, 14) of the Jacobi Zone along the Barranco de Tollo Caravaca, Province of Murcia, Spain. Deposited in the Naturalis Biodiversity Centre. Leiden, The Netherlands.
Derivatio nominis: Dedicated to Mr. Willem Bont, collector of Lower Cretaceous ammonites.
Material: One badly preserved specimen from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain. RGM 617 912 (bed Z46).
Description: Compressed half a whorl with a wide umbilicus and high subtrapezoidal whorl section, thickest at 1/3 flank height, the venter is truncated. The first part of the whorl is provided with a narrow mid-ventral groove, on the last part (from D = 55) the ventral groove has disappeared and the ribs are slightly lowered at mid-venter. The ornamentation consists of radial, high, primary ribs, which originate at the umbilical seam and bifurcate at two thirds of the flank height. Four ribs are trifurcate. The latter are distributed at regular distances separated by three or four bifurcate ribs. There are 22 ribs on half a whorl. The secondary ribs are slightly prorsiradiate. At mid-flank all primary ribs are raised like stretched-out tubercles, but the secondary ribs are low, which suggests the presence of long lateral tubercles. However, at diameters smaller than 55 mm the ventral ends of the secondary ribs are also raised, but from a diameter of 55 mm onward the secondary ribs are not raised anymore. Umbilical tubercles are absent.
Measurements: See Table XXII.
Remarks: This species should be classified as *Chapericeras*. The inner whorls resemble the inner whorls of *Chapericeras chaperi,* but in the latter species the main ribs are more widely spaced and develop umbilical tubercles in the adult stage. *Ch. bonti* has a larger umbilicus. *Ch. aizyensis* (Mazenot, 1939) also has long stretched tubercles at mid-flank in every rib, but the umbilicus is much smaller, and the ribs less widely spaced.
Geographical distribution: Spain.

2.2.4. Subgenus *Berriasella* (*Berriasella*) Uhlig, 1905
Type species: *Ammonites privasensis* Pictet, 1867.

Systematics: The genus *Berriasella (Hegaratella)* is restricted to the Jacobi Zone, with the exception of *B.* (*H.*) *tithonica*, which is the only species that appears in the Vulgaris Zone, and *B.* (*H.*) *paramacilenta*, *B.* (*H.*) *subcallisto*, and *B.* (*H.*) *vasiceki,* which become extinct during the Subalpina Subchron, the basal subzone of the Occitanica Zone. Hoedemaeker (1982, and herein) subdivided the genus *Berriasella* into the subgenus *Berriasella* (*Berriasella*), which is restricted to the Occitanica and Boissieri zones and the subgenus *Berriasella* (*Hegaratella*) virtually restricted to the Jacobi Zone; the subgenera *B. (Hegaratella)* and *B.* (*Berriasella*) follow each other in time, and the first subgenus is the ancestor of the latter. The subgenus *Berriasella* (*Berriasella*) starts its range at a major sequence boundary (Be3), which is coupled with major extinctions and originations of ammonites (Fig. 3).
Le Hégarat (1973) made another subdivision; he subdivided the genus *Berriasella* (in which he included *Berriasella* (*Hegaratella*) also into two subgenera,

Table XXI: Measurements *Chapeiriceras chaperi* (Pictet, 1868)

RGM 617 911	±D = 94	Wh = 37 (39.4)	U = 37 (39.4)

Table XXII: Measurements *Chapericeras bonti* sp. nov.

RGM 617 912	D = 61.3	Wh = 18.7 (30.5)	U = 29 (47.2)	Wt = 11.6 (18.9)

Berriasella (*Berriasella*) and *Berriasella* (*Picteticeras*). In general the subgenus *B.* (*Berriasella*) consists of more compressed species with rather narrow umbilici, whereas subgenus *B.* (*Picteticeras*) comprises thicker species with wider umbilici. However, there are many transitional species with intermediate umbilical widths in the Jacobi Zone and also in the Occitanica and Boissieri zones; a subgeneric distinction on these grounds is meaningless and helps only during the process of the identification of species. Hoedemaeker (1982, and herein), therefore, considers the introduction of subgenus *B.* (*Picteticeras*) irrelevant.

The distinction of the subgenera *B.* (*Hegaratella*) *sensu* Hoedemaeker and *B.* (*Berriasella*) *sensu* Hoedemaeker is justified, because these groups are separated in time and can be distinguished from each other by their characteristic appearances. The former is the ancestral group of the latter.

***Berriasella* (*Berriasella*) *privasensis* (Pictet, 1867)**
Pl. X. figs 1-3

**pars* 1867. *Ammonites privasensis*, Pictet.– Pictet, p. 84, pl. 18, fig. 1a, b, *non* fig. 2a-c [= *Berriasella picteti* (Kilian, 1906)].
1880. *Ammonites* (*Perisphinctes*) *Calisto*, d'Orbigny.– Favre, p. 37, pl. 3, figs 5a, b, 6a, b, *non* fig. 7 (= *Pseudosubplanites* sp.).
non 1889. *Hoplites privasensis* Pictet sp.– Kilian, p. 660, pl. 30, fig. 3a, b. [= *Berriasella* (*Hegaratella*) *kleini* sp. nov.].
pars 1939. *Berriasella privasensis* (Pictet, 1867).– Mazenot, p. 45, pl. 1, fig. 3a, b, *non* fig. 4 (= *Berriasella* sp. indet.), *non* fig. 6. [= *Berriasella (Hegaratella) aurousei* Le Hégarat, 1973].
non 1939. *Berriasella* aff. *privasensis* (Pictet).– Mazenot, p. 46, pl. 2, fig. 5 [= *Berriasella (Hegaratella)* aff. *jacobi*? Mazenot, 1939].
1953. *Berriasella privasensis* (Pictet, 1867).– Arnould-Saget, p. 23, pl. 2, fig. 9a-c.
non 1960. *Berriasella privasensis* (Pictet).– Nikolov, p. 156, pl. 2, fig. 3 [= *Berriasella* (*Berriasella*) *moesica* Nikolov & Mandov, 1973], *non* fig. 4 [= *Berriasella* (*Berriasella*) *callisto* (d'Orbigny, 1847].
1960. *Berriasella* aff. *privasensis* (Pictet).– Nikolov, p. 157, pl. 3, figs 1, 2 [= *Berriasella* (*Berriasella*) *moesica* Nikolov & Mandov, 1967].
1960. *Berriasella privasensis* Pictet.– Drushchits, p. 175, pl. 20, fig. 1a, b.
1967. *Berriasella privasensis* (Pictet, 1867).– Dimitrova, p. 101, pl. 48, fig. 2.
1968. *Berriasella privasensis* (Pictet).– Le Hégarat & Remane, p. 27, pl. 4, fig. 3.
1973. *Berriasella* (*Berriasella*) *privasensis* (Pictet).– Le Hégarat, p. 61, pl. 5, figs 3-9, pl. 38, fig. 9.
1976. *Berriasella privasensis* (Pictet, 1867).– Khimshiashvili, p. 84, pl. 5, figs 1-3.
pars 1976. *Berriasella oppeli* (Kilian).– Patrulius & Avram, p. 172, pl. 4, figs 1a, b, 3a, b. *non* figs 2, 4 [= *Berriasella* (*Berriasella*) *picteti* (Kilian, 1906)].
non 1976. *Berriasella* aff. *privasensis* (Pictet).– Partrulius & Avram, p. 173, pl. 4, fig. 7 [=*Berriasella* (*Berriasella*) *moesica* Nikolov & Mandov, 1967)], *non* fig. 8 [= *Berriasella* (*Berriasella*) *multicostata* sp. nov.].
pars 1976. *Berriasella* cf. *privasensis* (Pictet).– Patrulius & Avram, p. 173, pl. 5, fig. 1, *non* pl. 4, fig. 9 [= *Berriasella* (*Berriasella*) *multicostata* sp. nov].
non 1976. *Berriasella* ex gr. *privasensis* (Pictet).– Patrulius & Avram, p. 174, pl. 5, fig. 2a, b [= *Berriasella* (*Berriasella*) *evoluta* Le Hégarat, 1964].
pars 1982. *Berriasella* (*Berriasella*) *privasensis* (Pictet, 1867).– Nikolov, p. 57, pl. 11, fig. 3, 4, *non* fig. 2 [= *Berriasella* (*Berriasella*) *fitchevi* Nikolov, 1982].
1982. *Berriasella* (*Berriasella*) *privasensis* (Pictet).– Hoedemaeker, p. 28, pl. 2, fig. 2.
1985. *Berriasella* (*Berriasella*) *privasensis* (Pictet).– Tavera, p. 254, pl. 35, fig. 6.
non 1990. *Berriasella privasensis* (Pictet, 1867).– Khimshashvili, p. 372, pl. 1, fig. 4 [= *Berriasella picteti* (Kilian, 1906)].
2004. *Berriasella callisto* (d'Orbigny, 1847).– Arkadiev & Bogdanova, p. 376, pl. 1, figs 8, 9.
2012. *Berriasella callisto* (d'Orbigny, 1847).– Arkadiev *et al.,* p. 148, pl. 4, figs 7, 8.

Lectotype: The specimen depicted by Pictet (1867) on pl. 18, fig. 1a, b, under the name *Ammonites Privasensis*, derived from the Berriasian stratotype near Berrias (Ardèche, France). A plaster cast of the lectotype is deposited in the Université Claude Bernard de Lyon, Département de Géologie under number FSL 14 316.

Material: Eleven specimens from the Subalpina Subzone (base of Occitanica Zone) along the Barranco de Tollo (bed numbers with Z) and from the Subalpina Zone of the Barranco de las Oicas (bed numbers with M): RGM 160 490 (bed Z234), RGM 160 239 (bed Z245), RGM 617 904 (bed Z206-210), RGM 617 910 (bed Z234), RGM 617 905 (bed Z234), RGM 617 906 (bed Z243), RGM 617 907 (bed Z243), RGM 617 908 (bed Z243), RGM 160 496 (M56-62), RGM 160 480 (bed M56-62), RGM 160 486 (bed M33-50). The specimens from higher subzones than the Subalpina Subzone are not described herein.

Description: Rather small planulates with a shallow umbilicus, which is smaller than the whorl height. Involution amounts to 50 percent of the penultimate whorl. Rather thin ribs, which are irregularly distributed, from rather distantly spaced to rather approximated; the approximated part may not develop. The majority of the ribs have a more or less convex shape, the lower part being prorsiradiate, the upper part rursiradiate to radial. The majority is dichotomous, but simple ribs are present; the point of furcation changes with growth from above mid-flank to below mid-flank. The secondary ribs start in a radial direction, but become projected on the uppermost part of the flanks; the projection becomes more pronounced when approaching the aperture.

Measurements: See Table XXIII.
Remarks: The specimen figured by Mazenot 1939 on pl. 2, fig. 5 with the name *Berriasella* aff. *privasensis* (Pictet) closely resembles the specimen depicted by Toucas (1890) on pl. 17, fig. 3a, b, with the name *Hoplites Calisto* d'Orbigny. Mazenot (1939, p. 56) assigned the specimen of Toucas to *Berriasella Callisto* (d'Orbigny). However, Le Hégarat (1973) refigured the specimen of Toucas on pl. 38, fig. 3 and assigned it to *Berriasella* (*Berriasella*) *jacobi* Mazenot. As the umbilicus of '*H. Calisto* [*sensu* Toucas, 1890, *non* Mazenot (1939)]' is clearly wider than that of *B.* (*H.*) *jacobi*, and as the rib-ends reach the thin mid-ventral furrow at an angle of about 45 degrees forming a chevron-like pattern, which does not occur in *B.* (*H.*) *jacobi*, the author suspects *Hoplites Calisto* (*sensu* Toucas, 1890) to be closely related to Mazenot's *Berriasella* aff. *privasensis* (pl. 2, fig. 5 in Mazenot, 1939)
Geographical distribution: Spain, France, Bulgaria, Romania, Georgia, Ukraine (The Crimea).

2.2.5. Genus *Subthurmannia* Spath, 1939

Type species: *Subthurmannia fermori* Spath, 1939.

Systematics: Spath (1939) introduced the genus *Subthurmannia* (type species *Subthurmannia fermori* Spath, 1939) for a group of species, which he compared with *Ammonites boissieri* Pictet, 1867. The latter species was included by Le Hégarat (1973) in the genus *Fauriella* Nikolov, 1966, (type species *Berriasella gallica* Mazenot, 1939). Breistroffer (1964, p. 279) was the first who used the name *Subthurmannia* for *Pseudargentiniceras* (*Subthurmannia*) *boissieri* (Pictet, 1867) and *P.* (*Subthurmannia*) *rarefurcata* (Pictet, 1867). However, Dimitrova (1967) prefers to use the name *Subthurmannia* above *Pseudargentiniceras* Spath, 1925 for berriasellids with fasciculated ribs. Apparently she was not aware of the fact that shortly before her manuscript was published, Nikolov (1966) from the same University in Bulgaria had published his article on berriasellid genera introducing the genus *Fauriella*. As *Subthurmannia fermori* and *Fauriella boissieri* closely resemble each other, and as both species occur in the Tethyan Berriasian [Spath (1939) used the term 'Infra-Valanginian'], Hoedemaeker, (1982, and herein) also considered them congeneric and *Fauriella* a junior synonym of *Subthurmannia*.
In 1966 Nikolov in addition introduced the genus *Strambergella* (type species *Ammonites carpathicus* Zittel, 1868). This type species has a few fasciculate ribs on the body chamber. As the presence of fascicules is viewed as the main characteristic of the genus *Fauriella* (= *Subthurmannia*), it was considered a subgenus of '*Fauriella*' (= *Subthurmannia*) by Le Hégarat (1973), but Nikolov regarded *Strambergella* as a subgenus of *Berriasella* and not of '*Fauriella*', because it has only fascicules on the body chamber. Nikolov (1982) reported more species with fascicules only on the outer whorl from the upper Berriasian (Boissieri Zone) and included them in *Strambergella*, viz. *Berriasella* (*Strambergella*) *catrafilovi* (Nikolov, 1982), *B.* (*S.*) *tzankovi* (Nikolov, 1982), and *B.* (*S.*) *costelensis* (Nikolov, 1982). The present author includes these latter three species in *Subthurmannia*. He prefers for the time being to regard the name *Fauriella* Nikolov, 1966, as a junior synonym of *Subthurmannia* Spath, 1939 and to reserve the name *Strambergella* only for *Strambergella carpathica* (Zittel, 1868). Whether *Fauriella* and *Subthurmannia* are really synonyms or separate genera should be the purpose of a later study. Restricted to the Jacobi Zone are *Subthurmannia floquinensis* (Le Hégarat, 1973) and *Subthurmannia pseudocarpathica* sp. nov. [= *Fauriella* aff. *carpathica* (Le Hégarat, 1973, *non* Zittel)], which also exhibit fasciculation only on the outer whorl.
It should be mentioned here that *Fauriella shipkovensis* (Nikolov & Mandov, 1967) could better be assigned to the genus *Tirnovella* instead of to *Subthurmannia*, because of its narrow umbilicus.

'Subthurmannia' floquinensis Le Hégarat, 1973

Pl. X, fig. 4

1939. *Berriasella* cf. *callistoides* (Behrendsen, 1891).– Mazenot, p. 59, pl. 4, fig. 13a, b.
* 1973. *Fauriella floquinensis* n. sp. Le Hégarat, p. 156, pl. 23, figs 1, 2, pl. 47, figs 4, 5.
pars 1982. *Fauriella floquinensis* Le Hégarat 1973.– Nikolov, p. 109, pl. 28, fig. 1a, b, pl. 29, fig. 1, *non* pl. 28, fig. 2, pl. 29, fig. 2 (= *Subthurmannia* sp. indet.).
?non 1985. *Fauriella floquinensis* Le Hégarat.– Tavera, p. 284, pl. 43, figs 1, 2 [= possibly *Tirnovella shipkovensis* (Nikolov & Mandov, 1967)], *non* fig. 3 [= *Subthurmannia* aff. *carpathica* (Le Hégarat, 1973, *non* Zittel, 1868)].
? 2012. *Fauriella* cf. *floquinensis* Le Hégarat.– Arkadiev *et al.*, p. 156, pl. 7, fig. 2.

Holotype: The specimen depicted by Le Hégarat (1973)

Table XXIII: Measurements *Berriasella* (*Berriasella*) *privasensis* (Pictet, 1867).

RGM 160 239	D = 53	Wh = 20 (37.7)	U = 19 (35.8)	(with lappets)
RGM 160 481	D = 48	Wh = 19 (39.6)	U = 17 (35.4)	(with lappets)
RGM 617 905	D = 30	Wh = 11.5 (38.3)	U = 10 (33.3)	

on pl. 47, fig. 5, under the name *Fauriella floquinensis* n. sp., derived from the Jacobi Zone near St. Laurent-sous-Coiron (Ardèche, France), deposited in the Université Claude Bernard de Lyon, Département de Géologie under No. FSL 129 357.

Material: One whorl fragment from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain. RGM 160 690 (bed Z196).

Description: The whorl fragment looks most like the paratype of *Subthurmannia floquinensis* from Floquin (Drôme), figured in Le Hégarat, 1973 (pl. 47, fig. 4). It has a whorl height of 35 mm and shows an irregular, slightly prorsiradiate ribbing consisting of concave, bifurcate and simple ribs, which are fasciculated. The many additional simple ribs originating at various flank heights, gives the ribbing an overall irregular aspect. The fascicules are crested on the umbilical rim and the ribs are interrupted by a ventral furrow. On the upper part of the flank the ribs are projected and rather close together; the interspaces are as wide as the thickness of the ribs, but the interspaces between the umbilical crests is three times wider. The ribs do not cross the venter, which exhibits a smooth mid-ventral band.

Remarks: Notwithstanding the fascicules, the species exhibits some differences from the typical *Subthurmannia*, since the fascicules are restricted to the body chamber. In this respect they resemble *Strambergella carpathica* (Zittel, 1868). The ribbing on the last part of the phragmocone, visible on the paratype, is quite different and consists of strong, rather distantly spaced, straight, bifurcated ribs, which are projected. This sculpture is typical of *Hegaratella*. The furcation points are above mid-flank, but on the last whorl of the phragmocone the furcation points gradually lower towards the umbilicus to become fascicules on the body chamber.

Geographical distribution: Spain, France, Bulgaria, Ukraine (The Crimea)?

***'Subthurmannia' pseudocarpathica* sp. nov.**

Pl. X, fig. 5

**pars* 1973. *Fauriella* (*Strambergella*) aff. *carpathica* (Zittel, 1868).– Le Hégarat, p. 152, pl. 21, fig. 4, pl. 46, figs 2, 3, *non* pl. 21, figs 5, 6 [= *Strambergella carpathica* (Zittel, 1868)].

pars 1982. *Berriasella* (*Strambergella*) *carpathica* (Zittel, 1868).– Nikolov, p. 82, pl. 19, fig. 2, *non* fig. 1a, b [= *Strambergella carpathica* (Zittel, 1868)].

pars 2012. *Fauriella* aff. *carpathica* (Zittel, 1868).– Arkadiev *et al.,* p. 155, pl. 7, fig. 6, *non* fig. 5a-c (= *Tirnovella* sp. indet.).

Lectotype: The specimen depicted by Le Hégarat (1973) on pl. 46, fig. 3 under the name *Fauriella* (*Strambergella*) aff. *carpathica* (Zittel, 1868), derived from the Jacobi Zone of Sabatas (Ardèche, France), deposited in the Université Claude Bernard de Lyon, Département de Géologie, (Coll. Le Hégarat) under No. 141 076.

Material: One impression from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain: RGM 160 701 (bed Z136).

Description: The Barranco de Tollo specimen is conspecific with *Fauriella* aff. *carpathica* Le Hégarat, 1973, *non* Zittel. Small planulate shell with shallow umbilicus and whorls that slowly grow in height. The ornamentation on the last third of the outer whorl (= a little earlier than the beginning of the body chamber) consists of rather approximated, bifurcate ribs and simple ribs. In contrast to the lectotype of *Strambergella carpathica* (Zittel, 1868), which has straight, radial primary ribs and projected secondaries, the ribs of the Barranco de Tollo specimen are slightly sigmoidal with prorsiradiate beginnings of the primary ribs. Five fascicules are visible on the last third of the last whorl; they originate from small umbilical bullae. Two fascicules consist of two bifurcate ribs and three consist of one bifurcate and one simple rib. The penultimate whorl merely shows straight, prorsiradiate primary ribs, because the secondary ribs are covered by the last whorl. The last quarter of the last whorl is occupied by the body chamber.

Measurements: See Table XXIV.

Remarks: Because of the slightly sigmoidal ribs and the earlier start of the fasciculation, the two specimens in Le Hégarat (1973) and the specimen from the Barranco de Tollo deviate from the lectotype of *Strambergella carpathica* (Zittel, 1868). Le Hégarat (1973) regarded the genus *Strambergella carpathica* as a subgenus of "*Fauriella*" (= *Subthurmannia*). On the other hand, Nikolov regarded *Strambergella* as a subgenus of *Berriasella* and includes in it the species *B*. (*S*.) *carpathica* (Zittel, 1868), *B*. (*S*.) *catrafilovi* (Nikolov, 1982), *B*. (*S*.) *tzankovi* (Nikolov, 1982), and *B*. (*S*.) *costelensis* (Nikolov, 1982).

The subgenus *Strambergella* was defined by Nikolov (1966, p. 640) with *Ammonites carpathicus* (Zittel, 1868, p. 107, pl. 18, fig. 4) as type species. *Strambergella* is hitherto a monotypic genus. The lectotype of *S. carpathica* has thin, straight primary ribs, which bifurcate at two thirds of the flank height; the secondary ribs are only slightly projected; simple ribs are rare; one subvirgatotomous rib is present on the holotype; the inner whorls bear straight, wide-spaced ribs. *Subthurmannia floquinensis* (Le Hégarat, 1973), also shows fasciculation

Table XXIV: Measurements *'Subthurmannia' pseudocarpathica* sp. nov.

RGM 160 701	D = 56.0	Wh = 21 (36.8)	U = 20 (35.1)	wh = 14 (24.6)

of two or three ribs only on the body chamber, and exhibits strong, wide-spaced ribs on the inner whorls; it may also belong to genus *Strambergella*.

The author doubts whether *S. carpathica* (Zittel, 1868), should be incorporated in *Berriasella* or in *Subthurmannia*. It should for the time being be considered a separate genus. The mere presence of a few fascicules in the adult is not decisive for including the species in *Subthurmannia*, and virgatotomous ribs are absent in *Subthurmannia.* Nevertheless, I am inclined to consider *Strambergella* an independent genus and to consider the species *pseudocarpathica*, *catrafilovi*, *tzankovi* and *costelensis* for the time being as belonging to the genus *Subthurmannia.*

For comparison the author figured on Plate X, fig. 6 a specimen of *Strambergella carpathica* (Zittel, 1868) from the Col du Pin, which shows all the characteristics just mentioned. This specimen seems to be the third specimen of *Strambergella carpathica* figured in the literature; the second specimen is possibly the one described by Sapunov (1979) and refigured by Nikolov (1982).

Geographical distribution: (of *S. pseudocarpathica*) France, Spain, Bulgaria; (of *S. carpathica*) France, Czech Republic.

***Subthurmannia gallica* (Mazenot, 1939)**
Pl. X, fig. 7

**pars* 1939. *Berriasella gallica* n. sp. Mazenot, p. 140, pl. 23, fig. 3a, b, *non* fig. 4a, b [= *Subthurmannia clareti* (Le Hégarat, 1973)].
1960. *Berriasella gallica* Mazenot.– Nikolov, p. 169, pl. 9, fig. 5, pl. 10, fig. 2.
1967. *Subthurmannia gallica* Mazenot, 1939.– Dimitrova, p. 106, pl. 49, fig. 1.
1973. *Fauriella gallica* (Mazenot).– Le Hégarat, p. 158, pl. 22, figs 4, 5, pl. 46, fig. 4.
pars 1982. *Fauriella gallica* (Mazenot 1939).– Nikolov, p. 114, pl. 35, figs 5a, b, 6, 8a, b, *non* fig. 7 (= *Subthurmannia* sp. indet.), pl. 36, figs 4, 5a, b, *non* fig. 3 (= *Subthurmannia* sp. indet.).

Holotype: The specimen depicted by Mazenot (1939) on pl. 23, fig. 3a, b, under the name *Berriasella gallica* n. sp., derived from the Berriasian of La Faurie, deposited in the Faculté des Sciences de Grenoble, Institut Dolomieu, No. ID 503.

Material: Two imprints of identifiable whorl fragments from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain, RGM 791 176 (bed Z206-210), RGM 791 177 (bed Z232).

Description: Small compressed specimen with rather small umbilicus. The whorls grow rather rapidly in height. The flanks are slighty rounded, venter not visible. The ornamentation consists of thin ribs which are projected towards the venter. Half a whorl is preserved. 50% of the 28 visible ribs are simple, the other 50% bifurcate. Eight fascicules are counted, which either consists of two simple ribs, or of a simple rib with a bifurcate rib.

Measurements: See Table XXV.

Remarks: The presence of *Subthurmannia gallica* in the Subalpina Subzone was not known previously. Le Hégarat (1973) found only *S. clareti* in the Subalpina Subzone, not *S. gallica*.

Geographical distribution: Spain, France, Bulgaria.

2.2.6. Genus *Delphinella* (*Delphinella*) Le Hégarat, 1971

Type species: *Hoplites delphinensis* Kilian, 1889.

Systematics: This genus comprises ammonites with club-shaped (clavate) to spatula-shaped (spatulate) secondary ribs, which describe a slight biconcavity (= concave primaries and concave projected secondaries) or falcoid shape (= straight primaries and concave secondaries) producing a slightly adorally protruding kink at mid-flank. At this kink the primary ribs split into secondaries producing a weak longitudinal depression because of the abrubt ending of the high primary ribs on the lower part of the flank against the flat secondaries on the upper half of the flank. Most adult specimens show an effacement of the ribs beginning at mid-flank and broadening towards the aperture. *Delphinella* is restricted to the Jacobi Zone.

Tavera (1985, p. 234-236) regarded the introduction of genus *Delphinella* as unnecessary. He prefered to include the species of *Delphinella* in several other genera, for instance *D. delphinensis* Kilian, 1889, *D. garnieri* Mazenot, 1939, *D. berthei* Toucas, 1890 and *D. obtusenodosa* Retowski, 1894 in *Beriasella* Uhlig, 1905; *D. tresannensis* Le Hégarat, 1973 and *D. crimensis* Burckhardt, 1912 in *Tirnovella* Nikolov, 1966; *D. subchaperi* Retowski, 1894 in *Jabronella* Nikolov, 1966. The author does not support this idea; the collective characteristic features mentioned above are not present in these genera and justify the introduction of a separate genus. The name *Delphinella* is derived from *Delphinatum,* the Latin name for the French Dauphiné region approximately covering the departements of Drôme, Isère and Hautes-Alpes in France.

Wright *et al.* (1996) considered *Delphinella* a junior synonym of *Elenaella* Nikolov, 1966 (type species and only species *Berriasella cularensis* Mazenot, 1939). This idea of Wright *et al.* (1996) may be justified. However, Nikolov (1982) considered his genus *Elenaella* a subgenus of *Dalmasiceras*; this idea is followed herein.

Table XXV: Measurements of *Subthurmannia gallica* Mazenot, 1939.

RGM 791177	D = 38	Wh = 15 (39.5)	U = 12 (31.6)

***Delphinella* (*Subdelphinella*) subgen. nov.**

Type species: *Delphinella* (*Subdelphinella*) *ellenica* Nikolov, 1960.

Diagnosis: the species within this subgenus differ from their ancestors, *Delphinella* (*Delphinella*), in the stronger, more widely spaced, straight or slightly concave, bifurcate ribs; in the absence of sickle-shaped or biconcave ribs (except weakly on the nearly effaced part of the body chamber), in the absence of trifurcating or intercalary ribs (except on the body chamber), and in the presence of umbilical bullae on the body chamber. Intercalary ribs or trifurcation occur only on the nearly effaced beginning of the body chamber. On the other hand they exhibit traits of their ancestors, for instance, in having spatulate or clavate secondaries and the furcation points are heightened or bear weak nodes. On the living chamber the ornamentation becomes totally effaced with the exception of the umbilical bullae. This type of effacement differs from that of *Delphinella* (*Delphinella*) where the effacement begins at mid-flank and gradually widens in adoral direction.

Remarks: The five species that Le Hégarat (1973) included in *Delphinella* and that are restricted to the Subalpina and Privasensis subzones, such as *D. ellenica* Nikolov, 1960, *D. sevenieri* Le Hégarat, 1973, *D. auzonensis* Le Hégarat, 1973, *D. boisseti* Le Hégarat, 1973, *D. berthei* (Toucas, 1890, *sensu* Le Hégarat, 1973, pl. 42, only fig. 12), differ in essential traits from the fine-ribbed species of the Jacobi Zone. This group of species are clearly descendants of *Delphinella* of the Jacobi Zone. They could easily be separated from *Delphinella* (*Delphinella*) as a separate subgenus, because they differ in many collective aspects from *Delphinella* (*Delphinella*). The author proposes to name this subgenus *Delphinella* (*Subdelphinella*), type species: *Delphinella* (*Subdelphinella*) *ellenica* Nikolov, 1960 (p. 162, pl. 6, fig. 1).

This sudden change in the ornamentation from the typical *D.* (*Delphinella*) of the Jacobi Zone to *D.* (*Subdelphinella*) is probably due to the deep fall of the sea level at the major sequence boundary at the base of the Subalpina Subzone, since major sequence boundaries enhance extinction and a new diversification of ammonites. Representatives of *Delphinella* (*Subdelphinella*) were not encountered along the Barranco de Tollo.

Since Tavera (1985, p. 235) regarded the introduction of genus *Delphinella* as unnecessary and consequently also the subgenus *D.* (*Subdelphinella*), he included *D. ellenica* Nikolov, 1960 in *Fauriella* Nikolov, 1966; *D. ellenica* Le Hégarat, 1973 *non* Nikolov,1960, and *D. sevenieri* Le Hégarat in *Elenaella* Nikolov, 1966; *D. auzonensis* Le Hégarat, 1973 in *Pseudargentiniceras* Spath, 1925, and *D. boisseti* Le Hégarat, 1973 in *Malbosiceras* Grigorieva, 1938. The main difference between *D. ellenica* Nikolov and *D. ellenica sensu* Le Hégarat is the start of the effacement of the ribs. The effacement in Le Hégarat's and Mazenot's specimens starts at D = 80-90 mm, but in the holotype of Nikolov at the diameter of approximately 115 mm.

Delphinella* (*Delphinella*) *consanguinea
(Retowski, 1894)
Pl. X, fig. 8

**pars* 1894. *Hoplites consanguineus* n. sp. Retowski, p. 268, pl. 12, fig. 1a, b, non fig. 2 (= *Delphinella*?)
non 1939. *Berriasella consanguinea* (Retowski).– Mazenot, p. 79, pl. 7, fig. 4a-c (= *Chapericeras*?).
1939. *Berriasella* sp. (gr. de *B. chaperi*) Ech. No. 3.– Mazenot, p. 95, pl. 10, fig. 5a, b.
1960. *Berriasella consanguinea* Retowski.– Drushchits, p. 276, pl. 20, fig. 5a, b (= lectotype).
non 2013. *Delphinella consanguinea* (Retowski, 1893).– Vašíček & Skupien, p. 338, figs 5O, P [= inner whorls of *Chapericeras chaperi* (Pictet, 1868)].

Lectotype: The specimen depicted in Retowski, 1894, on pl. 12, fig. 1 under the name *Hoplites consanguineus,* n. sp., derived from the Tithonian of Feodosia in the eastern part of the Crimea (the Ukraine). It was designated by Mazenot (1939) and deposited in the Retowski collection, No. 44 /10916) in the CNIGR museum in St. Petersburg, Russia.

Material: One identifiable fragment: RGM 160 456 (bed Z118).

Description: The fragment shows about 8 prorsiradiate slightly concave main ribs, which taper towards the umbilicus where they are sharp. They become flat and somewhat broader towards the middle of the flank. The ribs are wide apart. At mid-flank they are provided with small, rather sharp tubercles. From the tubercles originate two flattened, prorsiradiate, slightly concave secondary ribs, which are sometimes attended by a short intercalated rib alongside one of the secondary ribs; these accompanying ribs suggest trifurcation, but a real trifurcation does not occur. The interspaces between the secondary ribs are about half as narrow as the breadth of the ribs. The whole rib (from umbilicus to venter) is weakly biconcave.

Remarks: The author included Retowski's *Hoplites consanguineus* in genus *Dephinella* Le Hégarat, 1973, because of the characteristic concave curvature of the secondary ribs, which rise from small but sharp tubercles at the upper ends of the primary ribs at mid-flank, and because of the bifurcation or trifurcation (or quasi trifurcation) of the flat secondary ribs originating from these tubercles. It has been sampled in rocks that have been dated as Tithonian. It clearly belongs to the group of *Delphinella* (*Delphinella*) *obtusenodosa* (Retowski, 1894), which show a similar trifurcation of the slightly rursiradiate secondary ribs and a similar row of lateral tubercles.

A specimen from La Faurie with the name *Berriasella consanguinea* has been described and figured by Mazenot

(1939) on p. 79, pl. 7, fig. 4a-c. It differs in many small aspects from the lectotype. For example, it does not show the characteristic backward direction of the secondary ribs that generate from the tubercle; the secondary ribs are not spatulate or clavate and are projected instead of concave; the primary ribs are radiate instead of prorsiradiate. The umbilicus is clearly larger and the growth in height of the whorls is slower. The number of ribs is also smaller. These differences are small, but they give the specimen quite a different aspect. Therefore the author considers Mazenot's species not conspecific with the lectotype of *Delphinella (Delphinella) consanguinea* Retowski, 1894. The coarseness of the ribs gives it some *Chapericeras*-like features. The author provisionally classified this species in genus *Chapericeras*.
On the other hand, Mazenot's specimen depicted on pl. 10, fig. 3a, b under the name *Berriasella* sp. (gr. de *B. chaperi*) Ech. No. 3 (Mazenot, 1939, p. 95), is without doubt *Delphinella (Delphinella) consanguinea.*
Geographical distribution: Spain, France, Ukraine (The Crimea).

***Delphinella* (*Delphinella*) *miravetensis* sp. nov.**
Pl. X, fig. 9

1982. *Delphinella consanguinea* (Retowski, 1894).– Hoedemaeker, pp. 10, 14, 76.

Holotype: RGM 160 447 (bed Z123) (Pl. X, fig. 9) from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain. Deposited in the Naturalis Diversity Centre, Leiden, The Netherlands.
Material: One specimen from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain: RGM 160 447 (bed Z123).
Derivatio nominis: From the Cortijeria de Los Miravetes, a large farm along the right border of the Barranco de Tollo where it runs into the Río Argos.
Diagnosis: Platycone with moderately large umbilicus, which is as wide as the whorl height. The ornamentation of the phragmocone consists of slightly flexuous bifurcating ribs and two simple ribs on the phragmocone. The living chamber is ornamented with bifurcating and trifurcating ribs with a tubercle on the forking points on every second primary rib. The primaries are straight and slightly prorsiradiate. The secondary ribs are rursiradiate near their origins and a little projected near the venter resulting in a concave curvature. The furcation points are situated on adorally directed kinks in the ribs at mid-flank. Typical for this species is the thinness and sharpness of the secondary ribs, which brings about wide interspaces. In other species of *Delphinella* they are generally broad and flat or clavate with thin interspaces.
Material: One well preserved imprint from the Jacobi Zone along the Barranco de Tollo near Caravaca, Province of Murcia, Spain: RGM 160447 (bed Z123).
Description: This specimen exhibits characteristics comparable with those of *Delphinella consanguinea*. The platycone shell is thickest at mid-flank where the tubercles are. Just above the row of tubercles is a shallow longitudinal depression on the whorl sides. The umbilicus is shallow and the low umbilical wall is bounded by a rounded umbilical rim.
The characteristic ornamentation with trifurcating ribs and lateral tubercles starts just after the beginning of the body chamber. The secondary ribs are rursiradiate, thin and sharp, but become projected on the uppermost part of the flanks. They markedly differ from the flat and broad secondary ribs of *D.* (*D.*) *consanguinea*. The primary ribs are sharp as well, and prorsiradiate. At mid-flank the ribs form a rather sharp bend and most of them split into two secondary ribs; four ribs trifurcate, twelve bifurcate and five remain simple. All trifurcating ribs and six bifurcating ones have a lateral tubercle at the furcation points. The other six bifurcating ribs and the simple ribs do not have a tubercle. It should be mentioned that in case of trifurcation all three secondary ribs originate from the tubercle. At 10 of the furcating sites small but protruding tubercles are present. On the body chamber the ribs have wide interspaces. The body chamber occupies half a whorl.
The ribbing on the phragmocone is quite different from that of the body chamber. The ribs are much closer together and the interspaces are only half as wide as on the body chamber. They also are thin and sharp, but they do not form a sharp bend at mid-flank; they are slightly flexuous instead. Lateral tubercles are absent. Most ribs are bifurcate, only a few are simple.
Measurements: See Table XXVI.
Remarks: This specimen differs from *D. consanguinea* in the sharpness of the thin ribs, which display a greater flexuosity. The equally thin and sharp secondary ribs are rather distant from each other. The author's specimen is not conspecific with *D.* (*D.*) *consanguinea* and the author has given it a new name, *Delphinella* (*Delphinella*) *miravetensis* sp. nov. This is the only *Delphinella* without spatulate or clavate secondary ribs.
Geographical distribution: Spain.

Table XXVI: Measurements of three specimens of different species for comparison.

D. (*D.*) *consanguinea* Lectotype	D = 57	Wh = (37)	U = (39)
RGM 160447 *D.* (*D.*) *miravetensis*	D = 60.4	Wh = 21. 1 (35)	U = 23.4 (38.7)
Mazenot's *B. consanguinea*	D = 62.8	Wh = 21.0 (33.4)	U = 26 (41.4)

Delphinella (*Delphinella*) *delphinensis* (Kilian, 1889)
Plate X, fig. 10

* 1889. *Hoplites delphinensis* n. sp. Kilian, p. 662, fig. 1 (in text).
non 1894. *Hoplites Calisto* var. *delphinensis* Kilian.– Retowski, p. 264, pl. 11, fig. 4 [= *Delphinella crimensis* (Burckhardt, 1912), p. 165].
1939. *Berriasella delphinensis* (Kilian).– Mazenot, p. 67, pl. 6, figs 14a, b, 15a-c.
1953. *Berriasella delphinensis* (Kilian).– Arnould-Saget, p 45, pl. 4, figs 10 a-c, 11 a-c.
1973. *Delphinella delphinensis* (Kilian).– Le Hégarat, p. 104, pl. 13, figs 7, 8; pl. 42, figs 3, 9.
1982 *Delphinella delphinensis* (Kilian, 1889).– Nikolov, p. 86, pl. 20, figs 2a, b-4.
? 1999. *Delphinella* cf. *delphinensis* (Mazenot).– Kvantaliani, p. 96, pl. 12, fig. 2a, b.
2005. *Delphinella delphinensis* (Kilian 1889).– Arkadiev & Bogdanova, p. 494, pl. 6, fig. 5.
2012. *Delphinella delphinensis* (Kilian 1889).– Arkadiev *et al.,* p. 164, pl. 10, fig. 4.

Holotype: The specimen depicted by Kilian (1889) on p. 662, fig. 1 under the name *Hoplites delphinensis*, derived from the Calcaire Bréchoïde de Luc, Upper Tithonian near Luc-en-Diois (Drôme, France), deposited in the Faculté des Sciences de Lyon (Sorbonne collection) No. 127 337. Refigured by Mazenot, 1939, pl. 6, fig. 15a, b.
Material: One rather well-preserved specimen: RGM 160 453 (bed Z121) from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain.
Description: The platycone shell has a small, shallow umbilicus. The flat flanks exhibit a weak longitudinal ridge at mid-flank, where the whorl is thickest. The primary ribs taper towards the umbilical rim where they make a concave curve to continue in a prorsiradiate direction. They broaden towards mid-flank where they split into two secondary ribs, which are flattened and projected. A few ribs remains simple, but also have, like the secondaries, a flattened, projected upper end. The interspaces between the secondaries are very narrow. Just above the longitudinal ridge at mid-flank the secondary ribs tend to fade away so that the secondary ribs become detached from the primaries. The inner whorls have straight, sharp, radial ribs, which split into two sharp secondary ribs at two-thirds flank height; the secondaries are slightly projected. The body chamber begins at a diameter of 38 mm only two-thirds of the body chamber is preserved.
Measurements: See Table XXVII.
Remarks: *D.* (*D.*) *delphinensis* closely resembles *D.* (*D.*) *janus* (Retowski, 1894), but its ribbing is finer, the primaries are thin and trifurcation is rare. *D.* (*D.*) *janus* has many trifurcating ribs with broader primaries.
Geographical distribution: The Crimea, Spain, France, Tunisia, Bulgaria.

Delphinella (*Delphinella*) *subchaperi* (Retowski, 1894)
Plate X, fig. 11

**pars* 1894. *Hoplites subchaperi* n. sp. Retowski, p. 269, pl. 12, fig. 3, *non* fig. 4 (= unidentifiable ammonite fragment).
non 1899. *Hoplites sub-Chaperi* Retowski.– Simionescu, p. 479, pl. 1, fig. 2 [= *Jabronella jabronenesis* (Mazenot, 1939) holotype].
non 1938. *Dalmasiceras* (?) *subchaperi* Retowski.– Grigorieva, p. 118, pl. 7, fig. 2a, b (= *Mazenoticeras broussei* Mazenot, 1939).
non 1939. *Berriasella* cf. *subchaperi* (Retowski).– Mazenot, p. 90, pl. 9, fig. 7a, b (= sp. indet.).
non 1960. *Berriasella subchaperi* (Retowski).– Drushchits, p. 276, pl. 21, fig. 1 [= *Retowskiceras andrussowi* (Retowski, 1894)].
non 1985. *Jabronella subchaperi* (Retowski).– Tavera, p. 304, pl. 46, fig. 1 (= species indet).
pars 1973. *Delphinella subchaperi* (Retowski).– Le Hégarat, p. 112, pl. 13, fig. 12, *non* pl. 42, fig. 10 (= *Delphinella* sp.).
2005. *Delphinella subchaperi* (Retowski, 1893).– Arkadiev & Bogdanova, p. 491, pl. figs 8, 9a, b.
2012. *Delphinella subchaperi* (Retowski, 1893).– Arkadiev *et al.,* p. 160, pl. 11, figs 8, 9a, b.

Lectotype: The specimen depicted by Retowski (1894) on pl. 12, fig. 3 under the name *Hoplites subchaperi* n. sp., derived from the Upper Tithonian of Feodosia (The Crimea), deposited under No. 46/10916 in the CNIGR Museum, St. Petersburg Russia. Designated by Mazenot (1939).
Material: Two specimens from the Jacobi Zone along the Barranco de Tollo, Caravaca, province of Murcia, Spain: RGM 160 461 (bed Z114-117), RGM 160 455 (Z107).
Description: Large, but incomplete specimen of which the shallow umbilicus is just wider than the whorl height at diameters exceeding 85 mm and narrower at smaller diameters. The ornamentation consists of thin, rather approximated flexuous ribs, which are prorsiradiate; they start at the umbilical seam and describe a concave curve at the umbilical rim. On the last whorl they are heightened at the umbilical rim; at mid-flank they bifurcate. The part of the outer whorl with tubercles at the furcation points is missing, but a large part of the body chamber is

Table XXVII: Measurements *Delphinella* (*Delphinella*) *delphinensis* (Kilian, 1889).

RGM 160 453	D = 52	Wh = 20.6 (39.6)	U = 16.5 (31.7)

preserved which shows prorsiradiate, concavely curved, still heightened primaries which lower and broaden and become effaced around mid-flank. Near the venter short projected secondaries are still visible; they disappear towards the aperture, so that on the last part of the body chamber only the distantly spaced, curved, heightened, parts of the primaries are preserved around the umbilicus.
Measurements: See Table XXVIII.
Remarks: This species resembles *D.* (*D.*) *obtusenodosa* (Retowski, 1894). It is difficult to identify an incomplete specimen of *D.* (*D.*) *subchaperi* (Retowski, 1894) if the tuberculate part is missing, as in the Barranco de Tollo example, but the large umbilicus and the slowly increasing whorl height are diagnostic. The umbilicus of *D.* (*D.*) *obtusenodosa* is much smaller and the whorls grow more rapidly in height.
Geographical distribution: France, Spain, Ukraine (The Crimea).

Delphinella (*Delphinella*) *janus* (Retowski, 1894)
Pl. XI, fig. 1

* 1894. *Hoplites Janus* n. sp. Retowski, p. 264, pl. 11, figs 5, 6.
1939. *Berriasella* aff. *Janus* (Retowski).– Mazenot, p. 70, pl. 6, figs 20, 21.
1982. *Delphinella janus* (Retowski, 1893).– Nikolov, p. 88, pl. 21, fig. 5.
pars 1973. *Delphinella obtusenodosa* (Retowski, 1984).– Le Hégarat, p. 109, pl. 41, fig. 7, *non* pl. 13, figs 10, 11, 13, 14, pl. 41, figs 1, 5, 6, [= *Delphinella obtusenodosa* (Retowski, 1894)].
1976. *Delphinella obtusenodosa* (Retowski, 1893).– Khimshiashvili, p. 100, pl. 16, fig. 6.
pars 2005. *Delphinella janus* (Retowski, 1893).– Arkadiev & Bogdanova, p. 495, pl. 5, fig. 1-3, pl. 6, fig. 10 (?),
2012. *Delphinella janus* (Retowski, 1893).– Arkadiev *et al.,* p. 164, pl. 10, fig. 8 (?), pl. 11, figs 1a, b, 2, 3a, b.

Lectotype: The specimen depicted by Retowski (1894) on pl. 11, fig. 5 under the name *Hoplites Janus* (designated by Mazenot, 1939) derived from the Tithonian near Feodosia, The Crimea, deposited in the Retowski Collection, No. 38/10916 in the CNIGR Museum, St-Petersburg.
Material: Two whorl fragments from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain: RGM 160 468 (bed Z 95), RGM 160 454 (Bed Z135, loose).
Description: The whorl fragment from the Barranco de Tollo exhibits primary ribs, which are tapering towards the umbilicus and broadening towards mid-flank. They are prorsiradiate and separated by interspaces, which have the width of one rib. At mid-flank they are very broad and flat, and split into two or three secondary ribs, which are also flat. There are also a few simple ribs. The secondaries are separated from each other by very narrow interspaces, which have a width of one-third of the breadth of the adjacent secondaries. Characteristic is the appearance of many trifurcating ribs at an early stage.
Remarks: The excessive broadening and flattening of the primary rib at mid-flank is characteristic for this species. The primaries of *D. obtusenodosa* broaden a little, but remain high up to the place of furcation, where a primary suddenly lowers into two or three flat secondaries; this produces a false node.
Geographical distribution: Spain, France, Ukraine (The Crimea).

Delphinella (*Delphinella*) *tresannesis* Le Hégarat, 1973
Plate XI, figs 2-4

* 1973. *Delphinella tresannensis* n. sp. Le Hégarat, p. 113, pl. 13, fig. 15; pl. 42, figs 1, 2.
1982. *Berriasella (Delphinella) tresannensis* Le Hégarat.– Hoedemaeker, p. 10, pl. 1, fig. 4.
pars 2005. *Delphinella tresannensis* Le Hégarat, 1971.– Arkadiev & Bogdanova, p. 494, pl. 5, fig. 5, *non* pl. 5, fig. 4 [= *Tirnovella allobrogensis* (?) (Mazenot, 1939)].
pars 2012. *Delphinella tresannensis* Le Hégarat, 1973.– Arkadiev *et al.,* p. 163, pl. 11, fig. 5, *non* fig. 4 [*Tirnovella allobrogensis* (?) (Mazenot, 1939)].
2012. *Delphinella* cf. *trezannensis* Le Hégarat.– Guzhikov, p. 19, pl. 2, fig. 7.

Holotype: The specimen depicted by Le Hégarat (1973) on pl. 42, figs 1, 2 under the name *Delphinella tresannesis* n. sp., derived from the Jacobi Zone near Trésanne (Isère, France), deposited in the Université Claude Bernard de Lyon, Département de Géologie, No. FSL128 080.
Material: Six specimens from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain. RGM 160 450 (bed Z94), RGM 160 452 (bed Z105), RGM 160 235 (bed Z124), RGM 160 448 (bed Z118), RGM 160 449 (bed Z171), and RGM 160 470 (bed Z120-123). The last specimen is the oral part of the body chamber with lappets.
Description: Very flat, fine ribbed, discoidal platycone with rather small shallow umbilicus. The whorls grow rapidly in height. The ribs are fine and sharp on the inner whorls; most ribs are bifurcated, but there are also simple ribs and fasciculating ribs. On the last whorls they slowly increase in thickness towards the venter. Near the venter

Table XXVIII: Measurements *Delphinella* (*Delphinella*) *subchaperi* (Retowski, 1894).

RGM 160 455	D = 88.4	Wh = 32.7 (37.0)	U = 32.5 (36.8)

the interspaces are narrow (one third to one quarter of the rib thickness) and the ribs are projected. Most ribs split into two or, rarely, into three secondary ribs at mid-flank where the ribs make a slight convex curve. There are in addition several short simple ribs. Towards the aperture the ribs tend to fade a little at mid-flank, and near the aperture the middle and upper parts of the flank are smooth and a large lappet is preserved.

Measurements: See Table XXIX.

Remarks: *D.* (*D.*) *tresannensis* differs from *D.* (*D.*) *crimensis* in the late start of the rib effacement at mid-flank, in the presence of fasciculating and simple ribs, in the slow growth of the whorl height and in the the larger umbilicus.

Geographic distribution: France, Spain, the Crimea (The Ukraine).

Delphinella (*Delphinella*) *crimensis* (Burckhardt, 1912)

Pl. XI, figs 5-7

* 1894. *Hoplites Calisto* v. *delphinensis* Kil.– Retowski, p. 262, 264, pl. 11, fig. 4.

1912. *Steueroceras crimense* Burckhardt, 1912, p. 165.

1973. *Delphinella crimense* (Burckhardt).– Le Hégarat, p. 103, pl. 42, figs 6, 8.

1984. *Delphinella crimense* (Burckhardt, 1912).– Bogdanova *et al.,* p. 32, pl. 2, fig. 6, pl. 3, fig. 6 .

pars 2005. *Delphinella crimensis* (Burckhardt, 1912).– Arkadiev & Bogdanova, p. 491, pl. 6, figs 7, 9, *non* fig. 8a, b [= *Delphinella kaffae* (Rousseau, 1842 in Retowski, 1894)].

pars 2012. *Delphinella crimensis* (Burckhardt, 1912).– Arkadiev *et al.,* p. 161, pl. 10, figs 6, 7, non 5a, b [= *Delphinella kaffae* (Rousseau, 1842 in Retowski, 1894)].

Lectotype: The specimen depicted by Retowski (1894) on pl. 11, fig. 4 under the name of *Hoplites Calisto* var. *delphinensis* Kilian, 1889, derived from the Tithonian of Feodosia, the Crimea, (the Ukraine) and deposited in the Retowski Collection under No. 37/10916 in the CNIGR Museum of St. Petersburg.

Material: Five specimens of the Jacobi Zone along the Barranco de Tollo, Caravaca, province of Murcia, Spain: RGM 160 472 (bed Z115), RGM 160 471 (bed Z102), RGM 160 469 (bed 105), RGM 160 451 (bed Z102), RGM 160 459 (bed Z119).

Description: On the inner whorls the thin, closely spaced ribs are straight, very prorsiradiate and projected approaching the venter. They furcate into two secondaries, which hardly broaden towards the ventral side, or they remain simple. The splitting occurs at or below mid-flank and the secondaries are almost parallel. All ribs start at the umbilical seam, in a radial direction and no fasciculation was detected. The ribs start already fading away at two-thirds flank height from a diameter of 35 mm. Within the fading area the ribs become very flat, furcate and make a hardly visible concave curve before becoming projected. Then only simple, strongly prorsiradiate primaries are visible around the umbilicus, fading away. On the highest part of the flanks near the venter are only short projected secondaries visible, which disappear near the aperture. Only the prorsiradiate primaries remain.

Measurements: See Table XXX.

Remarks: *D.* (*D.*) *crimensis* resembles *D.* (*D.*) *tresannensis* closely. The main differences with the latter are: the finer, sharper ribs of *D.* (*D.*) *crimensis* in which no fasciculation occurs, the smaller umbilicus of *D. crimensis*, the more rapid increase in height of the whorls of *D.* (*D.*) *crimensis* during growth, and the earlier start of the fading of the ribs at mid-flank.

D. (*D.*) *crimensis* also resembles *Delphinella* (*Delphinella*) *kaffae* (Rousseau, in Retowski, 1894), but in *D.* (*D.*) *kaffae* the effacement of the ribs around mid-flank begins much later and the umbilicus is much wider. The author is of the opinion that the species *Hoplites Calisto* var. *Kaffae* (Rousseau in Retowski, 1894) belongs to genus *Delphinella.* The falcoid shape of the ribs and their effacement on the last portion of the last whorl are *Delphinella*-like, the absence of a siphonal furrow is not disturbing, because several other species of *Delphinella* lose their furrow during growth.

The idea of Nikolov (1982, p. 50) and Kvantaliani (1999,

Table XXIX: Measurements *Delphinella* (*Delphinella*) *tresannesis* Le Hégarat, 1973.

RGM 160 235	D = 45.6	Wh = 19.0 (41.7)	U = 9.3 (20.4)
RGM 160 448	D = 39	Wh = 18.6 (47.7)	U = 9.2 (23.6)
RGM 160 449	D = ±40	Wh = 16.5 (41.3) overlap ⅓	U = 10 (25.0)

Table XXX: Measurements *Delphinella* (*Delphinella*) *crimensis* (Burckhardt, 1912).

RGM 160 472	D = 56.9	Wh = 23 (40.4)	U = 17.5 (30.8)	wh = 16.3 (28.6)
RGM 160 469	D = 54.0	Wh = 23.5 (43.5)	U = 15.4 (28.5)	wh = 14.7 (27.2)
RGM 160 451	D = 35.0	Wh = 16.1 (46.0)	U = 8.9 (25.4)	wh = 8.1 (23.2)

p. 93) that two paratypes of *Berriasella (Hegaratella) paramacilenta* Mazenot (1939, pl. 20, fig. 3a-e, pl. 21, fig. 1) and four paratypes of *Berriasella evoluta* Le Hégarat, 1964 in Le Hégarat (1973, p. 74, pl. 8, figs 3, 7, pl. 39, figs 9, 13) should be identified as *Berriasella (Berriasella) kaffae* (Rousseau in Retowski), is erroneous. All these specimens belong to one species, which should have a new name, because they are not conspecific with *B.* (*H.*) *paramacilenta,* nor with *B.* (*Berriasella*) *evoluta,* nor with *Delphinella kaffae*. The author proposed to call this species *Berriasella* (*Berriasella*) *multicostata* sp. nov. [see paragraph 2.2.2. Systematics and emendation]. In fact, the specimen depicted in Arkadiev & Bogdanova (2005) on pl. 6, fig. 8a, b under the name *Delphinella crimensis* (Burckhardt) is according to the author probably the second specimen of *Delphinella* (*Delphinella*) *kaffae* (Rousseau in Retowski, 1894) depicted in the literature after 1894.
Geographical distribution: France, Spain, Ukraine (the Crimea).

***Delphinella* (*Delphinella*) *berthei* (Toucas, 1890)**
Pl. XI, fig. 8

- * 1890. *Hoplites Calisto* var. *Berthei* Toucas, p. 601, pl. 17, figs 6, 7a, b.
- 1890. *Hoplites Privasensis* (Pictet, 1867).– Toucas, p. 599, pl. 17, fig. 1.
- 1894. *Hoplites Calisto* var. *Berthei* Toucas.– Retowski, 1894, p. 263, 264, pl. 11, fig. 3.
- *pars* 1939. *Berriasella Berthei* (Toucas) Gevrey.– Mazenot, p. 43, pl. 2, figs 9a, b, 10a-c, *non* figs 11a, b, 12a, b [= *Delphinella* (*Subdelphinella*) *sevenieri* Le Hégarat, 1973].
- 1953. *Berriasella Berthei* (Toucas 1890).– Arnould-Saget, p. 26, pl. 2, figs 12a, b, c, 13a, b, c, pl. 3, fig. 3a, b, c.
- *non* 1968. *Berriasella berthei* (Toucas, 1890).– Le Hégarat & Remane, p. 20, pl. 5, fig. 5 (= *Delphinella angustiumbilicata* sp. nov.).
- *non* 1973. *Delphinella berthei* (Toucas).– Le Hégarat, p. 99, pl. 13, figs 3-5, *non* pl. 42, fig. 11 [= *Berriasella* (*Hegaratella*) *paramacilenta* Mazenot, 1939], *non* fig. 12 [= inner whorls of *Delphinella* (*Subdelphinella*) *ellenica* Nikolov, 1960].
- 1985. *Berriasella berthei* (Toucas).– Tavera, p. 248, pl. 34, figs 1, 2.
- ? 2005. *Berriasella berthei* (Toucas, 1890).– Arkadiev & Bogdanova, p. 496, pl. 6, figs 3a, b, 4.
- ? 2012. *Berriasella berthei* (Toucas, 1890).– Arkadiev *et al.,* p. 149, pl. 5, figs 8a, b, 9.

Lectotype: The specimen depicted by Toucas (1890) on pl. 17, fig. 6 under the name *Hoplites Calisto* var. *Berthei*, derived from the upper Tithonian (Calcaire de Chomérac), deposited in the collection of the Sorbonne (Paris), designated by Mazenot, 1993.
Material: One specimen from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain: RGM 160 463 (bed Z140).
Description: The shell is an evolute planulate with a wide shallow umbilicus. The umbilicus is eccentric and is equal to the whorl height at a diameter of 30 mm. The umbilicus has a sloping wall. The whorls grow only slowly in height. The involution is small, about 1/8. Two small specimens from the Col du Pin are figured to show the small umbilicus in specimens smaller than 30 mm.
The ornamentation of the inner whorls consists of uniform bifurcating ribs, which are straight, slightly prorsiradiate and thin, and which originate at the umbilical seam. They are rather wide spaced, about 35 ribs on the penultimate whorl. The secondaries are clavate, make a V-shape and are weakly projected. The points of furcation are somewhat raised.
The ornamentation of the last quarter of a outer whorl is quite different. The ribs start at the umbilical seam; at the umbilical rim they are rursiradiate, describe a small concave curve and change direction to become prorsiradiate. On the umbilical rim they are very thin, and at first they remain rather thin; the secondary ribs are still clavate. However, at a diameter of 50 mm the primary ribs gradually broaden and flatten until mid-flank. They are still rather wide apart and separated by rather wide interspaces, which are two times wider than the breadth of the ribs. They are slightly biconcave. At mid-flank they are broadest and have the same breadth as the interspaces. Here they bifurcate into two broad and flattened (spatulate) secondary ribs, which all are separated by very narrow interspaces. Just above the furcation is a shallow longitudinal depression in which the secondaries are very flat; this is a typical *Delphinella* feature.
Measurements: See Table XXXI.
Remarks: The presence of club-shaped secondary ribs, but especially the weak biconcavity of the ribs, the thin interspaces between the spatulate secondary ribs and the shallow longitudinal depression directly above the raised forkings on the last eighth part of the last whorl are the arguments of the author for including this species in *Delphinella*. It was included in genus *Berriasella* by Tavera (1985) and by Arkadiev & Bogdanova (2005). The specimen from section Z closely resembles the specimen depicted by Mazenot (1939) on pl. 2, fig. 10.
Under the name *D.* (*D.*) *berthei* also a specimen with a small umbilicus was included by Le Hegarat & Remane

Table XXXI: Measurements *Delphinella* (*Delphinella*) *berthei* (Toucas, 1890).

RGM 160 463	D = 57.9	Wh = 18.2 (31.4	U = 25.2 (43.5)

(1968, pl. 5, fig. 5). The author regards it as a separate species, because the differences with *D. berthei* are too great to consider them varieties. The author proposes to name this species ***Delphinella*** **(*Delphinella*)** ***angustiumbilicata*** sp. nov. [Type species: *Berriasella berthei* (Toucas) in Le Hégarat & Remane (1968), pl. 5, fig. 5, from the bed BR31 (Jacobi Zone) of Broyon (Ardèche, France), deposited in the Université Claude Bernard de Lyon, Département de Géologie, No. FSL 127 434, Measurements: D = 25, Wh = 10 (40), U = 8.7 (34.8), wh = 6 (24)].
Diagnosis: Small species with small umbilicus and whorls that rapidly grow in height. Wide-spaced, thin, sharp primaries, which bifurcate at mid-flank into two clavate secondaries. The points of furcation are raised.
Geographical distribution: France, Spain, Tunisia, Ukraine (The Crimea).

Delphinella **(*Delphinella*)** ***obtusenodosa***
(Retowski, 1894)
Pl. XI, fig. 11

* 1894. *Hoplites obtusenodosus* n. sp. Retowski, p. 267, pl. 11, figs 10, 11.
1939. *Berriasella obtusenodosa* (Retowski).– Mazenot, p. 72, pl. 8, figs 3, 4.
non 1939. *Berriasella* aff. *obtusenodosa* (Retowski).– Mazenot, p. 72, pl. 7, figs 6a-c, 7a, b (= *Delphinella ellenica* Nikolov, 1960).
1953. *Berriasella obtusenodosa* (Retowski 1893).– Arnould-Saget, p. 46, pl. 5, fig. 1.
1960. *Berriasella obtusenodosa* (Retowski).– Drushchits, p. 275, pl. 22, figs 1a, b.
non 1968. *Berriasella* aff. *obtusenodosa* (Retow.).– Le Hégarat & Remane, p. 23, pl. 4, fig. 2 [= inner whorls of *Delphinella* (*Subdelphinella*) *ellenica* Nikolov, 1960].
pars 1973. *Delphinella obtusenodosa* (Retowski).– Le Hégarat, p. 109, pl. 13, figs 10, 11, 13, 14, pl. 41, figs 1, 6, *non* fig. 7 [= *Delphinella janus* (Retowski, 1894)].
pars 1973. *Delphinella boisseti* n. sp.– Le Hégarat, pl. 41, fig. 5, *non* figs 3, 4 (= *Delphinella boisseti* Le Hégarat, 1973).
1979. *Berriasella* (*Delphinella*) *obtusenodosa* (Retowski, 1893).– Sapunov, p. 178, pl. 56, fig. 8.
2005. *Delphinella obtusenodosa* (Retowski, 1893).– Arkadiev & Bogdanova, p. 493, pl. 5, figs 6, 7.
2012. *Delphinella obtusenodosa* (Retowski, 1894).– Arkadiev *et al.*, pl. 10, fig. 5, pl. 11, figs 6, 7.
2013. *Malbosiceras* cf. *asper* (Mazenot, 1939).– Vašíček & Skupien, p. 339, fig. 5R.

Lectotype: The specimen depicted by Retowski (1894) on pl. 11, fig. 10 under the name *Hoplites obtusenodosus* n. sp., derived from the upper Tithonian of Feodosia, The Crimea (Ukraine), deposited under No. 42/10916 in the CNIGR Museum in St.-Petersburg. Designated by Mazenot, 1939.
Material: Three whorl fragments from the Jacobi Zone along the Barranco de Tollo, Caravaca, province of Murcia, Spain. RGM 160 457 (bed Z124), RGM 160 462 (bed Z119), RGM 169 460 (bed Z97).
Description: The ornamentation of the whorl fragment of the smallest specimen, 19 mm high, consists of closely spaced, prorsiradiate primary ribs, which begin at the umbilical rim as very thin ribs; they become somewhat broader and higher towards the middle of the flank. At mid-flank they flatten suddenly, but remain broad, and split into two or three flat secondary ribs, which slightly curve forward; a very few ribs remain simple. This sudden flattening produces "false nodes". The ribbing is slightly falcoid. The secondaries are three times broader than the narrow interspaces.
The ornamentation of the whorl fragment of the larger specimen, 27 mm whorl height, consists of prorsiradiate primary ribs, which begin as high thin ribs, curve backward to a radial direction and become broad and flat and nearly efface. The effacements form a longitudinal, almost smooth band just below mid-flank. Here the ribs split into two or three broad, flat secondary ribs, which curve forward again. The ribbing is sigmoid. The secondaries are three times broader than the narrow interspaces. The spatulate secondaries are interrupted on the venter by a smooth band.
Remarks: The author does not support the idea of Tavera (1985) and Klein (2005) that *Dephinella obtusenodosa* would possibly be a species of genus *Busnardoiceras* Tavera, 1985. It resembles the type species of *Busnardoiceras*, viz. *Parapallasiceras busnardoi* Le Hégarat, 1973 (= *Berriasella ciliata* Mazenot, 1939, pl. 1, fig. 1a, b), but the latter lacks the "false nodes" at the points of splitting between diameters of 60 to 85 mm and the effacement of the splitting points at diameters greater than 85 mm. Moreover, the umbilicus of *D.* (*D.*) *obtusenodosa* is much smaller than that of *Busnardoites busnardoi* (Le Hégarat, 1973) and the whorls section of *D.* (*D.*) *obtusenodosa* more compressed and subtrapezoidal.
Geographic distribution: Spain, France, Bulgaria, Tunisia, Ukraine (The Crimea).

2.2.7. Genus *Dalmasiceras* Djanélidze, 1921

Type species: *Ammonites Dalmasi* Pictet, 1867.

Dalmasiceras **n. sp. aff.** ***D. dalmasi*** **Djanélidze, 1921,**
non **Pictet, 1867**
Pl. XI, fig. 12

* 1921. *Hoplites* (*Dalmasiceras*) n. sp. aff. *Dalmasi* Pict. sp. Djanélidze, p. 269, pl. 12, fig. 5.
1939. *Dalmasiceras* n. sp. Djanélidze aff. *D. dalmasi* (Pict.).– Mazenot, p. 163, pl. 25, fig. 5.

Type: The specimen depicted by Djanélidze (1921) on pl. 12, fig. 5 under the name *Hoplites* (*Dalmasiceras*) n. sp. aff. *Dalmasi* Pict. sp., derived from the upper Tithonian of Chomérac, Ardèche (France), deposited in

the Faculté des Sciences de Grenoble, Institut Dolomieu.
Material: One imprint of a specimen from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain: RGM 617 909 [bed Z12 (loose)].
Description: The shell is a platycone with a small umbilicus and with whorls that rapidly grow in height. The whorl section has the shape of a high oval with a narrow but rounded venter. The flanks are slightly rounded. Only up to a diameter of 22 mm ribs can be discerned. The last whorl is totally smooth except for a row of comma-shaped (concave in adoral direction) bullae on the umbilical rim, about 23 on the last whorl.
Measurements: See Table XXXII.
Remarks: This species cannot be *D. dalmasi* (Pictet, 1867), because it is derived from the Upper Tithonian of Chomérac instead of the Berriasian Dalmasi Subzone. The Barranco de Tollo specimen has the same measurements as *D*. n. sp. aff. *dalmasi* Djanélidze, 1921, but does not show any trace of ventrolateral riblets, of which one seems vaguely present (?) on Djanélidze's specimen. Whether this is a question of preservation or of the true absence of these riblets on the Barranco de Tollo specimen cannot be decided from the photograph. The specimen closely resembles *D. Djanélidzei* Mazenot, 1939, but the latter has a much larger umbilicus, and the whorls grow slowly in height.
Geographic distribution: France, Spain.

2.2.8. Genus *Substeueroceras* Spath, 1923

Type species: *Odontoceras koeneni* Steuer, 1897.

Systematics: The genus *Substeueroceras* was introduced by Spath (1923) for a group of fine-ribbed ammonites from Argentina. As type species he indicated *Substeueroceras koeneni* Steuer, 1897, from the upper Tithonian of Argentina.
When in 1904 Charles Jacob, a well-known French palaeontologist, studied the ammonites of the Gevrey collection (deposited in the University of Grenoble, Institut Dolomieu), he gave new names to specimens without publishing descriptions. A number of specimens were given the name *Hoplites Beneckei*, some others were given the name *Hoplites Koeneni*. According Mazenot (1939, p. 209) some of the specimens that Jacob named *Hoplites Beneckei* (*in* coll.) could not be distinguished from those he called *Hoplites Koeneni* (*in* coll.). Whether this means that Jacob regarded *H. beneckei* and *H. Koeneni* as closely related, cannot be concluded with certainty. However, Mazenot (1939) apparently did not, because he incorporated *Hoplites beneckei* in the genus *Neocomites.*
Breistroffer (1964, p. 280) appears to be the first palaeontologist who included *Hoplites Beneckei* in the genus *Substeueroceras*. However, he also included in it *Tirnovella suprajurensis* (Mazenot, 1939) and, with a question mark, *Tirnovella allobrogensis* (Mazenot, 1939). It is probable that *Tirnovella* is derived from *Substeueroceras.*
The author (Hoedemaeker, July 1982, p. 68) agreed to Jacob's and Breistroffer's idea that *Neocomites beneckei* Mazenot, 1939, from the Upper Tithonian Jacobi Zone, closely resembles *Substeueroceras koeneni* (Steuer, 1897), and he included this species in *Substeueroceras*. The author still holds this view, all the more since *Substeueroceras* has a peculiar suture line with a very wide and deep lateral lobe, which is also present in *Neocomites beneckei* Mazenot. This large lateral lobe is a characteristic feature of *Substeueroceras*. The author also included *Pseudargentiniceras flandrini* Le Hégarat, 1973, in *Substeueroceras;* it closely resembles *Substeueroceras permulticostatum* Steuer, 1897.
The author was unaware of the fact that two months earlier Nikolov (May 1982, p. 208) also had independently incorporated *N. beneckei* and *P. flandrini* in *Substeueroceras*. Nikolov has examined the Gevrey collection in the Institut Dolomieu in Grenoble.
Le Hégarat (1973) regarded *N. beneckei* Mazenot, 1939, as a species of the genus *Pseudargentiniceras* Spath, 1925. However, the latter lacks the characteristic thin, closely spaced ribs that characterize *Substeueroceras*. The sutureline is also different and does not show the peculiar, wide, and deep lateral lobe of *S. koeneni* that characterizes the species of *Substeueroceras.*
Many specimens of *Substeueroceras beneckei* (Mazenot, 1939) occur in the Jacobi Zone of southeast Spain and southeast France, and these beds could therefore be correlated with each other and with the *Substeueroceras*–*Parodontoceras* beds in Argentina and Central America.

Substeueroceras beneckei (Mazenot, 1939)
Pl. XI, fig. 13; Pl. XII, figs 1, 2

* 1939. *Neocomites Beneckei* (Jacob).– Mazenot, p. 208, pl. 32, figs 11a, b, 12a, b, c, 13, 14, *non* fig. 10a, b (= *Substeueroceras fasciculata* sp. nov.) *non* fig. 8a, b (= *Lemencia mazenoti* Donze & Enay, 1961), *non* fig. 9a, b (= *Tirnovella allobrogensis* Mazenot, 1939).
1982. *Substeueroceras beneckei* (Mazenot, 1939).– Nikolov, p. 204, pl. 72, figs 2-9.
1953. *Neocomites Beneckei* (Jacob) in Roman & Mazenot, 1937.– Arnould-Saget, p. 73, pl. 7, figs 6a-c, 7a-c, 9a-c.
1953. *Neocomites allobrogensis* Mazenot, 1939.– Arnould-Saget, p. 74, pl. 8, fig. 1a, b.
1979. *Pseudosubplanites* (*Hegaratella*) *paramacilenta* (Mazenot, 1939).– Sapunov, p. 191, pl. 56, fig. 1.

Table XXXII: Measurements *Dalmasiceras* n. sp. aff. *D. dalmasi* Djanélidze, 1921.

RGM 617 909	D = 44.5	Wh = 19.5 (43.8)	U = 14.5 (32.6)

1979. *Tinovella beneckei* (Jacob in Roman & Mazenot, 1937).– Sapunov, p. 197, pl. 59, fig. 4.
1982. *Substeueroceras beneckei* (Mazenot, 1939).– Nikolov, p. 208, pl. 72, figs 3-9
1982. *Substeueroceras beneckei* (Jacob).– Hoedemaeker, p. 14, pl. 1, fig. 3.

Holotype: The specimen depicted by Mazenot (1939) on p. 208, pl. 32, fig. 12a-c under the name *Neocomites Beneckei* (Jacob), derived from the Jacobi Zone of La Boissière (Ardèche), deposited in the Faculté des Sciencs de Grenoble, Institut Dolomieu, No. ID 719 (collection Gevrey).

Material: Six specimens from the Jacobi Zone along the Barranco de Tollo, Caravaca, Prov. of Murcia, Spain. RGM 160 692 (bed Z191), RGM 160 236 (bed Z132), RGM 617 913 (bed Z136), RGM 160 411 (bed Z200), RGM 160 719 (bed Z192), RGM 160 718 (bed Z31).

Description: Planulate shell with rounded inner whorls and compressed outer whorls. The flanks are slightly rounded. The ribs are thin and sharp, and originate from the umbilical wall. They often describe a concave curve, especially in the sickle shaped part. On the inner whorls they bifurcate at or just above mid-flank; on later whorls (D > 45 mm) they may bifurcate at, or just below mid-flank, but some 20 percent remain simple. There is no fasciculation. Our largest specimen has a diameter of 56.7 mm, which is much larger than the specimens commonly figured in literature, which are all smaller than 50 mm. Those specimens smaller than 45 mm exhibit straight prorsiradiate ribs; the later whorls of larger specimens show sickle shaped ribs. There is no fasciculation in the part with sickle-shaped ribs, but there are bifurcating and simple ribs, which generate just above the umbilical rim in between two normal ribs originating at the umbilical wall. On the venter the ribs are interrupted by a furrow. All Argentinian species of *Substeueroceras* lose their mid-ventral furrow during growth, *Substeueroceras koeneni* loses it at a diameter of 45-50 mm. No suture line is preserved in the material studied by the author.

Measurements: See Table XXXIII.

Remarks: *Substeueroceras beneckei* closely resembles *S. koeneni*; the ribbing is quite similar, for *S. koeneni* also has sickle-shaped ribs at the same diameter; only the umbilicus of the latter is smaller. *S. koeneni* loses it ventral furrow at a diameter of approximately 45 mm; the specimens depicted by Mazenot (1939) are provided with a ventral furrow, but they are smaller than 45 mm. From a diameter of 85 mm the ribs of *S. koeneni* become slightly thicker and wider apart; this part is not preserved in the specimens of *S. beneckei* studied.

The species-group name *beneckei* (Jacob in Mazenot, 1939) has also been used by Steuer (1897) for *Odontoceras beneckei*, which has been grouped in the genus *Parodontoceras* (type species *Hoplites callistoides* Behrendsen, 1891). However, *Parodontoceras* Spath, 1923 and *Substeueroceras* were united by Verma & Westermann (1973) into *Substeueroceras*, which was followed by Salazar Soto (2012). In these cases the species-group names *beneckei* are secondary homonyms. On the other hand Mazenot (1939) considered his species *N. beneckei* to belong to *Neocomites* and *B. callistoides* to *Berriasella*. Roman (1938) and Arkell *et al.* (1957) considered *Parodontoceras* and *Substeueroceras* independent genera. Wright *et al.* (1996), considered *Berriasella* (in which he includes *Parodontoceras* as a synonym) and *Substeueroceras* to be two independent genera. In these cases the species-group names *beneckei* are not homonymous. Since the present author considers *Parodontoceras* and *Substeueroceras* independent genera, he is justified to disregards the homonymy of the species-group name *beneckei*.

Geographic distribution: Spain, Bulgaria, Tunisia, France.

Substeueroceras broyonense sp. nov.

Pl. XII, figs 3-6

1939. *Neocomites beneckei* (Jacob) in Roman & Mazenot.– Mazenot, p. 208, pl. 32, figs 10a, b, *non* 11a, b, 12a-c, 13, 14 (= *Substeueroceras beneckei* Mazenot, 1939), *non* fig. 8a, b (= *Lemencia mazenoti* Donze & Enay, 1961), *non* fig. 9a, b (= *Tirnovella allobrogensis* Mazenot, 1939).
* 1968. *Neocomites* (?) *beneckei* (Jac.).– Le Hégarat & Remane, p. 20, pl. 5, fig. 3.
1985. *Tirnovella allobrogensis* (Mazenot).– Tavera, p. 296, pl. 45, fig. 1.
2013. *Tirnovella allobrogensis* (Mazenot, 1939).–Vašíček & Skupien, p. 337, figs 5K-M.

Holotype: The specimen depicted by Le Hégarat & Remane, pl. 5, fig. 3 under the name *Neocomites* (?) *beneckei* (Jac.), derived from the Jacobi Zone (bed BR 26 = Brèche supérieur) of Broyon (Ardèche, France), deposited in the Université Claude Bernard de Lyon, Collection Le Hégarat, No. FSL127 293.

Table XXXIII: Measurements *Substeueroceras beneckei* (Mazenot, 1939).

RGM 160 692	D = 56.7	Wh = 21.6 (38.1)	U = 16.3 (28.7)
RGM 160 411	D = 45	Wh = 18.8 (41.8)	U = 13.5 (30.0)
RGM 160 236	D = 41.4	Wh = 20.0 (48.3)	U = 10.1 (24.4)
RGM 617 913	D = 40	Wh = 17 (42.5)	U = 10.7 (26.7)

Derivatio nominis: from the carrière Broyon (near Chomerac, Ardèche, France), a well-known locality yielding ammonites of the Jacobi Zone.
Diagnosis: Fine-ribbed compressed planulate. The small umbilicus has a low wall and rounded rim. Fine, closely spaced, prorsiradiate ribs, which may be concave or slightly flexuous. The ribs are mainly bifurcate; simple ribs are not rare; the latter may form fascicules with one bifurcate rib; fascicules consisting of two bifurcate ribs are rare. The presence of many fascicules on the adult whorls is characteristic. The whorls grow moderately rapid in height; the whorl section is high elliptic.
Material: Four specimens from the Jacobi Zone along the Barranco de Tollo, Caravaca, province of Murcia, Spain. RGM 160 732 (bed Z174). RGM 617 914 (bed Z137), RGM 542 475 (bed Z115), RGM 160 702 (bed Z170).
Description: Planulate with rounded inner whorls; later whorls compressed and slightly rounded. Umbilicus shallow with low umbilical wall and rounded umbilical rim; it is smaller than about two thirds of the whorl height. The ornamentation consists of thin prorsiradiate ribs and the interspaces have the same width as the ribs. They originate on the umbilical seam. They are straight to somewhat concave or slightly flexuous. Most of them split just below mid-flank. A moderate number of simple ribs split off from the main rib as low as at one quarter or one third of the flank height. Other simple ribs split off at the umbilical rim; these are the fascicules. In the specimen RGM 160 732 (Pl. XII, fig. 3) from the Barranco de Tollo, three fascicules produce two bifurcate ribs and two fascicules one bifurcate and one simple rib. There are no umbilical tubercles.
Measurements: See Table XXXIV.
Remarks: Specimen RGM 160 732 from the Barranco de Tollo closely resembles the specimen of *Substeueroceras beneckei* as depicted by Mazenot (1939, pl. 32, fig. 10a, b). *S. broyonense* differs from *S. beneckei* in the presence of a moderate number (about six on half a whorl) of fascicules. This difference does not seem important, but since all the specimens of *S. beneckei* without exception lack fascicules, it becomes important. They occur at the same beds as *S. beneckei*, but as no intermediate forms with one or two fascicules have been found yet, one must conclude that it is a distinct species. The ribs of *S. broyonense* bifurcate below mid-flank, those of *S. beneckei* above mid-flank. *S. broyonense* has many simple ribs; in *S. beneckei* they are rare.
Geographic distribution: France, Spain.

***Substeueroceras* aff. *koeneni* (Steuer, 1897)**
Pl. XII, fig. 7

* 1897. *Odontoceras Koeneni* nov. sp. Steuer, p. 45, pl. 17, figs 1-5.
1988. *Substeueroceras koeneni* (Steuer).– Riccardi, p. 55, p. 3, figs 1, 2.
non 1945. *Substeueroceras koeneni* (Steuer).– Leanza, 1945, p. 28, pl. 5, figs 7, 8, pl. 7, fig. 4 (umbilicus too wide).
pars 2012. *Substeueroceras koeneni* (Steuer).– Salazar Soto, p. 105, 176, pl. 4.59, figs a-c (= plaster cast of lectotype), d-f (= wrongly designated as neotype), pl. 4.61, figs a-q, *non*? figs r, s.

Lectotype: The specimen depicted by Steuer (1897) on pl. 17, figs 1-3 under the name *Odontoceras Koeneni* nov. sp., derived from the Upper Tithonian of Argentina, designated by Spath, 1923, deposited in the Geowissenschaftliches Zentrum Göttingen (Germany), Plastercast.
Material: One impression from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain. RGM 160 236 (bed Z132).
Description: Platycone with whorls that rapidly grow in height and a narrow, shallow umbilicus. The slanting umbilical wall passes directly into a curved rim. On the inner whorls the ribs are radiate, but become prorsiradiate from a diameter of 20 mm. From a diameter of 30 mm the prorsiradiate ribs become slightly falcate, which changes into biconcavity at a diameter of 40 mm. The ribs are closely spaced, like in *S. beneckei* (Mazenot, 1939). All ribs originate from the umbilical seam. There is no fasciculation except for one fascicule in which two bifurcate main ribs originate at the umbilical rim from one short primary rib. However, from a diameter of 40 mm there are a few intercalated ribs, which originate just above the umbilical rim (at ⅛ or ¼ flank height) and may bifurcate or remain simple. The venter is not preserved.
Measurements: See Table XXXV.
Remarks: It closely resembles *Substeueroceras koeneni* (Steuer, 1897); it has the same small umbilicus and the same rapid growth of the whorl height. It differs from

Table XXXIV: Measurements *Substeueroceras broyonense* sp. nov.

RGM 160 732 Ht	D = 46.5	Wh = 20.0 (43.0)	U = 12.0 (25.8)

Table XXXV: Measurements *Substeueroceras* aff. *koeneni* (Steuer, 1897).

RGM 160 236	D = 45	Wh = 21 (46.6)	U = 10.3 (22.8)

S. beneckei (Mazenot, 1993) in the smaller umbilical width and the more rapid growth of the whorl height. It differs from *Tirnovella allobrogensis* in the absence of fascicules and the coarser ribbing. It was hard for the author to avoid the impression that Salazar-Soto (2012) lumped more than one species under the name *S. koeneni*.
Geographic distribution: Argentina, Chile, Spain?

2.2.9. Genus *Tirnovella* Nikolov, 1966

Type species: *Berriasella alpillensis* Mazenot, 1939.

Remarks: Compressed ammonites with elliptically coiled umbilicus, which remains smaller than the whorl height. Whorls rather rapidly grow in height. Whorl section high elliptical. The ribs are generally thin and slightly flexuous to falcoid. Umbilical bullae and/or nodes generally present.

The species of the genus *Tirnovella* resemble those of genus *Neocomites* Uhlig (type species *Ammonites neocomiensis* d'Orbigny, 1841) and, therefore, Mazenot included them in the latter genus. Le Hégarat (1973, p. 175) enumerated the differences with *Neocomites* and *Tirnovella.*

The distinction of *Tirnovella* from *Subthurmannia* is not always easy, for instance, *Subthurmannia gallica* has a small umbilicus and its whorls grow rapidly in height, but it lacks prominent umbilical bullae. *Tirnovella berriasensis* and *Tirnovella donzei* deviate from the general morphology of *Tirnovella* in having rather large umbilici and in the whorls growing rather slowly in height.

The species of *Tirnovella* from the Jacobi and Occitanica zones do not seem to have any phylogenetic relation with those of the Alpillensis Subzone. They merely resemble each other. The older group has prominent umbilical tubercles, whereas the younger group has no umbilical tubercles. A closer investigation may reveal whether these groups should be separated as different (sub)genera or not.

Tirnovella companyi sp. nov.

Pl. XII, figs 8-11

1953. *Neocomites subalpinus* Mazenot, 1939.– Arnould-Saget, p. 80, pl. 8, fig. 3a-c.
1982. *Pseudoneocomites allobrogensis* (Mazenot).– Hoedemaeker, p. 10, pl. 1, fig. 2.
pars 1982. *Tirnovella allobrogensis* (Mazenot, 1939).– Nikolov, p. 228, pl. 82, figs 5, 6, *non* figs 3, 4 (= *Tirnovella allobrogensis* Mazenot, 1939).
pars 1982. *Pseudosubplanites* (*Hegaratella*) *paramacilentus* (Mazenot, 1939).– Nikolov, p. 44, pl. 6, fig. 4, *non* fig. 5 [= *Berriasella (Hegaratella) paramacilenta* (Mazenot, 1939)], *non* pl. 7, figs 1-3 [= *Berriasella (Hegaratella) paramacilenta* (Mazenot, 1939)].
1999. *Berriasella* (*Tirnovella*) cf. *allobrogensis* (Mazenot).– Kvantaliani, p. 95, pl. 12, fig. 1.

Syntypes: They comprise the five incomplete specimens collected in the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain, deposited in the geological collection of Naturalis Diversity Centre, and in addition the five species mentioned in the list of synonyms. These 10 syntypes complement each other and together they give a good conception of the species.
Diagnosis: Compressed conch with an umbilicus, which is approximately three quarters of the whorl height. The whorl height only moderately grows in height. The dense ribbing consists of thin, slightly sigmoid ribs. Fasciculation sets in at D = 13 mm and from D = 30 mm the fascicules are generated from long, thin umbilical bullae. Towards the aperture the number of simple ribs increases, and the fascicules become bundles. Several ribs fork at two thirds of the flank height.
Material: Five identifiable specimens from the Jacobi Zone along the Barranco de Tollo, Caravaca, Prov. of Murcia, Spain. RGM 160 237 (bed Z174), RGM 160 734 (bed Z187), RGM 160 731 (bed Z160), RGM 160 719 (bed Z192), RGM 617 915 (bed Z143).
Description: Compressed conch with a rather small, shallow umbilicus and high whorls. The umbilicus has a sloping rim. The later whorl overlaps the inner whorl for a quarter of the whorl height. The flanks are slightly rounded. The ribbing of the innermost whorls consists of simple and bifurcate ribs. They are thin, rather strongly prorsiradiate and originate singly from the umbilical seam; the interspaces are as wide as the thickness of the ribs. With increasing height of the flanks the thin ribs become longer, while the interspaces and the thickness of the ribs remain the same, the result is a dense ribbing. From a diameter of 13 mm fasciculation sets in. A fascicule generally consist of one bifurcate rib and one simple rib. The fascicules are separated by non-fasciculate ribs. The furcation points gradually shift towards the umbilicus with the result that the fascicules consist of two simple ribs. There are also simple ribs that originate low on the flanks.
From a diameter of about 30 mm the fascicules originate from small umbilical bullae. The number of simple ribs increases with the growth of the conch, and the fascicules become bundles of simple ribs; forking in the higher part of the flank is not rare. The ribs are sickle-shaped and prorsiradiate. The umbilical bullae become stronger and close together. At a diameter of 55 mm the distance between the bullae increases. The ribs are still thin and the interspaces as wide as the thickness of the ribs.
Measurements: See Table XXXVI.
Remarks: The best specimen available is an imprint (RGM 160 237) collected from the Jacobi Zone along the Barranco de Tollo. Previously the author (Hoedemaeker, 1982) identified these specimens erroneously as *Pseudoneocomites allobrogensis* Mazenot, 1939, but *Tirnovella companyi* has a much wider umbilicus than *T. allobrogensis* (see measurements). *Tirnovella companyi* resembles *Tirnovella subalpina* Mazenot, 1939,

but differs from the latter in the finer and denser ribbing. The whorl height of *T. subalpina* is a little higher and the umbilicus a little smaller. The density of the ribbing of *T. companyi* resembles that of *Tirnovella allobrogensis* Mazenot, 1939. The ribs of *T. companyi* are still finer than those of *T. bogdanovae* sp. nov. *T. companyi* resembles the specimen depicted by Le Hégarat, 1973, on pl. 47, fig. 2, under the name *Fauriella shipkovensis* (Nikolov & Mandov). However, the latter specimen has coarser ribs than *T. companyi*, and its whorls grow more rapidly in height.

Geographical distribution: France, Spain, Bulgaria, Ukraine (The Crimea).

Tirnovella subalpina (Mazenot, 1939)
Pl. XIII, figs 1, 2

* 1939. *Neocomites subalpinus* n. sp.– Mazenot, p. 216, pl. 34, fig. 1a-c, pl. 35, fig. 2a-c.
1953. *Neocomites subalpinus* Mazenot, 1939.– Arnould-Saget, p. 80, pl. 8, fig. 3a-c.
non 1968. *Neocomites subalpinus* Mazenot.– Le Hégarat & Remane, p. 26, pl. 4, fig. 4 (= *Tirnovella bogdanovae* sp. nov.).
pars 1973. *Tirnovella subalpina* (Mazenot).– Le Hégarat, p. 187, pl. 48, figs 2, 4, *non* pl. 28, fig. 4 (= *Tirnovella bogdanovae* sp. nov.).
pars 1982. *Tirnovella subalpina* (Mazenot, 1939).– Nikolov, p. 232, pl. 83, figs 3, 5, *non* fig. 4 (= *Tirnovella bogdanovae* sp. nov.).

Holotype: The specimen depicted on pl. 35, fig. 2a, b, by Mazenot (1939) under the name *Neocomites subalpinus* n. sp. from the Subalpina Zone of La Faurie, Hautes-Alpes, France. Deposited in the Faculté des Sciences de Grenoble, Institut Dolomieu, No. ID724.

Material: Seven specimens. Five whorl fragments and two impressions of specimens from the Jacobi Zone along the Barranco de Tollo (section Z, three kilometres west of Caravaca) and the Barranco de las Oicas (section M, ten kilometres west of Caravaca): RGM 160 242 (bed M53-54), RGM 160 697 (bed M61), RGM 160 700 (bed M60-62), RGM 160 696 (bed M61), RGM 160 699 (bed Z206), RGM 160 695 (bed Z232), RGM 617 918 (bed Z212). From bed Z210 a well-preserved specimen of *T. subalpina* was collected and marked in the field book; it could not be retrieved, but due to its stratigraphic importance marked on the range chart.

Description: Very compressed, disk-shaped, fine-ribbed shell with a small, shallow umbilicus. From a diameter of about 80 mm a row of umbilical bullae marks the umbilical rim. At first the umbilical bullae are long and may be described as slightly raised rib beginnings. They give rise to single ribs and fascicules of two ribs. With growth of the shell, the umbilical bullae become more prominent, more distant, and give rise to fascicules of two or more ribs. At this stage the ribs become effaced around mid-flank leaving only umbilical bullae and weak ribs on the upper part of the flanks.

Measurements: See Table XXXVII.

Remarks: The author collected in addition four specimens, which are finer ribbed and larger umbilicated than *T. subalpina*. The whorls of these four specimens increase less rapidly in height and their ribs tend to become effaced on the living chamber. The author considers these finer ribbed specimens as a new species, *T. bogdanovae* sp. nov. This species takes an intermediate position between *Tirnovella companyi* sp. nov. and the holotype of *Tirnovella subalpina*.

Geographical distribution: Spain, France, Bulgaria, Tunisia

Tirnovella bogdanovae sp. nov.
Pl. XII, figs 12-14

* 1968. *Neocomites subalpinus* (Mazenot).– Le Hégarat & Remane, p. 26, pl. 4, fig. 4.
1982. *Tirnovella subalpina* (Mazenot, 1939).– Nikolov, p. 232, pl. 83, fig. 4, pl. 84, fig. 1, *non* pl. 83, figs 3, 5 (= *Tirnovella subalpina* (Mazenot, 1939).
1982. *Tirnovella occitanica* (Pictet, 1867).– Nikolov,

Table XXXVI: Measurements *Tirnovella companyi* sp. nov.

RGM 160 237	D = 64.5	Wh = 27.5 (42.6)	U = 20.7 (32.1)	wh = 18.0 (27.9)
RGM 160 734	D = 32.8	Wh = 13.6 (41.5)	U = 11.0 (33.5)	wh = 8.0 (24.4)
RGM 160 731	D = 31.5	Wh = 13.2 (41.9)	U = 10.0 (31.7)	wh = 7.5 (23.8)

For comparison: measurements of the photograph of holotype of *T. allobrogensis* Mazenot, 1939

Photograph	D = 52	Wh = 26 (50)	U = 12.4 (23.8)	wh = 14.3 (27.5)
Mazenot meas.	D = 48	Wh = 23.5 (48)	U = 12.0 (25)	

Table XXXVII: Measurements *Tirnovella subalpina* Mazenot, 1939.

RGM 160 242	D = 84	Wh = 37 (44.0)	U = 25 (29.8)

p. 230, pl. 83, fig. 2, *non* fig. 1 (= *Subthurmannia* sp. indet.), *non* pl. 85, fig. 4 [= possibly *Tirnovella subalpina* (Mazenot, 1939)].

Holotype: The specimen figured by Le Hégarat & Remane (1968) on pl. 4, fig. 4 under the name *Neocomites subalpina* (Mazenot), derived from bed 148 of the Berriasian Stratotype near Berrias (Ardèche), France, deposited in the Université Claude Bernard de Lyon, Departement de Géologie, FSL 126 825.
Derivatio nominis: After Dr. Tamara N. Bogdanova, specialist in Lower Cretaceous ammonites, who studied ammonites from the Jacobi Zone of the Crimea.
Material: Four specimens from the Subalpina Zone: two from the beds along the Barranco de Tollo (3 km west of Caravaca): RGM 617 916 (bed Z234), RGM 617 917 (bed Z234), and two from the Barranco de las Oicas (10 km west of Caravaca): RGM 160 698 (bed M62), RGM 160 735 (bed M45-57).
Description: Very compressed shell with a rather wide umbilicus, which is a little narrower than the whorl height. The ribbing is fine and dense and consists on the inner whorls of prorsiradiate S-shaped ribs, which describe a kink at three quarters flank height on the body chamber; here the uppermost parts of the ribs become marked prorsiradiate. The ribs become effaced around the middle of the flanks on the body chamber. The umbilical bullae, from which fascilated ribs originate, become suddenly wide-spaced on the body chamber.
The three specimens figured by Nikolov (1982) on pl. 83, figs 2, 4, pl. 84, fig. 1, do not show effacement of the ribs, nor the kink in the curve of the ribs, but have similar measurements as the holotype. On the specimens figured by Nikolov (1982) the umbilical bullae become close-spaced instead of wide-spaced. The author interpreted this difference as variability.
Measurements: See Table XXXVIII.
Remarks: The measurements of *T. bogdanovae* rather strongly deviate from those of *T. subalpina* and are close to those of *T. companyi*. However, the ribs of *T. companyi* are still finer and denser than in *T. bogdanovae* sp. nov. *T. bogdanovae* is finer ribbed and larger umbilicated than *T. subalpina*, and the whorls increase less rapidly in height than in *T. subalpina*; the ribs tend to efface on the living chamber.
Geographical distribution: France, Bulgaria, Spain.

2.2.10. Genus *Neocosmoceras* Blanchet, 1922

Type species: *Hoplites sayni* Simionescu, 1899.

Neocosmoceras sayni (Simionescu, 1899) (microconch)

Pl. XIII, fig. 3

* 1899. *Hoplites Sayni* n. f. Simionescu, p. 480, pl. 1, figs 7, 8.
1939. *Neocosmoceras Sayni* (Simionescu).– Mazenot, p. 182, pl. 28, figs 6, 7, 9a-c, pl. 29, figs 1a, b, 2a, b (= aff. *sayni*).
non 1967. *Neocosmoceras sayni* (Simionescu).– Dimitrova, p. 118, pl. 56, fig. 4 (= *Neocosmoceras* sp.).
1973. *Neocosmoceras sayni* (Simionescu).– Le Hégarat, p. 140, pl. 43, fig. 3, pl. 45, fig. 6.
1976. *Neocosmoceras sayni* (Simionescu, 1899).– Khimshiashvili, p. 111, pl. 9, fig. 2.
pars 1982. *Neocosmoceras sayni* (Simionescu, 1899).– Nikolov, p. 219, pl. 79, figs 1, 2, 4, *non* fig. 3 (= *Neocosmoceras* sp.).

Holotype: The specimen depicted in Simionescu (1899) on pl. 1, fig. 7 under the name *Hoplites Sayni* n. f., derived from the Berriasian of Saint-André-en-Bauchaine, France, deposited in the collection of the Faculté des Sciences de Grenoble, Institut Dolomieux, No. ID704
Material: One whorl fragment of a small specimen from the Subalpina Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain: RGM 160 684 (bed Z227).
Description: The whorl fragment belongs to a small specimen of *Neocosmoceras sayni*. It resembles the small specimen figured by Simionescu (1899) on pl. 1, fig. 8, which was refigured by Mazenot (1939) on pl. 28, fig. 7. The whorl height is 14,5 mm. The ornamentation on the rounded left flank consists of four simple trituberculate main ribs. In this specimen the lateral tubercles are strongly reduced to merely low raisings of the main ribs. Unfortunately, the umbilical tubercles cannot be studied owing to mispreparation. However, the ventrolateral tubercles are situated on the main ribs and are well-developed into long spines. Two main ribs are accompanied on their adoral side by simple ribs of nearly the same prominence. Two other ribs have accompanying ribs at both sides. These accompanying ribs cross the venter without interruption. According to Mazenot (1939, p. 184) the specimen of pl. 28, fig. 7, shows an accelerated ontogenetic development, because of the virtual disappearance of the lateral tubercles, which normally takes place near the aperture. This is also the case with the specimen from the Barranco de Tollo.
Remarks: The author is of the opinion that this specimen

Table XXXVIII: Measurements *Tirnovella bogdanovae* sp. nov.

RGM 160 698	D = 87.3	Wh = 35.3 (40.4)	U = 28.5 (32.6)
Holotype	D = 95.2	Wh = 37.3 (39.2)	U = 33.2 (34.9)
Nikolov specim.	D = 140.7	Wh = 55.7 (39.6)	U = 46.2 (32.8)

could well be a microconch of *N. sayni* Simionescu 1899. The research of the author (Hoedemaeker, 2013) on the heterochrony of *Pseudothurmannia* (Lower Cretaceous Ancyloceratidae) revealed that the ontogeny of macroconchs is conservative and should preferably be used in phylogenetic studies to trace the phylogenetic lineages, whereas the ontogeny of microconchs often appreciably deviates from the conservative macroconchs; they often show adult features at smaller diameters. This phenomenon is also visible in *Pseudosubplanites lorioli* (microconch) (see paragraph 2.2.1.).
Geographical distribution: Spain, France, Bulgaria, Rep. Georgia.

Family Himalayitidae
Genus *Himalayites* Uhlig, 1910
2.2.11. Subgenus *Himalayites* (*Himalayites*) Uhlig, 1910
Type species: *Himalayites treubi* Uhlig in Böhm, 1904.

The presence of two species of Himalayitidae in the Jacobi Zone is remarkable. The first clearly belongs to the same species as the specimen figured by Retowski (1894) on plate 10, fig. 11. Retowski identified this species as *Himalayites cortazari* (Kilian, 1889), but Kvantaliani (1979) as *Himalayites seideli* (Oppel, 1863). The shells of Retowski's specimen and the specimen of the Barranco de Tollo are, however, more evolute than *H. cortazari* and closely resemble the specimen of *H. seideli* depicted by Uhlig (1910) on pl. 39, fig. 2a, b.
The second specimen can be identified as *Pomeliceras breveti* (Pomel, 1889). The sculpture of the body chamber consists of primary ribs with short, thick spines from which four to five secondary ribs fan out in a prorsiradiate direction; long intermediate ribs starting at the umbilical rim are absent from a diameter of 73 mm, i.e. from the beginning of the body chamber. *Pomeliceras* differs from *Himalayites* merely in having small umbilical bullae on all the primary ribs of the last whorl. Therefore *Pomeliceras* is more closely related to *Himalayites* than to Neocomitidae (Berriasellinae) and had better be placed in Himalayitidae. The author considers *Pomeliceras* a subgenus of *Himalayites*.

***Himalayites* (*Himalayites*) cf. *seideli* (Oppel, 1863)**
Pl. XIII, fig. 4

* 1863. *Ammonites Seideli* Oppel.– Oppel p. 283, pl. 80, fig. 3a, b.
pars 1894. *Perisphinctes cortazari* (Kil.).– Retowski, p. 258, pl. 10, fig. 11, *non* fig. 12 (= *Retowskiceras retowskyi* Kvantaliani & Lysenko, 1979, p. 629).
1910. *Himalayites seideli* Oppel sp.– Uhlig, p. 140, pl. 39, fig. 2a, b, pl. 40, fig. 1.
1999. *Himalayites seideli* (Oppel).– Kvantaliani, p. 158, pl. 45, fig. 3a, b.
2012. *Himalayites cortazari* (Kilian, 1889).– Arkadiev, p. 208, pl. 34, figs 3-5.

Holotype: The specimen depicted by Oppel (1863) on pl. 80, fig. 3a, b under the name *Ammonites Seideli* sp. n., derived from the Spiti Shales at Lochambelkichak (Upper Tithonian, India), deposited in the Bayerischen Staatssammlung für Paläontologie und historische Geologie, Munich Germany.
Material: Only one badly preserved though identifiable specimen: RGM 160 334 (bed Z95) from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain.
Description: Evolute conch with rounded whorls and large umbilicus. The whorls are rounded and only grow slowly in height. Only three quarters of the last whorl are present, but badly preserved; half of the penultimate whorl is preserved. The involution is 25% of the previous whorl.
The most striking feature of the ornamentation is the presence of large pointed lateral tubercles at rather regular distances. They are situated on the main ribs, which originate on the rounded umbilical wall. Six lateral tubercles give rise to three secondary ribs, from one lateral tubercle rise only two; the number of secondary ribs that originate from the other lateral tubercles are not known, because they are not preserved. The secondary ribs are strongly projected forward. The interspaces between the tuberculated main ribs may be occupied by one intermediate rib, or are without an intermediate rib. On the penultimate whorl all interspaces are provided with an intermediate rib, in one case with two. The intermediate ribs also originate on the umbilical wall, but have no lateral tubercle. Umbilical tubercles are absent on all ribs. Neither the venter nor the suture line are preserved.
Measurements: See Table XXXIX.
Remarks: The specimens called *H. seideli* in literature constitute a rather variable group. The specimen from the Barranco de Tollo resembles most the specimen figured by Retowski (1894) on pl. 10, fig. 11, under the name *Perisphinctes cortazari* (Kilian). This specimen has been refigured by Kvantaliani (1999) with the name

Table XXXIX: Measurements *Himalayites* (*Himalayites*) cf. *seideli* (Oppel, 1863).

Holotype Oppel	D = 95	Wh = 30 (31.6)	U = 43 (45.8)
Retowski specim.	D = 87	Wh = 27.2 (31.3)	U = 38.2 (43.9)
RGM 160 334	D = 77	Wh = 23.5 (30.6)	U = 33.5 (43.5)

Himalayites seideli (Oppel) and closely resembles the specimen depicted by Uhlig (1910) on pl. 39, fig. 2a, b. Retowski's specimen has, like the Barranco de Tollo specimen, only one intermediate rib between the tuberculate ribs. On the holotype of *Ammonites Seideli* Oppel (1865) the distance between the large lateral tubercles is not as regular as in the specimen of the Barranco de Tollo and in the Retowski specimen; the number of intermediate ribs between the tuberculated ones varies between one and three instead of zero and one as in Retowski's and the Barranco de Tollo specimens.
Geographical distribution: India, Czech Republic, Ukraine (The Crimea)

2.2.12. Subgenus *Himalayites* (*Pomeliceras*) Grigorieva, 1938

Type species: *Pomeliceras breveti* (Pomel, 1889).

Systematics: When Pomel introduced *Ammonites breveti*, he also described two 'varieties' of *A. breveti*, which show an ornamentation closely similar to the peculiar ornamentation of *A. breveti* except for the absence of small umbilical tubercles, which are present in *A. breveti*. These 'varieties' differ only in the shape of the whorl section. According to the present classification, these "varieties of *A. breveti*" should be classified as representatives of *Himalayites* Uhlig, 1910, whereas the type *A. breveti* would be included in *Pomeliceras* because of the presence of small umbilical tubercles, which are absent in *Himalayites*. These 'varieties' indicate that the genus *Pomeliceras* has the closest affinities with *Himalayites*. Uhlig (1910, p. 139) recognized *Ammonites Breveti* Pomel as a *Himalayites* and included the species in that genus.
Pomel (1889) studied only the reworked ammonites within Hauterivian sediments. Most of these reworked ammonites are of Berriasian age. However, Pomel (1889) rightly considered *Ammonites telloutensis, Ammonites breveti, Ammonites kasbensis* and *Ammonites Aulisuae* (all introduced by him) to have a 'singular Jurassic cachet' ("cachet singulièrement jurassique"); nevertheless they were provisionally considered by him to be of Berriasian age. It now appears that *Pomeliceras breveti* occurs in the Jacobi Zone, which up to 1975 was considered to represent the Upper Tithonian, but since 1975 considered to represent the Lower Berriasian. So Pomel's intuition that *P. breveti* and its 'varieties' have a 'singular Jurassic cachet' was right after all. The specimens that were considered 'varieties of *A. breveti*,' by Pomel (1889) and *A. kasbensis* and *A. aulisuae*, belong to genus *Himalayites*; these species are restricted to the upper Tithonian and become extinct in the Jacobi Zone. A neotype of *A. kasbensis* has been proposed by Tavera (1985); it was found loose, but according to Tavera possibly derived from the "Andrussowi Zone."
Kilian (1910, p. 176) considered *Ammonites Breveti* Pomel, 1889, to belong to the genus *Spiticeras* Uhlig, 1903. Grigorieva (1938, p. 113) regarded *Pomeliceras* as a subgenus of *Acanthodiscus* Uhlig, 1905 (type species *Ammonites radiatus* Bruguière, 1789), which occurs in the Berriasian (she called it "lower Valanginian"). Khimshiashvili (1976) considered *Mazenoticeras* Nikolov, 1966, (type species *Berriasella Broussei* Mazenot, 1939) a junior synonym of *Pomeliceras*. On the other hand, Nikolov (1982) regarded *Mazenoticeras* as a subgenus of *Pomeliceras*. *Mazenoticeras* is characterized by the the absence of long intermediate ribs that reach the umbilicus. On the contrary, the younger whorls of the specimen of *Pomeliceras* from the Jacobi Zone along the Barranco de Tollo, shows long intermediate ribs between the primary ribs up to diameter of 70 mm; only at diameters of more than 70 mm, the long intermediate ribs are absent. The absence of long intermediate ribs in the holotype, which represents merely the adultmost part, could possibly be the cause of Khimshiashvili's and Nikolov's idea. Moreover, *Mazenoticeras* has not the broad kidney-shaped whorl section of *Pomeliceras*. The ornamentation of the genus *Pomeliceras* rather resembles the ornamentation of the genus *Malbosiceras* (type species *Ammonites Malbosi* Pictet, 1867) more than of the genus *Mazenoticeras*, because *Malbosiceras* has, like *Pomeliceras*, long intermediate ribs between the tuberculate main ribs. However, neither *Malbosiceras* has the broad kidney-shaped whorl section and the strongly projected secondary ribs that characterize *Pomeliceras*. This means that neither *Mazenoticeras* nor *Malbosiceras* can be considered subgenera of *Pomeliceras.* Moreover, broad, kidney-shaped whorl sections often occur within genus *Himalayites*, which have long intermediate ribs.
Therefore the author is of the opinion that *Pomeliceras* Grigorieva, 1938 would better be considered a subgenus of *Himalayites* Uhlig, 1903, from which it merely differs by the presence of small umbilical tubercles. At the moment the subgenus *Pomeliceras* consists of only one species, and cannot be included neither in *Malbosiceras*, nor in *Mazenoticeras*, nor in *Himalayites*.
The author is of the opinion that *Malbosiceras nikolovi* Le Hégarat, 1973 from the Jacobi Zone probably represents the inner whorls of *Himalayites* (*Pomeliceras*) *breveti*; *"M." nikolovi* also has the small umbilical tubercles, prominent lateral tubercles, long intermediate ribs, and the strongly projected secondary ribs of *H.* (*P.*) *breveti*. Such strong a projection does not occur in genus *Malbosiceras*.

***Himalayites* (*Pomeliceras*) *breveti* (Pomel, 1889)**

Pl. XIII, fig. 7

* 1889. *Ammonites Breveti* Pomel, p. 74, pl. 9, figs 1-5.
non 1938. *Protacanthodiscus* (*Pomeliceras*) *Breveti* Pomel.– Grigorieva, p. 113, pl. 6, fig. 1a, b, pl. 7, fig. 1a, b. (= *Mazenoticeras* sp.).
non 1939. *Himalayites* (?) aff. *Breveti* (Pomel).– Mazenot, p. 237, pl. 39, fig. 6a, b, pl. 40, fig. 15a, b (= *Mazenoticeras boisseti* Nikolov, 1979).

non 1960. *Himalayites breveti* Pomel.– Drushchits, p. 279, pl. 24, fig. 1a, b [= *Mazenoticeras boisseti* (Nikolov, 1979)].
non 1973. *Mazenoticeras* aff. *breveti* (Pomel).– Le Hégarat, p. 116, pl. 14, figs 1-4, pl. 45, figs 1, 2 (= *Mazenoticeras boisseti* Nikolov, 1979).
? 1973. *Malbosiceras nikolovi* n. sp. Le Hégarat, p. 88, pl. 11, fig. 2?, 3, pl. 40 fig. 6, 8?
non 1976. *Pomeliceras breveti* (Pomel 1889).– Khimshiashvili, p. 90, pl. 12, fig. 2, pl. 25, figs 1, 2 (= *Mazenoticeras* sp.).
non 1999. *Pomeliceras breveti* (Pomel).– Kvantaliani, p. 153, pl. 44, fig. 1. (= *Mazenoticeras boisseti* Nikolov, 1982).
non 2012. *Pomeliceras breveti* (Pomel, 1889).– Arkadiev *et al.,* p. 187, pl. 19, fig. 2a, b. (= *Mazenoticeras* sp. indet.).

Holotype: By monotypy. The specimen depicted by Pomel (1889), on pl. 9, figs 1-5 under the name *Ammonites Breveti*, reworked from rocks of presumably the Jacobi Zone into Hauterivian sediments near Ouled-Mimoun in Algeria. Designated by Grigorieva, 1938.
Material: One well identifiable specimen, which is extremely flattened, and the right and left sides are shifted a little along the median plane: RGM 617 919 (bed Z167) from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain.
Description: Thick-whorled planulate with the same ornamentation as the holotype, viz. thick primary ribs with small umbilical tubercles and large, thorn-like lateral tubercles from which four to five secondary ribs fan out. Of these fans only three or four are linked with the tubercle and one or two do not, but the lower ends of these loose secondary ribs point towards the primary rib and clearly belong to the fan. Owing to tectonic deformation the last part of the last whorl shows the flank and the entire ventral side. The thickness of the specimen cannot be measured. Ventrolateral tubercles are absent. There are no intermediate ribs between the primary ribs at diameters greater than 70 mm. Long intermediate ribs are present at smaller diameters and originate, like the primary ribs, at the umbilical wall. Between two primaries is only one long intermediate rib, but below a diameter of 40 mm there are two long intermediate ribs between each primary rib. On the penultimate whorl the lateral tubercles become gradually smaller in apical direction, and the primaries still bear small umbilical tubercles. On the next inner whorl the lateral tubercles are still visible. The innermost whorls are not preserved. The body chamber of the Barranco de Tollo specimen begins at D = 74. The ribs cross the venter without interruption, but at midventer the ribs are slightly lower.
Measurements: See Table XL.
Remarks: In fact the holotype of *Pomeliceras breveti* is inadequate, because it merely shows two parts of the last whorl, and the inner whorls are not known. Fortunately the beds of the Jacobi Zone along the Barranco de Tollo yielded a well identifiable specimen, whose inner whorls are preserved, except for the innermost ones. The younger part of the specimen from Barranco de Tollo is quite similar to "*Malbosiceras"nikolovi* Le Hégarat, 1973, and the author is of the opinion that "*M." nikolovi* probably represents the inner whorls of *Himalayites* (*Pomeliceras*) *breveti.*
Mazenoticeras boisseti (Nikolov, 1979) is the species that has generally been synonymized with *Pomeliceras breveti* (Pomel, 1889), but the latter has a much larger umbilicus than *M. boisseti*, and the directions of the secondary ribs is obviously influenced by the lateral spines. In *M. boisseti* the secondary ribs do not show conspicuous groups fanning out from the tubercles; they all have nearly the same direction and distance. In *P. breveti* however, the secondary ribs clearly fan out in adoral direction from the tubercles, the grouping into fans from the tubercles is conspicuous.
Geographic distribution: Algeria, Spain.

Family Olcostephanidae Haug, 1910
Subfamily Spiticeratinae Spath, 1924
2.2.13. Genus *Proniceras* Burckhardt, 1919
Type species: *Ammonites pronus* Oppel, 1865.

Proniceras debillon **Djanélidze, 1922**
Pl. XIII, figs 5, 6

* 1922. *Spiticeras* (*Proniceras*) *gracile* var. *de Billon* n. var. Djanélidze, p. 79, pl. 2, fig. 8a-c.

Holotype: The specimen depicted by Djanélidze (1922) on pl. 2, fig. 8a-c under the name *Spiticeras* (*Proniceras*) *gracile* var. *de Billon* n. var., derived from the Upper Tithonian at Billon, Isère, France, deposited in the Faculté des Sciences de Grenoble, Institut Dolomieux.
Material: Only one badly preserved, but well-identifiable specimen from the Jacobi Zone along the Barranco de Tollo, Caravaca, province of Murcia, Spain: RGM 617 920 (bed Z140).
Description: Small, rather compressed shell with a medium wide umbilicus, which is smaller than the whorl height. Whorls rather rapidly grow in height with slightly rounded flanks. Umbilical wall is rounded. Two concave curved constrictions on the last whorl; the constrictions are lined by an extra thick rib on the adapical or adoral side. Three other constrictions are visible on the inner

Table XL: Measurements *Himalayites* (*Pomeliceras*) *breveti* (Pomel, 1889).

RGM 617 919	D = 87	Wh = 29 (33.3)	U = 32 (36.8)

whorls. The ornamentation consists of fine, closely spaced, prorsiradiate, simple and bifurcating ribs, which are prorsiradiate and adorally concave. Every rib has a small umbilical bulla. On the last whorl the ribs become effaced in the middle part of the flanks, and the ornamentation is restricted to the umbilical bullae on the umbilical rim and the upper third of the flank. The ribs cross the venter without interruption.

Measurements: See Table XLI.

Remarks: Djanélidze (1922) regarded this species as a variety of his *Spiticeras* (*Proniceras*) *gracile*, which he depicted on pl. 2, figs 6 and 7a, b. However *S.* (*P.*) *gracile* has an umbilicus, which is much wider than the whorl height, umbilical bullae, which are much longer and further apart than in *P. debillon* (Djanélidze, 1922), and a whorl, which grows only slowly in height. *S.* (*P.*) *gracile* is quite different from *Proniceras debillon*.

Geographical distribution: Spain, France.

2.2.14. Genus *Spiticeras* Uhlig, 1903

Type species: *Ammonites spitiensis* Blanford, 1863.

Spiticeras cf. *mutabile* Djanélidze, 1922

Pl. XIII, fig. 8

* 1922. *Spiticeras mutabile* n. sp.; Djanélidze, p. 150, pl. 16, fig. 1a, b

Lectotype: The only specimen that was figured by Djanélidze (1922) on pl. 16, fig. 1a, b under the name, *Spiticeras (Spiticeras) mutabile* échantillon A, derived from the Berriasian of La Faurie (Hautes Alpes, France), deposited in the Faculté des Sciences de Grenoble, Institut Dolomieu. The only other specimen, échantillon B, was not figured, nor described. Designated herein.

Material: One impression of one third of a whorl: RGM 791 152 (bed Z241) from the Subalpina Subzone along the Barranco de Tollo, Caravaca (Province of Murcia).

Description: The impression shows eight strong umbilical tubercles. The umbilicus is smaller than the whorl height. The spaces between the tubercles are smooth, non-ribbed. There are 36 ribs on seven umbilical tubercles; this means that there are about five ribs per tubercle. There are ten tubercles on half a whorl. The ribs are thin and do not bifurcate; from every tubercle originate two ribs. The other ribs disappear before reaching the umbilical rim. The ribs describe a regular concave curve. The widths of the interspaces are equal to the rib breadths. The spiral shows only three whorls. The innermost ones are not visible. The three visible inner whorls show only umbilical tubercles and one constriction.

Unfortunately, the ribbing of the inner whorls of the type of *S. mutabile* is not known. Only the number of umbilical tubercles is known and the width of the umbilicus being smaller than the whorl height.

Measurements: See Table XLII.

Remarks: The whorl fragment closely resembles *Spiticeras multiforme* Djanélidze, but *S. multiforme* does not appear before the Upper Berriasian.

Geographical distribution: France, Spain.

2.2.15. *Genus Negreliceras* Djanélidze, 1922

Type species: *Ammonites Negreli*; Matheron, 1880, pl. B-27, fig. 1.

Negreliceras proteum (Retowski, 1894)

Pl. XIV, figs 1, 2

* 1894. *Holcostephanus* (?) *proteus* n. sp. Retowski, p. 10, figs 3a, b, 4.
1922. *Spiticeras (Negreliceras) paranegreli* n. sp. échantillon C.– Djanélidze, p. 108, pl. 6, fig. 2.
1949. *Spiticeras proteus* Retowski.– Luppov *et al.,* p. 195, pl. 58, fig. 1.
1960. *Spiticeras proteus* Retowski.– Drushchits, p. 270, pl. 14, fig. 2.
1982. *Spiticeras* (*Negreliceras*) *paranegreli* Djanélidze nov. subsp.– Hoedemaeker, p. 30, pl. 2, fig. 3.
1984. *Spiticeras obliquelobatum* Uhlig.– Sakharov, pl. 5, fig. 4.
1999. *Spiticeras* (*Spiticeras*) cf. *proteus* Retowski.– Kvantaliani, p. 81, pl. 8, fig. 2a, b, pl. 9, fig. 2a, b.
1999. *Spiticeras obliquelobatum* Uhlig.– Kvantaliani, p. 78, pl. 7, fig. 3a, b.
1999. *Spiticeras kiliani* Djanélidze.– Kvantaliani, p. 82, pl. 9, fig. 1a-c, 2a, b.

Lectotype: The specimen depicted by Retowski (1894) on pl. 10, fig. 3a, b under the name *Holcostephanus* (?) *proteus* n. sp., probably derived from the lower part of the Occitanica Zone near Feodosiya, The Crimea (Ukraine), deposited in the CNIGR Museum Feodosiya, No. 25/10916.

Table XLI: Measurements *Proniceras debillon* Djanélidze, 1922.

RGM 617 920	D = 32.5	Wh = 12.8 (39.4)	U = 11.4 (35.1)

Table XLII: Measurements *Spiticeras* cf. *mutabile* Djanélidze, 1922.

RGM 791 152	D = ±90	Wh = ±32 (± 35.5)	U = ±30 (± 33.3)

Material: One specimen from one of the beds of the Subalpina Subzone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain: GIA-J. 9932.
Description: The specimen from the Subalpina Zone along the Barranco de Tollo closely resembles sample C of Djanélidze (1922) which he depicted on pl. 6, fig. 2. The ornamentation consists of short primary ribs, secondary ribs and intercalated ribs. The primary ribs bifurcate below mid-flank into two secondaries; intercalary ribs also originate below mid-flank and are inserted between two bidichotomous ribs. The intercalated ribs may or may not bifurcate, and some secondaries also may split. In general each primary correspond to three secondaries: 15 primaries to 43 secondaries. In the specimen from the Barranco de Tollo the primaries are radial, the secondaries slightly rursiradiate on the last third part of the last whorl. On other parts of the conch the secondaries are also radial. All ribs cross the venter without interruption. There are straight, radial and deep constrictions on the whorls; they are flanked at both sides by broad, thick ribs. These prominent constrictions occur at regular distances of 180 degrees and can be descerned down to the inner whorls. No suture lines visible.
Measurements: See Table XLIII.
Remarks: Hoedemaeker (1982) was of the opinion that *Spiticeras* (*Negreliceras*) *paranegreli* echantillon C depicted by Djanélidze (1922) on pl. 6, fig. 2 should be separated from *N. paranegreli* as a new subspecies, because it is the only specimen of *N. paranegreli* with prominent primary ribs and strong radial constrictions. It looks therefore rather different from the other members of the species, which display only the fine ribs on the uppermost part of the whorl and umbilical bullae at the umbilical rim, while the middle part of the flanks remain almost smooth. Now the author can identify the specimen as *Negreliceras proteus* (Retowski, 1894). Since *Negreliceras* has never been collected in the Jacobi Zone, the author is of the opinion that *Negreliceras proteus* indicates the lower part of the Occitanica Zone in The Crimea.
Geographical distribution: France, Spain, Ukraine (The Crimea).

Family Bochianitidae Spath, 1922
Subfamily Protancyloceratinae Breistroffer, 1947

2.2.16. Genus *Protancyloceras* Spath, 1924

Type species: The specimen of *Ancyloceras Guembeli*, Zittel, 1870, pl. 12, fig. 1a-c.

Protancyloceras punicum Arnould-Saget, 1953
Pl. XIV, figs 3, 4

- * 1953. *Protancyloceras punicum* nov. sp. Arnould-Saget, p. 114, pl. 11, figs 1a-e.
- *pars* 1985. *Protancyloceras punicum* Arnould-Saget, 1953.– Company & Tavera, p. 158, pl. 1, figs 2-7, *non* fig. 1 [= *Leptoceras brunneri* (Ooster, 1860)], *non* fig. 8 [= *Leptoceras studeri* (?) (Ooster, 1860)].
- *pars* 1987. *Protancyloceras punicum* Arnould-Saget, 1951.– Company, p. 89, pl. 1, figs 2, 4, *non* figs 1 [= *Leptoceras brunneri* (Ooter 1860)], *non* figs 3, 5, 6 [= *Leptoceras studeri* (Ooster, 1860)].
- 1998. *Protancyloceras punicum* Arnould-Saget, 1951.– Faraoni *et al.,* p. 63, pl. 3, fig. 14.
- 2003. *Protancyloceras punicum* Arnould-Saget, 1953.– Vašíček & Hoedemaeker, p. 13, pl. 1, figs 1, 2.

Holotype: The specimen depicted by Arnould-Saget (1953) on pl. 11, figs 1a-e under the name *Protancyloceras punicum* nov. sp., derived from the Upper Tithonian of Djebel Nara, deposited in the collection of the Service des Mines of Tunisia, No. TB 6137.
Material: Two impressions of specimens from the Subalpina Subzone (lowest subzone of the Occitanica Zone), one from the Baranco de Tollo: RGM 365 225 (bed Z227) and one seven kilometres more west from the Barranco de Las Oicas: RGM 365 224 (bed M43).
Description: The shape of the conch is an open spiral; the whorl slowly increases in height. On the impression could only be seen the ornamentation of the flanks. The venter and dorsum are not preserved. The ornamentation consists of rather closely spaced thin, sharp, simple ribs, with a straight lower part and a projected upper part. The lower parts of the ribs may be convex, which makes the ribs S-shaped. The interspaces gradually widen in adoral direction.
Measurements: The Barranco de Tollo specimen consists of half a whorl of a specimen of 19 mm in diameter. The largest whorl height is 5 mm and the smallest at 180 degrees from the largest is 3 mm. The other specimen is larger and has a greatest whorl height of 7 mm and a smallest at 90 degrees from the largest is 6 mm.
Remarks: Company (1987), Company & Tavera (1985), Faraoni *et al.* (1998) and Vašíček & Hoedemaeker (2003) also found *P. punicum* in the basal Valanginian, which means that the range of this species is at least from the Subalpina Subzone up to the Basal Valanginian Pertransiens Zone. It is interesting and important to know that species of *Protancyloceras* and *Leptoceras* become frequent only (just below and above) major sequence boundaries. This can be explained as an opportunistic strategy of these genera. The base of the Subalpina

Table XLIII: Measurements *Negreliceras proteum* (Retowski, 1894).

G.I.A. J.99321	D = 46	Wh = 14.9 (32.4)	U = 19.4 (42.2)	wh = 11.9 (25.9)

Subzone is very close to a major sequence boundary Be 3 (Hoedemaeker, 1998) and sequence boundary Va1 at the base of the Valanginian.
Geographical distribution: Spain, Tunisia, Italy, Slowakia.

***Protancyloceras bicostatum* Arnould-Saget, 1953**
Pl. XIV, figs 5, 6

* 1953. *Protancyloceras bicostatum* nov. sp. Arnould-Saget, p. 119, pl. 11, fig. 11a-e.
1998. *Protancyloceras bicostatum* Arnould-Saget, 1951.– Faraoni *et al.,* p. 63, pl. 4, figs 2-4.
2003. *Protancyloceras bicostatum* Arnould-Saget, 1953.– Vašíček & Hoedemaeker, p. 14, pl. 1, fig. 3.

Holotype: The specimen of *Protancyloceras bicostatum* sp. nov., depicted by Arnould-Saget (1953) on pl. 11, fig. 11a-f, derived from the Upper Tithonian of the Djebel Nara (Tunisia), deposited in the Collections of the Service des Mines of Tunisia: No TB 6143.
Material: One specimen from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain: RGM 212 416 (bed Z195).
Description: The shape of the conch is an open spiral. The whorl slowly increases in height. Only half a whorl is preserved. The rather wide-spaced, thin, sharp ribs have a radial direction and are regularly distributed. Most ribs end in long, sharp spines and sometimes two ribs converge into one spine (fibulation). There are also many ribs which do not end in a spine. The ribs originate at the rim of the dorsal side. The dorsal side is smooth; the ventral side is not visible, nor the suture line.
Measurements: See Table XLIV.
Remarks: The Barranco de Tollo specimen represents the young part of the ammonite in which not all ribs end in a ventrolateral spine, and where fibulation is rare. It differs from *P. punicum* in the presence of fibulation and in the prominent ventrolateral spines.
Geographical distribution: Spain, Tunisia, Italy.

***Protancyloceras acutituberculatum* Arnould-Saget, 1953**
Pl. XIV, fig. 7

* 1953. *Protancyloceras acutituberculatum* nov. sp. Arnould-Saget, p. 117, pl. 11, fig. 9a-e.

Holotype: The specimen depicted by Arnould-Saget (1953) on pl. 11, fig. 9a-e under the name *Protancyloceras acutituberculatum* nov. sp., derived from the upper Tithonian of the Djebel Nara, Tunisia; deposited in the collections of the Service des Mines of Tunisia: No. TB 6143.
Material: One impression of three quarters of a whorl from bed M35 of the Subalpina Subzone (basal Occitanica Zone) along the Barranco de Las Oicas (10 km west of Caravaca, Province of Murcia, Spain: RGM 365 219 (bed M35).
Description: The shape of the conch is an open spiral with whorls that slowly grow in height. The thin, sharp ribs are rather distant from each other. They are radiate or slightly prorsiradiate and straight. Each rib bears a small ventrolateral tubercle, which protrudes a little sidewards. The venter is not visible, and the suture lines are not preserved.
Measurements: See Table XLV.
Remarks: *P. acutituberculatum* differs from *P. punicum* in the straight ribs, which are more widely spaced than in *P. punicum*, and in the presence of ventrolateral tubercles, *P. punicum* lacks tubercles. Company & Tavera (1985) and by Company (1987) considered *P. acutituberculatum* to be a morphotype of *P. punicum* and synonymized it with the latter. The author does not agree on this idea.
Geographical distribution: Spain, Tunisia.

2.2.17. Genus *Bochianites* Lory, 1898
Type species: *Baculites neocomiensis* d'Orbigny, 1842.

***Bochianites* cf. *ambiguus* Arkadiev, Rogov & Perminov, 2011**
Pl. XIV, fig. 8

2008. *Bochinites goubechensis* Mandov, 1971.– Arkadiev, p. 474, pl. 3, fig. 6a, b.
* 2011. *Bochianites ambiguus* sp. nov.– Arkadiev *et al.,* p. 392, pl. 5, fig. 1a, b.
2012. *Bochianites* (?) *ambiguus* Arkadiev, Rogov & Perminov, 2011.– Arkadiev *et al.,* p. 222, pl. 39, figs 1-3.

Holotype: The specimen depicted by Arkadiev *et al.* (2011) on pl. 5, fig. 3a, b under the name *Bochianites ambiguus* sp. nov., derived from the Jacobi Zone of Cape St. Elias near Feodosiya, The Crimea, deposited in the CNIGR museum, No. 1/13217.

Table XLIV: Measurements *Protancyloceras bicostatum* Arnould-Saget, 1953.

RGM 212 416	D = 23.1	Wh = 5.4 (23.4)	U = 14.2 (61.7)	wh = 3.8 (16.4)

Table XLV: Measurements *Protancyloceras acutituberculatum* Arnould-Saget, 1953.

RGM 365 219	D = 24	Wh = 6.2 (25.8)	U = 13 (54.2)	wh = 4.5 (18.7)

Material: One specimen from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain: RGM 791 153 (bed Z193).
Description: Part of a shaft of 28.5 mm length and 3.6 mm greatest breadth is preserved; the smallest breadth of the shaft is 2.8 mm. The transverse section of the shaft is elliptical, probably due to diagenetic compression. The ventral and dorsal sides make an angle of 5 degrees with each other. The largest part of the shaft is smooth, but over the last 10 mm appear, weak, prorsiradiate ribs on the venter and ventralmost parts of the flanks; these ribs are 1 mm apart. In addition, four prorsiradiate constrictions can be discerned on the preserved part of the shaft. The constrictions are bordered at both sides by thick ribs, which cross the ventral and dorsal sides. It is quite possible that *B.* cf. *ambiguus* from the Barranco de Tollo is the young part of *B. ambiguus*.
Remarks: The fragment is too small to enable precise identification, but it displays a great similarity with *Bochianites ambiguus*. As constrictions in *Bochianites* are rare, it is quite possible that *B. ambiguus* described by Arkadiev *et al.* (2011) from the Jacobi Zone of the Crimea (near the village of Nanikovo) is an adult representative of the *Bochianites* cf. *ambiguus* discussed here.
Geographical distribution: Spain, Ukraine (The Crimea).

Bochianites crymensis Arkadiev, 2008
Pl. XIV, figs 9. 10

* 2008. *Bochianites crymensis* sp. nov. Arkadiev, p. 474, pl. 3, fig. 7a-d.
2012. *Bochianites crymensis* Arkadiev, 2008.– Arkadiev *et al.,* p. 221, pl. 38, fig. 7.

Holotype: The specimen depicted by Arkadiev (2008) on pl. 3, fig. 3a-d under the name *Bochianites crymensis* sp. nov., derived from the Jacobi Zone near the village of Nanikovo, Eastern Crimea, Ukraine, deposited in the CNIGR Museum No. 11/13169.
Material: One specimen, of which a portion of the shaft and its impression is preserved, RGM 791 154 (bed Z198). It was sampled from of the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain.
Description: Straight shaft of which the dorsum and the venter make an angle of five degrees. Only a portion of 40 mm is preserved. The ornamentation consists of prorsiradiate ribs, which describe a slightly adorally convex curve. They become effaced towards the dorsum, some ribs efface earlier than others; the dorsum is smooth. A few ribs are slightly more pronounced, but are not associated with constrictions. Suturelines not preserved.
Geographical distribution: Spain, Ukraine (The Crimea).

Bochianites aculeatus sp. nov.
Pl. XIV, fig. 11

1939. *Bochianites* sp. ind. Mazenot, p. 248, pl. 40, fig. 9a-c.

Holotype: The specimen depicted by Mazenot (1939) on pl. 40, figs 9a-c, 10, 11, 12, 13 under the name *Bochianites* sp. ind. from the pyritiferous Upper Tithonian of Sabotas near Chomérac, deposited in the Faculté des Sciences de Grenoble.
Derivatio nominis: *Aculeatus* is the Latin word for 'sharply pointed like a needle.'
Material: One specimen of 36 mm long from of the Subalpina Subzone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain. RGM 791 155 (bed Z249).
Diagnosis: Long, thin, sharply pointed smooth shell without any ornamentation. The dorsum and venter make an angle of three degrees. Mazenot's specimen is composed of small rounded pyritized cylinders of different specimens. The Barranco de Tollo specimen consists of one long impression and is the evidence that such needle-like specimens really exist.
Description: A smooth thin shaft of which the dorsum and the venter make an angle of three degrees. The shaft has an elliptical section, but is diagenetically compressed. No constrictions, no ornamentation, no suture lines. It is identical to *Bochianites* sp. ind. depicted by Mazenot (1939) on pl. 40, figs 9-13, which is also smooth and also has an angle of three degrees between dorsum and venter. Mazenot's specimen is chosen as the holotype because it shows suture lines. The specimen from section Z shows the true outline.
Geographical distribution: Spain, France.

Order Phylloceratida Zittel, 1884
Suborder Phylloceratina Zittel, 1884
Superfamily Phylloceratoidea Zittel, 1884
Family Phylloceratidae Zittel, 1884

Environment: The phylloceratids (and lytoceratids) of the Jacobi Zone and Subalpina Subzone (lowest Subzone of the Berriasian Occitanica Zone) along the Barranco de Tollo are rare in relation to their abundance in the higher parts of the Berriasian a few hundreds of metres further south-west. High percentages of phyloceratids and lytoceratids indicate greater depth of the palaeo-sea. In the Jacobi Zone and Subalpina Subzone these ammonite families were preserved as calcareous internal an external moulds, whereas from the Dalmasi Zone onward they almost without exception consists of limonitized internal casts of limonite. During the Jacobi Zone and Subalpina Subzone the Berriasian sea was shallower (probably deep shelf) than during the later parts of the Berriasian when the sea would have a depth of about 300 metres (Hoedemaeker & Leereveld, 1995).

Subfamily Ptychophylloceratinae Collignon, 1956
Genus *Ptychophylloceras* Spath, 1927

2.2.18. Subgenus *Ptychophylloceras* (*Semisulcatoceras*) Joly, 2000

Type species: *Ammonites ptychoicus* Quenstedt, 1845

Systematics: In 1927 Spath introduced *Ptychophylloceras tithonicum* sp. nov. (Mem. 2, part 1, p. 48, pl. 5, fig. 4a, b), which differs from the holotype of *Pt. ptychoicum* (Quenstedt, 1845) only in its thicker whorls. Though Collignon (1960) still regarded them as two separate species, Joly (1977), in his study on the phylloceratids of Madagascar, considers *Pt. tithonicum* to be a form of *Pt. ptychoicum* referring to it as *'Ptychophylloceras ptychoicum* (Quenstedt) f. *tithonicum* Spath' (f. = "forma" = an infrasubspecific notation), thus as a variety within the species. In Madagascar Joly (1977) measured a large number of specimens with a gradually increasing Wt/Wh ratio; there is no jump or gap in the gradual increase of the whorl thickness and the specimens could be interpreted as belonging to one and the same species. Joly calls all specimens with Wt/Wh ratio of 0.82 and smaller *Pt. ptychoicum*, and those with a Wt/Wh ratio of 0.82 and larger *Pt. ptychoicum* f. *tithonicum*. Joly (2000) still held this view and the author follows this opinion. The author found abundant specimens of *Pt. semisulcatum* which also are thick-whorled to more compressed in higher Berriasian and lower Valanginian zones of the Río Argos succession; he considers them mere variants within the species.

However, Fatmi & Zeiss (1999) consider *Pt. tithonicum* a subspecies of *Pt. ptychoicum*. Still later, Zeiss (2001) returns to the original view of Spath (1927) stating that they represent two separate species.

Quenstedt (1845, p. 220) mentioned that the transverse ridges of *Pt.* (*S.*) *ptychoicum* are present only on the body chamber, whereas the specimens from Madagascar (Joly, 1977) also show the ridges on the phragmocone (the Madagascar material mainly consists of phragmocones without body chambers). This is also the case with the small specimens of *Ptychoceras* in the Jacobi Zone along the Barranco de Tollo.

Ptychophylloceras (*Semisulcatoceras*) *ptychoicum* (Quenstedt) has the same shape and the same suture lines with tetraphyllic saddle endings as *Ptychophylloceras* (*S.*) *semisulcatum* (d'Orbigny, 1841). Both species display rosettes of curved constrictions around the umbilicus. According to Joly (2000, 2006) the only difference between the two species should be the presence of transverse ridges on the venter of internal moulds and on the venter of external moulds in *ptychoicum*, and their presence only on external moulds of *semisulcatum*. In the Berriasian Occitanica and Boissieri zones and in the lower Valanginian the author also found a few fragments of large external moulds with transverse ridges among the hundreds of small limonitized specimens without transverse ridges of *Pt.* (*S.*) *semisulcatum*. Though difficult to prove, the author follows the idea of Joly. Reboulet (1995) depicted six large external moulds of *Pt.* (*S.*) *semisulcatum* with several transverse ridges from the Valanginian Campylotoxus and Verrucosum zones (pl. 35, figs 14-19) and Arkadiev *et al.,* 2012) one example from the Tauricum Subzone. Faraoni *et al.* (1998) also depicted one external mould from the Verrucosum zone of the Malga Gasparine section (Lessini Mts, Italy).

Kilian (1888, p. 141, footnote 3; 1910, p. 174, footnote 1), Sayn (1901, p. 12), and Arkadiev & Bogdanova (2001) regarded the two species as identical and *Pt.* (*S.*) *ptychoicum* (Quenstedt, 1845) as a junior synonym of *Pt.* (*S.*) *semisulcatum* (d'Orbigny, 1841). In 1982 the author followed this idea, but in this paper he followed the idea of Joly (2000, 2006). Drushchits & Kudrjavtsev (1960), Nikolov (1960), Immel (1987) and Kvantaliani (1999) figured small specimens with transverse ridges on the venter under the name *Pt. semisulcatum* (d'Orb.), but which according to the ideas of Joly should be *Pt. (S.) ptychoicum*. On the other hand, Drushchits & Kudrjavtsev regarded the thick-whorled specimens as *ptychoicum* and the moderately compressed specimens as *semisulcatum*.

However, according to Joly (2006) the transverse ribs in *Pt.* (*S.*) *semisulcatum* occur only on larger phragmocones, whereas in *Pt.* (*S.*) *ptychoicum* they also occur on small specimens. Therefore, the author identified these small *Pt.* (*S.*) *semisulcatum* specimens with riges as *Pt.* (*S.*) *ptychoicum*.

Ptychophylloceras (*Semisulcatoceras*) *ptychoicum* (Quenstedt, 1845)

Pl. XIV, figs 12-14

* 1845. *Ammonites ptychoicus* Quenstedt.– Quenstedt, p. 219, pl. 17, fig. 12a-c.
1868. *Ammonites ptychoicus* Quenst. sp.– Von Zittel, p. 59, pl. 4, figs 3a-c, 4a, b, 5a, b, 6a, b, 7a, b, 8, 9.
1901. *Phylloceras semisulcatum* d'Orbigny sp.– Sayn, p. 11, pl. 1, figs 10-12, pl. 2, figs 5, 6.
1910. *Phylloceras semisulcatum* d'Orb.– Kilian, p. 174, pl. 2, fig. 1a, b.
1927. *Ptychophylloceras tithonicum* sp. nov. Spath, p. 48, pl. 5, fig. 4a, b.
1953. *Phylloceras* (*Ptychophylloceras*) *semisulcatum* (d'Orbigny, 1841).– Arnould-Saget, p. 4, pl. 1, fig. 3, 6.
1960. *Ptychophylloceras semisulcatum* (d'Orbigny).– Nikolov, p. 154, pl. 1, figs 1, 2.
1960. *Ptychophylloceras ptychoicum* Qu.– Collignon, pl. 138, figs 524-526.
1960. *Ptychophylloceras semisulcatum* (Orbigny).– Drushchits & Kudrjavtsev, p. 250, pl. 1, figs 3a,b, 4, 5a, b, 6, 7.
1960. *Ptychophylloceras ptychoicum.*Quenstedt.– Drush-chits & Kudrjavtsev, p. 250, pl. 1, figs 1, 2a, b.
1976. *Ptychophylloceras ptychoicum* (Quenstedt).– Avram, p. 20, pl. 7, fig. 2a, b.
1976. *Ptychophylloceras ptychoicum* (Quenstedt).– Patrulius & Avram, p. 163, pl. 1, fig. 8.
1976. *Ptychophylloceras ptychoicum* (Quenstedt, 1845).– Khimshiashvili, p. 59, pl. 1, fig. 1.

1979. *Ptychophylloceras ptychoicum* (Quenstedt, 1847).– Sapunov, p. 33, pl. 3, fig. 6a, b.
1991. *Ptychophylloceras ptychoicum* (Quenstedt, 1847).– Cecca & Enay, p. 40, pl. 1, figs 2-7.
2012. *Ptychophylloceras semisulcatum* (d'Orbigny, 1840).– Arkadiev *et al.,* p. 129, pl. 2, figs 3a-c (from Tauricum = Dalmasi Subzone), pl. 3, figs 1, 3, 4 (from Jacobi Zone), fig. 2a, b (from Tauricum = Dalmasi Subzone).

Holotype: By monotypy. The specimen depicted by Quenstedt (1845) on pl. 17, fig. 12a-c under the name *Ammonites ptychoicus*, derived from the Tithonian of Roveredo (Verona, Italy), deposited in the Geologisches-Paläontologisches Institut Tübingen, Germany.
Material: Eight fragments (calcareous external moulds) from the Jacobi Zone: seven from the beds along the Barranco de Tollo, Caravaca, Province of Murcia, Spain; RGM 791 156 (bed Z140), RGM 791 157 (bed Z142), RGM 791 158 (bed Z201), RGM 791 160 (bed Z208), RGM 162 272 (bed Z4), RGM 162 273 (bed Z140), RGM 791 161 (bed Z170), and one from the Barranco de las Oicas 10 km west of Caravaca: RGM 161 182 (bed M4).
Description: The small external moulds of the whorl fragments show about six prominent ribs on the upper part of the flank and on the venter. The ribs are straight or slightly curved; they cross the venter in a straight way or with a slight curve. The surface between the thick ribs is smooth. The distance between the ribs is not equal. A few whorl fragments display a rosette of constrictions. The external moulds are flattened due to diagenetic compression. The transverse ridges are already present in young specimens.
Remarks: On one internal mould with a diameter of 48 mm in the Jacobi Zone (RGM 161 182), tranverse ridges and a rosette are not present. This specimen shows suture lines with quadriphyllic saddle endings. Whether this specimen is a *Pt.* (*S.*) *ptychoicum* in which the transverse ridges appear later or a specimen of *Pt.* (*S.*) *semisulcatum* cannot be decided.
Geographical distribution: Spain, France, Germany, Romania, the Crimea (Ukraine).

Ptychophylloceras (*Semisulcatoceras*) *inordinatum* (Toucas, 1890)

Pl. XIV, figs 15, 16

1880. *Ammonites ptychoicus,* Quenstedt.– Favre, p. 22, pl. 2, figs 4, 5, *non* fig. 6 [= *Ptychophylloceras ptychoicus* (Quenstedt, 1845)].
* 1890. *Phylloceras ptychoicum* (Quenstedt) var. *inordinatum* Toucas, p. 592, pl. 15, figs 5a, b, 6.
1894. *Phylloceras ptychoicum* var. *inordinatum* Toucas, 1890.– Retowski p. 228, pl. 9, fig. 4.
1976. *Ptychophylloceras ptychoicum inordinatum* (Toucas).– Patrulius & Avram, p. 163, pl. 1, fig. 7.
1979. *Ptychophylloceras inordinatum* (Toucas).– Sapunov, p. 32, pl. 3, fig. 5.
1991. *Ptychophylloceras ptychoicum* morph *inordinatum*.– Cecca & Enay, p. 40, pl. 1, figs 5, 6.
2000. *Ptychophylloceras* (*Semisulcatoceras*) *ptychoicum inordinatum* (Toucas, 1890).– Joly, p. 127, pl. 31, figs 4a, b, 5.
2001. *Ptychophylloceras inordinatum* (Toucas, 1890).– Arkadiev & Bogdanova, p. 482, pl. 3, fig. 1a, b.
2012. *Ptychophylloceras inordinatum* (Toucas, 1890).– Arkadiev *et al.,* p. 134, pl. 3, fig. 5.

Lectotype: The specimen depicted by Toucas, 1890, on pl. 15, figs 5a, b under the name *Phylloceras ptychoicum* (Quenstedt) var. *inordinatum*, derived from the upper Tithonian of Chomérac, designated by Sapunov, 1979, deposited in the Université Claude Bernard de Lyon, Département de Géologie, Collection Toucas, No. FSL 140475A.
Material: Two specimens (one external impression and one external mould) from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain: RGM 162 276 (bed Z102), RGM 162 277 (bed Z128-138).
Description: The external mould is diagenetically compressed and has a very small umbilicus (width 2.5 mm), convex flanks and a rounded venter. The umbilicus is surrounded by curved constrictions forming a rosette. On the venter there are six transverse ridges at more or less regular distances. These ridges become more prominent in adoral direction. Their number corresponds with the number of constrictions in the umbilical rosette. Characteristic are the presence of double to sixfold ridges on the ventral side. RGM 162 276 has one triple ridge, RGM 162 277 has one quadruple ridge. Between the ridges the surface of the shell is smooth.
Measurements: See Table XLVI.
Remarks: *Pt. ptychoicum inordinatum* (Toucas, 1890) was considered by Toucas to be a "variety" of *Pt. ptychoicum.* Most authors, however, regard this taxon as a subspecies of *Pt. ptychoicum.* There is a unwritten rule that the subspecies within one genus should not live in the same sea at the same time. As they occur in the same sea and in the same time as *Pt. ptychoicum*, it means that subspecies *inordinatum* can either be a variety of *Pt. ptychoicum* or a separate species. The author (Hoedemaeker, 1982) preferred, and still prefers, to consider it a separate species. It is probably a small species,

Table XLVI: Measurements *Ptychophylloceras* (*Semisulcatoceras*) *inordinatum* (Toucas, 1890).

RGM 162276	D = 33	Wh = 18 (54.5)	U = 2 (6.1)	wh = 13 (39.4)
RGM 162277	D = 38.8	Wh = 21.1 (54.4)	U = 2.5 (6.4)	wh = 14.5 (37.4)

which does not grow larger than 40-50 mm. Arkadiev & Bogdanova (2001) also separated *Pt. inordinatum* from *Pt. semisulcatum* in which they include *Pt. ptychoicum* and *Pt. tithonicum*. Arkadiev *et al*. (2012, pl. 3, fig. 5a, b) figured a specimen of *Pt. inordinatum* from the Valanginian.

It seems that the larger specimen of *Pt. inordinatum* shows its apertural rim; this seems also the case with the specimen figured by Patrulius & Avram (1976, pl. 1, fig. 9; D = 37 mm). This could mean that *Pt. inordinatum* may not grow larger than about 39 mm.

Geographical distribution: Spain, France, Romania, Bulgaria, Ukraine (The Crimea).

Subfamily Calliphylloceratinae Spath, 1927

2.2.19. Genus *Holcophylloceras* Spath, 1927

Type species: *Phylloceras mediterraneum* Neumayr, 1871.

Holcophylloceras silesiacum (Oppel, 1865)

Pl. XIV, fig. 17

1865. *Ammonites Silesiacum* Opp.– Oppel, p. 550, No. 65.
1867. *Ammonites berriasensis* Pictet, p. 70, pl. 12, fig. 1a-c.
1868. *Ammonites berriasensis* Pictet.– Pictet, p. 227, pl. 37bis, fig. 2a, b.
* 1868. *Phylloceras Silesiacum* Opp. sp.– Zittel, p. 62, pl. 5, figs 1a, b, 2a, b,3, 4a-c, 5a, b, 7.
1901. *Phylloceras Calypso* d'Orbigny sp.– Sayn, p. 9, pl. 2, figs m2a, b, 3, 4a, b.
1953. *Phylloceras Calypso* (d'Orbigny 1840).– Arnould-Saget, p. 3, pl. 1, fig. 4a-c.
1964. *Holcophylloceras calypso* (Orb.).– Fülöp, pl. 12, fig. 3.
1976. *Holcophylloceras* aff. *mediterraneum* (Neumayr).– Avram, p. 19, pl. 7, fig. 3.
1976. *Holcophylloceras* (?) *calypso* (d'Orbigny).– Patrulius & Avram, p. 162, pl. 1, fig. 3.
1979. *Holcophylloceras polyolcum* (Benecke), 1866).– Sapunov, p. 30, pl. 2, figs 3, 4, 5.
1979. *Holcophylloceras silesiacum* (Oppel, 1865).– Sapunov, p. 31, pl. 3, figs 1a, b, 2a, b, 3a, b, 4.
1982. *Holcophylloceras calypso* (d'Orbigny, 1841).– Hoedemaeker, p. 33, 77.
2000. *Holcophylloceras silesiacum* (Oppel, 1865).– Joly, p. 103, pl. 26, figs 4, 5.
2002. *Leiophylloceras calypso* (d'Orbigny, 1840).– Arkadiev, p. 609, pl. 3, figs 1-7.
2012. *Leiophylloceras calypso* (d'Orbigny, 1840).– Arkadiev *et al.,* p. 136, pl. 3, figs 9-11, pl. 4, figs 1-3.

Lectotype: The specimen depicted by Zittel (1868) on pl. 5, fig. 4a-c under the name *Phylloceras Silesiacum* Opp. sp., derived from the Upper Tithonian of Stramberg, designated by Joly (2000, p. 105), deposited in the Bayerische Staatssammlung für Paläontologie und historische Geologie, München, Germany.

Material: One impression of a fragment from the Jacobi Zone along the Barranco de Tollo: RGM 791 173 (bed Z141).

Description: The impression of the fragment shows a part of the whorl with three constrictions and half an umbilicus. The whorl height is 28.7 mm, and the width of the umbilicus 7 mm. The constrictions show a kink just above mid-flank, and both parts of the constrictions are rather straight. The lower part of the constriction is prorsiradiate, the upper part rursiradiate. In between the constrictions the shell is smooth.

Remarks: *Ammonites silesiacum* (Zittel) and *Ammonites Calypso* d'Orbigny are often considered synonyms (also by the author, Hoedemaeker, 1982), but according to Joly (2000) *A. calypso* has quite a different suture line and should be included in *Sowerbyceras*. The constrictions of *Sowerbyceras calypso* assume a strongly prorsiradiate direction directly from the umbilical rim. The author now agrees to the view of Joly (2000). Arkadiev (2002) introduced the new genus name *Leiophylloceras* with *Sowerbyceras calypso* as type species; however he merely figured and includes in it specimens of *Holcophylloceras silesiacum*.

Geographical distribution: France Spain, Hungaria, Roumania, Bulgaria, Tunisia.

Subfamily Phylloceratinae Zittel, 1884.

Genus *Phylloceras* Suess, 1865

2.2.20. Subgenus *Phylloceras* (*Hypophylloceras*) Salfeld, 1924

Type species: *Phylloceras onoensis* Stanton, 1896.

Phylloceras (*Hypophylloceras*) *serum* (Oppel, 1865)

Pl. XIV, fig. 18; Pl. XV, fig. 1.

1865. *Ammonites serus* Opp.– Oppel, p. 550, No. 63.
1868. *Phylloceras serum* Oppel.– Zittel, 1868, p. 66, pl. 7, figs 5a-c, 6a-c.
1953. *Phylloceras serum* (Oppel, 1865).– Arnould-Saget, p. 5, pl. 1, fig. 5.
1960. *Phylloceras serum* Oppel in Zittel.– Collignon, pl. 134, figs 506, 507.
1960. *Euphylloceras serum* (Oppel).– Drushchits & Kudrjavtsev, p. 251, pl. 1, fig. 8.
1976. *Phylloceras* (*Hypophylloceras*) *serum* (Oppel).– Patrulius & Avram, p. 160, pl. 1, fig. 2.
1979. *Phylloceras serum* (Oppel, 1865).– Sapunov, p. 27, pl. 1, fig. 5.
1999. *Phylloceras serum* (Oppel).– Kvantaliani, p. 69, pl. 4, figs 3a-c, 4a-c.
2000. *Phylloceras* (*Hypophylloceras*) *serum* (Oppel, 1865).– Joly, p. 53, 139, pl. 9, figs 5-7; pl. 34, figs 5a, b, 6a, b, 7.

Holotype: The specimen depicted by von Zittel (1868) on pl. 7, fig. 5a-c under the name *Phylloceras serum*, derived from the white Limestone of Stramberg, Upper Tithonian, designated by Joly (2000, p. 53), deposited in the Bayerische Staatssammlung für Paläontologie und historische Geologie, München, Germany.

Material: Nine specimens in the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain.

RGM 162 395 (bed M6-7), RGM 162 403 (bed Z152), RGM 162 404 (bed Z95), RGM 162 402 (bed Z147), RGM 160 361 (bed Z115), RGM 162 401 (Z119), RGM 791.159 (bed Z171), RGM 162 274 (bed Z158), RGM 791 162 (bed Z138).

Description: Rather compressed phylloceratid with a rapid increase of the whorl height and a very small umbilicus. The small umbilicus is nearly situated at one-third of the diameter; the whorl height at 180^0 is half the adult whorl height. The ornamentation consists of straight, densely packed ribs, which are as thin as a hair.

Measurements: See Table XLVII.

Remarks: If no ornamentation is preserved, *Hypophylloceras serum* of the Jacobi Zone can be identified by the compressed shape of the conch and the strong increase of the whorl height.

Geographical distribution: Spain, France, Czech Republic, Bulgaria, Roumania, Tunisia, Madagascar.

Suborder Lytoceratina Hyatt, 1889
Superfamily Lytoceratoidea Neumayr, 1875
Family Lytoceratidae, Neumayr, 1875
Subfamily Lytoceratinae Neumayr, 1875

2.2.21. Genus *Lytoceras* Suess, 1865

Type species: *Ammonites fimbriatus* (Sowerby, 1817)

***Lytoceras subfimbriatoides* sp. nov.**
Pl XV, figs 2-4; pl. 16, figs 1-5

? 1848. *Ammonites adelae* d'Orbigny.– d'Orgigny, p. 494, pl. 183, figs 1, 2.
? 1868. *Ammonites subfimbriatus* d'Orb.– Pictet, p. 230, pl. 37, fig. 4.
? 1960. *Thysanolytoceras strambergense* (Oppel).– Nikolov, p. 155, pl. 2, fig. 2.
? 1960. *Thysanolytoceras sutile* (Oppel).– Nikolov, p. 156, pl. 1, figs 6, 7.
? 1976. *Lytoceras* sp. aff. *sutile* (Oppel).– Patrulius & Avram, p. 164, pl. 2, fig. 2.
? 1979. *Lytoceras liebigi* (Oppel).– Sapunov, p. 37, pl. 5, fig. 2, *non* fig. 1 [= *Lytoceras liebigi* Zittel, 1868 (?)].
? 1994. *Lytoceras liebigi* (Oppel, 1865).– Geyssant & Gauthier, p. 161, pl. 85, fig. 3, pl. 86, fig. 3.

Syntypes: The eleven incomplete specimens mentioned in paragraph 'Material'. They are all figured except two, viz RGM 365 131 and RGM 365 802. They collectively constitute the name bearing type and represent several different ontogenetic stages, which together give a adequate conception of the species. The largest specimen RGM 365 134 is a impression, which shows the adult ornamentation. The large specimen RGM 365 173 is undeformed, but only sparsely shows its ornamentation. Most of the other specimens are positive fragments. They are all derived from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain, except one specimen, RGM 365 173, which was collected 7 km more west in the barranco directly north of the Cortijo de Las Oicas de Enmedio, which I herein called Barranco de Las Oicas. They are all deposited in the collection of the Naturalis Biodiversity Center, Leiden, The Netherlands.

Derivatio nominis: This species looks like *Lytoceras subfimbriatum* d'Orbigny, 1841.

Diagnosis: Large evolute conch, hardly overlapping whorls. Fine closely spaced, fimbriate ribs, which describe a concave curve. At the umbilical slope they describe a small concave curvature. At regular distance high thin ribs (flares) are present, five on the half last whorl. The flares are parallel to the ribs at the apical side of the flares, but truncating the ribs at its oral side. It resembles *Lytoceras subfimbriatum.*

Material: Nine specimens from the Jacobi Zone along the Barranco de Tollo and one from the Baranco de las Oicas: RGM 365 131 (bed Z92), RGM 365 132 (bed Z95), RGM 365 133 (bed Z95), RGM 365 134 (bed Z95), RGM 365 136 (bed Z198), RGM 365 171 (bed Z97), RGM 365 173 (bed M6-7), RGM 365 802 (bed Z31A), RGM 791 163 (bed Z135), RGM 791 164 (bed Z141), The largest specimens (RGM 365 134 is an impression, but specimen RGM 365 173 is a positive.

Description: Large evolute conch with hardly overlapping whorls. The conch is very compressed through diagenetic compression. The overlap of the whorl near the aperture is very small, five mm at Wh = 60 mm. The ornamentation consists of uniform, very thin, closely spaced ribs, which are very regularly distributed with almost equal interspaces of about 1-1.5 mm. The ribs are fimbriate, prorsiradiate and describe an adorally concave curve. On the lower part of the flank they are straight or slightly curved, while on the upper part of the flank the curvature is stronger. At the umbilical slope they describe a small concave curvature. At irregular distances are higher, but thin ribs (flares), which follow the same curve as the ribs at the adapical side of the flare, but cut through the ribs at the adoral side. On half a whorl are five flares. The ribbing of the inner whorls, which at a few places could be discerned, is similar to the ribbing of the last whorl. However, the ribbing of the inner whorls is better preserved on two smaller whorl fragments (Pl. XV, figs 2, 3, Pl. XVI, fig. 3). The number of flares is less than on the adult whorl, viz. only two on one third of a whorl. The small specimen of bed Z97 (Pl. XVI, figs 5 and 6) shows three flares. The author includes in this species a smaller

Table XLVII: Measurements *Phylloceras* (*Hypophylloceras*) *serum* (Oppel, 1865).

RGM 162 395	D = 113	Wh = 71.5	(63.3)	U = 0	wh = 42	(37.2)
RGM 162 274	D = 30	Wh = 19	(63.3)	U = 0	wh = 11	(36.7)

specimen and two small neanic forms. The smaller specimen is badly preserved, the two neanic forms show on the inner whols a similar ornamentation as the holotype, which have the same shape and measurements as the inner whorls of the large specimen. One of them (RGM 365 132) exhibits slightly adorally convex ribs with interspaces of 1-1½ mm and small concave curves on the umbilical rim.
Measurements: See Table XLVIII.
Remarks: *Lytoceras subfimbriatoides* sp. nov. closely resembles *Lytoceras subfimbriatum* d'Orbigny, 1841, which is expressed in the name. Only the measurements of *Lytoceras subfimbriatoides* differs from *L. subfimbriatum*. The former has a larger whorl height and a smaller umbilicus, but the measurements do not differ much.
For comparison we give the measurements of the lectotype of *L. subfimbriatum* (d'Orbigny) as given by Busnardo, in Fischer & Gauthier, 2006, pl. 10, fig. 1 (see Tab. XLVIII).
Geographical distribution: Spain, France, Romania, Bulgaria.

Lytoceras sutile (Oppel, 1865)
Pl. XVI, fig. 6; Pl. XVII, fig. 1

1865. *Ammonites sutilis* Opp.– Oppel, p. 551, No. 74.
* 1868. *Lytoceras sutile* Opp.– Zittel, p. 76, pl. 12, figs 1-5.
1870. *Lytoceras sutile* Opp. sp.– Zittel, p. 47, pl. 3, fig. 1a-c.
1894. *Lytoceras sutile* Opp.– Retowski, p. 239, pl. 9, fig. 9.
non 1960. *Thysanolytoceras sutile* (Oppel).– Nikolov, p. 156, pl. 1, fig. 6, 7, pl. 2, fig. 1 (all possibly are *Lytoceras subfimbriatoides* sp. nov.).
1976. *Lytoceras liebigi* Oppel.– Avram, p. 21, pl. 7, figs 4a, b.
1979. *Lytoceras sutile* (Oppel, 1856).– Sapunov, p. 40, pl. 6, fig. 2.

Lectotype: The specimen *Lytoceras sutile* depicted by von Zittel, 1868, on pl. 12, fig. 1a, b under the name *Lytoceras sutile* Opp, derived from Stramberg, designated by Patrulius & Avram (1976), deposited in the Bayerische Staatssammlung für Paläontologie und historische Geologie, München, Germany.
Material: Two specimens. One from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain: RGM 791 165 (bed Z169); and one along the Barranco de Las Oicas: RGM 365 174 (bed M8).
Description: The conch consists of almost round whorls, which rapidly grow in height and thickness. The whorl height is slightly larger than the whorl thickness. The umbilicus is slightly narrower than the whorl height. The ornamentation is only visible on one third of the last whorls and consists of thin fimbriate ribs, which describe a slightly concave curvature. On the holotype the ribs describe convex curves; only near the umbilicus the ribs describe a stronger concavety.
Measurements: See Table XLIX.
Remarks: The difference between the shapes of the conchs of *L. sutile* and *Protetragonites juilleti* d'Orbigny, 1841 are only small. *P. juilleti* has a whorl height, which is equal to the umbilical width, and *L. sutile* a whorl height, which is a little larger than the umbilical width. *P. juilleti* has a circular whorl section and *L. sutile* a slightly oval whorl section. According to Hoffmann (2010, p. 42) *P. juilleti* has no fimbriate ribs and simple suture lines, and should therefore be included in genus *Protetragonites*, while *L. sutile* has fimbriate ribs characteristic for *Lytoceras*. The suture lines of *P. juilleti* are simpler then those of *L. sutile*. However, *L. sutile* mainly occurs in the Upper Tithonian and Berriasian whereas *P. juilleti* occurs in the Valanginian. The difference between *L. sutile* and *L. liebigi* is that the whorl section of the former is slightly higher than broad, whereas the whorl section of the latter is broader than high.
Geographical distribution: Czech Republic, Ukraine (The Crimea), Bulgaria, Romania, Spain, France.

Table XLVIII: Measurements *Lytoceras subfimbriatoides* sp. nov.

RGM 365 134	D = 178	Wh = 60.4 (34.0)	U = 85 (47.8)	wh = 36.3 (20.4)
RGM 365 173	D = 142	Wh = 48 (33.8)	U = 60 (42.2)	wh = 34 (24.6)
RGM 365 132	D = 30	Wh = 9.3 (31.0)	U = 13 (43.3)	Wh = ±7 (23.3)
RGM 365 131	D = 27.5	Wh = 10 (36.4)	U = 12.4 (45.1)	wh = 5.5 (20,0)
RGM 365 133	D = 23.1	Wh = 8.1 (32.3)	U = 11.1 (44.2)	wh = 6.4 (25.5)
L. subfimbriatum	D = 172	Wh = 53 (30.8)	U = 80 (46.5)	wh = 39 (22.7)

Table XLIX: Measurements *Lytoceras sutile* (Oppel, 1865).

RGM 791 165	D = ±128	Wh = 53.7 (42)	U = 48 (37.5)
RGM 365 174	D = 72.5	Wh = 29.3 (40.4)	U = 26.4 (36.4)

2.2.22. Genus *Protetragonites* Hyatt, 1900

Type species: *Protetragonites quadrisculcatus* d'Orbigny, 1841.

Systematics: Though *Protetragonites* has the typical lytoceratid construction of the suture line, ELU_2 U_1 L, it should not be incorporated in *Lytoceras*, because it lacks fimbriated ribs, and the lobes and saddles are simpler and less frilled (Hoffmann, 2010). *Protetragonites* should neither be incorporated in the Tetragonitidae, because the latter are characterized by a six-lobated primary suture line and by the presence of a suspensive lobe. Nevertheless, the Tetragonitidae are supposed to be derived from *Protetragonites*, because tetragonitids are also smooth with growth lines or exhibit non-fimbriate ribs.

***Proteragonites quadrisculcatus* (d'Orbigny, 1841)**
Pl. XVII, figs 2, 3

1841. *Ammonites quadrisulcatus* d'Orb. in d'Orbigny, p. 151, pl. 49, figs 1-3.
1868. *Lytoceras quadrisulcatum* d'Orb. sp.– Zittel, p. 71, pl. 9, figs 1a-c, 2a-c, 3, 4, 5a, b, 6a-c.
1870. *Lytoceras quadrisulcatum* d'Orb.– Zittel, p. 44, pl. 26 (2), fig. 2a, b.
1901. *Lytoceras quadrisulcatum* d'Orbigny sp.– Sayn, p. 2, pl. 7 (1), fig. 1a, b.
1976. *Protetragonites quadrisulcatus* (d'Orbigny.).– Avram, p. 22, pl. 7, fig. 6a, b.
1976. *Protetragonites quadrisulcatus* (d'Orbigny.).– Patrulius & Avram, p. 164, pl. 2, fig. 3.
1979. *Protetragonites quadrisulcatus* (d'Orbigny, 1840).– Sapunov, p. 41, pl. 6, figs 3, 4a-b).
1995. *Protetragonites quadrisulcatus* (d'Orbigny, 1840).– Főzy, p. 135, pl. 20, fig. 11, pl. 21, fig. 3.
1999. *Protetragonites quadrisulcatus* (d'Orbigny).– Kvantaliani, p. 72, pl. 4, fig. 7a-c.
* 2006. *Protetragonites quadrisulcatus* (d'Orbigny, 1841).– Busnardo, p. 54, pl. 8, fig. 1.

Neotype: The specimen figured on pl. 8, fig. 1 under the name *Protetragonites quadrisulcatus* (d'Orbigny), derived from the Valanginian near Senez (Alpes-de-Haute-Provence, France), deposited in the Puzos collection, Université de Lyon-Villeurbanne, No. EM–5501, designated by Busnardo, in Fischer & Gauthier, 2006.

Material: Fourteen badly preserved specimens from the Jacobi Zone and Subalpina Subzone along the Barranco de Tollo and Barranco de Miraveter, Caravaca, Province of Murcia, Spain: RGM 365 773 (bed M56-62), RGM 365 774 (bed M67), RGM 365 775 (bed M68), RGM 365 801 (bed Z85), RGM 365 803 (bed Z102), RGM 365 804 (bed Z102), RGM 365 805 (bed Z107), RGM 365 806 (bed Z118), RGM 365 807 (bed Z181), RGM 365 809 (bed Z187), RGM 365 810 (bed Z202), RGM 365 811 (bed Z210), RGM 365 812 (bed Z224-226), RGM 791 166 (bed Z152).

Description: Very evolute lytoceratids with smooth, rounded (in some specimens tending to subquadratic), advolute whorls, large umbilicus and very low whorl expansion rate. The specimens from the Jacobi Zone are flattened owing to compaction. *Protetragonites* are characterised by four constrictions per whorl, which gave the ammonite its name.

Measurements: See Table L.

Geographical distribution: Spain, France.

Superfamily Haploceratoidea Zittel, 1884
Family Haploceratidae Zittel, 1884

2.2.23. Genus *Haploceras* Zittel, 1870

Type species: *Haploceras carachtheis* (microconch) (Zeuschner, 1846, pl. 4, fig. 1a-d). Designated by Enay & Cecca, 1986. Formerly the type species was *Haploceras elimatum* (Oppel) in Zittel, 1868, pl. 13, fig. 1 (= *Haploceras carachtheis* (Macroconch) designated by Spath 1923, p. 14.

Systematics: According to Enay & Cecca (1986) *Haploceras carachtheis* (Zeuschner, 1846) appears in the Lower Tithonian and ranges through the entire Tithonian. They considered this species to be the microconch of *Haploceras elimatum* (Zittel, 1868), which also ranges through the entire Tithonian. As they found all transitions between the macroconchs *H. elimatum* and *H. staszycii* (Zeuschner, 1846) in the lower and middle parts of the Tithonian and between *H. elimatum* and *H. tithonicum* (Zittel, 1868) in the middle and higher parts of the

Table L: Measurements *Proteragonites quadrisculcatus* d'Orbigny, 1841.

RGM 365 812	D = 36	Wh = 10	(27.8)	U = 17.5	(48.6)
RGM 365 806	D = 34.8	Wh = 12.2	(35.1)	U = 16.6	(47.7)
RGM 791 166	D = 31	Wh = 9.5	(30.3)	U = 16.4	(52.2)
RGM 365 811	D = 27	Wh = 8.4	(31.1)	U = 15	(55.6)
RGM 365 805	D = 27	Wh = 8	(29.6)	U = 12.0	(44.4)
RGM 365 774	D = 25.8	Wh = 7	(27.1)	U = 13.6	(52.7)
RGM 365 804	D = 24.9	Wh = 7.4	(29.7)	U = 12.5	(50.2)

Tithonian, and as Enay & Cecca (1986) also found all transitions between the microconchs *H. carachtheis* and *H. carachtheis var. subtilior* (Zittel, 1870) in the middle part of the Tithonian, and between *H. carachtheis* and *H. leiosoma* or *H. rhinotomum* in the middle and higher part of the Tithonian, Enay & Cecca (1986) came to the conclusion that there is only one species with one variable microconch and one variable macroconch.

Some palaeontologists would consider this 'excessive lumping'. Zeiss (2001), for instance, prefers the old classification as it was used by Főzy (1988). The author is not familiar with Upper Tithonian ammonites and cannot judge, whether the conclusions of Enay & Cecca (1986) are sound.

The oldest, and therefore only available, name for this species is *H. carachtheis,* and this microconch ranges through the entire Tithonian. The oldest name for the macroconch is *H. staszycii*, but the morph *staszycii* occurs only in the lower and middle part of the Tithonian, while the morph *elimatum* ranges through the entire Tithonian. Consequently, the former morph was considered an interim variety of the latter morph, which clearly represents the main antidimorph of *H. carachtheis*. *H. elimatum* and *H. carachtheis* are sexual dimorphs of one and the same species that should be called *Haploceras carachtheis* (Zeuschner, 1846). All the other Tithonian species of *Haploceras* introduced by Zeuschner (1846) and Zittel (1868, 1870) are not more than varieties of the microconchs and the macroconchs of *H. carachtheis.* Accordingly they rightly consider *H. elimatum* a junior synonym of *H. carachtheis* and propose to call all specimens of *H. elimatum* henceforward *Haploceras carachtheis* morph *elimatum* and all species of *H. carachtheis* henceforward *Haploceras carachtheis* morph *carachtheis*. *H. carachtheis* (M) and *H. carachtheis* (m) would also suffice. The terms 'variety' and 'form' are used to denote infrasubspecific groups, whereas the term 'morph' denotes the different groups within polymorphic species, which include sexual dimorphs.

The microconch of *Neolissoceras grasianum* (d'Orbigny, 1841) closely resembles *H. carachtheis* and has erroneously been called *Neolissoceras "carachtheis"* by the author (Hoedemaeker, 1982). However, these microconchs should be referred to as *Neolissoceras grasianum* (microconch), and not as *Haploceras carachtheis*, notwithstanding their close similarity with *H. carachtheis*. However, there are no intermediate forms between *N. grasianus* and *H. elimatum.* Would Zeiss (2001) be right when he called the ideas of Enay & Cecca (1986) 'excessive lumping'? The microconchs of *N. grasianum* probably range up to the top of the Hauterivian, where it would be the microconch of *Neolissoceras grasianum subgrasianum* (Drushchits & Kudrjavtsev, 1960), which is the last *Neolissoceras;* it has a smaller umbilicus than *N. grasianum*.

According to Zeiss (2001) *Haploceras elimatum* (Zittel, 1868) would also be a microconch, on account of the presence of rounded lappets and a rostrum. However, according to Callomon (1981, p. 120) *Haploceras elimatum* is a large macroconch; he notes (p. 120) that "in the microconchs the lappets have shortened, while in the macroconchs the adult peristome has flexuous lateral projections of almost the same proportions, so that both dimorphs appear to be similarly, if only moderately, lappeted."

Haploceras charachtheis (Zeuschner, 1846) acted as the type species of the following two subgenera: *Haploceras* (*Hypolissoceras*) Breistroffer, 1947, and *Haploceras* (*Neoglochiceras*) Patrulius & Avram, 1976. The latter is an objective junior synonym of the former and now also a junior synonym of *Haploceras*, of which its antidimorph is the type species.

Haploceras carachtheis morph *carachtheis* (Zeuschner, 1846) [= *Haploceras carachtheis* (microconch)]

Pl. XVII, figs 4-6

* 1846. *Ammonites carachtheis* n. sp. Zeuschner, pl. 4, fig. 1a-d.
1868. *Ammonites carachtheis* Zeuschner.– Zittel, p. 84, pl. 15, figs 1a-e, 2a, b, 3a, b.
1890. *Haploceras carachtheis* Zeuschner sp.– Toucas, p. 577, pl. 13, fig. 5a, b.
1894. *Haploceras carachtheis* Zeuschn.– Retowski, p. 242, pl. 9, figs 10, 11.
1953. *Haploceras carachtheis* (Zeuschner 1846).– Arnould-Saget, p. 7, pl. 1, fig. 8a, b, 11a, b.
1960. *Haploceras carachtheis* Zeuschner.– Drushchits, p. 268, pl. 13, figs 2a, b, 3a, b.
1962. *Glochiceras carachtheis* (Zejszner).– Barthel, p. 17 (fig. 3), pl. 2, figs 1-4, pl. 3, figs 1-7.
1976. *Haploceras* (*Neoglochiceras*) *carachtheis* (Zeuschner).– Avram, p. 36, pl. 8, fig. 9a, b.
1976. *Haploceras* (*Neoglochiceras*) *carachtheis* (Zeuschner).– Patrulius & Avram, p. 168, pl. 3, fig. 8.
? 1978. *Glochiceras* (*Lingulaticeras*) *carachtheis* Zeuschner.– Olóriz, p. 124, pl. 10, figs 6a, b, 7, 8.
1979. *Glochiceras* (*Glochiceras*) *carachtheis* (Zejszner).– Sapunov, p. 64, pl. 14, fig. 2a, b.
1979. *Neolissoceras grasianum* (d'Orbigny, 1841).– Sapunov, p. 44, pl. 7, figs 5, 6.
1982. *Neolissoceras carachtheis* (Zeuschner, 1846).– Hoedemaeker, p. 77.
1986. *Haploceras carachtheis* morph *carachtheis* (Zeuschner).– Enay & Cecca, p. 52, pl. 2, figs 1, 3, 4, 7, 8, 10, pl. 3, figs 1, 2, 6-16, 18-19.
1988. *Haploceras* (*Hypolissiceras*) *carachtheis* (Zeuschner, 1846).– Főzy, p. 59, pl. 3, figs 3, 4.
1991. *Haploceras* (*Haploceras*) *carachtheis* (m) (Zeuschner).– Cecca & Enay, p. 43, pl. 1, fig. 8a, b.
1995. *Haploceras carachtheis* (Zeuschner, 1846).– Főzy, p. 163, pl. 20, fig. 12.
1999. *Haploceras carachtheis* (Zeuschn.).– Kvantaliani, p. 77, pl. 7, fig. 2a, b.
2001. *Haploceras* (*Hypolissoceras*) *carachtheis* (Zeuschner, 1846).– Zeiss, p. 38, pl. 5, figs 4, 5.

Holotype of microconch: The specimen depicted by Zeuschner, (1846) on pl. 4, fig. 1 under the name *Ammonites carachtheis*, derived from the Upper Tithonian (grey limestone) of Koniakau, Silesia.
Material: Six small, diagenetically flattened specimens from the Jacobi Zone along the Barranco de Tollo, Caravaca, Province of Murcia, Spain: RGM 161 677 (bed Z188), RGM 161 678 (bed Z193), RGM 161 679 (bed Z196), RGM 161 680 (bed Z202), RGM 791 168 (Z138), RGM 791 169 (bed Z199), RGM 791 167 (bed Z158).
Description: Smooth shell with compressed whorls and a rather large umbilicus, larger than its antidimorph *H. carachtheis* morph *elimatum*; the flanks are flat and parallel, the ventrolateral shoulders are rounded, the venter shows transverse ridges (RGM 791 169, Pl. XVII, figs 4, 5). The umbilical rim is rounded, through which it can be distinguished from *Neolissoceras grasianum* (d'Orbigny, 1841); the latter has a slanting umbilical wall, which makes a clear angle with the flat flank. *N. grasianum* has not been found in the Jacobi Zone along the Barranco de Tollo, but appears in the Dalmasi Subzone.
Measurements: See Table LI.
Remarks: This specimen differs from *Haploceras carachtheis* morph *elimatum* Zittel, 1868, in its flat sides and its slightly larger umbilicus. It differs from the equally parallel flat-sided *Neolossiceras grasianum* d'Orbigny, 1841 in the flat venter and the rounded umbilical rim. *N. grasianum* has a rounded venter and a bevelled umbilical rim. *H. grasianum* does not occur in the Jacobi Zone, but appears later, in the Dalmasi Subzone of the Occitanica Zone. In the Subalpina Subzone of the same zone still *Haploceras carachtheis* morph *elimatum* occurs.
Geographical distribution: Czech Republic, France, Ukraine (The Crimea), Tunisia, Spain, Germany, Romania, Bulgaria, Hungary, Austria.

Haploceras carachtheis* morph *elimatum
(Oppel, 1865)
[= *Haploceras carachtheis* (Macroconch)]
Pl. XVII, figs 7, 8

1865. *Ammonites elimatus* Opp.– Oppel, p. 549, No. 53.
* 1868. *Ammonites elimatus* Opp.– Zittel, p. 79, pl. 13, figs 1-7.
1870. *Haploceras elimatum* Opp.– Zittel, p. 51, pl. 3, fig. 7a, b.
1890. *Haploceras elimatum* Oppel sp.– Toucas, p. 593, pl. 13, fig. 4.
1933. *Haploceras elimatum* (Oppel).– Spath, p. 673, pl. 81, fig. 6a, b.
1976. *Haploceras elimatum* (Oppel).– Avram, p. 34, pl. 8, fig. 1a, b.
1978. *Haploceras carachtheis* morph *elimatum* (M) (Zeuschner).– Enay & Cecca, pl. 4, figs 1-5.
1988. *Haploceras elimatum* (Oppel, 1865).– Főzy, p. 51, pl. 2, figs 1-3.
1995. *Haploceras elimatum* (Oppel, 1865).– Főzy, p. 136, pl. 20, fig. 9.
1999. *Haploceras elimatum* (Oppel).– Kvantaliani, p. 37, pl. 5, figs 6, 7.
2001. *Haploceras elimatum* (Oppel, 1865).– Zeiss, p. 37, pl. 5, figs 6, 7.

Holotype of macroconch: The specimen depicted by Zittel (1868) on pl. 13, fig. 1a-c under the name *Ammonites elimatus* from the upper Tithonian of Stramberg. Designated by Avram (1976, p. 34). Spath (1923, p. 14) designated this macroconch as the type species of the genus *Haploceras* (Oppel) in Zittel, 1868.
Material: Three calcareous internal moulds, which are diagenetically compressed: RGM 791 172 (bed Z234), RGM 791 171 (bed 243) and RGM 791 170 (bed Z243), from the Subalpina Subzone along the Barranco de Tollo, Caravaca (Province of Murcia, Spain).
Description: The smooth shells of this macroconch have

Table LI: Measurements *Haploceras carachtheis* (microconch).

RGM 161 677	D = 14.7	Wh = 5.6 (38.1)	U = 3.6 (24.5)
RGM 161 678	D = 15.6	Wh = 6.8 (43.6	U = 4 (25.6)
RGM 791 169	D = 17.8	Wh = 8.6 (48.3)	U = 3.6 (20.2)
RGM 161 680	D = 19	Wh = 9 (47.3)	U = 4 (21.0)
RGM 791 168	D = 30	Wh = 14.7 (49.0)	U = 7.6 (25.3)
RGM 791 167	D = 30	Wh = 14.7 (49.0)	U = 7.6 (25.3)

Table LII: Measurements of *Haploceras carachtheis* (Macroconch).

RGM 791 170	D = 32	Wh = 16.2 (50.6)	U = 7 (21.8)	wh = 11.1 (34.7)
RGM 791 172	D = 32	Wh = 14.6 (43.8)	U = 6 (18.8)	wh = 10.8 (35.7)
RGM 791 171	D = 25	Wh = 12.3 (49.2)	U = 5 (20.0)	wh = 7.7 (30.8)

an elliptical whorl section with rounded venter. It has a rather small umbilicus in relation to its antidimorph *H. carachtheis* morph *carachtheis* (Zeuschner, 1846) and slightly rounded flanks in contrast to the flat parallel flanks of its microconch *carachtheis.*
Measurements: See Table LII.
Remarks: The umbilicus of macroconch morph *elimatum* (Oppel, 1865) is wider than those of morph *tithonicum* (Oppel, 1865). It is remarkable that the morph *elimatum* was found only in the Subalpina Subzone along the Barranco de Tollo, whereas the microconch morph *carachtheis* was found only in the Jacobi Zone along the Barranco de Tollo. *Neolissoceras grasianus* (d'Orbigny, 1841) starts in the Dalmasi Subzone of the Occitanica Zone and its microconch can hardly be differentiated from morph *carachtheis*.

2.3. Concluding remarks

2.3.1. Differences in the ammonite faunal compositions of the various subzones

The Jacobi Zone (in the sense used herein) was defined by the Cephalopod Team of the IGCP-Project 262 (Hoedemaeker *et al.,* 1993) as the joining together of Le Hégarat's (1973) Jacobi zone (below) and Grandis zone (above) [= the Jacobi/Grandis zone of the 'Colloque sur la limite Jurassique-Crétacé', 1975 = Euxinus Zone of Wiedmann (in Allemann, Grün & Wiedmann, 1975)], into one single zone to which the name 'Jacobi Zone' was given. This Jacobi Zone is the ammonite zone between the Vulgaris Zone below and the Occitanica Zone (Subalpina Subzone) above, and the lowest ammonite zone of the Berriasian Stage. It is also the range zone of *Berriasella (Hegaratella) jacobi*. The name Vulgaris Zone was proposed by Sarti (1988, p. 473) to replace the former Durangites Zone, the uppermost ammonite zone of the Jurassic System. The limestones of the Vulgaris Zone are in brittle ammonitico rosso facies, with red colours and without siliciclastic detritus. It is interpreted to be deposited on a rather shallow, isolated submarine swell with only 0.1 to 1% clastic grains.
The basal bed of the Jacobi Zone (bed Z1) is a 0.5 m thick graded calcirudite composed of reworked, rounded, calpionellid-bearing, micritic limestone fragments in a limestone matrix with many reworked *Saccocoma* fragments. The limestone fragments mainly consist of reworked Ammonitico Rosso limestone. Van Veen (1969) considered bed Z1 as the top bed of the Jurassic Tollo Formation, but Wiedmann (in Allemann *et al.,* 1975) mentioned the first *Berriasella jacobi* (Mazenot) from this bed.
This bed is here interpreted as a graded mudflow deposit (Hoedemaeker, 1974, p. 56-57) caused by the rapid shallowing of the sea during the falling-stage systems tract (forced-regression). The major sequence boundary Be1 is situated 1.5 m higher at the top of bed Z4. In Allemann *et al*. (1975) and in Hoedemaeker (1982), the base of bed Z1 is drawn as a hiatus. However, bed Z1 lies conformable upon the Ammonitico Rosso bed of the Vulgaris Zone and no signs of emersion could be detected. The base of bed Z1 probably represents not more than a short period of non-deposition before the start of a forced regression on top of an isolated, rather shallow marine swell. The limestone grains were disengaged from the Ammonitico Rosso sediment by wave action when the decending wave base reached the top of the swell.
In fact, this calcirudite bed heralds quite a different depositional regime. The slow average sedimentation rate (aproximately one millimetre in 178.6 years) of the Jurassic limestones [Toarcian to Tithonian = 210 m thick (Van Veen, 1969)], which encloses several intervals developed in Ammonitico Rosso facies [Tollo Formation of Van Veen (1969); the Spanish geologists prefer to use the name 'Formación Ammonitico Rosso Superior'], changes into a rhythmic limestone-marlstone succession [Miravetes Formation of Van Veen (1969); the Spanish geologists prefer to use 'Formación Carretero'] with an average sedimentation rate of approximately one millimetre in 25.7 years, which is about seven times more rapid than the average sedimentation rate of the Jurassic Tollo Formation. This implies a rather sudden acceleration in the subsidence of the continental basement in the Caravaca area starting at the Jurassic/Cretaceous boundary simultaneous with a rapid rise of the sea level. Contrary to the Tollo Formation, the Miravetes Formation contains large amounts of clay, which suggests a connection of the swell with the coast. However, sand-sized siliciclastic grains remain rare, less than 1%.
In section Z along the Barranco de Tollo, the Jacobi Zone is 70 m thick and bounded by two major sequence boundaries: Be1 at the base, and Be3 at the top, which function as the boundaries of the Jacobi Zone. This zone may, therefore, be designated as a depositional sequence of the second order. The duration of the Jacobi Zone is 1.8 million years (Ogg *et al.,* 2004). Be2 is a minor sequence boundary between Be1 and Be3 and divides the Jacobi Zone into two sequences of the third order. The ammonites collected from the Jacobi Zone along the Barranco de Tollo (section Z), are generally not well-preserved, though well identifiable.
Major sequence boundaries are generally attended by profound changes of the ammonite faunas. These faunal changes can be explained by the strong reduction of the biotopes of the ammonite species during great amplitude relative sea-level falls causing extreme retreats of the sea (Hoedemaeker, 1995b). This reduction would enhance selection pressure and extinction, but also the generation of many new taxa. Especially ammonites appear to be sensitive for these major sea level fluctuations. The amount of extinctions and generations of new taxa is less at minor sequence boundaries in which the amplitude of the relative sea level fall is smaller. The faunal change

at a major sequence boundary takes place just before the sequence boundary, viz. in (the last part of) the falling stage systems tract of the foregoing depositional sequence, and lasts only about two or three precessions of the equinoxes, i.e. within about 40.000 to 60.000 years (Hoedemaeker, 2013, sequence boundary Ha7). In that period most extinctions and originations of species take place. Only a few species may survive a little longer.

Ammonite faunal composition of the total Jacobi Zone: (Figs 2A, 2B, 3) The Jacobi Zone has, apart from Phylloceratina, Lytoceratina, and Haploceratidae, a very singular and unique ammonite fauna, mainly consisting of species of the genera *Pseudosubplanites*, *Delphinella* (*Delphinella*), *Substeueroceras,* and *Chapericeras*. None of these (sub)genera occur in the underlying or overlying zones. Vitually, the subgenus *Berriasella* (*Hegaratella*) can also be regarded as characteristic for the Jacobi Zone, although it starts with only one species in the Vulgaris Zone (Tavera, 1985; Tavera *et al.,* 1994), and only three species cross the upper boundary of the Jacobi Zone to become extinct shortly afterwards.

Elenaella Nikolov, 1966 (type species *Berriasella cularensis* Mazenot, 1939) was considered a subgenus of *Dalmasiceras* by Nikolov (1982); this idea is followed by the author; *Elenaella* was also regarded as a senior synonym of *Delphinella* (*Delphinella*) by Wright *et al.* (1996); not followed by the author. "*Hoplites" Aristides* Kilian, 1896 (p. 679) was considered a representative of *Dalmasiceras* by Mazenot (1939) and the author (Hoedemaeker, 1982, and herein). Both *E. cularensis* and "*Hoplites" Aristides* occur in the lower part of the Jacobi Zone, but have not been encountered in section Z.

The genera *Dalmasiceras*, *Tirnovella* and *Spiticeras* also start their ranges at the base of the Jacobi Zone, but continue their ranges up to the Boissieri Zone. Somewhat later in the Jacobi Zone the first representatives of genus *Subthurmannia* appear; these genera also continue their ranges into the overlying Occitanica and Boissieri zones. In addition, the Jacobi Zone contains the last upper Tithonian ammonite genera *Himalayites, Proniceras* and *Busnardoiceras* (not encountered in section Z), which become extinct in the Jacobi Zone. Finally Checa (1985), Tavera (1985), Tavera *et al.* (1986) and Checa *et al.* (1986) showed that the last representatives of *Aspidoceras* and *Schaireria* also range up to the top of the Jacobi Zone in the sections of the Gaena-Carcabuey area (Province of Cordoba, Southern Spain); these genera have not been encountered along the Barranco de Tollo. The genus *Retowskiceras* Nikolov, 1966, which has not been found in section Z, has been reported only from the upper part of the Jacobi Zone and in the lowest part of the Occitanica Zone of the Crimea (Arkadiev *et al.,* 2012) and Southern Spain (Tavera, 1985). In total 54 ammonite species were described by the author from the Jacobi Zone from section Z along the Barranco de Tollo, and nine from the Subalpina Subzone.

Three species range through the totality of the Jacobi Zone, viz. *Berriasella* (*Hegaratella*) *jacobi*, *Pseudosubplanites crymensis*, and *Pseudosubplanites lorioli*.

De Cisneros (1911) and Van Veen (1969), who studied the geology of the area around Caravaca, collected a few ammonites from the Jacobi Zone. In 1971 Wiedmann sampled ammonites from the section. The author started collecting systematically in section Z in 1973 (Hoedemaeker, 1981, 1982), but continued collecting systematically and measuring the totality of the Lower Cretaceous rocks as they are exposed along the Río Argos (Caravaca, Province of Murcia) until 1999.

Wiedmann (in Allemann *et al.,* 1975), who also collected ammonoids from the section Z in 1971 (collection possibly deposited in Basel, Switzerland), mentions from bed Z1 a typical Jacobi zonal association, viz. *Berriasella* (*Hegaratella) jacobi* and *Chapericeras tarini*, and from levels about five metres higher *Chapericeras tarini, Chapericeras chaperi*, and *Proniceras praenegreli*. At both levels *Micracanthoceras microcanthus* was mentioned. The latter species, if correctly identified, may be reworked from beds below the Jacobi Zone. Reworking has been demonstrated in many beds of the lowermost part up to bed Z61 of the Jacobi Zone along the Barranco de Tollo [reworking of *Saccocoma*, see Part 3 (Calpionellids)]. The last specimen of *B*. (*H.*) *jacobi* was found two metres from the top of Jacobi Zone; so its range extends through the entire Jacobi Zone.

Lower Subzone (= depositional sequence Be1): (Fig. 2A) The Jacobi Zone comprises two depositional sequences, Be1 and Be2 (Hoedemaeker & Leereveld, 1995; Hoedemaeker, 1995b, 1998, 2002, 2003) separated by sequence boundary Be2. The author dissociates himself from his former sequence boundary Be1', which is now interpreted as a parasequence boundary. The faunal change at sequence boundary Be2 is conspicuous and therefore functions as a natural zonal boundary. This means that the subzones used here are in fact depositional sequences. *Berriasella* (*Hegaratella*) *jacobi* may well function as index species for the lower subzone (= sequence Be1), though it ranges through the whole Jacobi Subzone. The Jacobi subzone is 47 m thick.

Inherited from the Tithonian are the (sub)genera *Himalayites* (*Himalayites*), *Himalayites* (*Pomeliceras*), *Proniceras*, *Busnardoiceras* (not found in section Z), *Aspidoceras* (not encountered in section Z), and *Schaireria* (not collected in section Z). In the basal part of the Jacobi Zone Tavera (1985) and Tavera *et al.* (1994) mentioned four survivers of the Vulgaris Zone, viz. *Durangites sutneroides* Tavera, *Protacanthodiscus heterocosmus* Canavari, *P. berriasensis* Tavera, and "*Corongoceras*" *koelikeri* (Oppel). None of the latter four species were sampled from section Z.

At the base of the sequence many new genera are generated, such as *Berriasella* (*Hegaratella*) [only one species of this genus starts its range in the Vulgaris Zone, viz. *Berriasella* (*Hegaratella*) *tithonica* Tavera,

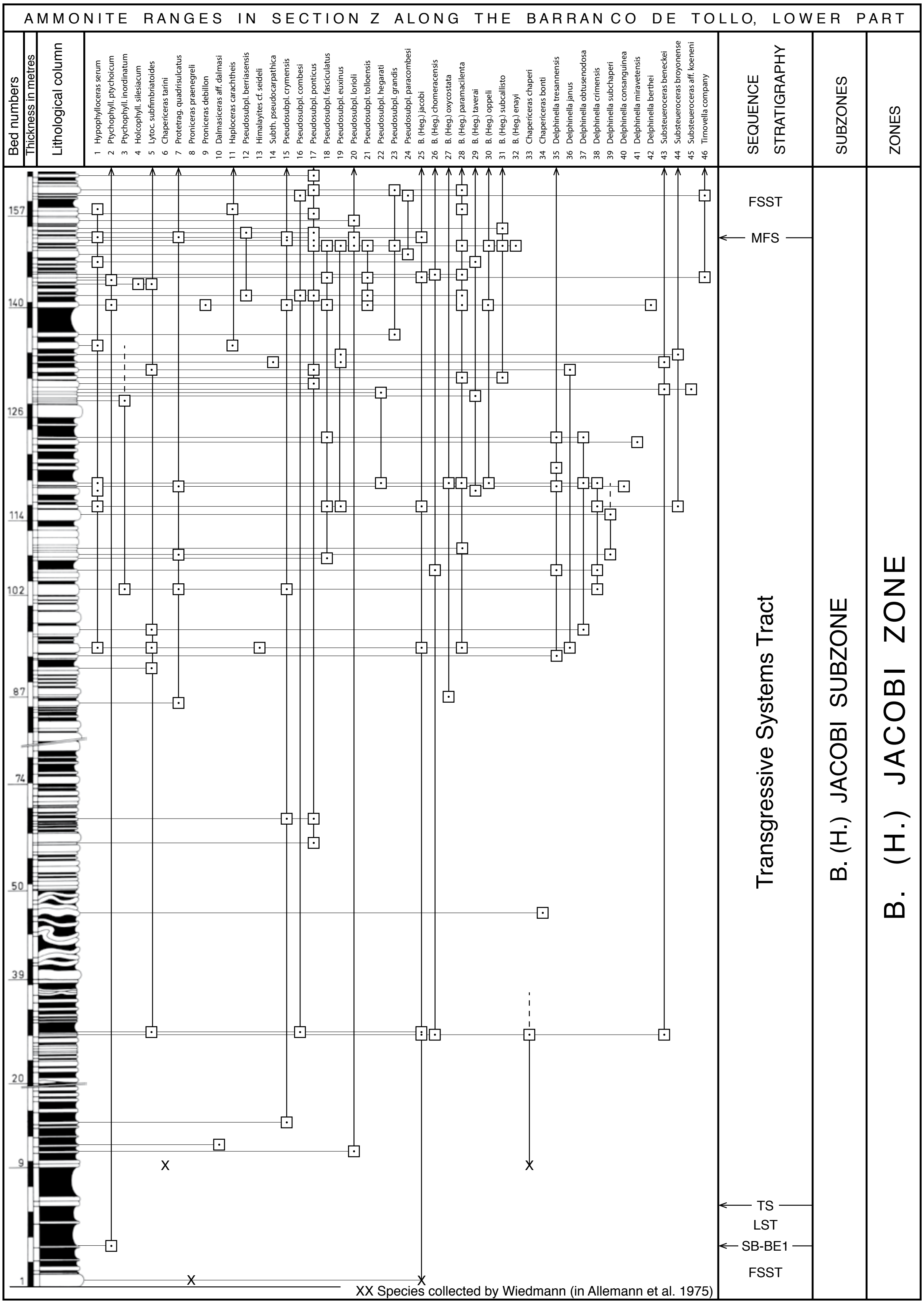


Fig. 2A: Ranges of the ammonite species in the lower part of section Z showing the major part of the Jacobi Subzone and its sequence stratigraphy. Abbreviations: FSST = Falling Stage Systems Tract; LST = Lowstand Systems Tract; MFS = Maximum Flooding Surface; SB = Sequence Boundary; TS = Transgressive surface. Be1, Be2, Be3 = Berriasian 1, 2, 3 sequence boundaries.

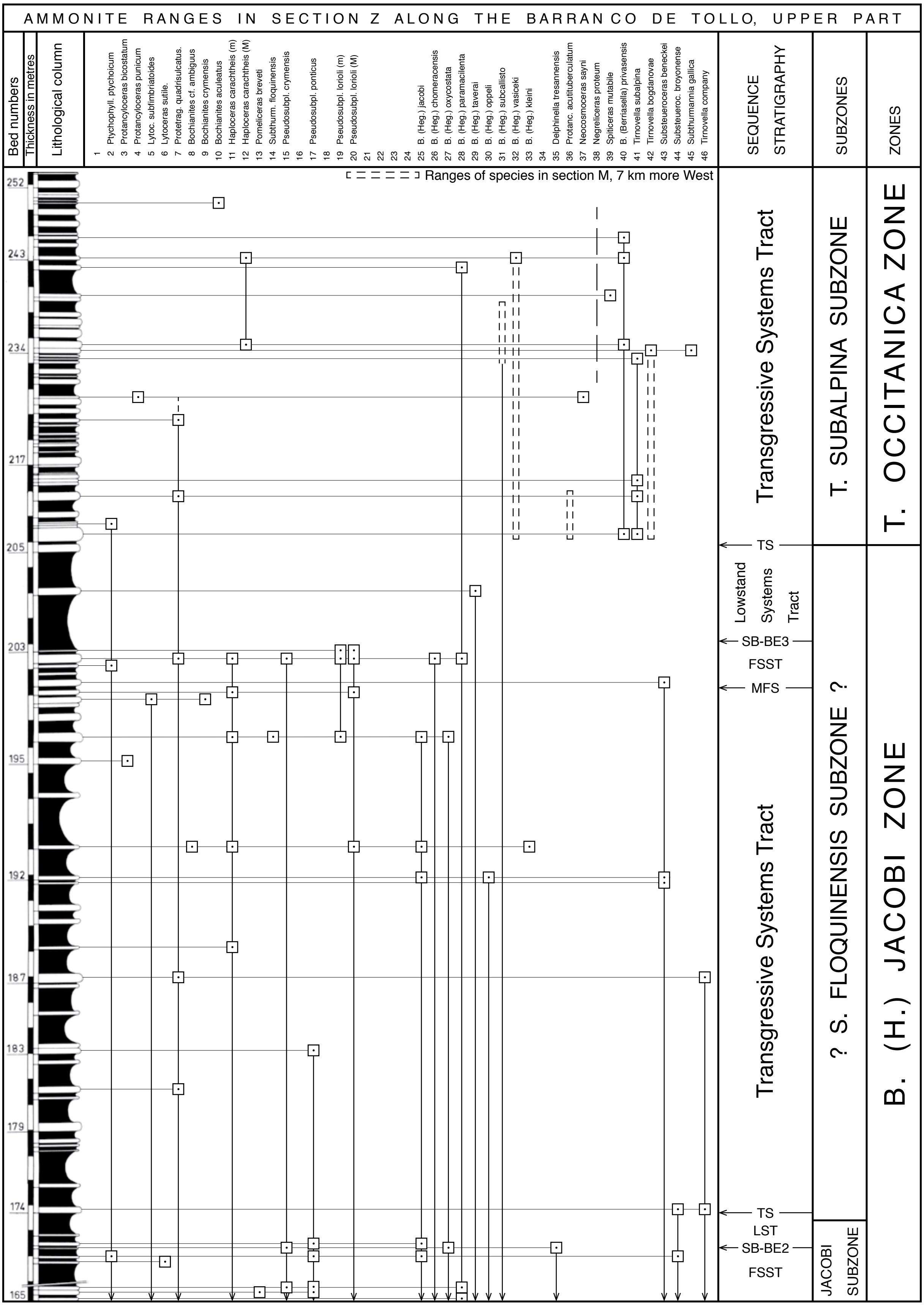


Fig. 2B: Ranges of the ammonite species in the upper part of section Z showing the top part of the Jacobi subzone, the Floquinensis Subzone and the Subalpina subzone and the sequence stratigraphy. Abbreviations: see Fig. 2A.

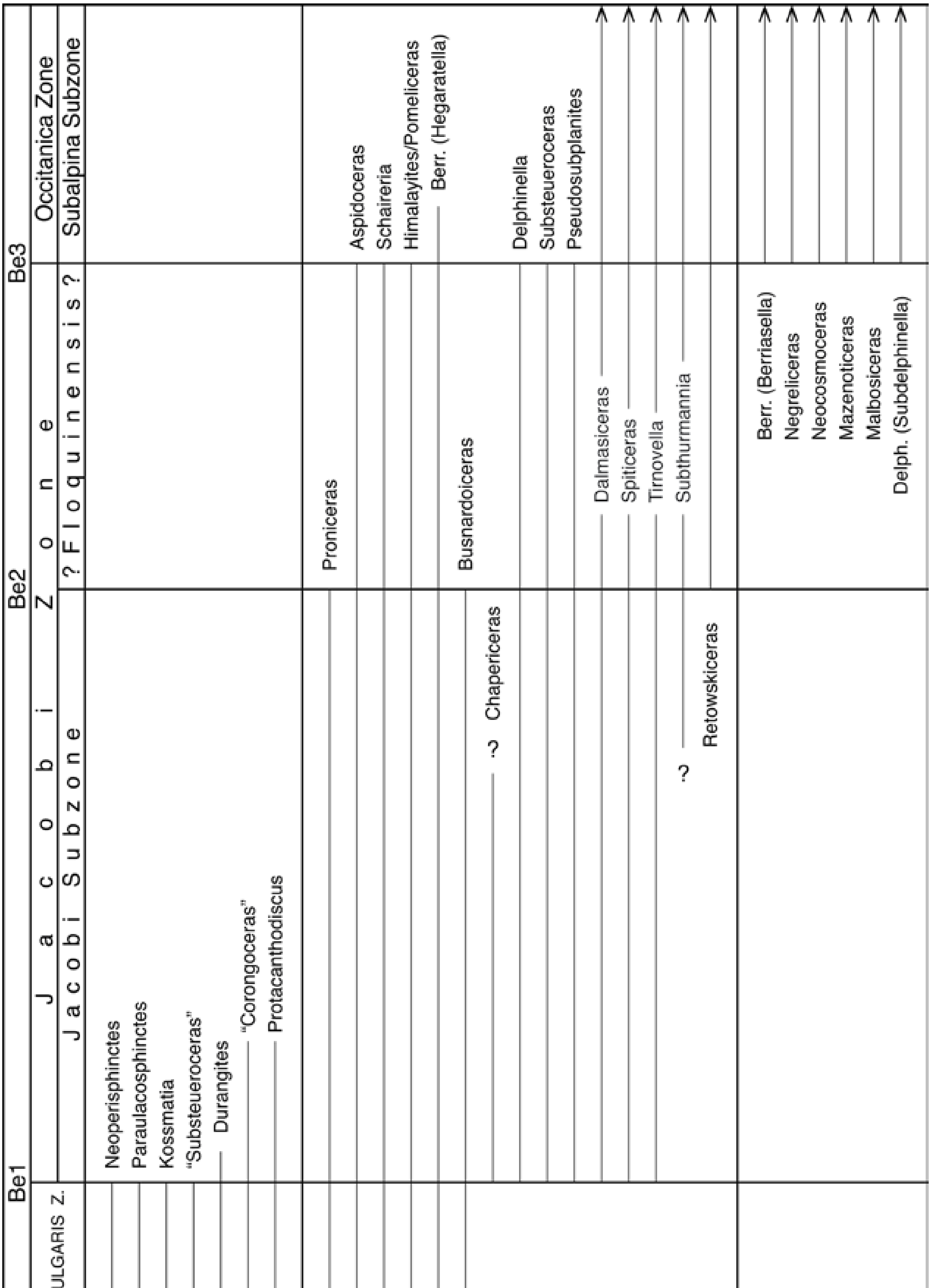


Fig. 3: Ranges of the ammonite genera and subgenera in the subsequent depositional sequences Be1, Be2 and Be3 and the ammonite genera of the *D. vulgaris* Zone.

1985], *Pseudosubplanites*, *Delphinella* (*Delphinella*), *Chapericeras*, *Substeueroceras*, *Tirnovella*, *Spiticeras*, *Dalmasiceras*. The latter three continue their ranges into the Occitanica and Boissieri Zones. *Tirnovella allobrogensis* (Mazenot, 1939) and *T. suprajurensis* (Mazenot, 1939) probably occur only in the lower subzone (sequence Be1), but were not collected from the Barranco de Tollo section. Only *Tirnovella companyi* starts its range in the maximum flooding interval of depositional sequence Be1. The species of *Tirnovella* in the lower and middle Berriasian differ from those in the upper Berriasian in the presence of umbilical tubercles; they could perhaps be treated as different species.

In addition, genus *Subthurmannia* (*S. pseudocarpathica*) originated in the maximum flooding interval of sequence Be1 and continues its range into the Occitanica and Boissieri Zones.

The ammonite genera that occur in depositional sequence Be1 also occur in depositional sequence Be2, with the exception of *Chapericeras* and probably of *Busnardoiceras*. It seems that *Chapericeras* is restricted to the lower part of sequence Be1. Sapunov (1979) and Nikolov (1982) distinguished a "*Malbosiceras*" *chaperi* Subzone directly below their "Grandis Zone;" they equated their Chaperi Subzone with the "Jacobi Zone" *sensu* Le Hégarat, 1973.

All species of (sub)genera *Berriasella* (*Hegaratella*), and *Substeueroceras* continue their ranges in sequence Be2, but of the other genera of sequence Be1 only a few species occur in sequence Be2, viz. the neotype of *Himalayites* (*Himalayites*) *kasbensis* Pomel (possibly from the basal part of "Andrussowi Zone", see paragraph 2.2.2.), *Pseudosubplanites lorioli*, *P. crymensis, P. ponticus,* and probably a species of *Delphinella* [the ancestor of the subgenus *Delphinella* (*Subdelphinella*)]. The species *P. lorioli, P. crymensis* and *P.* (*H.*) *jacobi* range through the whole of the Jacobi Zone.

The near absence of *Pseudosubplanites* in the upper part of the Jacobi Zone needs some elucidation, because the ranges of *Pseudosubplanites* published by Le Hégarat (1973) show that all species have their greatest abundance in the upper part of the Jacobi Zone, i.e. in the former "Grandis Zone." The reason of the near absence of *Pseudosubplanites* is, that the author put the top of the Jacobi Subzone at a higher level than Le Hégarat did, viz. at the boundary between the sequences Be1 and Be2. Because of this, the maximum flooding interval and the highstand systems tract of sequence Be1 (which harbour the greatest abundance of ammonites and the acme of *Pseudosubplanites*) became located in the higher part of the Jacobi Subzone in the sense used herein. The consequence of this higher position of the top of the lower subzone is that the acme of genus *Pseudosubplanites* became included in the Jacobi Subzone. Le Hégarat (1973) included these beds in the "Grandis Zone."

In section Z the first *Pseudosubplanites grandis* appears in bed Z139 and is restricted to the acme of *Pseudosubplanites* in the beds just below and above the maximum flooding surface of sequence Be1 (Fig. 2A). All the other species of *Pseudosubplanites* also occur in these beds, except for two species, which continue their ranges up to the top of the Jacobi Zone. As *P. grandis* does not occur in sequence Be2, it would be better to give the upper part of the Jacobi Zone another name.

Tirnovella allobrogensis and *T. suprajurensis* probably occur only in sequence Be1 but were not collected from the Barranco de Tollo section. Only *Tirnovella companyi* starts its range in the maximum flooding interval of depositional sequence Be1.

In the Jacobi Subzone the beds with the acme of genus *Chapericeras* is followed by beds with the acme of genus *Pseudosubplanites*. This may perhaps allow the introduction of two ammonite horizons, the *C. chaperi* and *P. grandis* horizons.

Upper subzone (= depositional sequence Be2): (Fig. 2B) The composition of the ammonite fauna in depositional sequence Be2 (23 m thick) is quite different from that of sequence Be1, because of the near absence of *Pseudosubplanites* and *Delphinella* (*Delphinella*)*,* the extreme rarity of *Spiticeras* and *Dalmasiceras* (see Le Hégarat, 1973), and the total absence of *Proniceras, Chapericeras* and possibly also *Busnardoiceras*. On the other hand, all species of the (sub)genera *Berriasella* (*Hegaratella*) and *Substeueroceras* that occur in sequence Be1 range into sequence Be2. The genera *Subthurmannia*, (mainly *S. floquinensis*), *Tirnovella* (mainly *T. companyi* sp. nov. and *T. shipkovensis*) and "*Malbosiceras*" *nikolovi* Le Hegarat, 1973 [which probably represents the inner whorls of subgenus *H.* (*Pomeliceras*) *breveti*] also range into sequence Be2. Tavera (1985) found *Himalayites*, *Aspidoceras*, and *Schaireria* in his Andrussowi Zone (see paragraph 2.2.2.), which approximately comprises both the upper part of the Jacobi Zone and the Subalpina Subzone; so these genera most likely range into sequence Be2, but do not cross the upper boundary of the Jacobi Zone. Hitherto, *Retowskiceras andrussowi* Retowski (1894) has been reported only from the upper part of the Jacobi Zone (Arkadiev *et al.,* 2012; Kvantaliani, 1999); *Retowskiceras retowskii* (Kvantaliani & Lysenko, 1979) was reported from the the upper Jacobi Zone and the lower Occitanica Zone (Arkadiev *et al.,* 2012, p. 73-74). As *Pseudosubplanites grandis* only occurs in the upper quarter of sequence Be1 (= Jacobi Subzone), sequence Be2 clearly correlates with the upper part of the former "Grandis Zone" sensu Le Hégarat (1973).

It was not possible to indicate an index species for depositional sequence Be2 in section Z. One of the following three species *Subthurmannia floquinensis* (Le Hégarat, 1973), *Tinovella shipkovensis* (Nikolov & Mandov, 1967) or *"Malbosiceras" nikolovi* Le Hégarat, 1973 [which representes the inner whorls of *Himalayites* (*Pomeliceras*) *breveti* (Pomel, 1889)] may provisionally function as the index species of this depositional sequence, for Le Hégarat (1973) mentioned 15 specimens (= 93%) of each of these species as occurring to his former "Grandis Zone." However, according to Le Hégarat (1973, tables 19, 22, 23, 24) these three species also occur together with the last specimens of *P. grandis*, which would mean that their ranges possibly just overlap the end of the range of *P. grandis*. However, it must be mentioned here that the specimen depicted by Le Hégarat (1973) on pl. 37, fig. 9, is not *P. grandis*, but *P. crymensis* Bogdanova & Arkadiev, 2005. This makes Le Hégarat's range of *P. grandis* unreliable. *P. crymensis* ranges up to the top of the Jacobi Zone.

The author chose *S. floquinensis* as provisional index species of sequence Be2. The provisional Floquinensis subzone (= sequence Be2; 23 m thick) comprises the upper part of the former "Grandis Zone" of Le Hegarat (1973).

Alternative biozones: In this biostratigraphic description the Jacobi zone clearly separates into two subzones, which have a quite different faunal composition. It appears that the boundary between these subzones is a sequence boundary and that each subzone comprises one depositional sequence. In this case the author uses depositional sequences as alternative biostratigraphic units, describes the composition of the fauna within each depositional sequence, and shows the differences with the faunal compositions of adjacent sequences. The surplus value of this approach becomes obvious, if comparing the faunal constitution of the 'Jacobi' and 'Grandis' zones of Le Hégarat (1973) and the faunal constitution of the sequences Be1 and Be2 of the author. In the range charts of section Z (Figs 2A, 2B, 3) the difference in the composition of the ammonite fauna of sequence Be1 and Be2 is conspicuous.

Vulgaris Zone: Directly below the base of bed Z1, red coloured nodular, locally brecciated rocks occur from which a rather badly preserved fauna of the Vulgaris Zone was collected by Nico Janssen with *Ptychophylloceras ptychoicum*, *Holcophylloceras silesiacum*, *Hypophylloceras serum*, *Haploceras carachtheis* (m), *Haploceras carachtheis* (M) (= *H. elimatum*), *Durangites acanthicus* Burckhardt, *Durangites vulgaris* Burckhardt, *Protacanthodiscus heterocosmos* (Canavari, 1899), *Protacanthodiscus* cf. *nodosus* Tavera, and "*Substeueroceras* sp. *sensu* Tavera (1985, pl. 33, figs 1, 2) *non* Spath, 1923. Tavera's species has constrictions at regular distances, which are not present in *Substeueroceras* Spath, 1923. The constitution of the Vulgaris zonal fauna below sequence boundary Be1 is quite different from that of depositional sequence Be1.

Half a metre lower, the beds yielded *Andalusphinctes sapunovi* Tavera, 1985, *Aulacosphinctes* cf. *sulcatus* Tavera, 1985 and *Zittelia eudichotoma* (Zittel, 1868); these species designate the Transitorius Zone.

Subalpina Subzone: Along the Barranco de Tollo the beds above major sequence boundary Be3 at the top of the Jacobi Zone represent the Subalpina Subzone. Sequence boundary Be3 is also the base of the Subalpina Subzone. Sequence boundary Be4, which forms the base of the Privasensis Subzone, is probably either situated on top of bed Z241 (not drawn in Fig. 2B) or above bed Z253. The Subalpina Subzone is characterized by the first appearance of the (sub)genera *Berriasella* (*Berriasella)*, *Delphinella* (*Subdelphinella*), *Negreliceras*, and *Neocosmoceras.* In addition, Le Hégarat (1973) mentioned the appearance of genus *Mazenoticeras* in the Subalpina subzone, and Tavera (1985) showed that genus *Malbosiceras* appears in his Adrussowi Zone (presumably in the part of this zone that correlates with the Subalpina Subzone or higher). Also *Retowskiceras "andrussowi" sensu* Tavera (1985) *non* Retowski (1894) appears to occur in the Subalpina Subzone (see paragraph 2.2.2.); this is probably a new species of *Retowskiceras*. Species *R. retowskii* (Kavantaliani & Lysenko, 1979) occurs in the upper part of the Jacobi Zone and in the lower part of the Occitanica Zone (Arkadiev *et al.,* 2012); *R. andrussowi* (Retowski, 1894) was mentioned only from the Jacobi Zone.

The only other species that cross the boundary between the Jacobi and Subalpina zones are *Berriasella* (*Hegaratella*) *paramacilenta, B*. (*H.*) *subcallisto,* and *B.* (*H.*) *vasiceki* sp. nov. Sequence boundary Be3 between the Jacobi Zone and the Subalpina subzone also produced the strong renewal of the ammonite fauna.

2.3.2. Comparisons with the Jacobi Zone in the Puerto Escaño section (Prov. of Cordoba, Spain) and in the Le Chouet section (Dep. Drôme, France)

Tavera (1985) studied the ammonite fauna of the Upper Tithonian and lower Berriasian in the region around Cabra, Gaena and Carcabuey (Province of Cordoba) thoroughly. It appears that the constitution of the fauna in that area is quite different from the one along the Baranco de Tollo. The Gaena-Carcabuey fauna contains many *Dalmasiceras*, but almost lacks *Pseudosubplanites* and *Delphinella*, whereas the Barranco de Tollo section contains only one specimen of *Dalmasiceras*, but many of *Pseudosubplanites* and *Delphinella*. The same differences exist between the ammonite fauna of the Aizy succession (with many *Dalmasiceras*) and the Chomérac succession (with many *Delphinella*) in southeastern France. Because of these differences, Kilian (1910) and Mazenot (1939) interpreted these successions as of different age. It was Le Hégarat (1973), who showed that both French successions are of the same age. The cause of these faunal differences should be sought for in different palaeoecological circumstances. The Puerta Escaño section (Ga 7) is the most celebrated section in the Gaena-Carcabuey area.

The successions of the Tithonian and lowest Berriasian in the Sierra de Gaena-Carcabuey are very condensed and consist of limestones in Ammonitico Rosso facies with predominantly red and green colours and hardly any siliciclastic admixture; every bed is topped by a small hiatus (diastems), and are therefore separated by small lacunas. The maximal thickness of the Jacobi zone in the Puerto Escaño section is 4.7 m of which only the lower 1.6 m produced ammonites. The rate of sedimentation was one millimetre in about 380 years. Sedimentological signs of sequence boundaries seem to be absent. The thicknesses are derived from Pruner *et al.,* 2010, fig. 12.

Nevertheless, the Puerto Escaño section (section Ga 7 near Carcabuey) is the most important section in the Gaena-Carcabuey area with respect to the base of the Jacobi Zone and Jurassic/Cretaceous boundary. The first *Berriasella* (*Hegaratella*) *jacobi* was found at a small distance above the base of the Jacobi Zone, viz. in bed 26. This bed is 0.25-0.5 m above the top of bed 24, which contains a clear Vulgaris zonal fauna. Bed 25, the basal bed of the Jacobi Zone, produced ammonites that are characteristic for the Jacobi Zone (Tavera, 1985), viz. *Chapericeras tarini*, *Elenaella cularensis*, *Berriasella* (*Hegaratella*) *chomeracensis*, *Dalmasiceras sayniforme*. Because of the abundance of *Elenaella cularensis* in bed 25, Tavera *et al.* (1994) suggested that this bed may be regarded as the basal biohorizon of the Jacobi Zone, which they named the 'Horizon of Cularensis.' *E. cularensis* was not encountered along the Barranco de Tollo. In the Puerta Escaño section (Ga 7) the only species that have crossed the Vulgaris-Jacobi zonal boundary, are: *Protacanthodiscus heterocosmos, Pr. berriasensis, Durangites sutneroides,* "*Corongoceras*" *hexagonus and* "*Corongoceras*" *koellikeri*. The Lower boundary of the Jacobi Zone is sharp, but sedimentological signs of a sequence boundary seem absent.

The stratigraphic position of the upper boundary of the Jacobi Zone poses some problems. This boundary is marked by the appearance of *Subthurmannia clareti*, *Berriasella* (*Berriasella*) *privasensis* and *"Retowskiceras andrusowi*" Tavera, 1985 (*non* Retowski, 1894). Tavera (1985, 342) introduced the Andrusowi Zone on top of the Jacobi Zone and defined this zone as being equivalent to the total range of *Berriasella* (*Hegaratella*) *paramacilenta*, because all his specimens of "*R. andrussowi*" occur within this range; this species also occurs together with either *Subthurmannia clareti* or *Berriasella (Berriasella) privasensis*. This means that his Andrusowi zone in the Gaena-Carcabuey area is approximately equivalent to the *Tirnovella subalpina* Zone.– However, for the time being (Tavera 1985, p. 342) considered the Andrusowi zone to be equivalent to the Occitanica Zone because of the lack of other exposures of the Occitanica Zone.– Neither Mazenot's (1939) nor Tavera's (1985) specimens of "*R. andrussowi"* are conspecific with *R. andrussowi* Retowski, 1894, but belong to a new species of *Retowskiceras*, which differs from the holotype in the much greater width of the umbilicus; Tavera's (1985) specimen of pl. 37, fig. 2 may be a small *Retowskiceras retowskii* Kvantaliani & Lysenko, 1979, which in the Crimea was reported to occur in the upper part of the Jacobi Zone, but also in the basal part of the Occitanica Zone (Arkadiev *et al.,* 2012).

Tavera (1985) also mentions several species of *Mazenoticeras* and *Malbosiceras* within the range of *B*. (*H.*) *paramacilenta,* which means that these genera already occur in the Subalpina Subzone. On the other hand, Tavera (1985) mentioned a few species of *Neocosmoceras* from the Jacobi Zone. The author hesitates as yet to accept these identifications.

In the Puerto Escaño section (Ga7) Tavera (1985) considers bed 32 as the boundary bed between the Jacobi and Andrussowi zones, because the ammonites that he mentioned from this bed were partly assigned by him to the Andrussowi Zone and partly to the Jacobi Zone. That would mean that the whole Jacobi Zone would be merely 1.7 m thick (8 beds). However, only in bed 45 the first *Subthurmannia clareti* and "*Retowskiceras andrusowi"* (Tavera, 1985, *non* Retowski, 1894) occur; from beds 33 to 44 no ammonites were reported. In addition, bed 45 yielded four specimens of *B*. (*H.*) *paramacilenta*. If bed 45 would be close to the base of the Subalpina Subzone, the Jacobi Zone would be 4.7 m thick (20 beds). From bed 53 the last four specimens of *B*. (*H.*) *paramacilenta* were collected. This bed could represent the maximum flooding surface occurring within the Subalpina Subzone. If so, this subzone would occupy more than 21 beds. It is, therefore, more likely that bed 45 is the approximate base of the Subalpina Subzone in the Puerto Escaño section, not bed 32.

This means that the total Jacobi Zone is probably 4.7 m thick. Only the lower 1.7 m (= Ga7 beds 25-32) of the Jacobi Zone produced ammonites, the upper three metres (Ga 7 beds 34-44) did not. The acme of *Calpionella alpina* is beds 28, 29 and 30 (Pruner *et al.,* 2010). The sharp boundary between the Vulgaris and Jacobi zones nearly coincides with the base of the normal polarity chron M19n (Pruner *et al.,* 2010). However, it is not known how large the lacuna is between beds 24 and 25. No signs of a sequence boundary were reported.

Tavera *et al.* (1994) showed next to the ranges of the ammonites also the rages of the most important calpionellids and nannoplankton, which allows a comparison with the Le Chouet section and with section Z.

As to the portion of the Le Chouet section investigated by the members of the Working Group on the Jurassic/Cretaceous boundary (Wimbledon *et al.,* 2013), only the ranges of the calpionellids, nannoplankton, and ammonites occurring just below and above the base of the Jacobi Zone are described. The base of the Jacobi Zone is rather sharp and the sequence boundary Be1 is likely to be situated just above or below bed 87. Like in the Puerto Escaño section, the Le Chouet section differs from section Z along the Barranco de Tollo in the presence of many species of *Dalmasiceras* and in the absence of *Pseudosubplanites* and *Delphinella*. It is also directly underlain by the Vulgaris Zone (called Andreaei Zone by Luc Bulot in Wimbledon *et al.,* 2013). Important is the magnetostratigraphy (given by Pruner), which shows that, like in the Puerto Escaño section, the base of the Jacobi Zone virtually coincides with the base of polarity chron M19n. However, it is not known how large the lacuna is at the base of bed 87. The Puerto Escaño and the Le Chouet sections are the only ammonite bearing ones in which the base of the Jacobi Zone was calibrated with magnetostratigraphy.

2.3.3. Comparison with the stratotype of the Berriasian near Berrias (Ardèche)

In the stratotype of the Berriasian near Berrias (Ardèche, France) the Jacobi Zone (in the sense used herein) hardly produced ammonites. Only *Pseudosubplanites grandis* and *Berriasella* (*Hegaratella*) *paramacilenta* were mentioned from bed 145 (± 1 m thick) just below sequence boundary Be3 (Le Hégarat, 1973; Jan du Chêne *et al.,* 1993). Below sequence boundary Be3 the rock consists of limestone that bursts into parallelepipeds with a sonorous clinging sound when hit by a hammer. *Tirnovella subalpina* was found in the basal part of the marly limestone in bed 148 just above sequence boundary Be3 (Le Hégarat, 1973). This change in rock type on either side of the sequence boundary marks the base of the original boundary of the Berriasian (Coquand, 1871, first use of the word Berriasien), which is at the beginning of the admixture of clay in the limestones (Jan du Chêne *et al.,* 1993). The same sequence boundary is also situated between the oolitic limestone beds that overly the semi-continental Purbeck beds in the Jura Mountains near Neuchâtel (Switzerland), which is the Jurassic/Cretaceous boundary defined by Oppel (1865, p. 535). It appears that the sequence boundary, which produces the important turnover of the ammonite fauna at the Jacobi-Subalpina zonal boundary, virtually coincides with the base of reversed polarity chron M17r (Jan du Chêne *et al.,* 1993). However, it is not known how great the lacuna is at the basal unconformity.
In fact, the Berriasian stratotype has been made inadequate as stratotype since the 'Colloque sur la limite Jurassique-Cretacé' lowered the base of the Cretaceous to the base of the Jacobi Zone (1.8 million years earlier) with the consequence that the ammonite fauna of the Jacobi Zone is almost absent in the Berriasian stratotype. Strange, therefore, is the presence of *Pseudosubplanites grandis* in bed 145 of sequence Be2 of the stratotype section, because this species becomes extinct at the end of sequence Be1. Perhaps this specimen could be identified as *Pseudosubplanites crymensis* Bogdanova & Arkadiev, 2005, of which a large specimen, has been depicted by Le Hégarat (1973) on pl. 37, fig. 9 under the name *P. grandis*. The species *P. crymensis* ranges through the entire Jacobi Zone.

2.3.4. The Jurassic/Cretaceous boundary from an ammonitologist's point of view

Hitherto the Jurassic/Cretaceous boundary is defined by ammonites. Since the 'Colloque sur la limite Jurassique-Crétacé (1975)' the base of the Jacobi Zone (in the sense used herein, i.e. the equivalent of the Jacobi/grandis zone of the 'Colloque') is considered the base of the Berriasian, and therefore the base of the Cretaceous. This boundary was used by all ammonite specialists and can easily be recognized by the conspicuous renewal of the ammonite fauna near this boundary.
The important ammonite faunal renewals at the base and the top of the Jacobi zone can be explained by the presence of two major sequence boundaries, Be1 and Be3 respectively. Especially ammonites appear to be sensitive for these major sea level fluctuations. At these boundaries many taxa became extinct and generated in a geologically short time (Hoedemaeker, 1995b, 2013). Tavera *et al.* (1986) determined a "first ammonite renovation" at the boundary between the Lower and Upper Tithonian and a "second ammonite renovation" at the boundary between the Vulgaris and Jacobi zones; both are major sequence boundaries. The latter boundary is the Jurassic/Cretaceous boundary that collected most votes (33 votes) after the 'Colloque sur la limite Jurassique-Crétacé (1975).' The upper boundary of the Jacobi Zone, at the base of the Occitanica Zone, may now be called the "third ammonite renovation." This level was indicated by Oppel (1865, p. 535, base of the full-marine 'Neocomian' in the Neuchâtel area, Switzerland) as the top of the Tithonian Stage, which has been used for 110 years as the Jurassic/Cretaceous boundary until the 'Colloque sur la limite Jurassique-Crétacé' in 1975, where the Vulgaris-Jacobi zonal boundary was voted for. At the lower boundary of the Jacobi Zone, eight new (sub) genera originated among which the author, for practical reasons, includes subgenus *Berriasella* (*Hegaratella*), which already occurs with only one species in the Vulgaris Zone. At this boundary approximately seven genera disappeared (except for a few species that became extinct shortly afterwards). At the upper boundary of the Jacobi Zone at least six new (sub)genera appeared and seven disappeared (except for three species that became extinct shortly afterwards). These two sequence boundaries, which determine the base and the top of the Jacobi Zone, are major sequence boundaries and consequently the Jacobi Zone a depositional sequence of the second order, harbouring two depositional sequences of the third order. The Berriasian genera *Subthurmannia*, *Tirnovella* and *Retowskiceras* appeared within the Jacobi Zone and continued their ranges up to the Occitanica, Boissieri or Pertransiens zones. The Tithonian genera *Himalayites*, *Proniceras*, *Aspidoceras* and *Schaireria* became extinct within this zone; *Pseudosubplanites* is considered to be the last representative of Late Jurassic Ataxioceratidae (Callomon, 1981, followed herein).

In the stratotype of the Berriasian (Jan du Chêne *et al.,* 1993) the unconformity of sequence boundary Be3 virtually coincides with the base of magnetic polarity chron M17r, and, as in the Puerto Escaño section in southern Spain (Pruner *et al.*, 2010) and in the section near Le Chouet (Drôme, France) (Wimbledon *et al.,* 2013), sequence boundary Be1 virtually coincides with the base of polarity chron M19n.2n, the Jacobi Zone virtually covers polarity chrons M19n, M18r and M18n. However, it is not known how great the lacunas are at the base of the Subalpina Subzone in the Berriasian stratotype section and at the top of the Vulgaris Zone in the Puerto Escaño section (Ga 7) and in the Le Chouet section. In section Z the sequence boundaries Be1, Be2 and Be3 are not attended by hiatuses. In Allemann *et al.* (1975), the base of bed Z1 is drawn as a hiatus, but Z1 lies conformable upon the Ammonitico Rosso bed of the Vulgaris Zone without any sign of emersion. The base of bed Z1 probably represents not more than a short period of non-deposition at the start of a forced regression on top of a rather shallow marine swell. According to Ogg *et al.* (2004) the duration of the Lower Berriasian (= Jacobi Zone) is 1.8 million years and the duration of the upper Tithonian is 1.7 million years.

The Jacobi Zone, as it was defined by the Cephalopod Team of the IGCP-Project 262 (Hoedemaeker *et al.,* 1993) and as it is used here, is characterized by a unique and clearly recognizable ammonite fauna, which has, next to the last four Tithonian and the first four genera that continue into the Berriasian Occitanica and Boissieri zones, its own six characteristic genera. This stratigraphic unit has its very own character and represents a well-defined unit in geological history.

As a stratigrapher who honours priority in stratigraphy, the author (Hoedemaeker, 1981, 1982, 1983, 1987, 1995a) has fervently favoured the upper boundary of the Jacobi Zone (major sequence boundary Be3) as the Jurassic/Cretaceous, because it is the oldest (proposed by Oppel, 1865) and consequently has priority, which should be honoured. It has been the reference for indicating the Jurassic/Cretaceous boundary all over the world during 110 years. During these 110 years most J/K boundaries in the world have already more or less been correlated with this boundary, for instance (*vide* Hoedemaeker, 1987, 1999, 2002, 2003) the Volgian/Ryazanian boundary (base Sibericus Zone) in north Siberia (which is also close to the base of polarity zone M17r: Bragin *et al.,* 2013), the top of the *Subcraspedites* beds in England, the 'Mammal bed' in the Purbeck of England [important unconformity close to the base of polarity chron M17r, described as dirt bed (Fischer, 1856; Arkell, 1933; Rayner, 1967; Perkins, 1977) or as dark-grey, carbonaceous shale resting on an irregular surface (Clements, 1993)], the boundary between the Katzberg and Serpulit members in northern Germany, the base of the Formation de Pierre Châtel in Switzerland, the boundary at the top of the *Parodontoceras*-*Substeueroceras* beds in North and South America and the boundary at the top of the *Substeueroceras koeneni* Zone in Argentina.

On the other hand, as a taxonomic ammonitologist, the author considers the appearance near the base of the Jacobi Zone of the family Neocomitidae and the genera *Spiticeras* and *Dalmasiceras*, which continue their ranges into the Berriasian and Valanginian, to be more important than the extinction of Tithonian genera. This was also the reason why Enay & Geyssant (1975) proposed to put the Jurassic/Cretaceous boundary at the base of the 'Jacobi Zone' (*sensu* Le Hégarat, 1973); this proposal was accepted by the attendants of the 'Colloque sur la Limite Jurassique-Crétacé (1975)'. This brought the author to change his earlier ideas and to support the view of Enay & Geyssant (1975). In fact the Neocomitidae already started with one species, *Berriasella* (*Hegaratella*) *tithonica* Tavera, 1985, in the Vulgaris Zone, but the important radiation of new species took place in the lowest part of the Jacobi Zone. It is a great advantage that the base of the Jacobi Zone (as it is used herein) is close to the base of polarity chron M19n (Pruner *et al.,* 2010; Wimbledon *et al.,* 2013).

According to the author (Hoedemaeker, 1987) the lower boundary of the Jacobi Zone would correlate with the boundary between the American *Kossmatia-Durangites* beds and the *Substeueroceras-Parodontoceras* beds, but probably also with the base of the *Substeueroceras koeneni* Zone in Argentina. It also would correlate with the boundary between the English Oppressus and Primitivus zones (Hoedemaeker, 2002, 2003), which designates the top of the Portlandian Stage as defined by d'Orbigny (1842-1851, p. 611). All these boundaries represent the same major sequence boundary Be1. The downward shift of the classical Jurassic/Cretaceous boundary proposed by Oppel (1865) to a nearly two million years older level, was inspired merely on taxonomic grounds.

This downward shift entails that the Jacobi Zone correlates with the English Primitivus, Preplicomphalus and Lamplughi zones, but also with the American *Substeueroceras-Parondontoceras* beds and with the Argentinian *Substeueroceras koeneni* Zone, which all should be included in the Berriasian, i.e. in the Cretaceous. The fact that the base of the Jacobi Zone is close to the base of polarity chron M19n.2n and virtually coincides with sequence boundary Be1, makes this boundary correlatable all over the world.

2.4. List of ammonite species

Berriasella (*Hegaratella*) *chomeracensis* (Toucas, 1890).
Berriasella (*Hegaratella*) *enayi* Le Hégarat, 1973.
Berriasella (*Hegaratella*) *jacobi* Mazenot, 1939.
Berriasella (*Hegaratella*) *kleini* sp. nov.
Berriasella (*Hegaratella*) *oppeli* (Kilian, 1889).
Berriasella (*Hegaratella*) *oxycostata* Mazenot, 1939.

Berriasella (*Hegaratella*) *paramacilenta* Mazenot, 1939.
Berriasella (*Hegaratella*) *subcallisto* (Toucas, 1890).
Berriasella (*Hegaratella*) *taverai* sp. nov.
Berriasella (*Hegaratella*) *vasiceki* sp. nov.
Bochianites cf. *ambiguus* Arkadiev, Rogov & Perminov, 2011.
Bochianites crimensis Arkadiev, 2008.
Bochianites aculeatus sp. nov.
Chapericeras bonti sp. nov.
Chapericeras chaperi (Pictet, 1868).
Dalmasiceras aff. *dalmasi* (Djanélidze, 1921, *non* Pictet).
Delphinella (*Delphinella*) *berthei* (Toucas, 1890).
Delphinella (*Delphinella*) *consanguinea* (Retowski, 1894).
Delphinella (*Delphinella*) *crimensis* (Burckhardt, 1912).
Delphinella (*Delphinella*) *delphinensis* (Kilian, 1889).
Delphinella (*Delphinella*) *janus* (Retowski, 1894).
Delphinella (*Delphinella*) *miravetens is* sp. nov.
Delphinella (*Delphinella*) *obtusenodosa* (Retowski, 1894).
Delphinella (*Delphinella*) *subchaperi* (Retowski, 1894).
Delphinella (*Delphinella*) *tresannensis* Le Hégarat, 1973.
Haploceras carachtheis (m) (Zeuschner, 1846).
Haploceras carachtheis (M) (Zeuschner, 1846).
Himalayites (*Himalayites*) cf. *seideli* (Oppel, 1865).
Himalayites (*Pomeliceras*) *breveti* (Pomel, 1889).
Holcophylloceras silesiacum (Oppel, 1865).
Hypophylloceras serum (Oppel, 1865).
Lytoceras subfimbriatoides sp. nov.
Lytoceras sutile (Oppel, 1865).
Negreliceras proteum (Retowski, 1894).
Neocosmocearas sayni (m) (Simionescu, 1899).
Proniceras debillon (Djanélidze, 1922).
Protancyloceras bicostatum (Arnould-Saget, 1953.
Protancyloceras punicum Arnouls-Saget, 1953.
Protancyloceras acuticostatum Arnould-Saget, 1953.
Protetragonites quadrisulcatus (d'Orbigny, 1841).
Pseudosubplanites berriasensis Le Hégarat, 1973.
Pseudosubplanites combesi Le Hégarat, 1973.
Pseudosubplanites crymensis (Bogdanova & Arkadiev, 2005).
Pseudosubplanites euxinus (Retowski, 1894).
Pseudosubplanites fasciculatus (Bogdanova & Arkadiev, 2005).
Pseudosubplanites grandis (Mazenot, 1973).
Pseudosubplanites hegarati sp. nov.
Pseudosubplanites lorioli (Zittel, 1868). (M + m)
Pseudosubplanites paracombesi sp. nov.
Pseudosubplanites ponticus (Retowski, 1894).
Pseudosubplanites tolloensis sp. nov.
Ptychophylloceras inordinatum (Toucas, 1890).
Ptychophylloceras ptychoicum (Quenstedt, 1845).
Spiticeras cf. *mutabile* Djanélidze, 1922.
Substeueroceras beneckei (Mazenot, 1939).
Substeueroceras broyonense sp. nov.
Substeueroceras cf *koeneni* (Steuer, 1897).
Subthurmannia floquinensis (Le Hégarat, 1973).
Subthurmannia gallica (Mazenot, 1939).
Subthurmannia pseudocarpathica sp. nov.
Tirnovella bogdanovae sp. nov.
Tirnovella companyi sp. nov.
Tirnovella subalpina (Mazenot, 1939).

New Species: only named and diagnosed:
Delphinella (*Delphin.*) *angustiumbilicata* sp. nov.
Delphinella (*Subdelphinella*) subgenus. nov.
Berriasella (*Berriasella*) *multicostata* sp. nov.

Collected and identified by J. Wiedmann (1975):
Chapericeras tarini (Kilian, 1889).
Proniceras praenegreli Djanélidze, 1922

3. BELEMNITES (N. M. M. Janssen)

3.1. Introduction

In outcrops along the Barranco de Tollo, a left bank tributary of the Río Argos, the alternating limestone-marlstone beds of the Jacobi Zone and the Subalpina Subzone are exposed. Directly below Z1, the basal bed of the Jacobi Zone, four fossiliferous nodular calcareous beds are exposed (Tollo Fm., van Veen, 1969, p. 30), herein numbered as Z0, Z-1, Z-2, and Z-3 (Fig. 5). These beds are in Ammonitico Rosso facies and contain ammonites indicating the latest Jurassic Vulgaris Zone and a part of the Transitorius Zone (see paragraph 2.3.1.), and Late Tithonian tintinnids of the *Crassicolaria intermedia* Zone (Allemann *et al.,* 1975, fig. 1). In addition, these beds yielded belemnites known from the latest Tithonian of the Alpine region (Vetters, 1905), Italy (Combémorel & Mariotti, 1986a, b; 1990; Marotti, 1995), and Hungary (Főzy *et al.,* 2011). These investigations contributed to the knowledge of Late Jurassic belemnites, especially of Italy, while Főzy *et al.* (2011) dealed with belemnites from the Late Jurassic of Hungary (Bakony Mts.). The present study will contribute to this knowledge, but still much is unknown of the stratigraphical distribution of the belemnites in these sediments.
It is demonstrated herein that several taxa, previously known only from the Tithonian, occur in sediments of the Jacobi Zone.

3.2. Material of section Z

The sediments directly below Z1, the basal bed of section Z, consist of irregular layers with abundant fossils, in part reworked and fragmented, and with calcareous nodules in a marly matrix. These are sediments of the *Durangites vulgaris* Zone. These sediments yielded *Hibolithes* cf. *fellabrunensis*, "*Pseudobelus*." *fischeri* and *Conobelus siciliensis*.
Above bed Z1, belemnites are not very common. Only

25 specimens of belemnites (Fig. 4) were collected in the lower part of section Z (up to bed Z131). Among these, the *Conobelus* and the *Hibolithes semisulcatus* group appear to be most common (for author affiliation see taxonomical section). This chapter is an addition and a partial revision of previously published belemnite taxa from this section (Janssen, 1997).

From bed Z1 up to bed Z71, the sediments yielded "typical" latest Tithonian species such as *Conobelus conophorus*, *Co. strangulatus*, "*Pseudobelus*." *fischeri*, and *Duvalia apenninica*. Beds Z72 to Z95 yielded *Conobelus*, *Hibolithes*, *Duvalia esba* and *Duvalia* cf. *tithonia*. All these belemnites would previously have indicated a Late Jurassic age.

Bed Z131 yielded a belemnite, which is morphologically comparable to the Early Cretaceous *Duvalia lata*-group. However, this belemnite is not well-enough preserved to give any definite identity. Above bed Z131, belemnites are very rare. Only six specimens were sampled, most resembling *Co. siciliensis*, but they occur in much younger levels, *i.e.* from beds Z152-168 (loose), Z161 and Z202 of the upper part of the Jacobi Zone, and from beds Z226 (2x), and Z232 of the "*Tirnovella*" *subalpina* Subzone. They are provisionally named *Conobelus* sp. (?aff. *siciliensis*).

The taxa recognized in this article belong to two families (Mesohibolitidae and Duvaliidae). The Mesohibolitidae are represented by *Hibolithes* only. The Duvaliidae are slightly more diverse; at least two genera are represented (*Conobelus*, *Duvalia*). Actually, it is still not clear, whether "*Pseudobelus*" *fischeri* belongs to the Duvaliidae, though this is generally assumed. Especially the taxonomical differences between *Produvalia*, certain taxa of the *D. lata*-group, and some *Pseudobelus* Auctorum (belonging to specimens around *Belemnites zeuschneri* Oppel, 1865) are not yet fully understood.

3.3. Taxonomic part

Subclass Coleoidea Bather, 1888
Order Belemnitida Zittel, 1895
Suborder Pachybelemnopseina Riegraf *in* Riegraf *et al.*, 1998
Family Mesohibolitidae Nerodenko, 1983

3.3.1. Genus *Hibolithes* Denys de Montfort, 1808

Type species: *Hibolithes hastatus* Denys de Montfort, 1808

***Hibolithes conradi* Kilian, 1889**
Pl. XXVIII, figs 2-3

1889. *Belemnites* (*Hibolites*) *Conradi* nov. sp. Kilian, p. 635, pl. XXVI, fig. 4.
? 2011. *Hibolithes conradi* (Kilian).– Főzy *et al.,* p. 428, text-figs 7.10-11 (cum syn.).

Material: One specimen from the bed Z72; *B. jacobi* Subzone.
Diagnosis: Rather robust, well-rounded, medium sized hibolitoid with clear alveolar groove.
Remarks: Specimen figured in Főzy *et al.* (2011) is a-typical, and could be a gerontic conobeloid.
Geography: Spain, France, Hungary and Italy.
Stratigraphy: Latest Jurassic - earliest Cretaceous (*P. transitorius* Zone to *B. jacobi* Sz.).

***Hibolithes* cf. *fellabrunnensis* (Vetters, 1905)**
Pl. XXVIII, fig.1

non 1871. *Belemnites Schloenbachi* nov. sp. Neumayr, p. 362 (66), pl. XVIII, figs 3-4 (= *Holcobelus*).
pars? 1886. *Belemnites Schloembachi* [sic!] Neumayr.– Nicolis & Parona, pl. III, fig. 1a.
1905. *Belemnites Fellabrunnensis* n. sp. Vetters, p. 245, text-fig. 1.
2011. *Hibolithes* cf. *fellabrunnensis* (Vetters).– Főzy *et al.*, p. 428, text-fig. 7.7.

Material: One incomplete specimen from bed Z0; *D. vulgaris* Zone.
Diagnosis: Very elongated hibolitoid with very long alveolar groove.
Geography: Spain, Hungary, northern Klippen Belt and (?)Italy.
Stratigraphy: Latest Jurassic (*P. transitorius* or *D. vulgaris* Zone).

group of *Hibolithes semisulcatus* (Münster, 1830)

1830. *Belemnites semisulcatus* Münster, p. 6, pl. 1, figs 1-8, 15.
1873. *Belemnites Orbignyanus* Duval.– Gilliéron, p. 204, pl. VIII, fig. 11.
1875. *Belemnites semisulcatus* (Munster)? var. *minuta* Pillet & Fromentel, p. 39, pl. V, figs 1-2.
2011. *Hibolithes semisulcatus* (Münster).– Főzy *et al.,* p. 428, text-figs 7.1, 2, 18, 19, 22, 23 (cum syn.).

Material: Ten specimens in different states of preservation from beds Z-2, Z12-13, Z30, Z31-37, Z76-78, Z80, Z85 (2x), Z95, Z95-99; *D. vulgaris* Zone to *B. jacobi* Subzone.
Diagnosis: Rather slim to robust hibolitoid species without extreme elongation, short to very long alveolar groove.
Remarks: this group most probably includes some juvenile or neanic specimens of *H. conradi*, the well-rounded *H. semisulcatus* var. *minuta* and/or other hibolitoid species that occur in the Late Jurassic to earliest Cretaceous. They represent the most common group among the investigated specimens.
Geography: Circum Mediterranean Tethys.
Stratigraphy: Latest Oxfordian to earliest Cretaceous (part of the Berriasian).

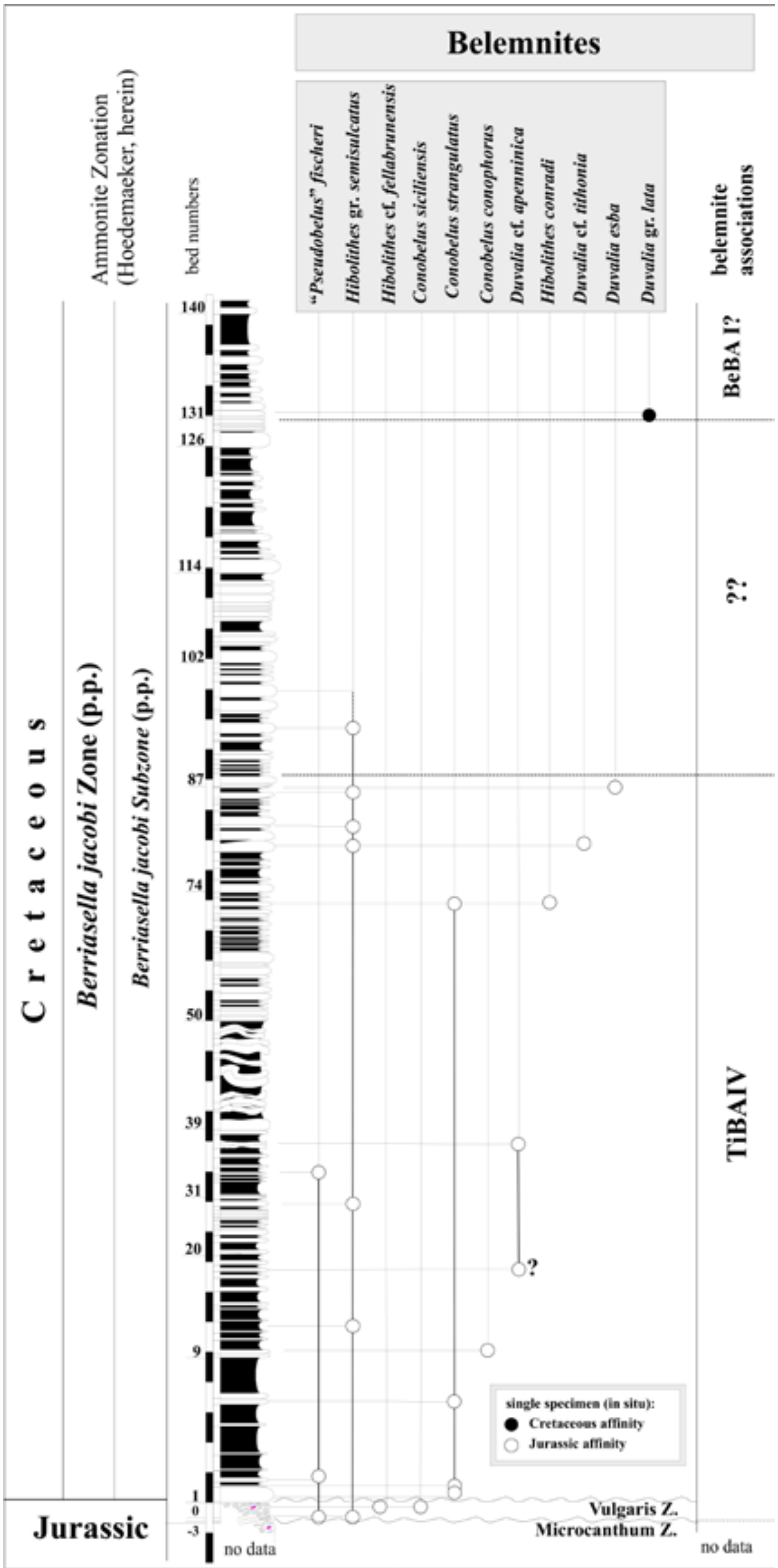


Fig. 4: Occurrences of the belemnite species in the top Transitorius Zone and the Vulgaris Zone directly below the base of section Z, and their ranges in the lower part of section Z (Jacobi Subzone) modified after Hoedemaeker (1985). Note, lithology between the beds Z39 to Z50 are slumped but the beds are not broken. Abbreviations used: TiBAIV = Tithonian Belemnite Association four, BeBAI = Berriasian Belemnite Association one.

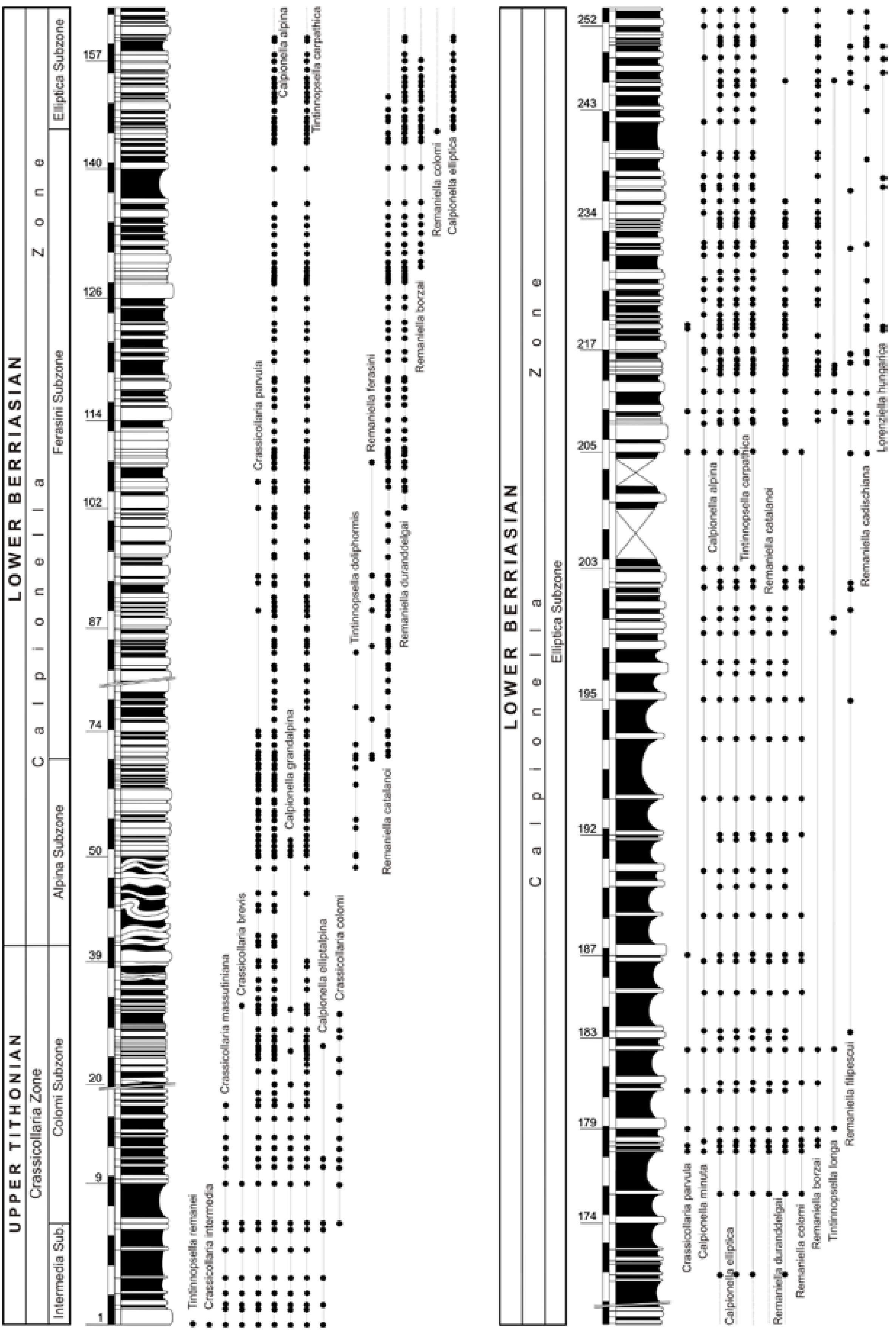


Fig. 5: Ranges of the calpionellid species in section Z and the limits of the calpionellid zone and subzones.

Family Duvaliidae Pavlow, 1914
3.3.2. Genus *Conobelus* Stolley, 1919
Type species: *Belemnites conophorus* Oppel, 1865

***Conobelus conophorus* Oppel, 1865**
Pl. XXVIII, figs 4-5

1865. *Belemnites conophorus* Oppel, p. 546.
1868. *Belemnites conophorus* Oppel.– Zittel, p. 34, pl. 1, figs 1-5.
pars 1870. *Belemnites conophorus* Oppel.– Zittel, p. 26 (not the synonymy).
? 1871. *Belemnites conophorus* Oppel.– Gemmellaro, p. 21, pl. III, figs 10-11 (phragmocone remains).
non 1875. *Belemnites conophorus* (Oppel).– Pillet & Fromentel, p. 64, pl. VIII, fig. 4.
1880. *Belemnites conophorus* Oppel.– Favre, p. 10, pl. I, fig. 1.
1932. *Conobelus conophorus* (Oppel).– Krymgol'ts, p. 42, pl. II, figs 40-41.
1972. *Conobelus gemmelaroi* [sic!] (Zittel).– Stoyanova-Vergilova, p. 145, pl. I, fig. 4.
1986a. *Rhopaloteuthis conophorus* (Oppel).– Combémorel & Mariotti, 306, pl. 1, figs 8-10 (cum syn.).
pars?1990. *Duvalia conica* (Blainville).– Combémorel & Mariotti, p. 210, pl. 1, figs 1-3 (not the synonymy).
1993. *Conobelus* aff. *conophorus* (Oppel).– Stoyanova-Vergilova, p. 95, pl. XLV, fig. 4 (= 1972).
1995. *Rhopaloteuthis conophorus* (Oppel).– Mariotti, p. 232, pl. II, figs 12-13 (= 1986a).
1997. *Rhopaloteuthis conophora* (Oppel).– Janssen, p. 29, pl. 2, figs 1-2 (erroneously indicated as *Rh. conicus*).

Material: One specimen from bed Z10; *B. jacobi* Subzone.
Diagnosis: The rostrumis very robust, short (sub)conical to more elongated and tapering down to the apex. It has a deep alveolus and a clear alveolar canal, and a well-rounded base. Cross sections are round, the apex in central position. The rostrum appears symmetrical from lateral as well as from dorsal view.
Remarks: It appears more robust in comparison to *Co. strangulatus*, more symmetrical with a centrally placed apex, which has a more obtuse aspect.
Geography: Circum Mediterranean Tethys.
Stratigraphy: Latest Jurassic-earliest Cretaceous (*Volanoceras volanense* Z. - *B. jacobi* Sz.).

***Conobelus siciliensis* Combémorel & Mariotti, 1986**
Pl. XXVIII, figs 6-7 (juv.)

? 1890. *Belemnites Orbignyi* Duval-Jouve var. *Jouvei* Toucas, p. 588, pl. XV, fig. 3.
* 1986a. *Rhopaloteuthis siciliensis* nov. sp. Combémorel & Mariotti, p. 308, pl. 1, fig. 11 (cum syn.).
1990. *Rhopaloteuthis siciliensis* (Combémorel & Mariotti).– Combémorel & Mariotti, p. 211, pl. 1, figs 8-10.
1995. *Rhopaloteuthis siciliensis* Combémorel & Mariotti.– Mariotti, p. 233, pl. II, fig. 7 (= 1986a).
non 1997. *Rhopaloteuthis siciliensis* Combémorel & Mariotti.– Janssen, p. 30, pl. 3, figs 1-2.

Material: One specimen from bed Z0; *D. vulgaris* Zone.
Diagnosis: Small to medium-sized conobeloid rostrum, with a faint but marked alveolar groove, although less pronounced than in the *Co. strangulates – conophorus* group, and a sub-conical to club-shaped outline and profile. Cross sections round. Apex orientated to the dorsal side.
Geography: Italy, Switzerland, France and Spain.
Stratigraphy: Latest Jurassic (*Volanoceras volanense – D. vulgaris* zones).

***Conobelus strangulatus* (Oppel, 1865)**

1865. *Belemnites strangulatus* Oppel, p. 545.
1868. *Belemnites strangulatus* Oppel.– Zittel, p. 35, pl. 1, figs 6, 7 (juv.).
1880. *Belemnites strangulatus* Oppel.– Favre, p. 12, pl. I, figs 3-5.
1890. *Belemnites Orbignyi* Duval-Jouve.– Toucas, p. 587, pl. XV, fig. 1.
? 1890. *Belemnites Orbignyi* Duval-Jouve var. *suborbignyi* Toucas, p. 588, pl. XV, fig. 2.
? 1932. *Belemnites strangulatus* Oppel.– Cohen, p. 44, pl. V, fig. 31.
1932. *Conobelus strangulatus* Oppel.– Krymgol'ts, p. 43.
1932. *Conobelus stangulatus* [sic!] Oppel.– Krymgol'ts, pl. II, figs 42-44.
1942. *Conobelus strangulatus* Oppel.– Mandev, p. 51, pl. III, figs 3-4.
1972. *Conobelus strangulatus* (Oppel).– Stoyanova-Vergilova, p. 144, pl. I, figs 5 (= Mandev, 1942), 6.
non 1976. *Conobelus strangulatus* (Oppel).– Patrulius & Avram, pl. X, fig. 22 (= *Bb*. gr. *conicus* Blainville).
1986a. *Rhopaloteuthis strangulatus* (Oppel).– Combémorel & Mariotti, pl. 1, figs 12-15 (pars cum syn.).
1997. *Rhopaloteuthis strangulatus* (Oppel).– Combémorel, pl. 28, fig. 13 (cast of HT).
non 1997. *Rhopaloteuthis strangulata* (Oppel).– Janssen, p. 5, 31.
non? 1997. *Rhopaloteuthis strangulata* (Oppel).– Janssen, pl. 3, figs 3-4.
non 1997. *Rhopaloteuthis strangulata* (Oppel).– Janssen, pl. 3, figs 5-6 (=? *Conobelus incertus* Weiss, 1991).
? 2011. *Conobelus strangulatus* (Oppel).– Főzy *et al.*, p. 429, figs 7.3-4.

Material: Four specimens from beds Z1, Z2, Z7, Z72(cf.); *D. vulgaris* Zone and *B. jacobi* Subzone.
Diagnosis: Resembling *Co. conophorus*, but less robust, and with dorsally placed apex.
Remarks: The Hungarian species appear to be pre-dating the "normal" range of this taxon.
Geography: Circum Mediterranean Tethys.

Stratigraphy: Latest Jurassic (*V. volanense* Zone) to earliest Early Berriasian (*B. jacobi* Sz.).

***Conobelus* aff. *siciliensis* Combémorel & Mariotti, 1986**
Pl. XXVIII, figs 8-9

1997. *Rhopaloteuthis siciliensis* Combémorel & Mariotti.– Janssen, p. 30, pl. 3, figs 1-2.

Material: Six neanic(?) specimens from beds Z152-168, Z161, Z202, Z226 (2x), Z232 in the upper part of the *Berriasella jacobi* Zone and in the "*Tirnovella*" *subalpina* Zone.
Diagnosis: Comparable to *Co. siciliensis*, but differs by a less club-shaped appearance, because the widest section is more posteriorly, and by a more faintly alveolar groove.
Remarks: If all the specimens are indeed neanic, separation from *Co. siciliensis* might be superfluous, because the ontogenetic development of the latter taxon is unknown. Moreover, the stratigraphic range is obviously different. *Co. incertus* Weiss, 1991 differs by a dorso-ventrally compressed cross sections and a different stratigraphic range, whereas *Co. beneckei* (Neumayr) *sensu* Weiss, 1991 has a dorso-ventrally compressed cross section and a different stratigraphic range. *Co. beneckei* (Neumayr) *sensu* Weiss, 1991, is dorso-ventrally compressed in the apical region, but occurs in the same stratigraphic levels.
Geography: Spain.
Stratigraphy: Late Early Berriasian to earliest Middle Berriasian; whether it occurs in younger stratigraphical levels is hitherto unknown.

3.3.3. Genus *Duvalia* Bayle, 1878
Type species: *Belemnites dilatatus* Blainville, 1827

***Duvalia* cf. *apenninica* Combémorel & Mariotti, 1986**
Pl. XXVIII, figs 15-16, 17-18 (×2)

* 1986a. *Duvalia apenninica* nov. sp. Combémorel & Mariotti, p. 305, pl. 1, figs 5-7.
1995. *Duvalia apenninica* Combémorel & Mariotti.– Mariotti, p. 231, pl. II, fig. 9.
1997. *Duvalia* cf. *apenninica* Combémorel & Mariotti.– Janssen, p. 15, pl. 2, figs 3-4.

Material: One (from bed Z18) and two possible (juvenile to neanic) specimens (from beds Z35-37 and Z37); *B. jacobi* Subzone.
Diagnosis: Small to medium-sized rostrum, laterally well-compressed, with medium long, clear but faint, alveolar groove, and a shallow, centrally placed alveolus. Outline hastate, profile with an almost straight dorsal side and a typical duvaliid curvation of the ventral side with the widest point in the apical part. Apex laterally flattened, pointed, placed to the dorsal side. Lateral depressions present, especially well-visible in the apical part.
Geography: Italy and Spain.
Stratigraphy: Latest Jurassic (*V. volanense* Zone) to earliest Early Berriasian (*B. jacobi* Sz.).

***Duvalia* cf. *esba* (Gregorio, 1885)**
Pl. XXVIII, figs 19-20

1885. *Belemnites esbus* Gregorio, p. 242.
1886. *Belemnites esbus* de Gregorio.– Gregorio, p. 4, pl. 1, figs 12a-b, 12c.
1997. *Duvalia* sp. nov? indet.– Janssen, p. 26, pl. 2, figs 5-6.
2011. *Duvalia* cf. *esba* (de Gregorio).– Főzy *et al.,* p. 430, figs 7.20-21 (cum syn.).

Material: One loose specimen from beds Z85-87; *B. jacobi* Subzone.
Diagnosis: Small to medium-sized rostrum, laterally well-compressed, with apparently a very short alveolar groove (not observed so far). Outline hastate, profile with an only slightly curved dorsal and a strongly curved ventral side; widest point in apical part. The apical-most part seems rounded, slightly flattened with rounded to pointed apex.
Remarks: Specimen depicted by Gregorio (1886) is reminiscent of *D. apenninica*, but apparently differs from it by the near absence of an alveolar groove and the stronger curvation of the ventral side. Apex apparently less flattened in comparison to *D. apenninica*. Currently an enigmatic but typical duvaliid.
Geography: Italy, Spain and Hungary.
Stratigraphy: Latest Jurassic (*M. microcanthum*) - earliest Cretaceous (early *B. jacobi* Sz.).

***Duvalia* aff. *lata* (Blainville, 1827)**
Pl. XXVIII, figs 21-22

pars 1997. *Duvalia lata* (Blainville).– Janssen, p. 5, 22.

Material: One specimen from bed Z131; *B. jacobi* Subzone.
Diagnosis: Medium sized, rather robust rostrum with long alveolar groove. Profile well compressed, outline apparently more markedly parallel except for the apical part.
Remarks: It apparently differs from taxa of the "*Duvalia*" *ensifera*-group by the more robust look (but this might be a result of its more mature status), a longer groove, and the younger stratigraphical occurrence. Otherwise, the lateral compression and the apparently shallow alveolus are shared characteristics. If it belongs to a species that is related to *D. lata*, it would be the first belemnite that would, as a matter of speech, "typically" indicate the presence of Early Cretaceous sediments.
Geography: Spain, France (from conglomerate of Chomérac).
Stratigraphy: Earliest Cretaceous (higher part of the *B. jacobi* Subzone).

Duvalia cf. _tithonia_ (Oppel, 1865)
Pl. XXVIII, figs 10-12

1865. *Belemnites tithonius* Oppel, p. 545
1868. *Belemnites tithonius* Oppel.– Zittel, p. 37, pl. I, figs 12-13.
pars 1870. *Belemnites tithonius* Oppel.– Zittel, p. 29, pl. I (25), fig. 6; non fig. 7.
1986b. *Duvalia tithonica* (Oppel) emend. Zittel.– Combémorel & Mariotti, p. 36, text-fig. 2 (cum syn.)
2011. *Duvalia tithonia* (Oppel).– Főzy *et al.,* p. 430 (cum syn.).

Material: One incomplete neanic specimen, loose from the beds Z76-78; *B. jacobi* Subzone.
Diagnosis: Duvalliid rostrum characterized by both a dorsal and a ventral depression (excavated), giving way to a typical cross-section (*fide* Combémorel & Mariotti, 1986b, text-fig. 2e).
Geography: Circum Mediterranean Tethys.
Stratigraphy: Latest Jurassic (*M. microcanthum*) - earliest Berriasian (*B. jacobi* Sz.).

3.3.4. Genus *Pseudobelus* Auctorum (*non* Blainville, 1827)

"_Pseudobelus_" _fischeri_ Combémorel & Mariotti, 1990
Pl. XXVIII, figs 13-14

pars? 1880. *Belemnites Datensis* nov. sp. Favre, p. 16, pl. I, figs 8-11 (?), non fig. 7 ("typical").
? 1894. *Belemnites* cfr. *datensis* Favre.– Retowski, p. 220, pl. XIV, figs 2a-c.
pars? 1986a. *Pseudobelus datensis* (Favre).– Combémorel & Mariotti, pl. II, fig. 9 (?), non figs 7-8.
1990. *Pseudobelus fischeri* n. sp. Combémorel & Mariotti, p. 212, pl. 2, figs 1-4.
? 1994. *Pseudobelus* cf. *giziltschaensis* Ali-Zade.– Vašíček *et al.,* pl. 29, figs 3-4 (see Eliáš *et al.,* 1996, p. 267 from Alpina Zone).
non 1995. *Pseudobelus datensis* (Favre).– Mariotti, p. 234, pl. II, fig. 8, pl. III, figs 5-6.
non 1996. *Pseudobelus giziltschaensis* Ali-Zade.– Eliáš *et al.,* p. 267, pl. IV, figs 10-11 (from calpionellid *Remaniella* spp. Zone = *Remaniella ferasini* Subzone).
2003. *Pseudobelus fischeri* Combémorel & Mariotti.– Janssen, p. 130.
2003. *Pseudobelus*? *fischeri* Combémorel & Mariotti.– Janssen, p. 160.

Material: Three specimens from beds Z-2, Z3, Z34; *P. vulgaris* Zone to early part of the *B. jacobi* Subzone.
Diagnosis: Small to very small, hastate specimens with clear lateral incisions. Cross sections are round or show slight lateral compression. Both, the morphology of the alveolar groove and the alveolus are unknown.
Remarks: The specimens are comparable to "*Pseudobelus*" *datensis*, some of species identified as "*P.*" *datensis* could possibly be "*P.*" *fischeri* or the reverse. "*P.*" *datensis* is known from Switzerland and Ukraine (Crimea). Typical "*Pb*." *datensis* shows a well-marked alveolar groove, and is conobeloid or *ensifera*-like. The specimens figured from Italy [Combémorel & Mariotti, 1986a (pars); Mariotti, 1995] are typically conobeloid. "*Pb*." *fischeri* abundantly occurs in condensed latest Jurassic sediments of the Tornajo Mt. (Spain – see Janssen, 2003, p. 130).
Stratigraphy: Latest Jurassic – earliest Cretaceous (earliest *B. jacobi* Subzone.).
Geography: Italy, France, Spain and probably Czech Republic, Switzerland and Ukraine (Crimea).

3.4. Conclusions

The sediments that straddle the base of the Jacobi Zone in section Z along the Barranco de Tollo (Río Argos, Spain) yielded relative few belemnites among which Mesohibolitidae and *Conobelus* (Duvaliidae) are the most abundant. Most species are probably neanic, except for some of the Mesohibolitidae. Especially the latest Jurassic (*D. vulgaris* Zone) and the earliest Cretaceous rocks (lower part of the *Berriasella jacobi* Subzone) yielded quite a diversified belemnite assemblage with taxa that in general would indicate the Late Jurassic. Several of these belemnites were already described and figured in Janssen (1997), but subsequent collecting in September 1999 resulted in a more diverse assemblage. A partly comparable assemblage was mentioned by Eliáš *et al.* (1996) from the *Berriasella jacobi* Subzone of the Czech Republic.
In bed Z131 a specimen occurs that closely resembles *D. lata*. This could possibly be the first indication of "typical" Early Cretaceous belemnites in the sediments investigated. Unfortunately, belemnites were rarely encountered in the higher part of the Jacobi Zone. The few specimens that were sampled in these sediments and in the earliest part of the Middle Berriasian (the beds Z161 to Z232), are all neanic conobeloids, which are closely reminiscent of *Co. siciliensis* (herein referred to as *Conobelus* aff. *siciliensis*).
Based on the distribution of belemnites, the oldest sediments investigated still yielded taxa that otherwise would indicate a Tithonian Age. Only above the beds Z88-Z131, an interval without indicative belemnites, a "typical" Cretaceous belemnite taxon occurs. Based on this distribution, the Jurassic/Cretaceous boundary would biostratigraphically, based on the available belemnite material, be situated within this barren interval between the beds Z88 and Z131.

3.5. List of belemnite species

Conobelus conophorus Oppel, 1865.
Conobelus siciliensis Combemorel & Mariotti, 1986.

Conobelus sp. (?aff. *siciliensis* Combemorel & Mariotti, 1986).
Conobelus strangulatus (Oppel, 1865).
Duvalia cf.*appenninica* Combemorel & Mariotti, 1986.
Duvalia cf. *esba* (Gregorio, 1885).
Duvalia aff. *lata* (Blainville, 1827).
Duvalia cf. *tithonia* (Oppel, 1865).
Hibolithes conradi Kilian, 1889.
Hibolithes cf. *fellabrunnensis* (Vetters, 1905).
Hibolithes gr. *semisulcatus* (Münster, 1830).
"Pseudobelus" fischeri Combemorel & Mariotti, 1986.

4. CALPIONELLIDS AND CALCAREOUS DINOFLAGELLATES

(D. Reháková and M. Jamrichová)

4.1. Introduction

The bed-by-bed sampled section Z provided well-supported evidence about facies and calpionellid distribution. The calpionellids and calcareous dinoflagellates were studied under a light microscope in 253 thin sections. Allochems and micrite have been evaluated under an optical microscope (LEICA DM 2500). The succession of calpionellid species obtained has been applied in a graphic form. Microfossil markers and microfacies were documented using a LEICA DFC 290 HD camera. The changes observed in the distribution of calpionellids and dinoflagellates in the microfacies, were studied in detail in order to correlate them with the ammonites and nannofossil associations. The thin sections are stored in the collections of the Department of Geology and Palaeontology (Faculty of Natural Sciences) in Bratislava.

4.2. Microfacies analysis and calpionellid biostratigraphy of section Z

The succession studied is composed of limestone beds separated by marlstone beds. The limestones normally consist of biomicrite (mudstones to wackestones). However, in the lower part of the section, limestones consisting of biopelmicrite and biopelmicrosparite (packstones) are intercalated. The calpionellids, radiolarians, saccocomids and residual biodetrital fragments were quantitatively evaluated using the optical charts of Baccelle & Bosellini (1965). Only the limestone beds were sampled.

In the studied samples the calpionellids are generally well-preserved; in beds rich in clayey admixture the loricas are slightly deformed, compressed and locally thinner, and their collars could hardly be recognized. Hyaline forms dominate. The calpionellid biostratigraphical scale (standard calpionellid zones and subzones) as proposed by Remane *et al.* (1986) and Reháková & Michalík (1997), and the calcareous dinoflagellate succession *sensu* Reháková (2000a) were used. Two calpionellid zones were recognized; the Crassicollaria Zone with the Intermedia and Colomi subzones, and the Calpionella Zone with the Alpina, Ferasini and Elliptica subzones.

4.2.1. Crassicollaria Zone, Intermedia Subzone

(*sensu* Remane *et al.,* 1986), (beds Z1-Z7).

The succession studied starts with a thick limestone bed consisting of *Saccocoma* packstone (bed Z1) in which fragments of the planktonic crinoid *Saccocoma* sp. dominate over the calpionellids. From this bed were identified *Crassicollaria intermedia*, *Crassicollaria massutiniana, Crassicollaria parvula*, *Crassicollaria brevis*, *Calpionella alpina*, *Calpionella grandalpina, Calpionella elliptalpina, Tintinnopsella remanei, Tintinnopsella Carpathica*. They are accompanied by less frequent fragments of foraminifers, (*Lenticulina* sp., and agglutinated foraminifers), bivalves, crinoids, echinoid spines, ophiuroids. The bioclasts, mainly saccocomids, are locally silicified.

Remarks: Generally, *Saccocoma* sp. created huge accumulations during Kimmeridgian and Early Tithonian, but decrease in abundance during the Late Tithonian; *Saccocoma* has never been recorded to cross the Jurassic/Cretaceous boundary (Borza, 1984). The sudden accumulation of saccocomids within Late Tithonian micritic *Crassicollaria* limestones are an indication of a more agitated water-body regime transporting not only coeval sediments, but older sediments were also recorded. Similar accumulations were also recorded within the Jurassic/Cretaceous boundary interval by Olóriz *et al.* (1995) and recently by Grabowski *et al.* (2010a), Michalík & Reháková (2011), Reháková *et al.* (2011) and finally by Wimbledon *et al.* (2013). The latter authors explained that similar rich accumulations of intraclasts, saccocomids, crinoids, pellets and ooids observed in the section of Le Chouet were transported and resedimented in discrete pulses, probably owing to synsedimentary erosion and/or eustatic fluctuations.

The overlying limestone beds (Z2 – Z7) consist of bioturbated biomicrites (wackestones) of calpionellid-globochaete microfacies and of biopelmicrites (wackestones) of calpionellid-globochaete microfacies. They contain abundant *Globochaete alpina* and the following calpionellid species: *Crassicollaria parvula*, *Crassicollaria massutiniana, Crassicollaria brevis*, *Calpionella alpina*, *Calpionella grandalpina*, *Calpionella elliptalpina, Tintinnopsella carpathica.* The following calcareous dinocysts were recognized: *Colomisphaera lapidosa*, *Cadosina semiradiata fusca, Cadosina semiradiata semiradiata,* and *Colomisphaera carpathica*). These are accompanied by less frequent radiolarians, fragments of *Saccocoma* sp., foraminifers such as *Lenticulina* sp. and *Spirillina* sp., bivalves, crinoids, echinoid spines, ophiuroids, and aptychi. A few bioclasts are phosphatized, the tests of radiolaria are locally recrystalized (preserved like ghosts). Silt-sized quartz grains are very rarely present, and there are scattered occurrences of pyrite and Fe-hydroxides, locally accumulated in nests.

4.2.2. Crassicollaria Zone, Colomi Subzone

(*sensu* Reháková & Michalík, 1997), (beds Z8-Z39).

The beds in this subzone consists of biomicrite limestones (wackestones to packstones) of calpionellid-globochaete, calpionellid-radiolarian-globochaete or calpionellid-globochaete-radiolarian microfacies.

In general they contain frequent *Crassicollaria parvula,* but less common *Crassicollaria massutiniana, Crassicollaria brevis*, *Crassicollaria colomi*, *Calpionella alpina*, *Calpionella grandalpina*, *Calpionella elliptalpina*, *Tintinopsella carpathica.* These beds also contain infrequent dinocysts: *Cadosina semiradiata fusca*, *Colomisphaera lapidosa, Colomisphaera carpathica*, *Stomiosphaera proxima*. These beds in addition contain globochaetes, calcified radiolarians, ophiuroids, crinoids, echinoids, fragments of planktonic *Sacccoma* sp., bivalves, ostracods, aptychi, rhyncholites, *Laevaptychus* sp. and the foraminifers *Lenticulina* sp., *Spirilina* sp., *Dentalina* sp., *Textularia* sp. and *Gaudryina* sp.

From bed Z17 upward calpionellids slowly decrease in abundance, some of the crassicollarians have thin and aberrant loricas. From bed Z31 onward crassicollarians become less abundant and are mainly represented by *Crassicollaria parvula*. Some beds contain smooth laminae rich in biofragments. The bioclasts are locally phosphatized or silicified; the siliciclastic fraction is represented by rare silt-sized quartz grains; pyrite (also framboidal) and Fe-hydroxides are scattered in the matrix, only locally accumulated in nests.

Remarks: The presence of *Calpionella grandalpina* and *Calpionella elliptalpina* so high in the Colomi Subzone and in the lower most interval of the Alpina Subzone is an indication of synsedimentary erosion and reworking.

4.2.3. Calpionella Zone, Alpina Subzone

(*sensu* Remane *et al.,* 1986; Reháková & Michalík 1997; Lakova *et al.* 1999; Boughdiri *et al.,* 2006; Andreini *et al.,* 2007; Wimbledon *et al.,* 2013) – (beds Z40-Z68).

The limestone beds in this subzone consist of slightly bioturbated biomicrites (predominantly wackestones), rarely biopelmicrites (wackestones to mudstones) in which the ratio of calpionellids, globochaetes and radiolarians determines the type of microfacies (calpionellid-globochaete, calpionellid-globochaete-radiolarian, calpionellid-radiolarian-globochaete). The Crassicollaria/Calpionella zonal boundary is situated in sample Z40. Overlying samples contain predominantly *Globochaete alpina* and sphaerical forms of *Calpionella alpina* with rare *Crassicollaria parvula,* and rare *Calpionella grandalpina*, *Tintinopsella carpathica, Tintinopsella doliformis*. In addition they rarely contain the following calcareous dinocysts: *Colomisphaera lapidosa, Colomisphaera carpathica*, *Stomiosphaera proxima, Cadosina semiradiata fusca*, *Cadosina semiradiata semiradiata*. The micritic matrix contains a small portion of calcified radiolarians, sponges, filaments, bivalves, brachiopods, and infrequent fragments of echinoids, crinoids, ostracods, aptychi (*Laevatpychus* sp.), rhyncholites, and the foraminifers (*Lenticulina* sp. and *Spirilina* sp. were identified); agglutinated foraminifers also are present.

A rapid decrease in calpionellid abundance was observed in bed 50, where they represent only 1% of the bioclasts (calculated *sensu* Bacelle & Bosellini, 1965) within a nannofossil mudstone with a rich admixture of regularly distributed siliciclasts. The beds contain locally laminae rich in bioclasts among which *Saccocoma* sp. was recorded (beds Z58, Z60) and many thin and deformed crassicollarian loricas. Locally these enriched laminae exhibit a weak gradation, and locally are rich in siliclastics. These laminae are indications that erosion and resedimentation occurred. From bed Z65 onwards the amount of crassicollarians rapidly diminishes while tintinopsellid loricas become more frequent.

Siliciclasts are represented by rare silt-sized quartz grains, muscovite flakes and glauconite grains. Bioclasts mainly consist of radiolarians and sponges, which are locally silicified; some of the clasts are phosphatized. The matrix is penetrated by smooth stylolites impregnated by Fe-oxides/hydroxides; locally greater accumulations of pyrite are present.

4.2.4. Calpionella Zone, Ferasini Subzone

(*sensu* Remane *et al.,* 1986) – (beds Z69-Z143).

The limestone beds consist of biomicrites (predominantly wackestones), which are locally slightly bioturbated. They have a calpionellid-radiolarian-globochaete, calpionellid-globochaete-radiolarian or radiolarian-calpionellid microfacies. The bioclasts consist of globochaetes, calcified radiolarians, ostracods, aptychi, bivalves, echinoderms, *Lenticulina* sp., *Spirillina* sp.; locally frequent bigger fragments of crinoid columnals and thick-walled bivalves occur. Within the calpionellid association *Calpionella alpina* dominates over less frequent *Remaniella ferasini, Remaniella catalanoi, Remaniella durandelgai, Remaniella borzai, Tintinopsella carpathica, Tintinopsella doliphormis, Crassicollaria parvula,* and calcareous dinocysts of *Colomisphaera lapidosa*, *Stomiosphaerina proxima, Colomisphaera carpathica, Cadosina semiradiata fusca, Cadosina semiradiata semiradiata*.

From bed Z75 onward, tintinopsellid loricas, and from bed Z91 onward remaniellid loricas increase slowly in abundance. From bed Z132 remaniellid loricas are common to frequent. From bed Z97 onward first loricas morphologically resembling *Calpionella elliptica* (Plate XXIV) appear in thin-sections; these forms also increase in abundance towards the end of the Ferasini Subzone. Beds rich in organic matter contain loricas rimmed by black borders; the samples still contain thin-walled and deformed calpionellid loricas.

Within the Ferasini Subzone some beds contain a siliciclastic admixture of silt-sized quartz grains and muscovite flakes, in some beds smooth laminae rich in bioclastic fragments (locally graded) were encountered. Pyrite occurs scattered in the matrix; some beds also contain framboidal pyrite, or pyrite accumulations in nests. Pyrite locally impregnated bioclasts, mainly radiolarians. In addition a few rare phosphatized bioclasts were recorded.

4.2.5. Calpionella Zone, Elliptica Subzone

(*sensu* Pop, 1974) – (beds Z144-Z253).

The limestone beds consist of biomicrite (wackestones), locally bioturbated, of calpionella-globochaete and radiolarian-calpionella-globochaete microfacies. They contain loricas of *Calpionella elliptica*, the index species of this subzone. Calpionellids show a higher morphological diversification. The associations are composed of *Calpionella alpina, Calpionella elliptica* (this species becomes more abundant from bed Z158 upward), *Calpionella minuta, Tintinopsella carpathica, Tintinnopsella longa, Lorenziella hungarica,* and frequent remaniellids such as *Remaniella catalanoi, Remaniella ferasini, Remaniella duranddelgay, Remaniella borzai, Remaniella colomi*; from bed Z184 onward *Remaniella filipescui*, and from bed Z205 onward *Remaniella cadischiana*. The first appearance of *Lorenziella hungarica* was recorded in bed Z219. *Calpionella alpina* start to decrease in abundance in bed Z214, more rapidly from bed Z226 onward.

Calcareous dinocysts are represented by *Colomisphaera lapidosa, Colomisphaera carpathica, Cadosina semiradiata semiradiata, Cadosina semiradiata fusca*, and from bed Z192 onward *Stomiosphaera wanneri, Cadosina semiradiata cieszynica, Colomisphaera heliosphaera, Colomisphaera conferta* were present. The latter three species were not documented in the Elliptica Subzone before now (Reháková 2000).

The matrix in addition contains globocheates, calcified radiolarians, sponges, rare fragments of ostracods, bivalves, crinoids, echinoids, aptychi and fragments of rhyncholites. Siliciclastics start to become much frequent from bed Z250 upward. The matrix is locally penetrated by calcite veins. In some beds a smooth lamination was observed. The laminae are generally much richer in bioclasts than the matrix. Pyrite occurs scattered in the matrix, but locally gathers in huge accumulations or nests, or impregnates bioclasts. Rare phosphatized grains were also observed. Most of calpionellid loricas are broken or deformed.

4.3. Discussion and conclusions

The high-resolution analysis of calpionellids and calcareous dinoflagellates in section Z can be used to perform precise long-distant correlations within the Jurassic/Cretaceous boundary interval.

Two calpionellid zones have been recognised in section Z along the Barranco de Tollo. The species identified belong to Crassicollaria and Calpionella Zones and to all five subzones of these Zones, viz. the Intermedia, Colomi, Alpina, Ferasini and Elliptica subzones. The presence of levels with abundant *Saccocoma* sp. in the lowermost part of the section, are the result of erosion and reworking through which mixed crassicolarian associations and huge accumulations of chaotically oriented saccocomids were deposited in the same manner as was recently reported from the Le Chouet section (SE France, Wimbledon *et al.,* 2013). Similar deposits are present in the Puerto Escaño section (Ga 7) in the Gaena-Carcabuey area (Province of Cordoba, Spain), but these deposits were not reported by Pruner *et al.* (2010).

The approximate Jurassic/Cretaceous boundary, the onset of the Alpina Subzone of the standard Calpionella Zone, was situated in sample Z40. In this bed, medium-sized sphaerical forms of *Calpionella alpina* (accompanied by rare *Crassicollaria parvula*) and globochaetes dominate in the biomicrite limestone. The upper Tithonian burst of calpionellids, their diversification and the decreasing of crassicollarians later, in the same manner as was described by Reháková in Michalík *et al.* (2009), was recorded in section Z, and the onset of the bloom of monospecific *Calpionella alpina*, generally accepted as the indicator for the Jurassic/Cretaceous boundary, was determined and documented (Pl. XXI, fig. A)

The base of the Alpina Zone corresponds with the J/K boundary favoured by Remane *et al.* (1986), and later by Altiner & Özkan (1991), Pop (1994), Reháková (1995, 2000b), Lakova *et al.* (1999), Ivanova *et al.* (2002), Grabowski & Pszczółkowski (2006), Boughdiri *et al.* (2006), Houša *et al.* (2004), Andreini *et al.* (2007), Azimi *et al.* (2008), Michalík *et al.* (2009), Grabowski *et al.* (2010), Pruner *et al.* (2010), Benzaggagh *et al.* (2010) and Lukeneder *et al.* (2010).

Reháková (in Wimbledon *et al.,* 2013) compares the J/K boundary intervals of several key sites as to their microfacies and their calpionellid associations and distributions. It appears that this interval in Section Z along the Barranco de Tollo resembles those known from the Puerto Escaño section (Pruner *et al.,* 2010) and from the Le Chouet section (Drôme, SE France).

4.4. List of calpionellid species and calcareous dinocyst species

Crassicollaria intermedia (Durand Delga, 1957).
Crassicollaria massutiniana (Colom, 1948).
Crassicollaria brevis Remane, 1962.
Crassicollaria parvula Remane, 1962.
Crassicollaria colomi Doben, 1963.
Calpionella alpina Lorenz, 1902.
Calpionella grandalpina Nagy, 1986.
Calpionella elliptalpina Nagy, 1986.
Calpionella elliptica Cadisch, 1932.
Calpionella minuta Houša, 1990.
Tintinnopsella carpathica (Murgeanu & Filipescu, 1933).
Tintinopsella doliphormis (Colom, 1939).
Tintinnopsella longa (Colom, 1939).
Remaniella ferasini (Catalano, 1965).
Remaniella catalanoi Pop, 1996.
Remaniella durandelgai Pop, 1996.
Remaniella colomi Pop, 1996.
Remaniella borzai Pop, 1996.
Remaniella filipescui Pop, 1996.
Remaniella cadischiana Pop, 1996.
Lorenziella hungarica Knauer & Nagy, 1964.
Cadosina semiradiata fusca (Wanner, 1940)
Cadosina semiradiata semiradiata (Wanner, 1940).
Cadosina semiradiata cieszynica (Nowak, 1966).
Colomisphaera lapidosa (Vogler)
Stomiosphaerina proxima Řehánek, 1987.
Colomisphaera carpathica (Borza, 1964).
Colomisphaera conferta Řehánek, 1985.
Colomisphaera heliosphaera (Vogler, 1941).
Stomiosphaera wanneri Borza, 1969.

5. CALCAREOUS NANNOFOSSILS
(C. E. Casellato and S. Gardin)

5.1. Introduction & Material and Methods

The Tithonian and the Jurassic/Cretaceous boundary are characterized by a main speciation event among calcareous nannofossils: several new genera and species appeared and rapidly evolved, especially at low latitudes (Perch-Nielsel, 1985; Bralower *et al.,* 1989; Roth, 1989; Casellato, 2010). Calcareous nannofossil biostratigraphy across this time interval is well constrained in both Tethyan (Bralower *et al.,* 1989; Casellato, 2010) and Boreal (Bown *et al.,* 1988; Bown & Cooper, 1998) realms, although the two schemes are not fully correlatable due to distinctive latitudinal differences which promoted calcareous nannofossil provincialism (Roth, 1983; Roth, 1986; Cooper, 1989; Mutterlose, 1992; Mutterlose & Kessels, 2000; Street & Bown, 2000).
In the last five years the Berriasian Working Group of the International Commission on Stratigraphy has collected and shared new integrated stratigraphic data across the Jurassic/Cretaceous boundary and has proposed a few bio-horizons which can be useful to locate the boundary at least at low latitudes (Wimbledon *et al.,* 2011).
In this account, the authors contribute to the integrated stratigraphic dataset across the Jurassic/Cretaceous boundary, refining the calcareous nannofossil bio-stratigraphy of the historical section Z along the Barranco de Tollo.
A total of 56 samples for calcareous nannofossil biostratigraphic investigation were examined. Bio-stratigraphic analyses were performed on simple smear slides processed without centrifuging, ultrasonic cleaning or settling of the sediment. Small chips of rock samples were gently crushed in distilled water, and the suspension was let sediment onto a cover slip and mounted onto a microscope slide with Norland Optical Adhesive. The smear slides were then inspected using a light polarizing microscope, at 1250x and/or 1500x magnification. The succession of bio-horizons recognized at Z section is reported in Fig. 6, and the range chart with the distribution of observed calcareous nannofossils is reported in Fig. 7.

5.2. Results

Calcareous nannofossils are rare to common and poorly to well preserved, with overgrowth more pervasive than etching. Assemblages are of Tethyan affinity, often characterized by dissolution resistant taxa, such as the genera *Watznaueria*, *Cyclagelosphaera, Diazomatolithus, Conusphaera* and *Polycostella* (Roth, 1983; Casellato, 2010). The biostratigraphic schemes adopted in this study are those of Bralower *et al.* (1989) and Casellato (2010). Twenty calcareous nannofossil bio-horizons spanning the latest Tithonian-Berriasian interval were observed. The NJT 17 Zone, divided into NJT 17a and NJT 17b subzones, the NKT Zone, the *Nannoconus steinmannii steinmannii* (NK-1) and *Cretarhabdus angustiforatus* zones (NK-2) were recognized. The base of investigated succession belongs to the Upper Tithonian NJT 17a nannofossil Subzone, based on the presence of *Nannoconus globulus minor* in the lowermost sample investigated. In the NJT 17a Subzone further bio-horizons include first occurrence (FO) of *Umbria granulosa minor, Cretarhabdus surirellus* and *Hexalithus geometricus*. The NJT 17a/NJT 17b subzonal boundary is placed at the FO of *Nannoconus wintereri*. The uppermost Tithonian NJT 17b Subzone is characterized by the FOs of *Nannoconus compressus, Lithraphidites carniolensis, Rhagodiscus asper* and *Umbria granulosa granulosa*. The NJT 17/NKT zonal boundary is placed at the FO of *Nannoconus steinmannii minor*. In the NKT Zone the FOs of *Cruciellipsis cuvillieri*, *Nannoconus kamptneri minor*, *Nannoconus globulus globulus*, *Nannoconus colomii* and *Cretarhabdus octofenestratus* were recognized. The NKT/NK-1 subzonal boundary is placed

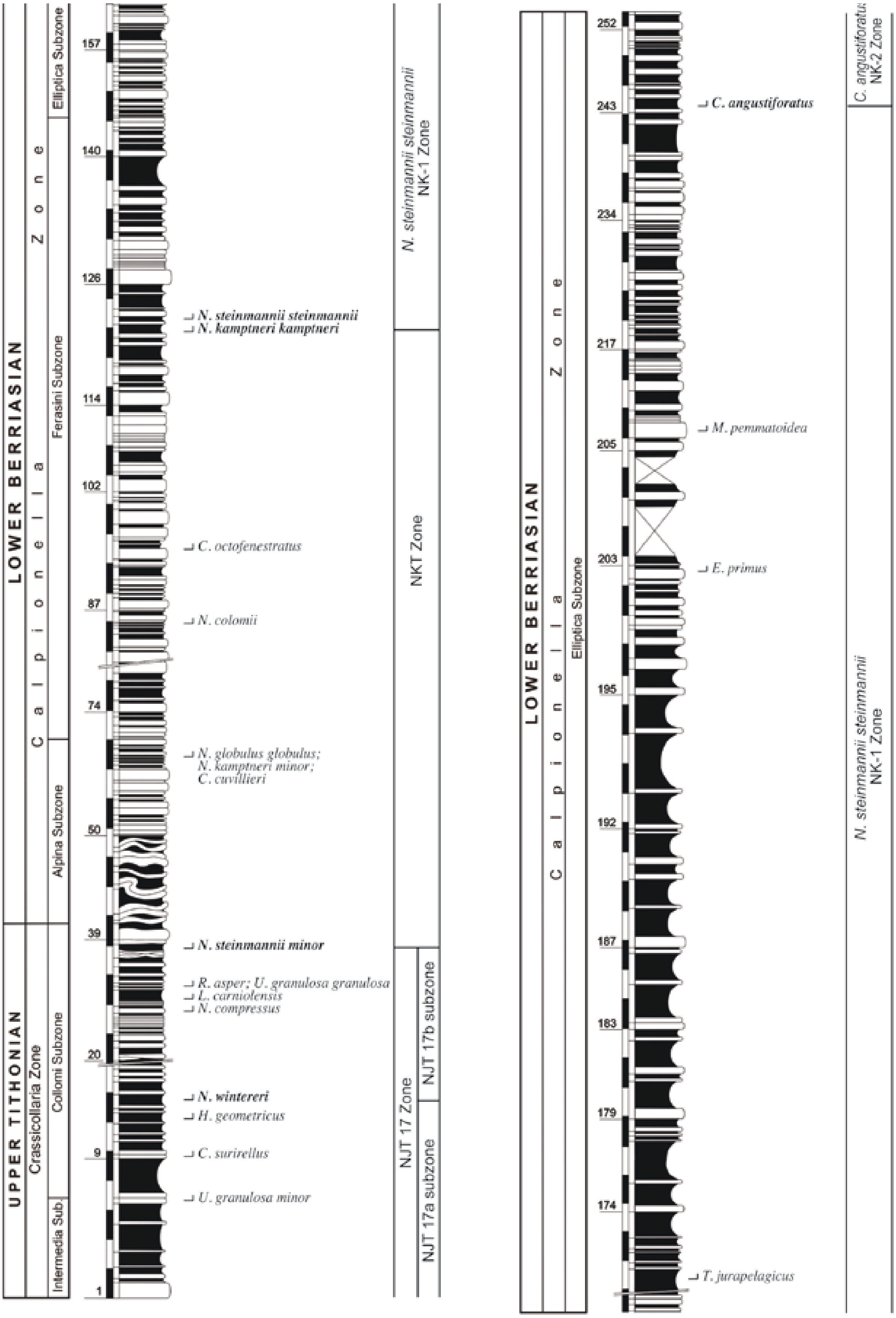
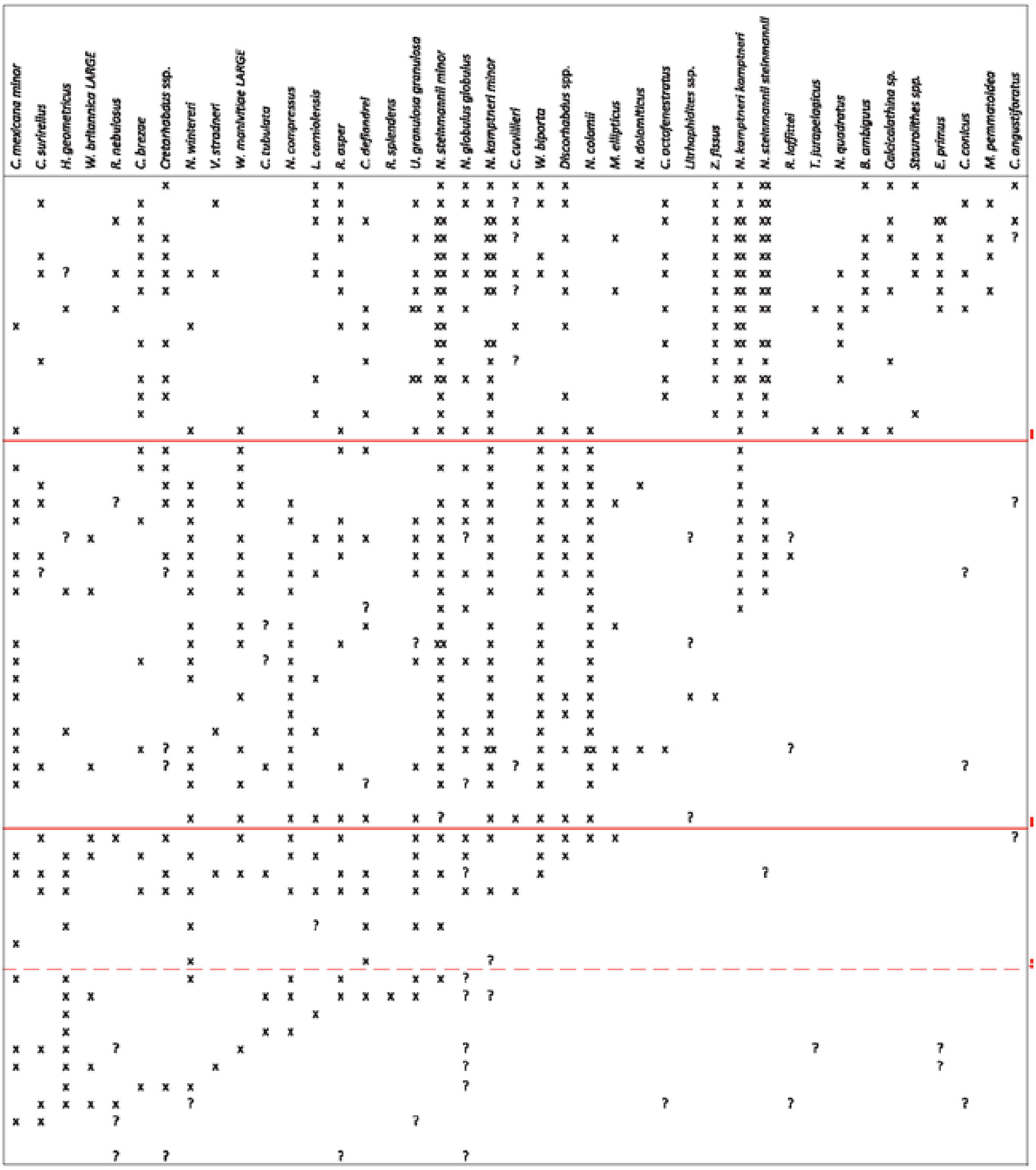


Fig. 6: Primary and secondary calcareous nannofossil bio-horizons recognized in the studied section plotted against the lithology and calpionellid zonation.

RIO ARGOS - section base to section Z	PRESERVATION	ABUNDANCE	Calcareous nannofossil SUBZONES	Calpionellid Subzones (Rehakova - this study)	*B. constans*	*C. argoensis*	*C. margerelii*	*C. mexicana mexicana*	*F. multicolumnatus*	*H. noeliae*	*M. chiastius*	*M. quadratus*	PENTALITHS	*N. erbae*	*N. globulus minor*	*N. infans*	*N. puer*	*Nannoconus* ssp. - sections	*P. beckmannii*	*P. senaria*	*Cr. crassus*	*W. barnesiae*	*W. communis*	*W. communis* LARGE	*W. britannica*	*W. fossacincta*	*W. manivitiae*	*Z. erectus*	*Z. fluxus*	*A. infracretacea*	*D. lehmanii*	*M. favula*	*W. cf. rawsonii*	*Z. embergeri*	*U. granulosa minor*
Z 275	P	F			x		x	x			x	x						x	x	x		x	x		x	x	x	x		x	x			x	
Z 248	P	F	NK-2		x		x	x			x	x							x	x		x	x		x	x	x	x	x	x	x			x	
Z 243	M	C			x	x	x	x			x	x										x						x	x	x	x			x	x
Z 234	P	C			x		x	x		?	x	x			x					x		x			x	x		x		x	x			x	x
Z 226	M	C			x	x	x	x			x								x	x		x	x		x	x		x	x	x	x			x	
Z 215	M	C			x		x	x			x									x		x			x	x	x	x		x	xx			x	
Z 206	P	C			x			x			x	x			x					x		x			x	x		x		x	x			x	x
Z 202	P	F						x												x								x						x	x
Z 196	P	F						x							x							x			x			x	x	x	x			x	
Z 192	VP	F		Elliptica	x			x			x						x		x			x				x			x	x	x			x	
Z 188	P	C				x	x	x			x											x			x	x			x	x	x			x	
Z 183	P	C					x	x			x	x							x	x		x			x	x			x	x	x			x	x
Z 179	P	F/C			x			x			x											x								x	x				
Z 178	P	C			x		x	x														x			x	x	x	x		x	x				
Z 168	P	C	NK-1			x	x	x	x		x						x					x				x			x	x	x	x	x		
z 157	VP	R					x	x														x							x	x	x		x		
z 147	P	F			x			x			x			x								x							x	x	x		x		x
z 137	P	F					x	x			x		x		x							x				x			x	x	x		x		
Z 127	P	C					x	x	?		x	x		x	x		x	x		x		x	x		x	x			x	x	x	x		x	
Z 126	P	C					x	x			x				x		x	x		x		x	x	x		x			x	x	x	x			
Z 125	G	F/C					x				x				x		x					x	x		x	x		?	x	x	x		x	x	x
Z 124	G	F/C					x	x		x	x			x	x		x	x		x		x	x		x	x	x		x	x	x		x	x	
Z 123	G	F/C					x	x	?		x	?			x	x	x	x		x		x	x		x	x	x		x	x	x		x	x	x
Z 122	G	C					x	x			x				x		x	x		?		x	x		x	x		x	x				x	x	
Z 121	G	F					x	x										x				x	x	x											
Z 120	G	C				x	x							x	x		x	x				x	x	x	x	x							x		
Z 118	G	C					x	x							x		x	x				x	x			x	x		x		x		x	x	x
Z 117	P	C				x	x	x							x		x	x				x	x			x				x	x	x	x		
Z 112	G	C		Ferasini			x	x			x							x		x		x	x			x	x								x
Z 111	P	F					x															x				x		x	x		x				x
Z 108	G	C					x								x		x	x				x							x		x			x	
Z 103	G	C					x	x							x		x	x				x	x			x	x		x					x	x
Z 95	P	F					x	x						x				x		x		x	x		x	x			x	x	x		x	x	
Z 91	G	C	NKT			x	x	x		x	x			x	x	x	x	x				x	x	x	x	x	x						x		
Z 85	G	F					x	x							?			x				x	x		x	x	x		x			x		x	
Z 83	P	F					x															x								x	x				
Z 81	G	F/C					x	x			x				?			x		x		x	x		x	x	x				x		x		x
Z 77	G	F/C			x	x	x				x			?	x		x	x		x		x	x	x	x	x	x	x	x					x	
Z 74	P	F					x			x			x		x		x			x		x					x				x		x	x	
Z 69	G	C					x	x		x	x				x	x	x	x	x	x		x	x		x	x	x		x				x	x	
Z 65	G	C				x	x	x	x		x	x		x	x		x	x	x	x	x	x	x		x	x	x	x	x	x	x			x	x
Z 61	B	R						x										x				x			x	x								x	
Z 57	B	R		Alpina				x							x			x		x		x	x		x									x	
Z 53	B	R					x											x				x	x												
Z 52	P	C					x	x										x	x	x		x	x		x	x	x			x	x				x
Z 37	P	C			x	x	x	x			x			x	x			x	x	x		x	x		x	x	x		x		x				x
Z 33	G	C				?	x	x	x	?					x		x	x	x	x		x	x		x	x	x		x		x			x	
Z 31	P	F					x	x			x			x	x	x	xx		x	x										x	x				x
Z 30	P	C					x	x			x								x	x		x	x		x	x	x				x				
Z 29	G	C	NJT-17b	Colomi			x	x			x				?			x		x		x	x	x	x	x	x		x		x				?
Z 25	G	C					x	x			x				?			x		x		x	x	x			x				x			x	
Z 15	P	F			x		x	x				x		xx	x	x	xx	x	x	x		x			x	x	x				x			x	
Z 13	P	F				x	x	x			x			x	x	x	xx	x	x	x		x			x		x			x	x	x		x	x
Z 9	P	F					x	x				?	x	x		x	x	x	x	x		x	x		x	x	x				x				x
Z 7	P	F/C	NJT-17a	Interemedia			x	x		x	x			x	x	x	x	x	x	xx		x			x		x		?	x	x	x	x	x	x
Z 5	P	F			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			?			

Fig. 7A, B: Range chart of observed calcareous nannofossils. The red lines indicate faults and a slump. The adjacent calcareous nannofossil assemblages could be incongruent with the main sequence of bio-horizons. Preservation codes – G: good; M: moderate; P: poor; VP: very poor. Total abundance codes; C = common; F/C = frequent/common; F = frequent; R = rare; ×× = abundant.


C. mexicana minor
C. surirellus
H. geometricus
W. britannica LARGE
R. nebulosus
C. brezae
Cretarhabdus ssp.
N. wintereri
V. stradneri
W. manivitiae LARGE
C. tubulata
N. compressus
L. carniolensis
R. asper
C. deflandrei
R. splendens
U. granulosa granulosa
N. steinmannii minor
N. globulus globulus
N. kamptneri minor
C. cuvillieri
W. biporta
Discorhabdus spp.
N. colomii
M. ellipticus
N. dolomiticus
C. octofenestratus
Lithraphidites ssp.
Z. fissus
N. kamptneri kamptneri
N. steinmannii steinmannii
R. laffittei
T. jurapelagicus
N. quadratus
B. ambiguus
Calcicalathina sp.
Stauroliths spp.
E. primus
C. conicus
M. pemmatoidea
C. angustiforatus

at the FO of *Nannoconus kamptneri kamptneri*, which is immediately followed by the FO of *N. steinmannii steinmannii*. This Zone is characterized by the FOs of *Tubodiscus jurapelagicus*, *Eiffelithus primus, Manivitella pemmatoidea*. The last bio-horizon detected within the studied interval is the FO of *C. angustiforatus*, which is the bio-horizon used to identify the base of NK-2 Zone.

5.3. Discussion & Conclusion

In the studied section almost all the primary and secondary bio-horizons reported by previous authors (Bralower *et al.,* 1989; Casellato, 2010) were recognized. The primary bio-horizons have been grossly found in the same stratigraphic order. The only exception is the FO of *C. cuvillieri* found within the FO of *N. kamptneri minor*, and the FO of *T. jurapelagicus*, found at considerably older level. The secondary bio-horizons show some discrepancies if compared with the literature: the FOs of *L. carniolensis*, *U. granulosa granulosa* and *R. asper* have been observed at younger levels after the FO of *N. wintereri*; the FO of *N. globulus globulus* is detected within the FO of *N. kamptneri minor,* thus display a younger occurrence; the FO of *M. pemmatoidea* occurs within the calpionellid Elliptica Subzone of Calpionella Zone, thus much later than the Alpina Subzone reported by Bralower *et al.* (1989).

Interestingly, the FO of *N. compressus* has been recognized within the calpionellid Colomi Subzone of the Crassicollaria Zone: this species was just reported from the DSDP Site 534A, Central Atlantic Ocean and its last occurrence was dated as the early Late Tithonian (Bralower *et al.,* 1989; Casellato, 2010). In the studied section this species appears at a younger level, and disappears after the FOs of *N. steinmannii steinmannii* and *N. kamptneri kamptneri*. Further investigation will shed light on the effective spatial and temporal distribution of this taxon.

Since calcareous nannofossil have a biostratigraphic resolution higher than that of calpionellids and ammonites, we believe the obtained results highlight stratigraphic discontinuities that the other biostratigraphic tools are not able to detect. It is evident from calcareous nannofossil assemblages that there is a gap coinciding with the fault reported at bed Z168. This is highlighted by the sudden appearance of *T. jurapelagicus* and *Calcicalathina* sp. which should occur at least in the uppermost Berriasian (Bralower *et al.,* 1989).

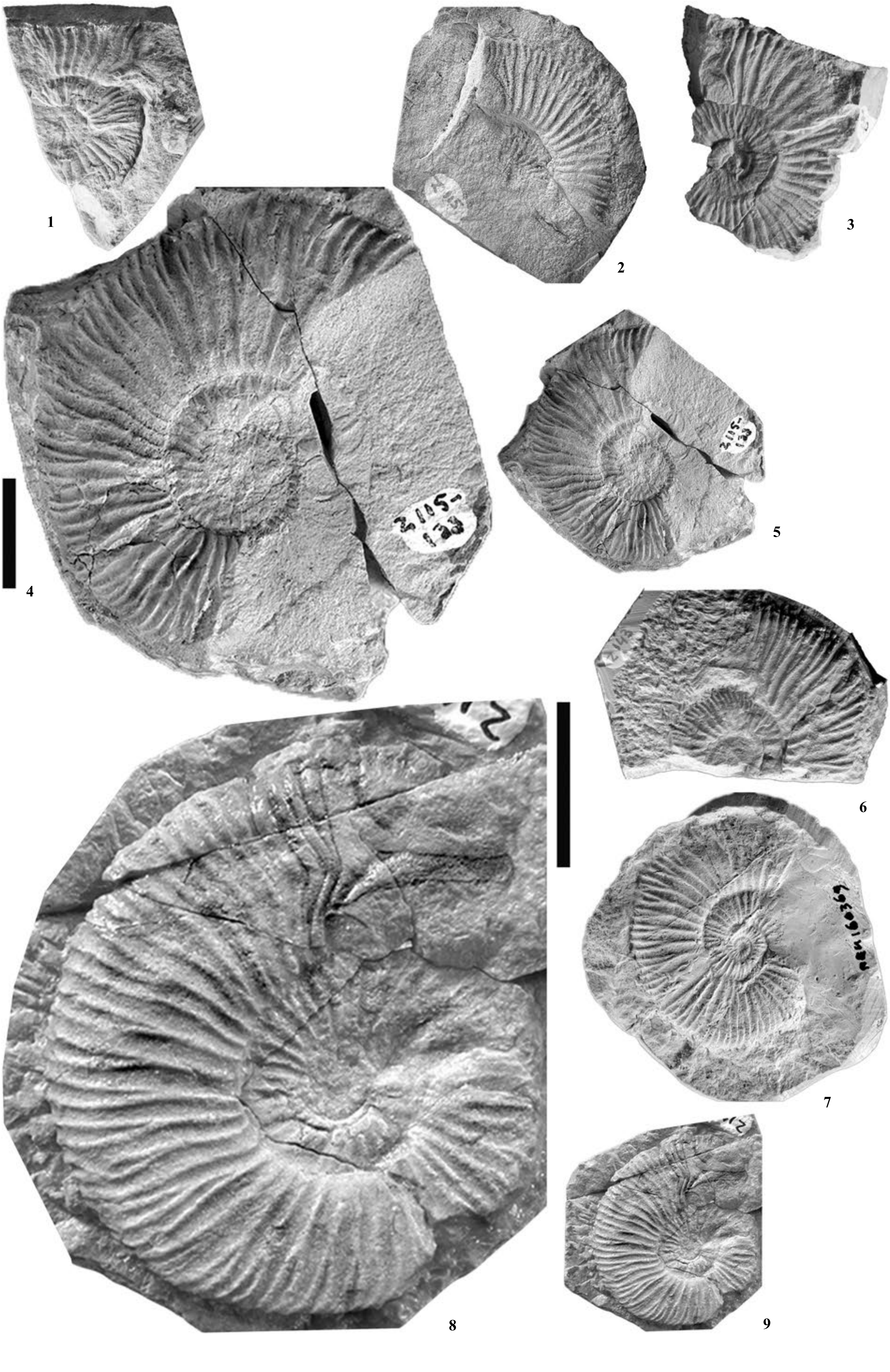
There are four calcareous nannofossil bio-horizons that have previously been proposed as useful to constrain the Jurassic/Cretaceous boundary interval, at least in the Tethyan Realm (Wimbledon *et al.,* 2011): the FOs of *N. wintereri* and *C. cuvillieri*, and the FOs of *N. steinmannii minor* and *N. kamptneri minor.* Data achieved in the studied section confirm the correlation of these bio-horizons and Calpionellids: the FOs of *N. wintereri* (bed Z15; Plate XXVII, fig. 15) has been detected within the Crassicollaria Zone (Colomi Subzone), while the FOs of *N. steinmannii minor* (bed Z57, Plate XXVII, fig. 16) and *N. kamptneri minor* (bed Z81; Plate XVII, fig. 5) in the Calpionella Zone (Alpina Subzone). According to the recent advances (see Wimbledon *et al.,* 2011 for a comprehensive review), the best constrain of the Jurassic/Cretaceous boundary is offered by: 1) the base of Calpionella Zone (B Zone) accompanied by the decrease of Crassicollaria species. 2) the "explosive" appearance of *C. alpina* (acme of *C. alpina*). 3) the FO of *N. steinmannii minor* and *N. kamptneri minor*. 4) the base of magnetochron M18. Although calcareous nannofossils are poorly to moderately preserved at Barranco de Tollo, and the magnetostratigraphy is not performable (as explained above), the succession of integrated bio-horizons (calcareous nannofossils, calpionellids and ammonites when available) across the Jurassic/Cretaceous boundary interval is comparable to that found in other Tethyan localities, such as Le Chouet (SE France, Wimbledon *et al.,* 2013), Torre de' Busi (Northern Italy, Casellato *et al.,* 2007; Wimbledon *et al.,* 2011), Brodno (Slovakia, Michalik *et al.,* 2009), and Lokut (Hungary, Grabowski *et al.,* 2010), Nutzhof (Austria, Lukeneder *et al.,* 2010).

Plate I

All specimens in natural size unless marked with a scale bar (10 mm).

Fig. 1: RGM 160 362 *Pseudosubplanites euxinus* (Retowski, 1894), bed Z115.
Fig. 2: RGM 160 379 *Pseudosubplanites euxinus* (Retowski, 1894), bed Z115.
Fig. 3: RGM 160 370 *Pseudosubplanites euxinus* (Retowski, 1894), bed Z150.
Fig. 4: RGM 160 346 *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005, bed Z115-133.
Fig. 5: Same.
Fig. 6: RGM 160 369 *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005, bed Z143.
Fig. 7: RGM 160 367 *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005, bed Z143.
Fig. 8: RGM 160 231 *Pseudosubplanites fasciculatus* Bogdanova & Arkadiev, 2005, bed Z124.
Fig. 9: RGM Same.

Plate I



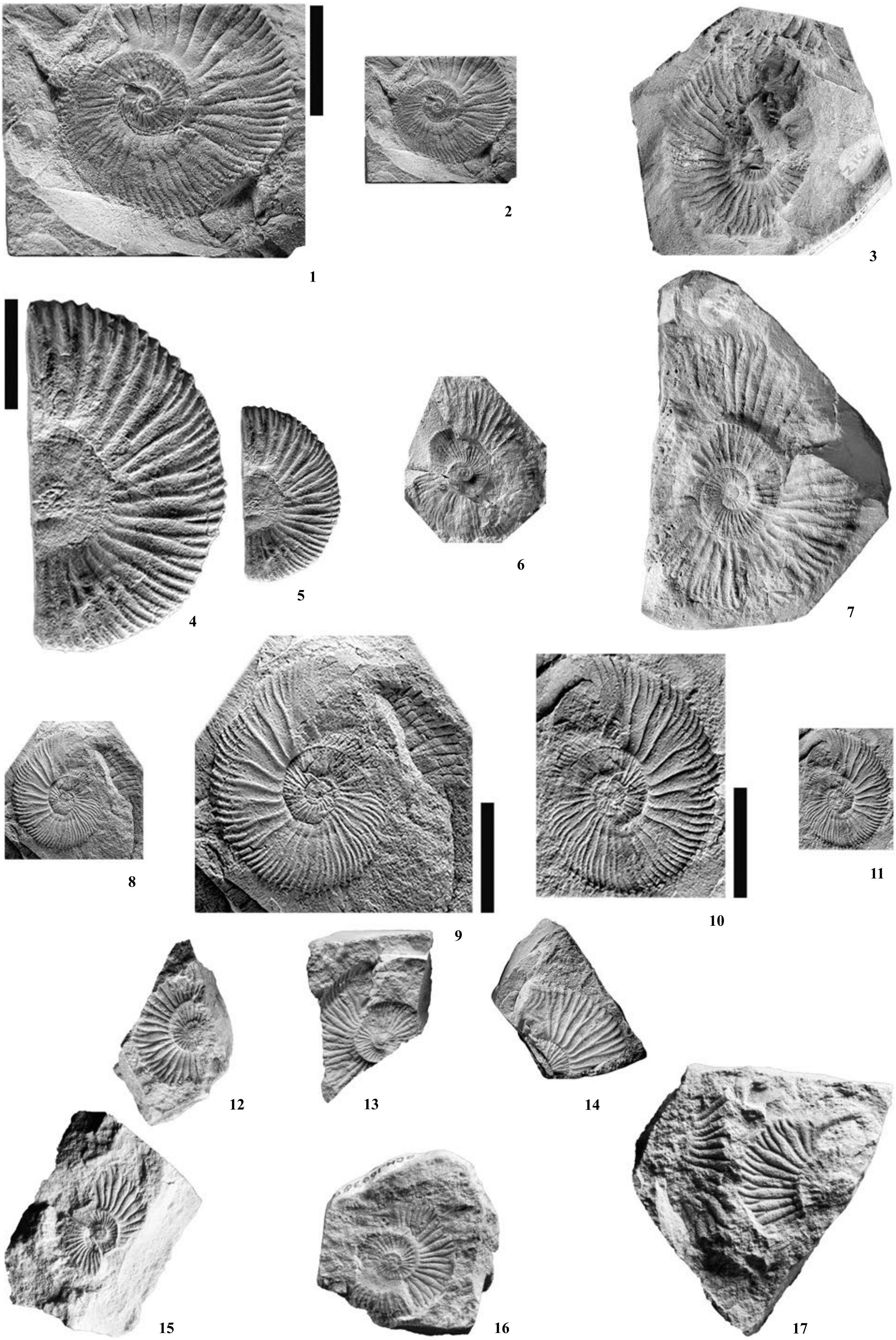
5.4. List of calcareous nannofossil species

Assipetra infracretacea (Thierstein, 1973) Roth, 1973.
B. ambiguus Black, 1971a.
Biscutum constans (Górka, 1957) Black, 1967.
C. brezae Applegate & Bergen, 1988.
Conusphaera mexicana (Trejo, 1969) subsp. *Minor.* (Bonw & Cooper, 1989) Bralower *in* Bralower *et al.,* 1989.
Conusphaera mexicana (Trego, 1969) subsp. *mexicana* Bralower in Bralower *et al.,* 1989.
Cyclagelosphaera argoensis Bown, 1992.
Cyclagelosphaera deflandrei (Manivit, 1966).
Cyclagelosphaera tubulata (Grün & Zweili, 1980) Cooper, 1987.
Cyclagelosphaera margerelii Noël, 1965.
Crepidolithus crassus (Deflandre *in* Deflandre & Fert, 1954) Noël, 1965.
Cretarhabdus angustiforatus (Black, 1971) Bukry, 1973.
Cretarhabdus conicus Bramlette & Martini, 1964.
Cretarhabdus octofenestratus Bralower in Bralower *et al.,* 1989.
Cretarhabdus surirellus (Deflandre in Deflandre & Fert, 1954) Reinhardt, 1970.
Diazomatolithus lehmanii Noël, 1965.
Eiffelithus primus Applegate & Bergen 1988.
Faviconus multicolumnatus Bralower in Bralower *et al.,* 1989.
Hexalithus geometricus Casellato, 2010.
Hexalithus noeliae (Noël, 1956) Loeblich & Tappan, 1966.
Lithraphidites carniolensis Deflandre, 1963.
Microstaurus chiastius (Worsley 1971) Bralower *et al.,* 1989.
Markalius circumradiatus (Stover 1966) Perch-Nielsen, 1968.
M. ellipticus Grün in Grün & Alleman, 1975.
Miravetesina favula Grün in Grün & Allemann, 1975.
M. pemmatoidea (Deflandre in Manivit 1965) Thierstein, 1971.
Microstaurus quadratus Black, 1971.
Nannoconus colomii (de Lapparent, 1931) Kamptner, 1938
Nannoconus compressus Bralower & Thierstein in Bralower *et al.,* 1989.
Nannoconus dolomiticus Cita & Pasquarè, 1959.
Nannoconus erbae Casellato, 2010.
Nannoconus globulus (Brönnimann, 1955) subsp. *globulus* Bralower in Bralower *et al.,* 1989.
Nannoconus globulus (Brönnimann, 1955) subsp. *minor* Bralower in Bralower *et al.,* 1989.
Nannoconus infans Bralower in Bralower *et al.,* 1989.
Nannoconus kamptneri (Brönnimann, 1955) subsp. *kamptneri* Bralower in Bralower *et al.,* 1989.
Nannoconus kamptneri (Brönnimann, 1955) subsp. *minor* Bralower in Bralower *et al.,* 1989.
Nannoconus puer Casellato, 2010.
Nannoconus steinmannii (Kamptner, 1931) subsp. *minor* Deres & Achéritéguy, 1980.
Nannoconus steinmannii (Kamptner, 1931) subsp. *steinmannii* Deres & Achéritéguy, 1980.
Nannoconus wintereri Bralower & Thierstein in Bralower *et al.,* 1989.
N. quadratus (Noël, 1969) Deres & Achéritégyi, 1980.
Polycostella beckmannii Thierstein, 1971.
Percivalia fenestrata (Worsley, 1971) Wise, 1983.
Polycostella senaria Thierstein, 1971.
Rhagodiscus asper (Stradner, 1963) Reinhardt, 1967.
Rhagodiscus nebulosus Bralower in Bralower *et al.,* 1989.
Rotellapillus laffittei (Noël, 1956) Noël, 1973.

Plate II

All specimens in natural size unless marked with a scale bar (10 mm).
Fig. 1: RGM 617 871 *Pseudosubplanites tolloensis* sp. nov. (negative), bed Z141.
Fig. 2: Same (negative).
Fig. 3: RGM 160 347 *Pseudosubplanites tolloensis* sp. nov., bed Z140.
Fig. 4: RGM 617 874 *Pseudosubplanites tolloensis* sp. nov., bed Z151.
Fig. 5: Same.
Fig. 6: RGM 160 355 *Pseudosubplanites tolloensis* sp. nov., bed Z150.
Fig. 7: RGM 160 350 *Pseudosubplanites tolloensis* sp. nov., bed Z143 (holotype).
Fig. 8: RGM 617 872 *Pseudosubplanites tolloensis* sp. nov. (positive), bed Z141.
Fig. 9: Same (positive).
Fig. 10: Same (negative).
Fig. 11: Same (negative).
Fig. 12: RGM 617 868 *Pseudosubplanites lorioli* (m) (Zittel, 1868), bed Z202.
Fig. 13: RGM 160 387 *Pseudosubplanites lorioli* (m) (Zittel, 1868), bed Z202.
Fig. 14: RGM 617 869 *Pseudosubplanites lorioli* (m) (Zittel, 1868), bed Z202.
Fig. 15: RGM 160 390 *Pseudosubplanites lorioli* (m) (Zittel, 1868), bed Z202.
Fig. 16: RGM 160 389 *Pseudosubplanites lorioli* (m) (Zittel, 1868), bed Z202.
Fig. 17: RGM 617 870 *Pseudosubplanites lorioli* (m) (Zittel, 1868), bed Z196.

Plate II



R. splendens (Deflandre, 1953) Verbeek 1977.
Turbodiscus jurapelagicus (Worsley, 1971) Roth, 1973.
Umbria granulosa subsp. *granulosa* Bralower & Thierstein in Bralower *et al.,* 1989.
Umbria granulosa subsp. *minor* Bralower & Thierstein in Bralower *et al.,* 1989.
Vagalapilla stradneri (Rood *et al.,* 1971) Thierstein, 1973.
Watznaueria barnesiae (Black in Black & Barnes, 1959) Perch-Nielsen, 1968.
Watznaueria biporta Bukry, 1969.
Watznaueria britannica (Stradner, 1963) Reinhardt, 1964.
W. britannica LARGE Casellato, 2010.
Watznaueria rawsonii Crux, 1987.
W. communis LARGE Casellato, 2010.
Watznaueria fossacincta (Black, 1971a) Bown in Bown & Cooper, 1989.
Watznaueria manivitiae (Bukry, 1973) Moshkovitz & Ehrlich, 1987.
W. manivitiae LARGE Casellato, 2010.
Zeugrhabdotus embergeri (Noël, 1958) Perch-Nielsen, 1984.
Zeugrhabdotus erectus (Deflandre in Deflandre & Fert, 1954) Reinhardt, 1965.
Zeugrhabdotus fluxus Casellato, 2010.
Z. fissus Grün & Zweili, 1980

ACKNOWLEDGMENTS

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Plate III

All specimens in natural size unless marked with a scale bar (10 mm).
Fig. 1: RGM 160 401 *Pseudosubplanites lorioli* (M) (Zittel, 1868), bed Z202.
Fig. 2: RGM 617 867 *Pseudosubplanites lorioli* (M) (Zittel, 1868), bed Z202.
Fig. 3: RGM 160 400 *Pseudosubplanites lorioli* (M) (Zittel, 1868), bed Z202.
Fig. 4: RGM 617 864 *Pseudosubplanites lorioli* (M) (Zittel, 1868), bed Z11.
Fig. 5: Same, enlarged two times.
Fig. 6: RGM 160 398 *Pseudosubplanites lorioli* (M) (Zittel, 1868), bed Z202.
Fig. 7: RGM 617 900 *Pseudosubplanites lorioli* (M) (Zittel, 1868), bed Z202.
Fig. 8: RGM 617 863 *Pseudosubplanites lorioli* (M) (Zittel, 1868), bed Z203.
Fig. 10: RGM 160 283 *Pseudosubplanites crymensis* Bogdanova & Arkadiev, 2005, bed Z152.
Fig. 11: RGM 160 345 *Pseudosubplanites crymensis* Bogdanova & Arkadiev, 2005, bed Z140.
Fig. 12: RGM 160 290 *Pseudosubplanites crymensis* Bogdanova & Arkadiev, 2005, bed Z66.
Fig. 13: RGM 617 876 *Pseudosubplanites crymensis* Bogdanova & Arkadiev, 2005, bed Z171.
Fig. 14: RGM 160 232 *Pseudosubplanites crymensis* Bogdanova & Arkadiev, 2005, bed Z102-108.

Plate III

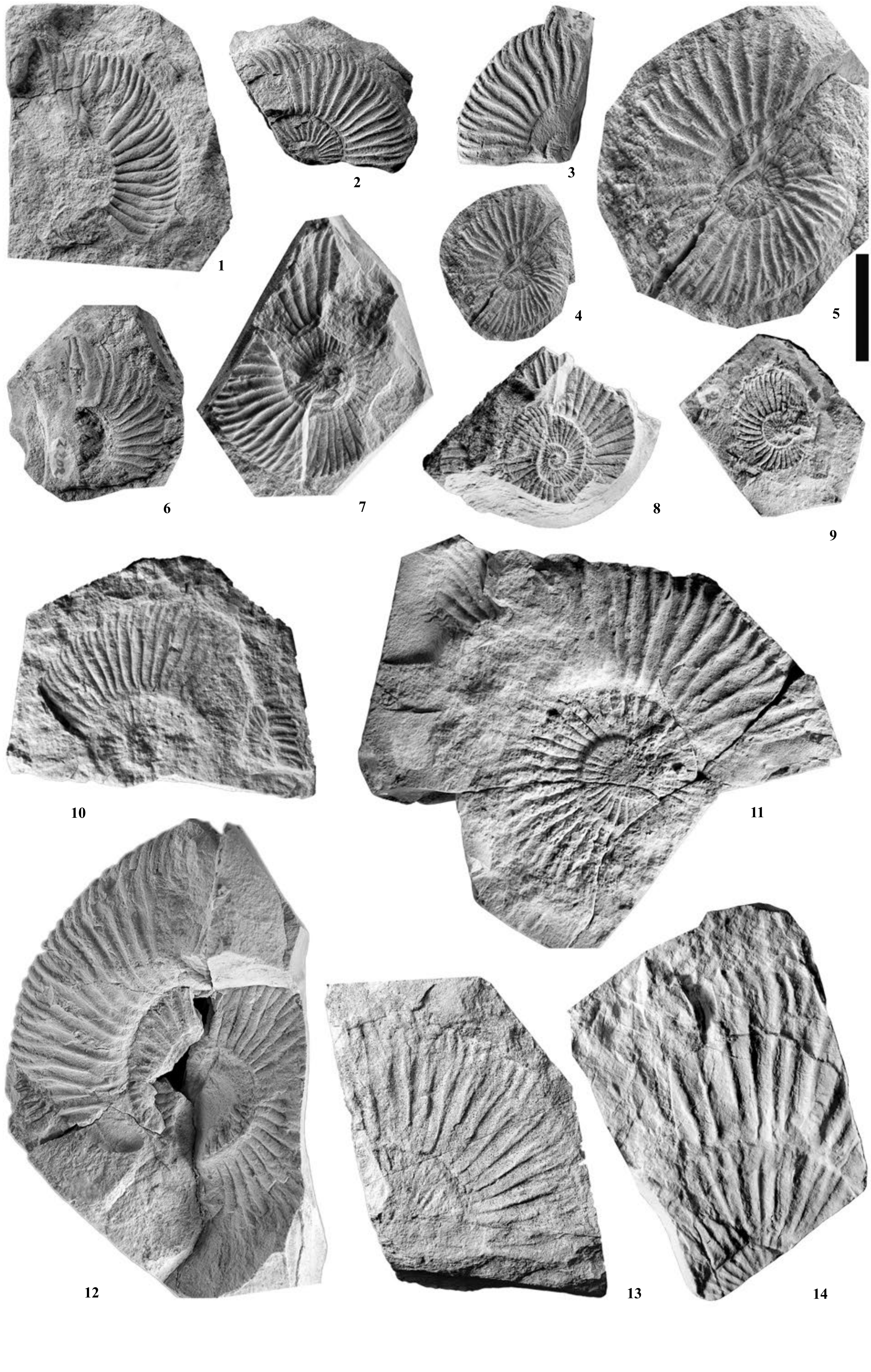

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Plate IV

All specimens in natural size.

Fig. 1: RGM 617 880 *Pseudosubplanites ponticus* (Retowski, 1894), bed Z141.
Fig. 2: RGM 160 310 *Pseudosubplanites ponticus* (Retowski, 1894), bed Z153-157.
Fig. 3: RGM 617 879 *Pseudosubplanites ponticus* (Retowski, 1894), bed Z157.
Fig. 4: RGM 160 312 *Pseudosubplanites ponticus* (Retowski, 1894), bed Z172.
Fig. 5: RGM 160 311 *Pseudosubplanites ponticus* (Retowski, 1894), bed Z161.
Fig. 6: RGM 617 878 *Pseudosubplanites ponticus* (Retowski, 1894) (negative), bed Z151.
Fig. 7: Same (positive).

Plate IV

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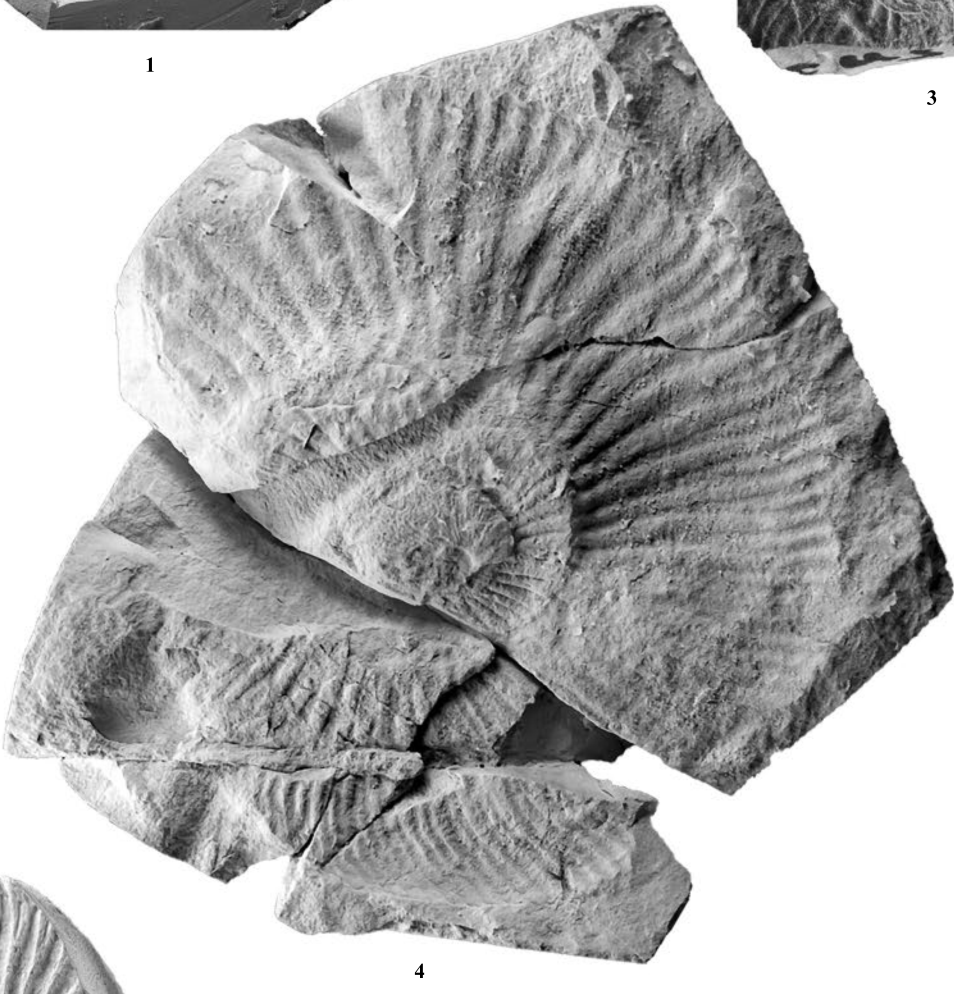

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Plate V

All specimens in natural size.
Fig. 1: RGM 160 291 *Pseudosubplanites paracombesi* sp. nov. (positive), bed Z148.
Fig. 2: Same (negative).
Fig. 3: RGM 617 888 *Pseudosubplanites paracombesi* sp. nov. (positive), bed Z160.
Fig. 4: Same (negative).

Plate V

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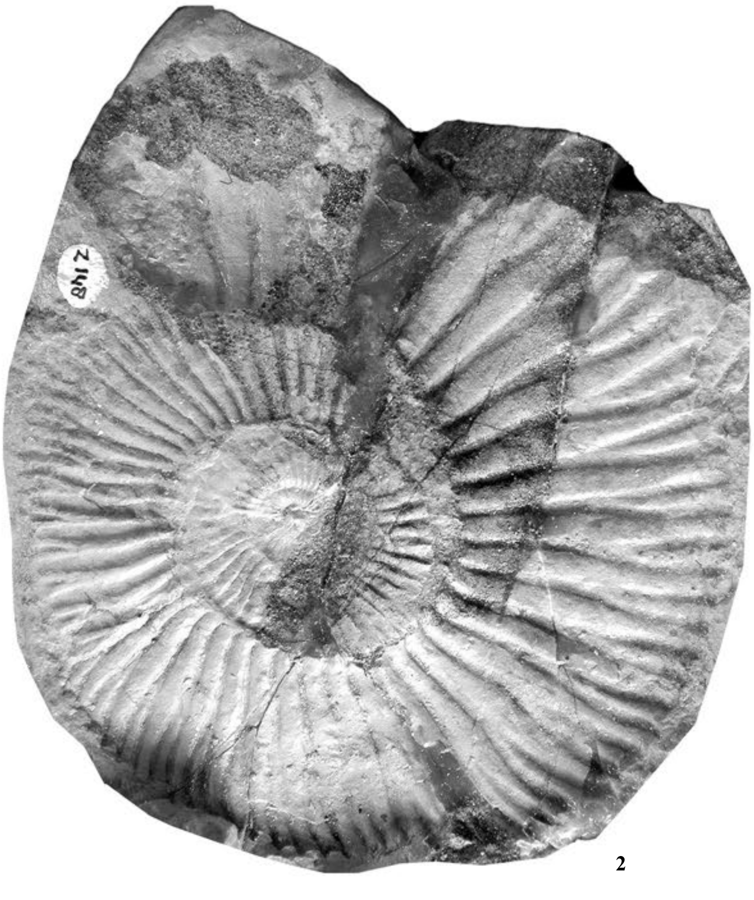

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Plate VI

All specimens in natural size.
Fig. 1: RGM 160 335 *Pseudosubplanites hegarati* sp. nov. (right side), bed Z131 (holotype).
Fig. 2: JK 44698 *Pseudosubplanites berriasensis* Le Hégarat, 1973, Col du Pin.
Fig. 3: RGM 617 875 *Pseudosubplanites berriasensis* Le Hégarat, 1973, bed Z141.
Fig. 4: RGM 160 353 *Pseudosubplanites berriasensis* Le Hégarat, 1973, bed Z153.
Fig. 5: RGM 160 336 *Pseudosubplanites hegarati* sp. nov., bed Z119.
Fig. 6: RGM 160 335 *Pseudosubplanites hegarati* sp. nov. (left side) (holotype).

Plate VI

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Plate VII

All specimens in natural size unless marked with a scale bar (10 mm).

Fig. 1: JK. 44712 *Pseudosubplanites combesi* Le Hégarat, 1973 (Col du Pin).
Fig. 2: JK. 44685 *Pseudosubplanites combesi* Le Hégarat, 1973 (Col du Pin).
Fig. 3: RGM 160 294 *Pseudosubplanites combesi* Le Hégarat, 1973, bed Z141-142.
Fig. 4: RGM 160 293 *Pseudosubplanites combesi* Le Hégarat, 1973, bed Z141-158.
Fig. 5: RGM 160 292 *Pseudosubplanites grandis* (Mazenot, 1939), bed. Z150-153
Fig. 6: RGM 791 174 *Pseudosubplanites* cf. *grandis* (Mazenot, 1939), bed. Z161-163.
Fig. 7: RGM 160 415 *Berriasella* (*Hegaratella*) *jacobi* Mazenot, 1939, bed Z143.
Fig. 8: RGM 791 175 *Berriasella* (*Hegaratella*) *jacobi* Mazenot, 1939, bed Z152.
Fig. 9: RGM 160 414 *Berriasella* (*Hegaratella*) *jacobi* Mazenot, 1939, bed Z115.
Fig. 10: RGM 160 234 *Berriasella* (*Hegaratella*) *jacobi* Mazenot, 1939, bed Z95.
Fig. 11: RGM 617 892 *Berriasella* (*Hegaratella*) *kleini* sp. nov., bed Z193.
Fig. 12: Same.

Plate VII

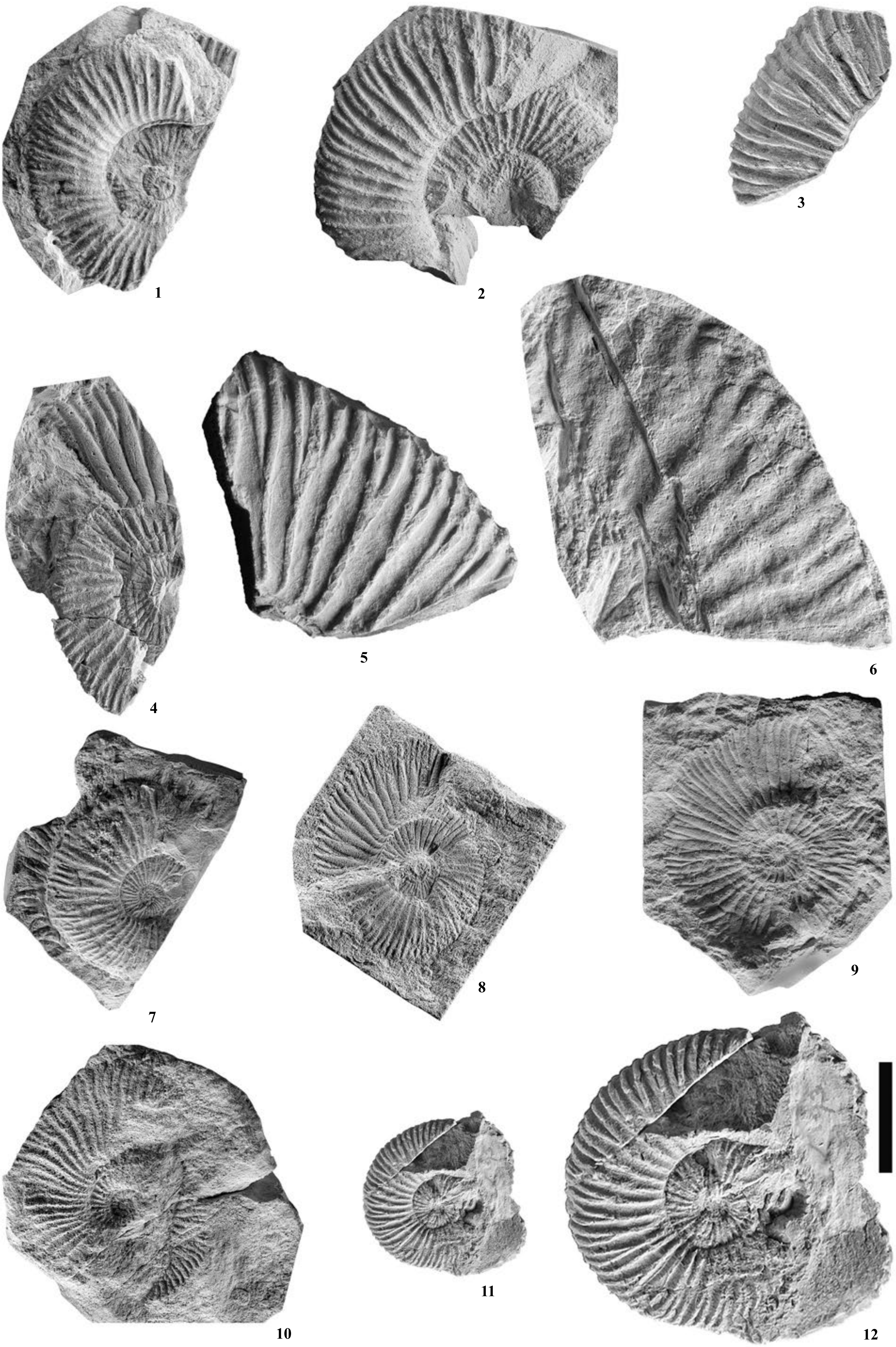

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Plate VIII

All specimens in natural size.

Fig. 1: RGM 160 420 *Berriasella* (*Hegaratella*) *subcallisto* (Toucas, 1890), bed Z134.
Fig. 2: RGM 160 422 *Berriasella* (*Hegaratella*) *subcallisto* (Toucas, 1890), bed M58-62.
Fig. 3: RGM 160 418 *Berriasella* (*Hegaratella*) *subcallisto* Toucas, 1890, bed Z150-153.
Fig. 4: RGM 791 178 *Berriasella* (*Hegaratella*) *paramacilenta* (Mazenot, 1973), bed Z242.
Fig. 5: RGM 160 421 *Berriasella* (*Hegaratella*) *vasiceki* sp. nov., bed M54-55.
Fig. 6: RGM 617 893 *Berriasella* (*Hegaratella*) *vasiceki* sp. nov., bed Z243.
Fig. 7: RGM 160 434 *Berriasella* (*Hegaratella*) *oxycostata* Mazenot, 1939, bed M8.
Fig. 8: RGM 160 429 *Berriasella* (*Hegaratella*) *oxycostata* Mazenot, 1939, bed Z192-197.
Fig. 9: RGM 160 433 *Berriasella* (*Hegaratella*) *oxycostata* Mazenot, 1939, bed M8.
Fig. 10: RGM 160 307 *Berriasella* (*Hegaratella*) *paramacilenta* Mazenot, 1939, bed Z95.
Fig. 11: RGM 160 410 *Berriasella* (*Hegaratella*) *paramacilenta* Mazenot, 1939, bed Z158.
Fig. 12: RGM 160 309 *Berriasella* (*Hegaratella*) *paramacilenta* Mazenot, 1939, bed Z140-168.
Fig. 13: RGM 160 465 *Berriasella* (*Hegaratella*) *paramacilenta* Mazenot, 1939, bed Z168-170.
Fig. 14: RGM 617 899 *Berriasella* (*Hegaratella*) *paramacilenta* Mazenot, 1939, bed Z168-170.
Fig. 15: RGM 160 464 *Berriasella* (*Hegaratella*) *paramacilenta* Mazenot, 1939, bed Z168.
Fig. 16: RGM 617 897 *Berriasella* (*Hegaratella*) *paramacilenta* Mazenot, 1939, bed Z110.

Plate VIII

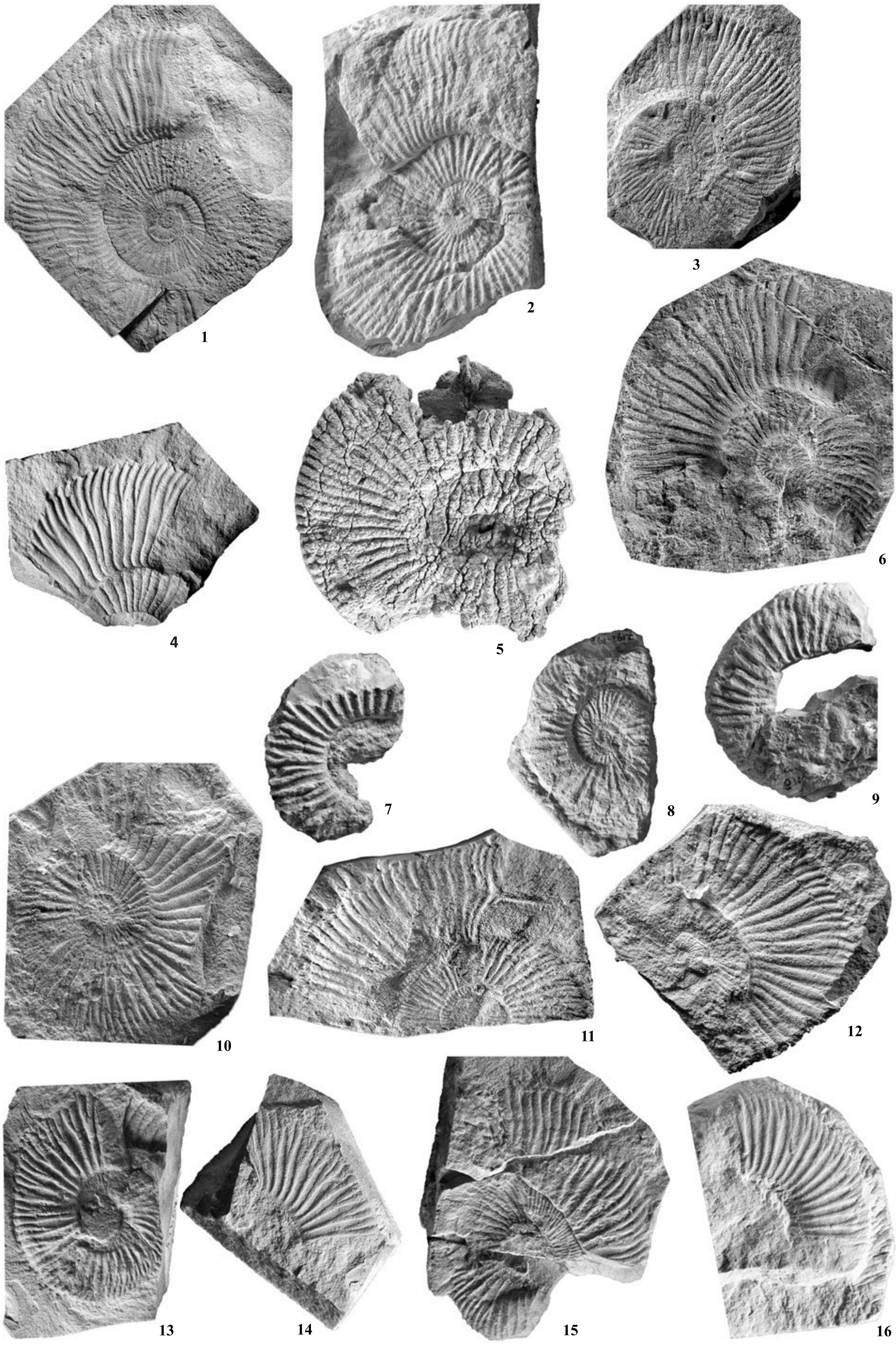

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Plate IX

All specimens in natural size unless marked with a scale bar (10 mm).
Fig. 1: RGM 160 233 *Berriasella* (*Hegaratella*) *oppeli* (Kilian, 1889), bed Z150-153.
Fig. 2: RGM 160 439 *Berriasella* (*Hegaratella*) *oppeli* (Kilian, 1889), bed Z192-197.
Fig. 3: RGM 160 426 *Berriasella* (*Hegaratella*) *chomeracensis* (Toucas, 1890), bed M8.
Fig. 4: RGM 160 428 *Berriasella* (*Hegaratella*) *chomeracensis* (Toucas, 1890), bed Z144.
Fig. 5: RGM 160 380 *Berriasella* (*Hegaratella*) *taverai* sp. nov., bed Z117-133.
Fig. 6: RGM Same.
Fig. 7: RGM 617 903 *Berriasella* (*Hegaratella*) *taverai* sp. nov., bed Z204.
Fig. 8: RGM Same.
Fig. 9: RGM 617 901 *Berriasella* (*Hegaratella*) *taverai* sp. nov., bed Z130.
Fig. 10: RGM 617 902 *Berriasella* (*Hegaratella*) *taverai* sp. nov., bed Z147.
Fig. 11: RGM 160 409 *Berriasella* (*Hegaratella*) *enayi* Le Hégarat, 1973, bed Z150.
Fig. 12: RGM 617 911 *Chapericeras chaperi* (Pictet, 1868), bed, Z32-37.
Fig. 13: RGM 617 912 *Chapericeras bonti* sp. nov. (ventral), bed Z46 (holotype).
Fig. 14: Same (lateral).

Plate IX

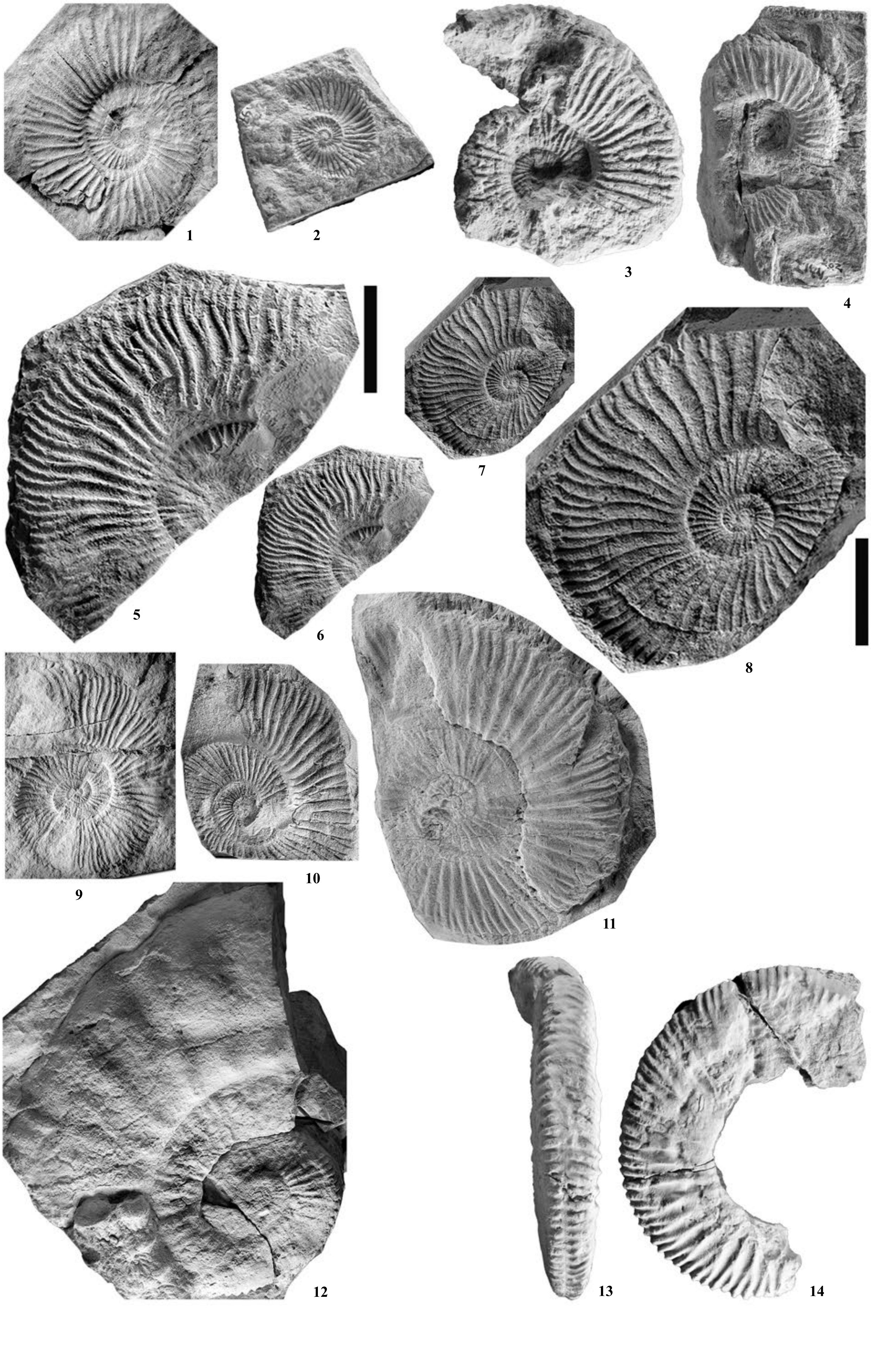

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Plate X

All specimens in natural size.

Fig. 1: RGM 160 239 *Berriasella* (*Berriasella*) *privasensis* (Pictet, 1867), (positive), bed Z245.
Fig. 2: Same (negative).
Fig. 3: RGM 617 905 *Berriasella* (*Berriasella*) *privasensis* (Pictet, 1867), bed Z234.
Fig. 4: RGM 160 690 *Subthurmannia floquinensis* (Le Hégarat, 1973), bed Z196.
Fig. 5: RGM 160 701 *Subthurmannia pseudocarpathica* sp. nov., bed Z136.
Fig. 6: JK. C *Strambergella carpathica* (Zittel, 1868), Col du Pin.
Fig. 7: RGM 791 177 *Subthurmannia gallica* (Mazenot, 1939), bed Z232.
Fig. 8: RGM 160 456 *Delphinella* (*Delphinella*) *consanguinea* (Retowski, 1894), bed Z118.
Fig. 9: RGM 160 447 *Delphinella* (*Delphinella*) *miravetensis* sp. nov., bed Z123 (holotype).
Fig. 10: RGM 160 453 *Delphinella* (*Delphinella*) *delphinensis* (Kilian, 1889), bed Z 121.
Fig. 11: RGM 160 455 *Delphinella* (*Delphinella*) *subchaperi* (Retowski, 1894), bed Z107.

Plate X

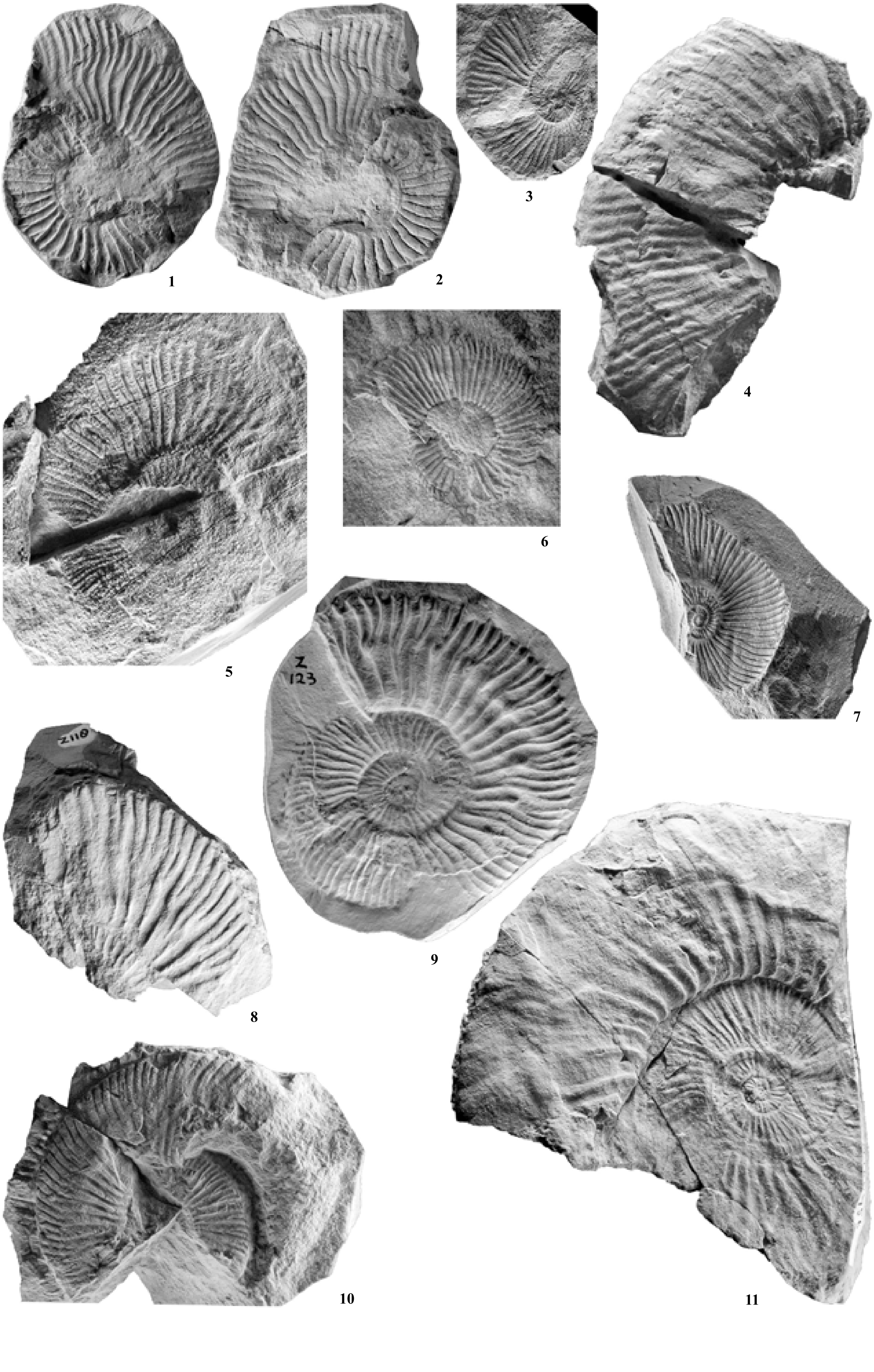

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Plate XI

All specimens in natural size.

Fig. 1: RGM 160 468 *Delphinella* (*Delphinella*) *janus* (Retowski, 1894), bed Z95.
Fig. 2: RGM 160 235 *Delphinella* (*Delphinella*) *tresannensis* Le Hégarat, 1973, bed Z124.
Fig. 3: RGM 160 470 *Delphinella* (*Delphinella*) *tresannensis* Le Hégarat, 1973, bed Z120-123.
Fig. 4: RGM 160 448 *Delphinella* (*Delphinella*) *tresannensis* Le Hégarat, 1973, bed Z118.
Fig. 5: RGM 164 451 *Delphinella* (*Delphinella*) *crimensis* (Burckhardt, 1912), bed Z102.
Fig. 6: RGM 160 469 *Delphinella* (*Delphinella*) *crimensis* (Burckhardt, 1912), bed Z105.
Fig. 7: RGM 160 472 *Delphinella* (*Delphinella*) *crimensis* (Burckhardt, 1912), bed Z115.
Fig. 8: RGM 160 463 *Delphinella* (*Delphinella*) *berthei* (Toucas, 1890), bed Z140.
Fig. 9: JK. 44693 *Delphinella* (*Delphinella*) *berthei* (Toucas, 1890), Col du Pin.
Fig. 10: JK. 44699 *Delphinella* (*Delphinella*) *berthei* (Toucas, 1890), Col du Pin.
Fig. 11: RGM 160 457 *Delphinella* (*Delphinella*) *obtusenodosa* (Retowski, 1894), bed Z124.
Fig. 12: RGM 616 909 *Dalmasiceras* n. sp. aff. *dalmasi* Djanélideze, 1921, bed Z12.
Fig. 13: RGM 160 692 *Substeueroceras beneckei* (Mazenot, 1939), bed Z191.

Plate XI

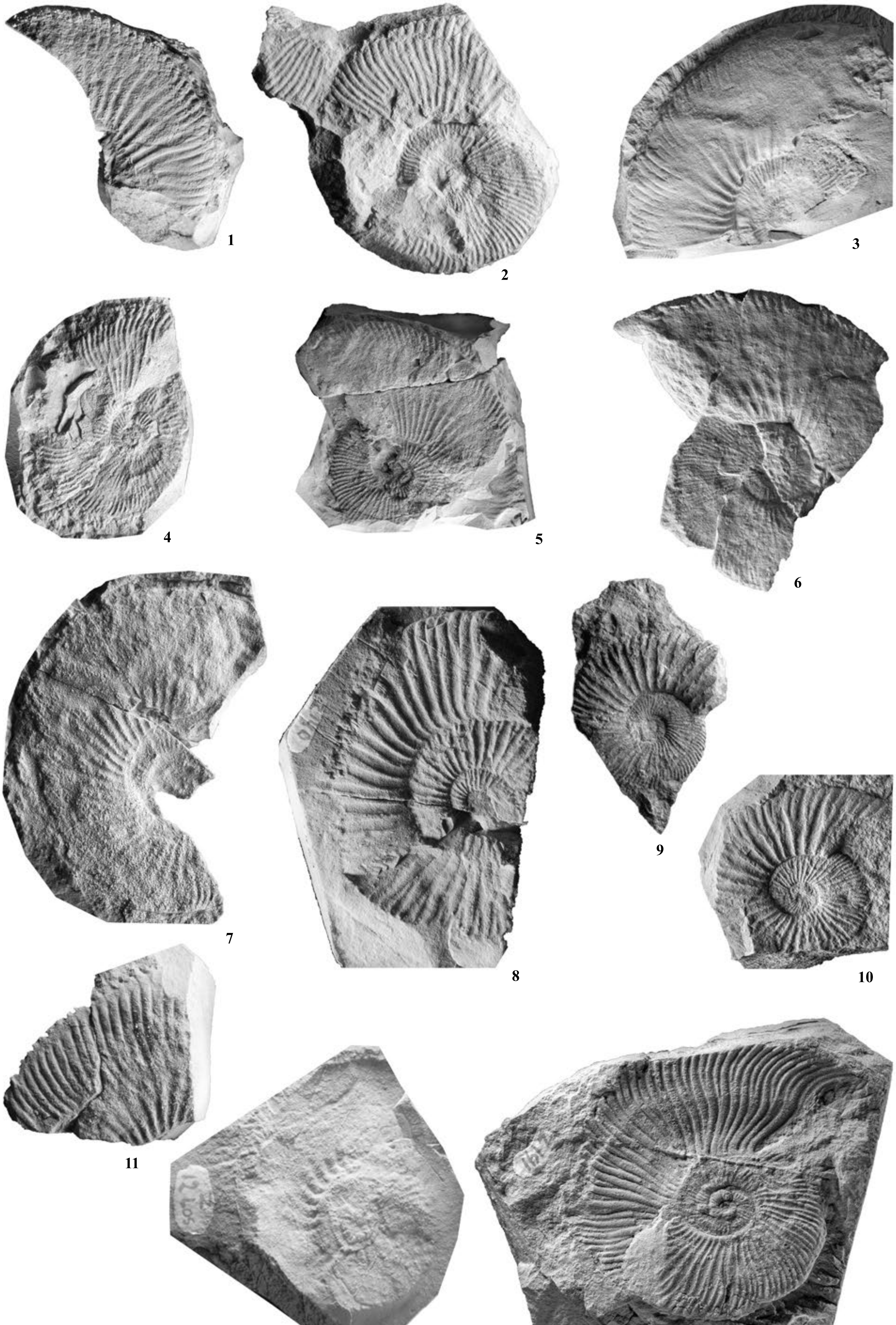

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Plate XII

All specimens in natural size.

Fig. 1: RGM 160 411 *Substeueroceras beneckei* (Mazenot, 1939), bed Z200.
Fig. 2: RGM 617 913 *Substeueroceras beneckei* (Mazenot, 1939), bed Z136.
Fig. 3: RGM 160 732 *Substeueroceras broyonense* sp. nov., bed Z174.
Fig. 4: RGM 617 914 *Substeueroceras broyonense* sp. nov., bed Z137.
Fig. 5: RGM 542 475 *Substeueroceras broyonense* sp. nov., bed Z115.
Fig. 6: RGM 160 702 *Substeueroceras broyonense* sp. nov., bed Z170.
Fig. 7: RGM 160 236 *Substeueroceras* aff. *koeneni* (Steuer, 1897), bed Z132.
Fig. 8: RGM 617 915 *Tirnovella companyi* sp. nov., bed Z143 (syntype).
Fig. 9: RGM 160 237 *Tirnovella companyi* sp. nov., bed Z174 (syntype).
Fig. 10: RGM 160 731 *Tirnovella companyi* sp. nov., bed Z160 (syntype).
Fig. 11: RGM 160 734 *Tirnovella companyi* sp. nov., bed Z187 (syntype).
Fig. 12: RGM 617 917 *Tirnovella bogdanovae* sp. nov., bed Z234.
Fig. 13: RGM 160 698 *Tirnovella bogdanovae* sp. nov. (negative), bed M62.
Fig. 14: Same (positive).

Plate XII

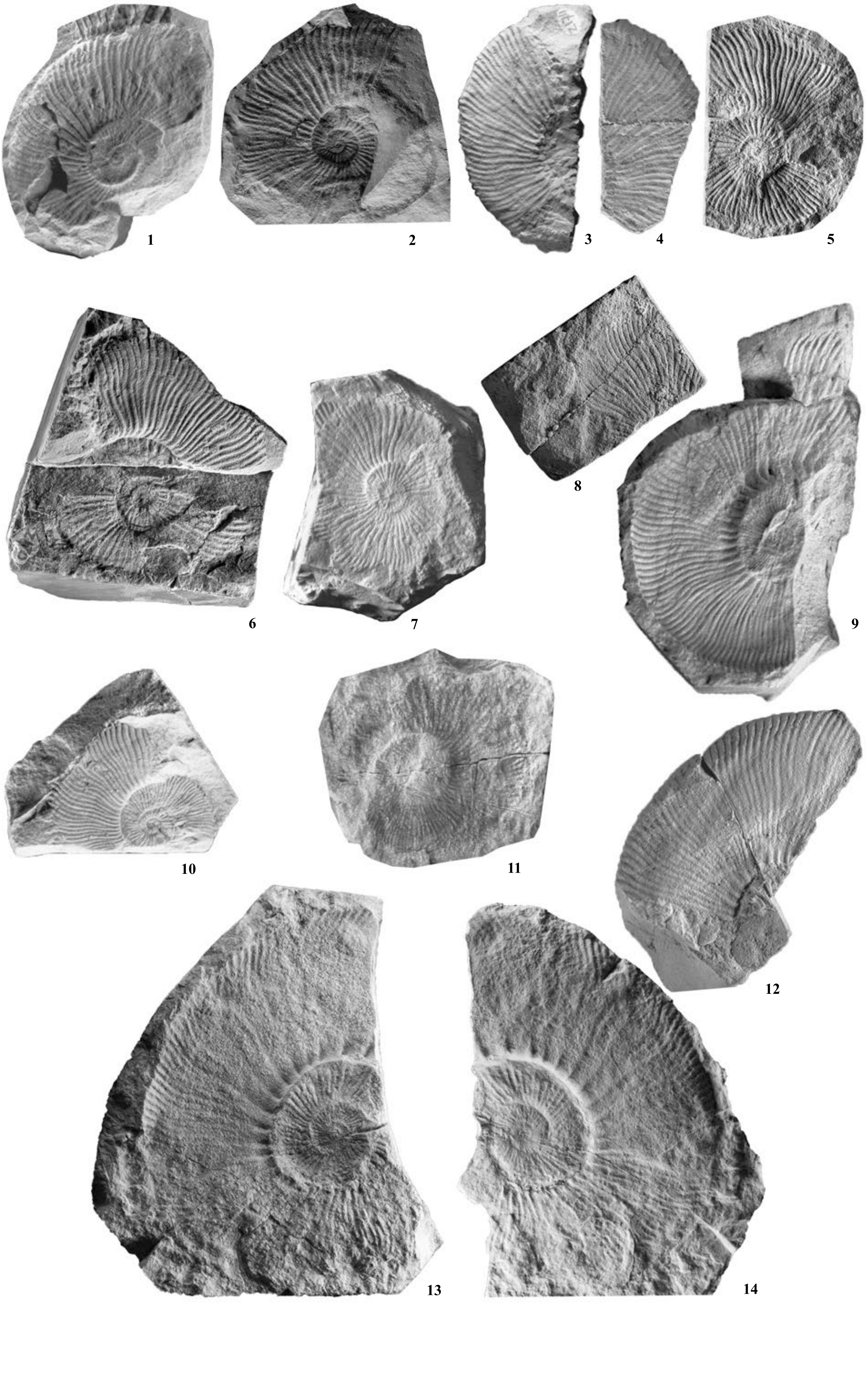

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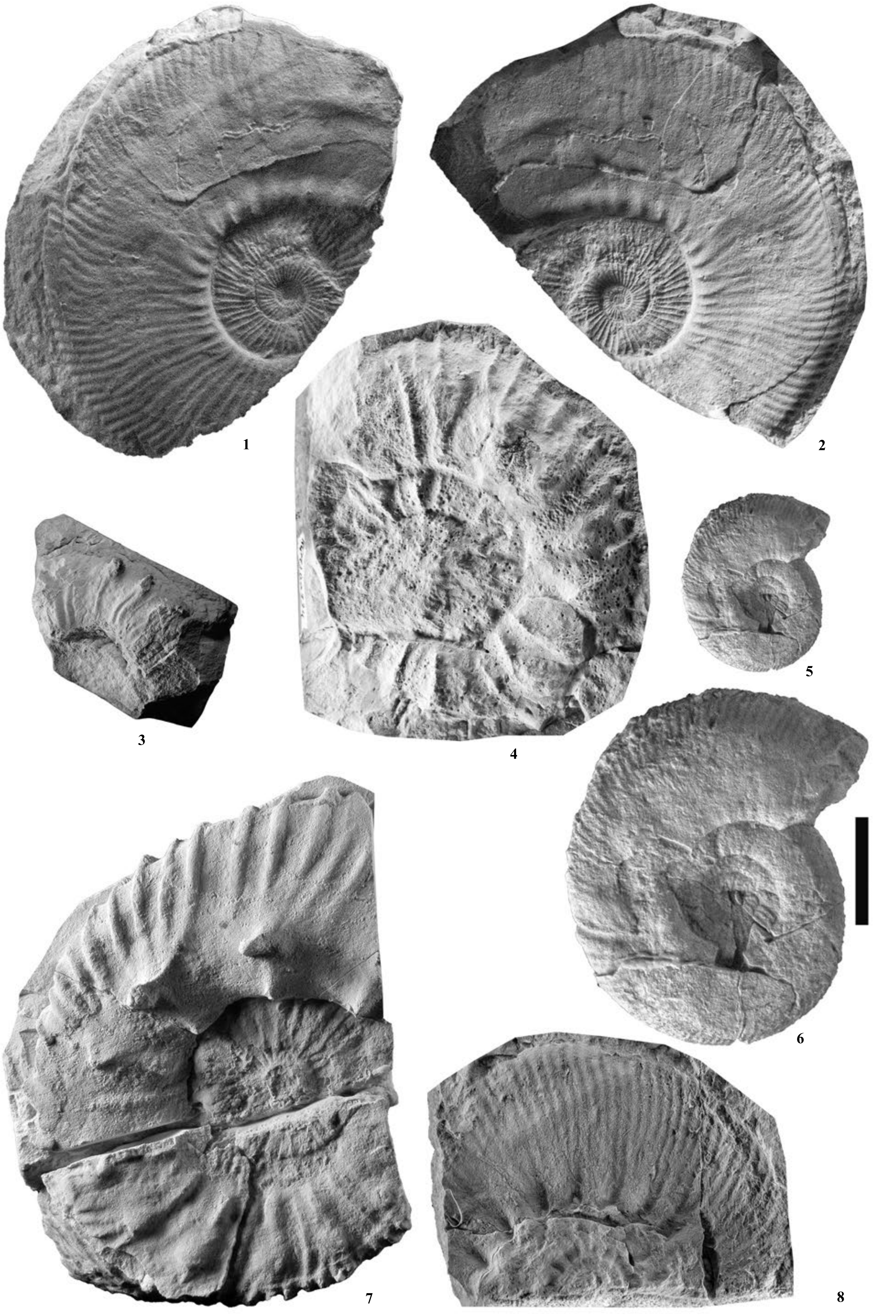
Plate XIII

All specimens in natural size unless marked with a scale bar (10 mm).

Fig. 1: RGM 160 242 *Tirnovella subalpina* (Mazenot, 1939) (positive), bed M53-54.
Fig. 2: Same (negative).
Fig. 3: RGM 160 684 *Neocosmoceras sayni* (m) (Simionescu, 1899), bed Z227.
Fig. 4: RGM 160 334 *Himalayites* (*Himalayites*) cf. *seideli* (Oppel, 1863), bed Z95.
Fig. 5: RGM 617 920 *Proniceras debillon* Djanélidze, 1922, bed Z14.
Fig. 6: Same.
Fig. 7: RGM 617 919 *Himalayites* (*Pomeliceras*) *breveti* (Pomel, 1889), bed Z167.
Fig. 8: RGM 791 152 *Spiticeras* cf. *mutabile* Djanélidze, 1922, bed Z241.

Plate XIII



west of Caravaca, south-eastern Spain. Thesis University of Amsterdam, pp. 1-143, 10 pls.

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Plate XIV

All specimens in natural size.

Fig. 1: GIA J. 9932 *Negreliceras proteum* (Retowski, 1894) (negative), Z206-252.
Fig. 2: Same (positive).
Fig. 3: RGM 365 224 *Protancyloceras punicum* Arnould-Saget, 1953, bed M43.
Fig. 4: RGM 365 225 *Protancyloceras punicum* Arnould-Saget, 1953, bed Z227.
Fig. 5: RGM 212 416 *Protancyloceras bicostatum* Arnould-Saget, 1953 (right side). Bed Z195.
Fig. 6: Same (left side).
Fig. 7: RGM 365 219 *Protancyloceras acutituberculatum* Arnould-Saget, 1953, bed M35.
Fig. 8: RGM 791 153 *Bochianites* cf. *ambiguus* (Arkadiev, Rogov & Perminov, 2011), bed Z93.
Fig. 9: RGM 791 154 *Bochianites crymensis* Arkadiev, 2008 (negative), bed Z198.
Fig. 10: Same (positive).
Fig. 11: RGM 791 155 *Bochianites aculeatus* sp. nov., bed Z249.
Fig. 12: RGM 791 156 *Ptychophylloceras ptychoicum* (Quenstedt, 1845), bed Z140.
Fig. 13: RGM 791 157 *Ptychophylloceras ptychoicum* (Quenstedt, 1845), bed Z142.
Fig. 14: RGM 791 160 *Ptychophylloceras ptychoicum* (Quenstedt, 1845), bed Z208.
Fig. 15: RGM 162 276 *Ptychophylloceras inordinatum* (Toucas, 1890), bed Z102.
Fig. 16: RGM 162 277 *Ptychophylloceras inordinatum* (Toucas, 1890), bed Z128-138.
Fig. 17: RGM 791 173 *Holcophylloceras silesiacum* (Oppel, 1865), bed Z141.
Fig. 18: RGM 162 274 *Hypophylloceras serum* (Oppel, 1865), bed Z158.

Plate XIV

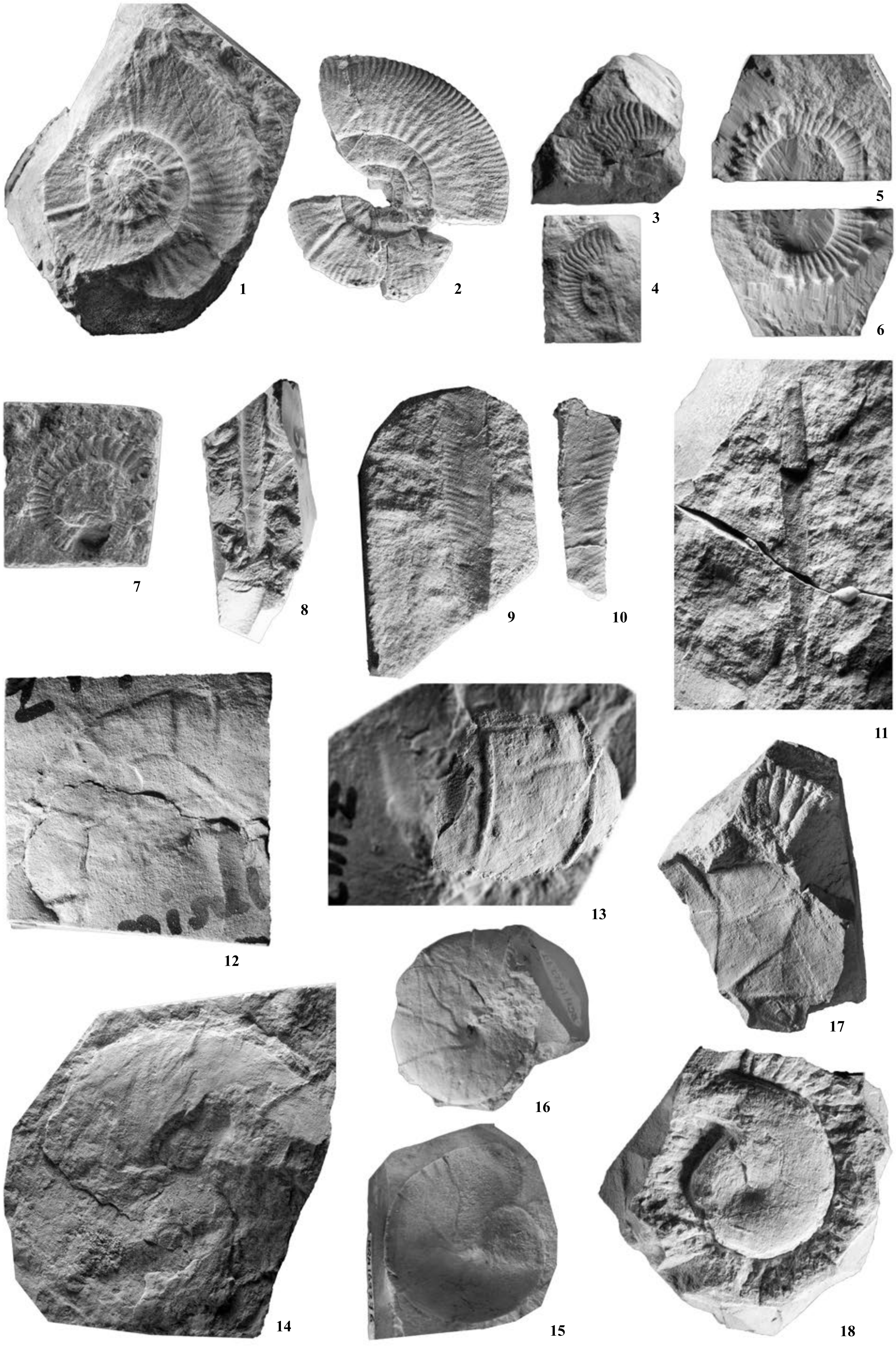

Plate XV

All specimens in natural size.
Fig. 1: RGM 162 395 *Hypophylloceras serum* (Oppel, 1865), bed M6-7.
Fig. 2: RGM 791 164 *Lytoceras subfimbriatoides* sp. nov., bed Z141 (syntype).
Fig. 3: RGM 365 136 *Lytoceras subfimbriatoides* sp. nov., bed Z198 (syntype).
Fig. 4: RGM 365 134 *Lytoceras subfimbriatoides* sp. nov., bed Z95 (syntype).

Plate XV

Plate XVI

All specimens in natural size.

Fig. 1: RGM 365 173 *Lytoceras subfimbriatoides* sp. nov., bed M6-7 (syntype).
Fig. 2: RGM 365 132 *Lytoceras subfimbriatoides* sp. nov., bed Z95 (syntype).
Fig. 3: RGM 365 133 *Lytoceras subfimbriatoides* sp. nov., bed Z95 (syntype).
Fig. 4: RGM 791 163 *Lytoceras subfimbriatoides* sp. nov., bed Z135 (syntype).
Fig. 5: RGM 365 171 *Lytoceras subfimbriatoides* sp. nov. (negative), bed Z97.
Fig. 6: Same (positive) (syntype).
Fig. 7: RGM 365 174 *Lytoceras sutile* (Oppel, 1865), bed M8.

Plate XVI

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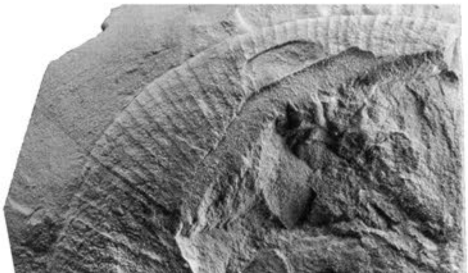

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Plate XVII

All specimens in natural size unless marked with a scale bar (10 mm).
Fig. 1: RGM 791 165 *Lytoceras sutile* (Oppel, 1865), bed Z169.
Fig. 2: RGM 791 166 *Protetragonites quadrisulcatus* (d'Orbigny, 1841), bed Z152.
Fig. 3: RGM 365 804 *Protetragonites quadrisulcatus* (d'Orbigny, 1841), bed Z102.
Fig. 4: RGM 791 169 *Haploceras carachtheis* (m) (Zeuschner, 1854), (ventral side with notches), bed Z199.
Fig. 5: Same (lateral side).
Fig. 6: RGM 161 678 *Haploceras carachtheis* (m) (Zeuschner, 1854), bed Z193.
Fig. 7: RGM 791 170 *Haploceras carachtheis* (M) (Zeuschner, 1854) (= *H. elimatum*), bed Z243.
Fig. 8: RGM 791 172 *Haploceras carachtheis* (M) (Zeuschner, 1854) (= *H. elimatum*), bed Z234.

Plate XVII

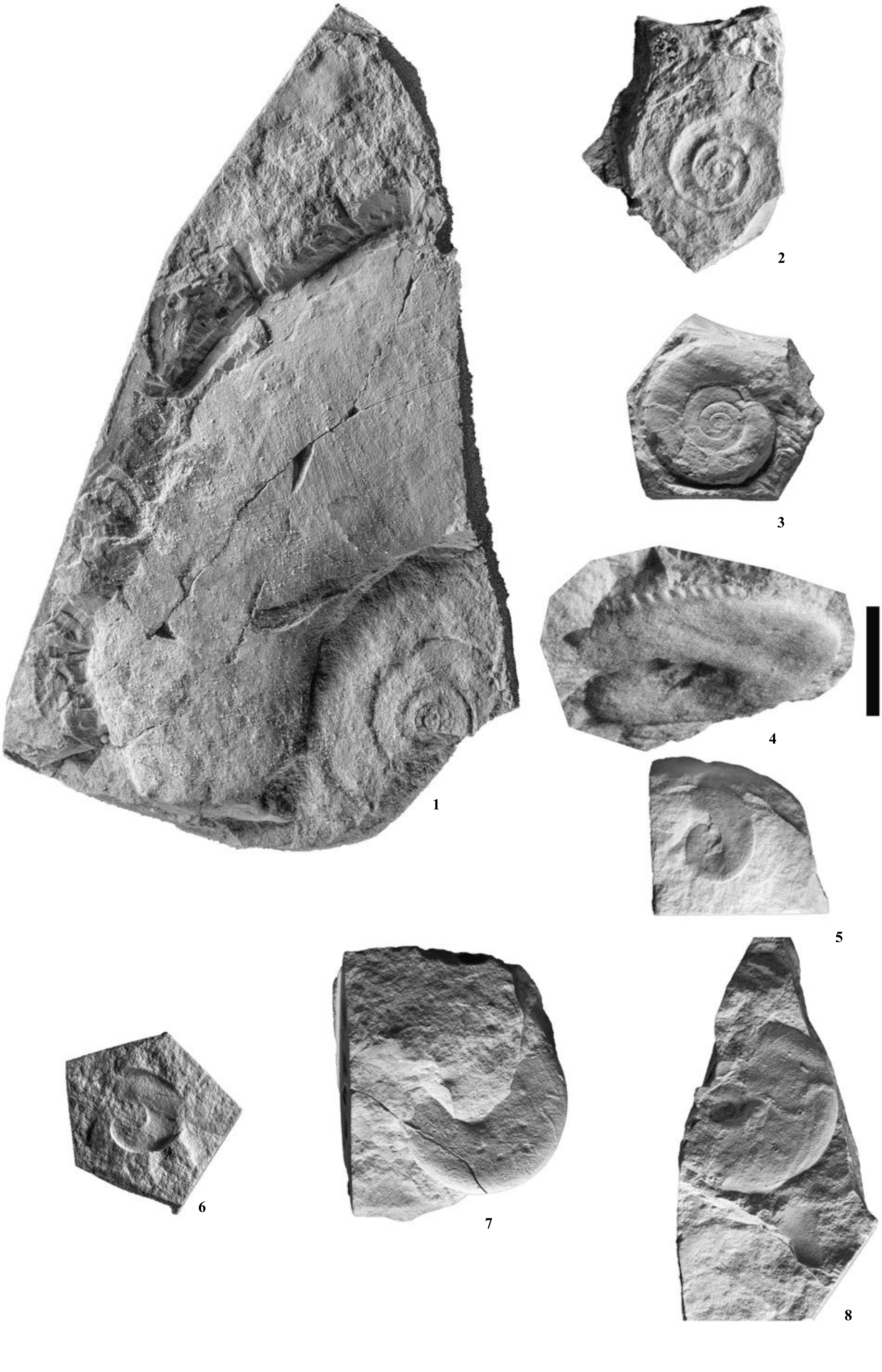

Plate XVIII

Belemnites from the Jurassic/Cretaceous boundary beds in the Río Argos (section Z). Every specimen is figured from two sides (except fig. 1). The image on the left shows the ventral side of the rostrum unless indicated otherwise. The image on the right shows the lateral side of the rostrum. In these lateral views the ventral side is either to the left (VL), or to the right (VR). In all specimens the alveolar view is shown (if known). Scale bar shows a centimetric scale.

Fig. 1: RGM 345851 *Hibolithes* cf. *fellabrunensis* (Vetters, 1905), Z0, Vulgaris Zone, (VL).

Figs 2-3: RGM 345863 *Hibolithes conradi* (Kilian, 1889), Z72, *B. jacobi* Subzone, (VL).

Figs 4-5: RGM 345226 *Conobelus conophorus* (Oppel, 1865), Z10, *B. jacobi* Subzone, (VR); refigured from Janssen (1997, pl. 2, figs 1-2).

Figs 6-7: RGM 345853 *Conobelus siciliensis* Combémorel & Mariotti, 1986 (juv.), Z0, Vulgaris Zone, (VL).

Figs 8-9: RGM 345229 *Conobelus* sp. (aff. *siciliensis* Combémorel & Mariotti, 1986), Z202, *S. floquinensis* Subzone, (VL); refigured from Janssen (1997, pl. 3, figs 1-2). Stippled line indicates depth of alveolus.

Figs 10-12: RGM 345287 *Duvalia* cf. *tithonia* (Oppel, 1865), Z78, *B. jacobi* Subzone; fig. 12. Cross-section shows typical dorso- and ventral excavations.

Figs 13-14: RGM 345850 "*Pseudobelus*" *fischeri* Combémorel & Mariotti, 1986, Z-2 Vulgaris Zone, (position ventral/dorsal side unknown).

Figs 15-16: RGM 345228 *Duvalia* cf. *apenninica* Combémorel & Mariotti, 1986, Z37, *B. jacobi* Subzone, (VR); refigured from Janssen (1997, pl. 2, figs 3-4); arrow indicates length of alveolar groove. Stippled line indicates depth of alveolus.

Fig. 17a-b: RGM 345858 *Duvalia* sp. (juv.) (cf. ?*apenninica* Combémorel & Mariotti, 1986), Z18, *B. jacobi* Subzone, (VL?). Cross-section approximately from middle part of rostrum.

Fig. 18a-b: *ibid*. (x2).

Figs 19-20: RGM 345290 *Duvalia* cf. *esba* (Gregorio, 1885), Z85-87, *B. jacobi* Subzone, (VR); refigured from Janssen (1997, pl. 2, figs 5-6).

Figs 21-22: RGM 345225 group *Duvalia lata* (Blainville, 1827), Z131, *B. jacobi* Subzone, (VL).

Plate XVIII

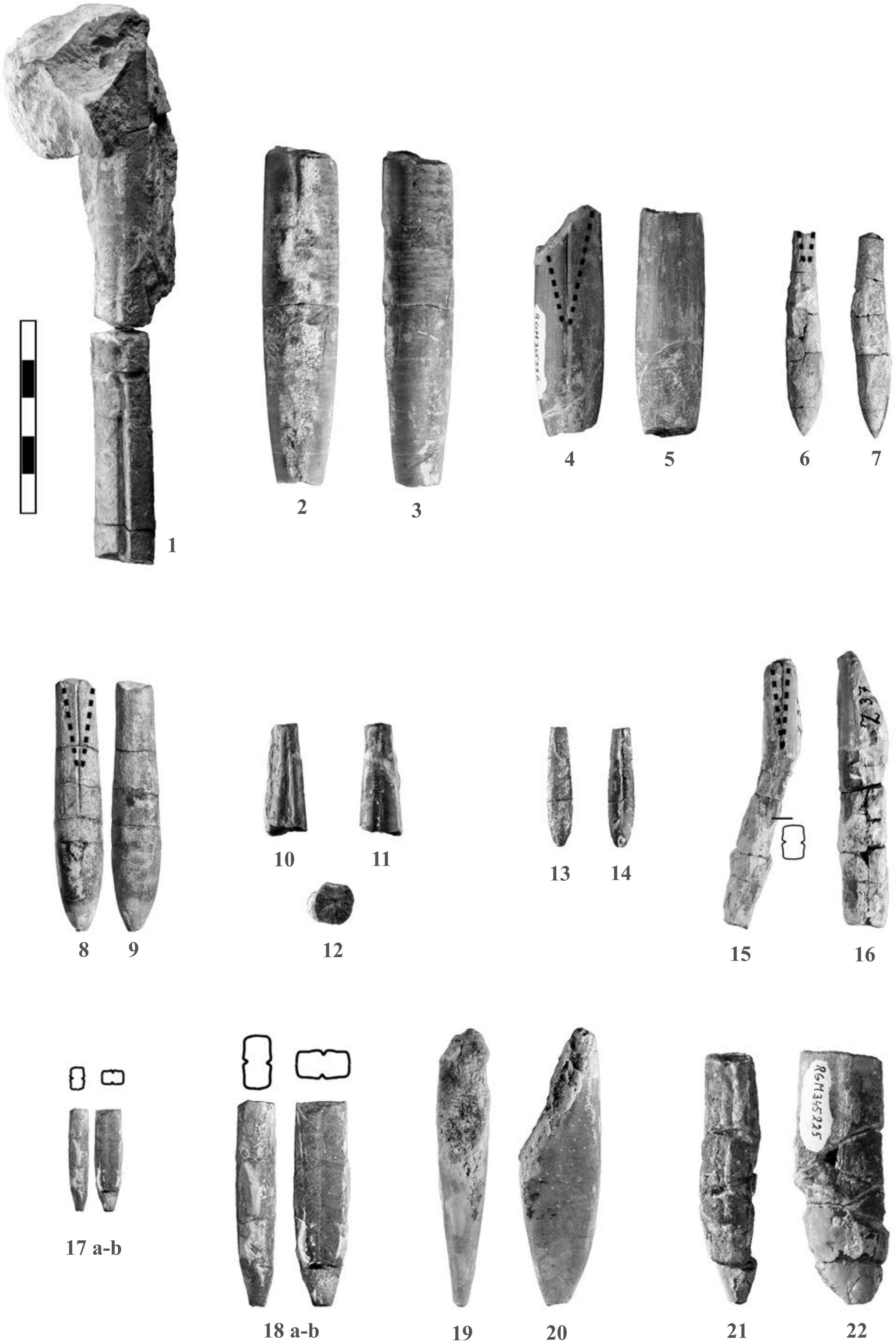

Plate XIX

Microfacies of the Intermedia-Brevis and the Collomi Subzones of the Crassicollaria Zone
Scale bar 100 µm

Fig. A: Saccocoma packstone with abundant fragments of planktonic crinoids *Saccocoma* Agassiz. Present are also *Crassicollaria intermedia*, *Crassicollaria massutiniana, Crassicollaria parvula* and *Calpionella alpina*. Sample Z1.

Fig. B: Fragments of *Paravalvulina* sp., *Colomisphaera carpathica* and *Calpionella grandalpina* in the saccocoma packstone of Fig. A. Sample Z1.

Fig. C: Calpionella-globochaete microfacies (wackestone to packstone) with frequent crassicollarians. Sample Z4.

Fig. D: Globochaete-calpionellid microfacies (packstone) with common cysts of *Colomisphaera lapidosa* and *Colomisphaera carpathica*. Sample Z5.

Fig. E: Biomicritic limestone (wackestone) with *Crassicollaria colomi*, *Crassicollaria parvula* and *Calpionella alpina*. Sample Z11.

Fig. F: Slightly bioturbated biomicrite limestone (wackestone) with nest accumulations of bioclasts. Pyrite is scattered in the matrix or is impregnated in the bioclasts. Sample Z19.

Plate XIX

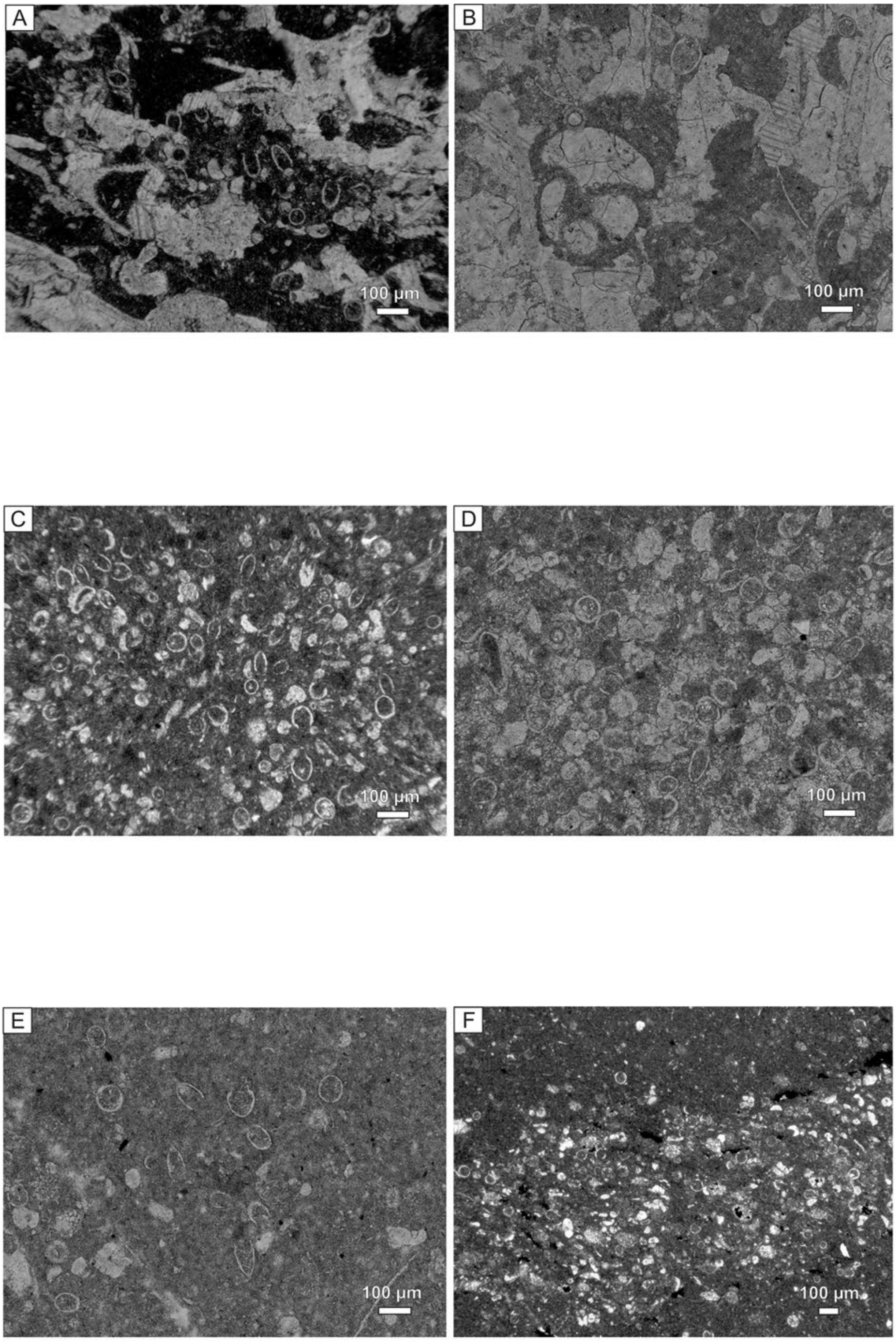

Plate XX

Microfossils of the Intermedia-Brevis and the Collomi Subzones of the Crassicollaria Zone
Scale bar 50 µm.

Fig. A: *Crassicollaria brevis* Remane. Sample Z7.
Fig. B: *Calpionella elliptalpina* Nagy and *Crassicollaria brevis* Remane. Sample Z4.
Fig. C: *Crassicollaria colomi* Doben. Sample Z9.
Figs D-F: *Crassicollaria massutiniana* (Colom). Samples Z13, Z14, Z21.
Figs G- I: *Crassicollaria parvula* Remane. Samples Z14, Z30, Z31.
Fig. J: *Colomisphaera cieszynica* Nowak. Sample Z1.
Fig. K: *Colomisphaera carpathica* (Borza). Sample Z12.
Fig. L: *Colomisphaera lapidosa* (Vogler). Sample Z1.
Figs M, N: *Colomisphaera fortis* Řehánek. Sample Z4, Z7.
Fig. O: *Didemnoides moreti* (Durand-Delga). Sample Z9.

Plate XX

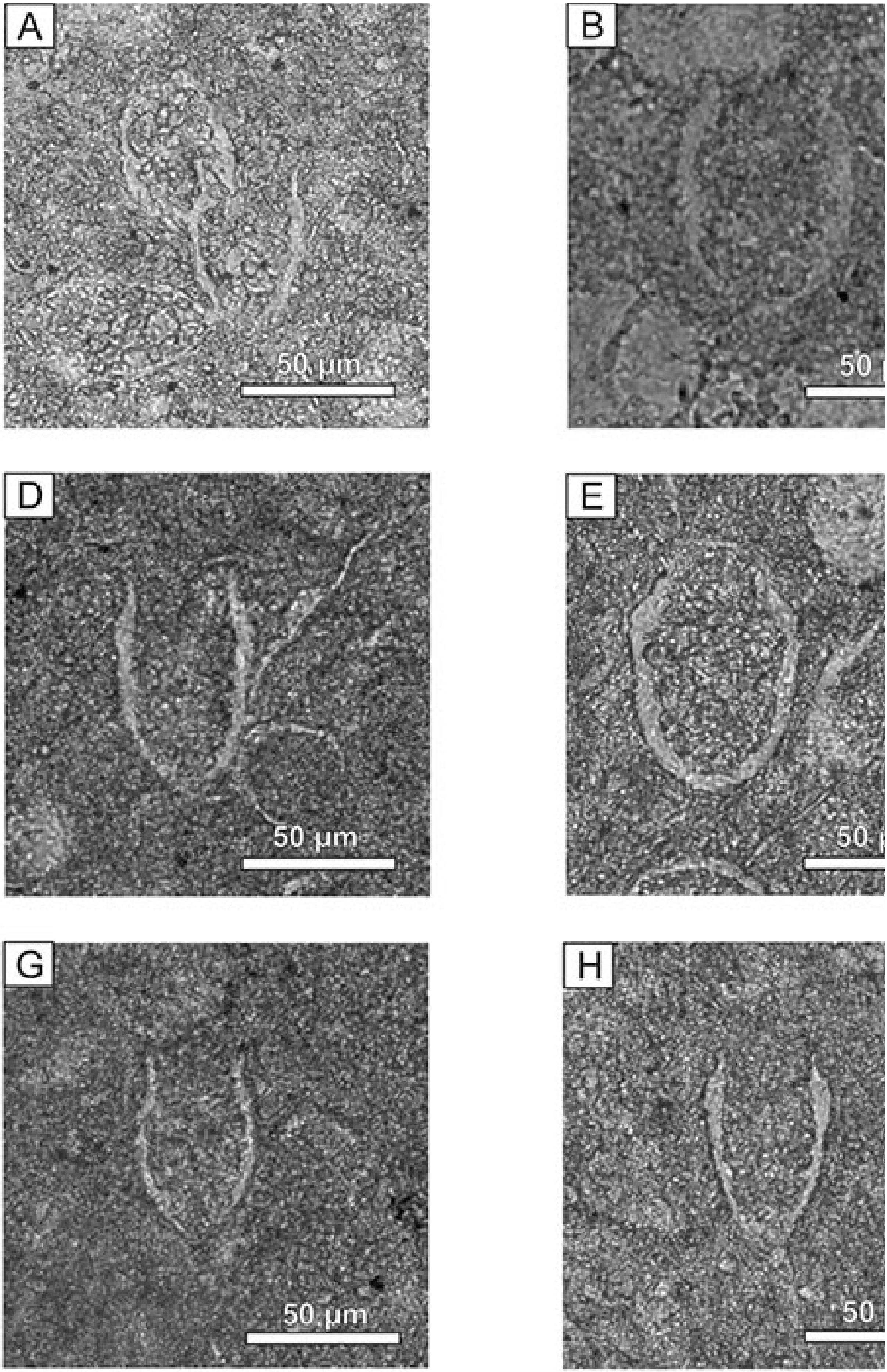

Plate XXI

Microfacies of the Alpina Subzone of the Calpionella Zone

Scale bar 100 µm

Fig. A: Biomicrite of calpionella-globochaete microfacies (wackestone) in which small sphaerical forms of *Calpionella alpina* are dominant. Calcified radiolarians commonly occur. Sample Z40.

Fig. B: Calpionella-globochaete packstone. Sample Z45.

Fig. C: Biomicrite (mudstone) with very rare calpionellid loricas. Sample Z50.

Fig. D: Globochaete-calpionellid-radiolarian microfacies (wackestone) in which rare, large, redeposited forms of *Calpionella grandalpina* occur. Sample Z51.

Fig. E: Small lithoclast (dark) in biomicrite of globochaete-calpionellid-radiolarian microfacies (wackestone). Indications of dynamic water movements. Sample Z57.

Fig. F: Biopelmicritic packstone with huge accumulations of loricas, specimens of globochaete and dark pellets; the biopelmicritic packstone passes into biomicritic wackestone with the same content of bioclasts. Sample Z64.

Plate XXI

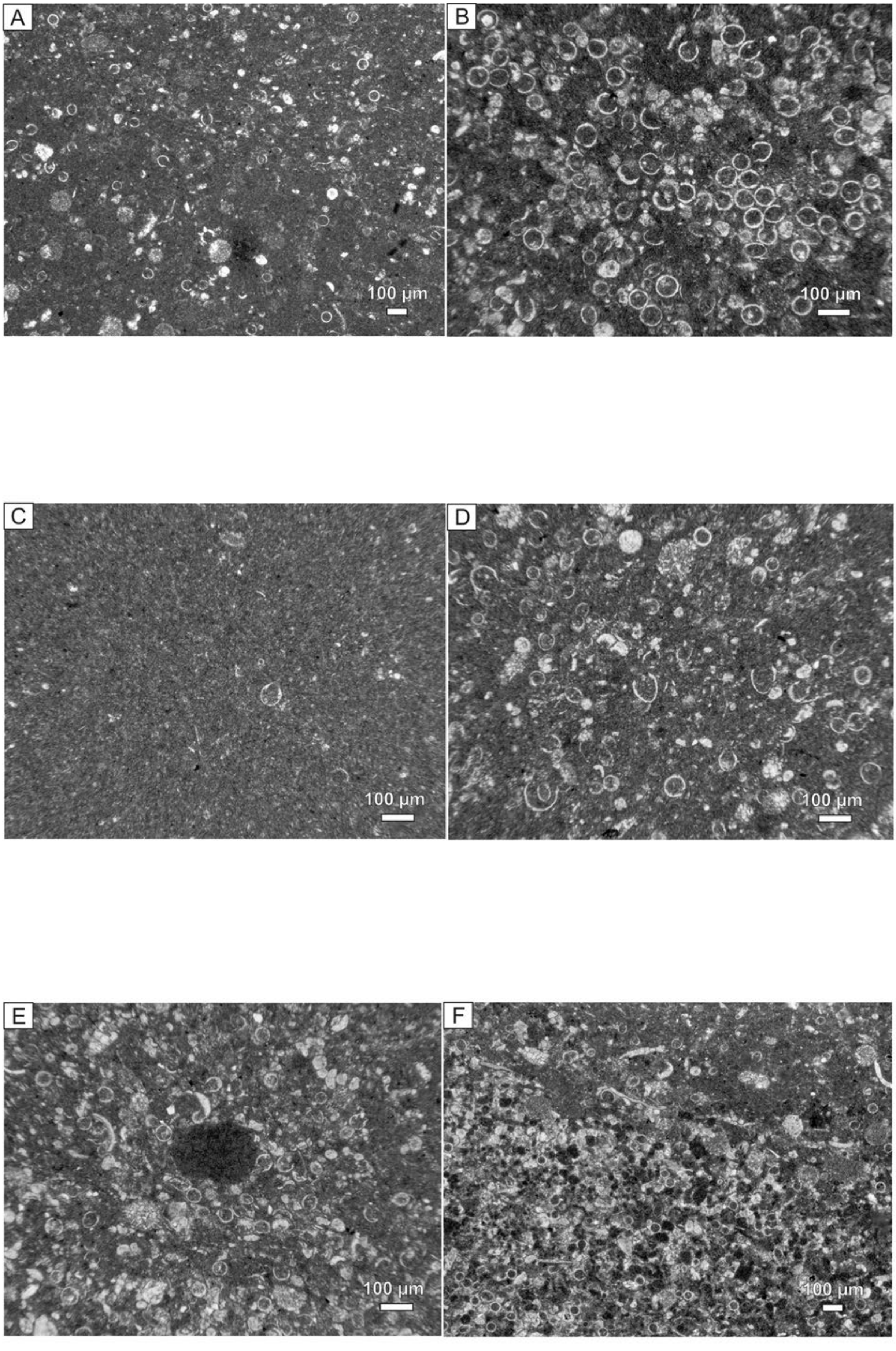

Plate XXII

Microfossils of the Alpina Subzone of the Calpionella Zone
Scale bar 50 µm.
Figs A, B: *Calpionella alpina* Lorenz. Samples Z40, Z45.
Figs C, D: *Calpionella grandalpina* Nagy. Samples Z53, Z40.
Fig. E: *Calpionella* sp. Sample Z 56.
Fig. F: *Crassicollaria parvula* Remane. Sample Z54.
Figs G, H: *Tintinnopsella carpathica* (Murgeanu & Filipescue). Samples Z56, Z60.
Fig. I: *Tintinnopsella doliphormis* (Colom). Sample Z64.
Fig. J: Test of calcified nasselarian radiolarian. Sample Z65.
Fig. K: *Cadosina semiradiata fusca* Wanner. Sample Z53.
Fig. L: *Colomisphaera lapidosa* (Vogler). Sample Z56.
Fig. M: *Stomiosphaerina proxima* Řehánek. Sample Z58.
Fig. N: *Colomisphaera carpathica* (Borza). Sample Z57.
Fig. O: *Colomisphaera cieszynica* Nowak. Sample Z65 .

Plate XXII

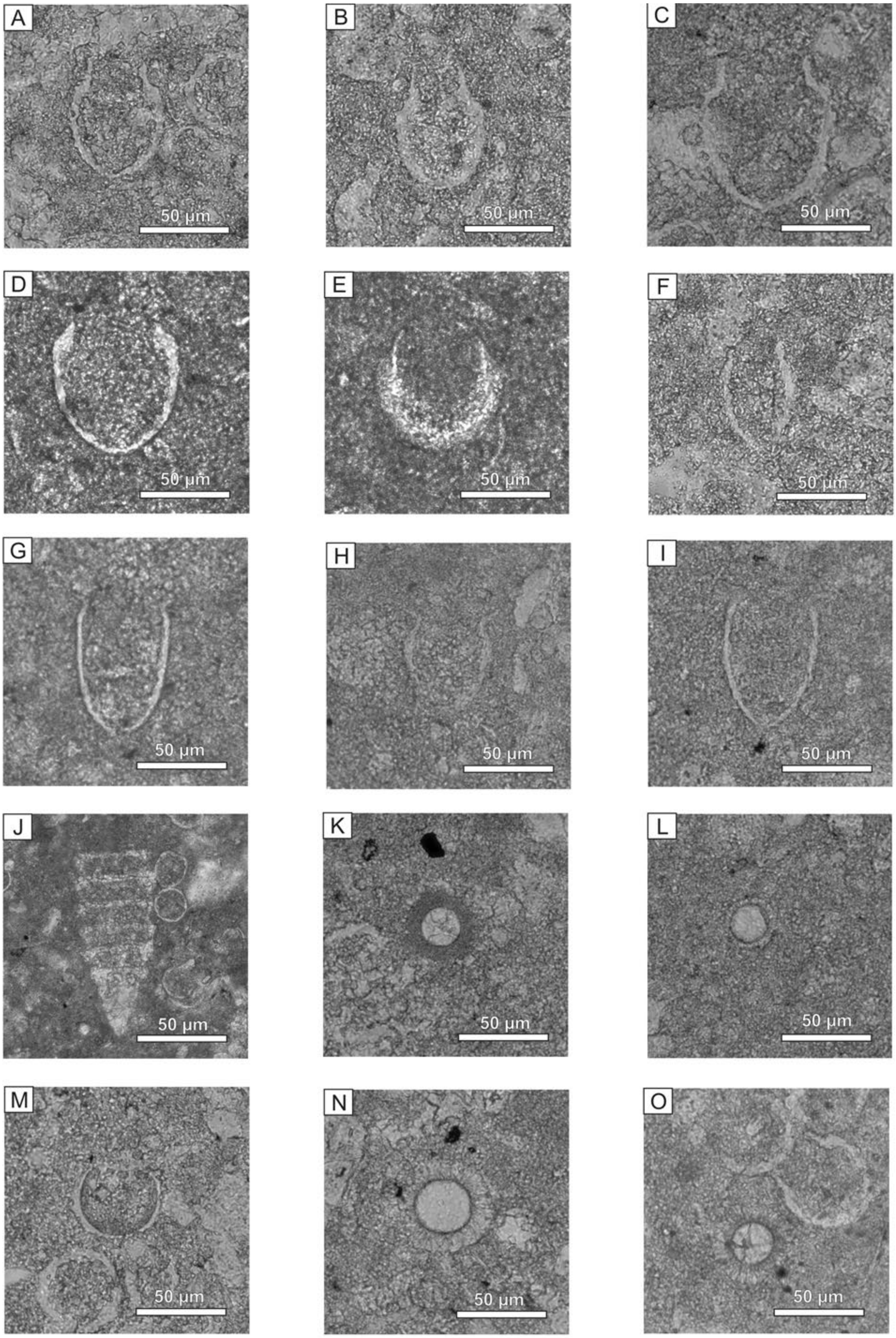

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Plate XXIII

Microfossils of the Ferasini Subzone of the Calpionella Zone
Scale bar 100 µm.
Fig. A: *Remaniella ferasini* (Catalano). Sample Z107.
Figs B, C: *Remaniella catalanoi* Pop. Samples Z 94, Z115.
Fig. D: *Remaniella durandelgai* Pop. Sample Z101.
Fig. E: *Remaniella colomi* Pop. Sample Z80.
Fig. F: *Remaniella borzai* Pop. Sample Z80.
Fig. G: *Crassicollaria parvula* Remane. Sample Z105.
Fig. H: *Calpionella alpina* Lorenz. Samples Z107.
Fig. I: *Tintinnopsella doliphormis* (Colom). Sample Z107.
Scale bar 50 µm.
Fig. J: *Stomiosphaerina proxima* Řehánek. Sample Z133.
Fig. K: *Colomisphaera lapidosa* (Vogler). Sample Z136.
Fig. L: *Colomisphaera carpathica* (Borza). Sample Z132.
Fig. M: *Colomisphaera cieszynica* Nowak. Sample Z136.
Fig. N: *Cadosina semiradiata semiradiata* Wanner. Sample Z135.
Fig. O: *Cadosina semiradiata fusca* Wanner. Sample Z132.

Plate XXIII

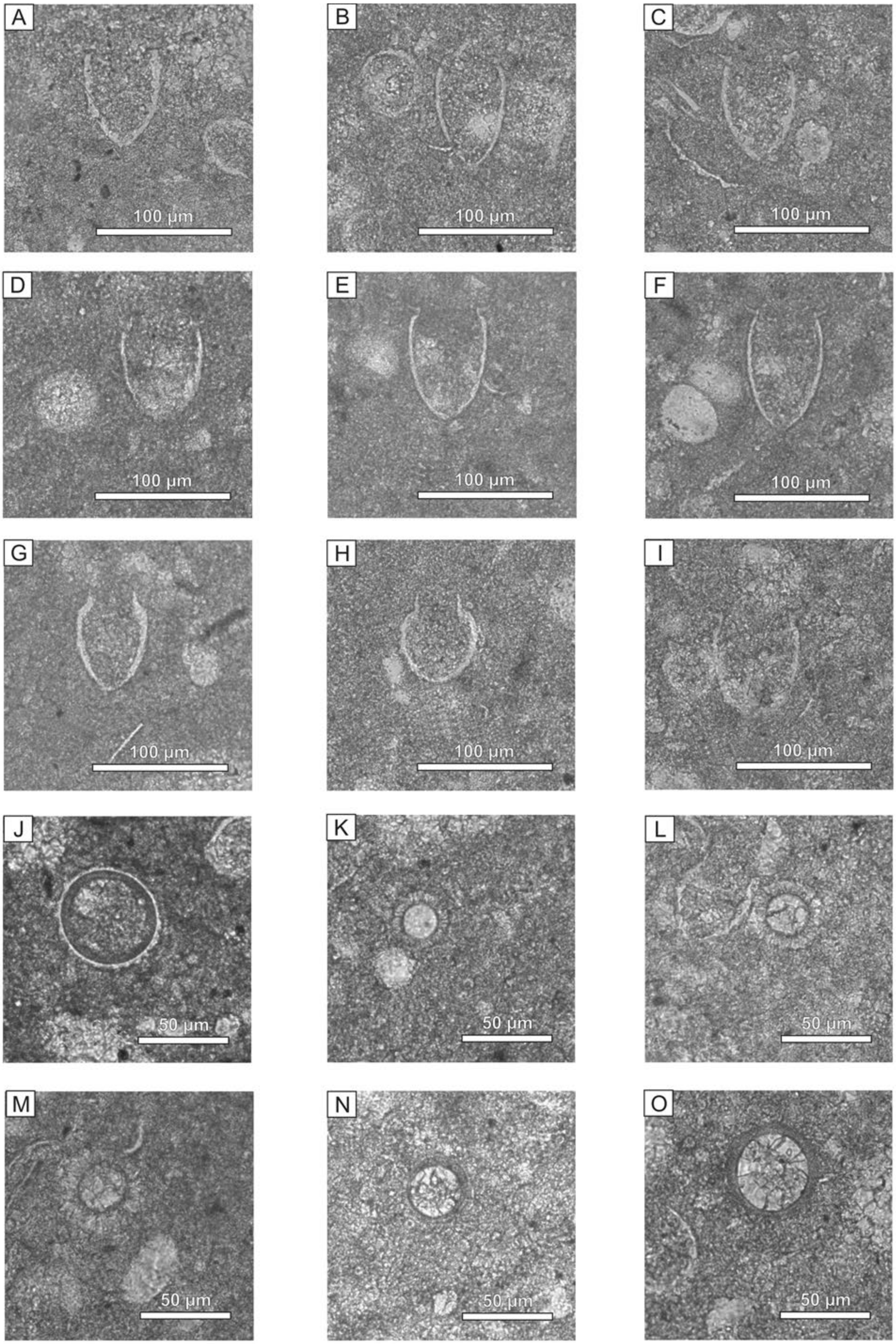
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Plate XXIV

First appearance of loricas morphologically resembling *Calpionella elliptica.*
Sample Z97. Scale bar 100 μm.

Plate XXIV

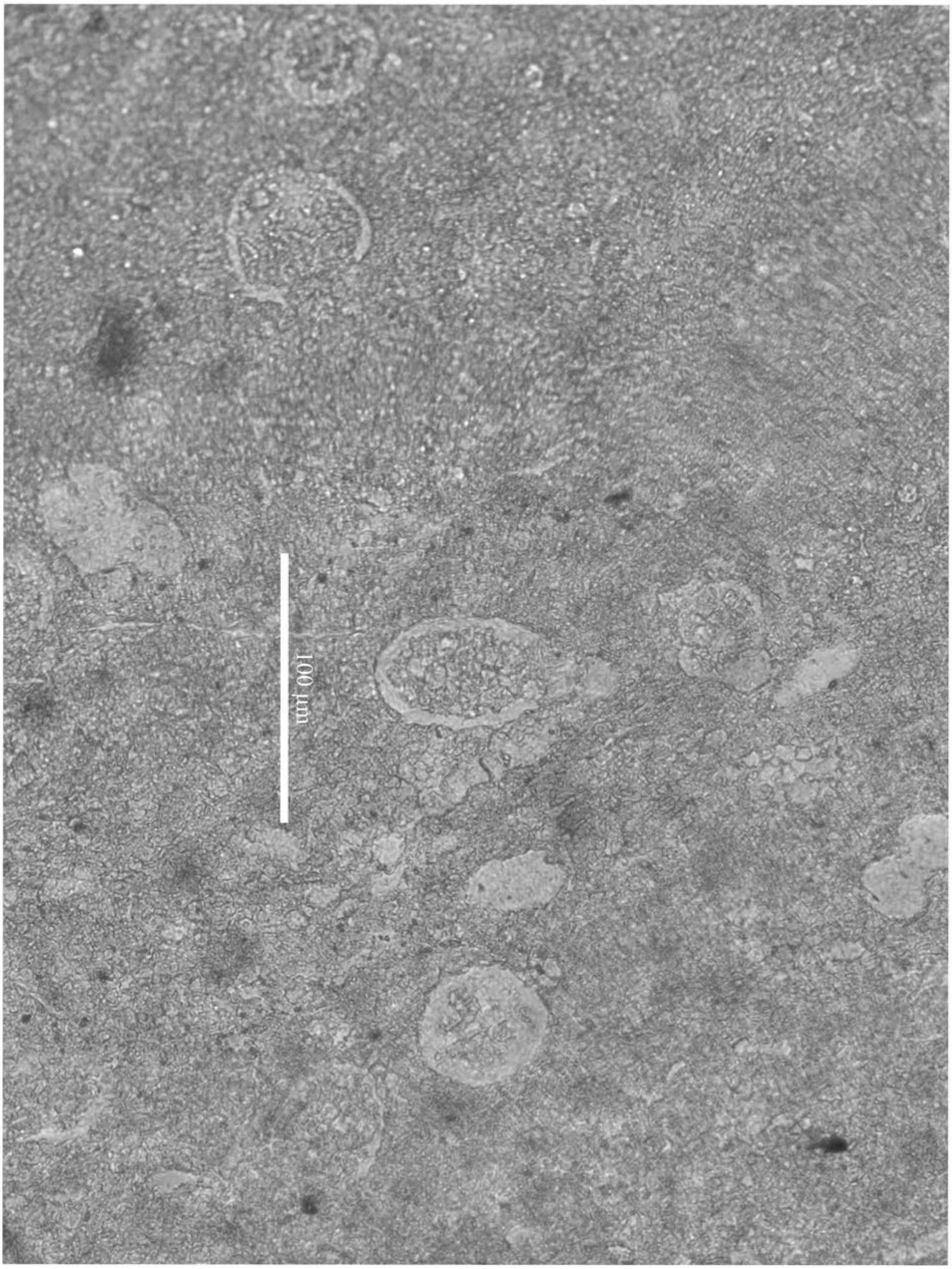

Plate XXV

Microfacies of the Ferasini and Elliptica Subzones of the Calpionella Zone
Scale bar 100 µm.

Fig. A: Biomicritic wackestone of calpionella-radiolarian microfacies with stylolites and fractures filled with pyrite; in addition calcified radiolarians impregnated by pyrite. Sample Z133.
Fig. B: Slightly bioturbated calpionella globochaete wackestone. Sample Z143.
Fig. C: Remaniellid loricas in calpionella globochaete wackestone. Sample Z142.
Fig. D: Small ooid in biomicritic wackestone of calpionellid-globochaete microfacies. Indications of dynamic water movements. Sample Z155.
Fig. E: *Calpionella elliptica* in biomicrite (wackestone). Sample Z177.
Fig. F: Biomicritic wackestone of calpionella-radiolaria microfacies. Sample Z194.

Plate XXV

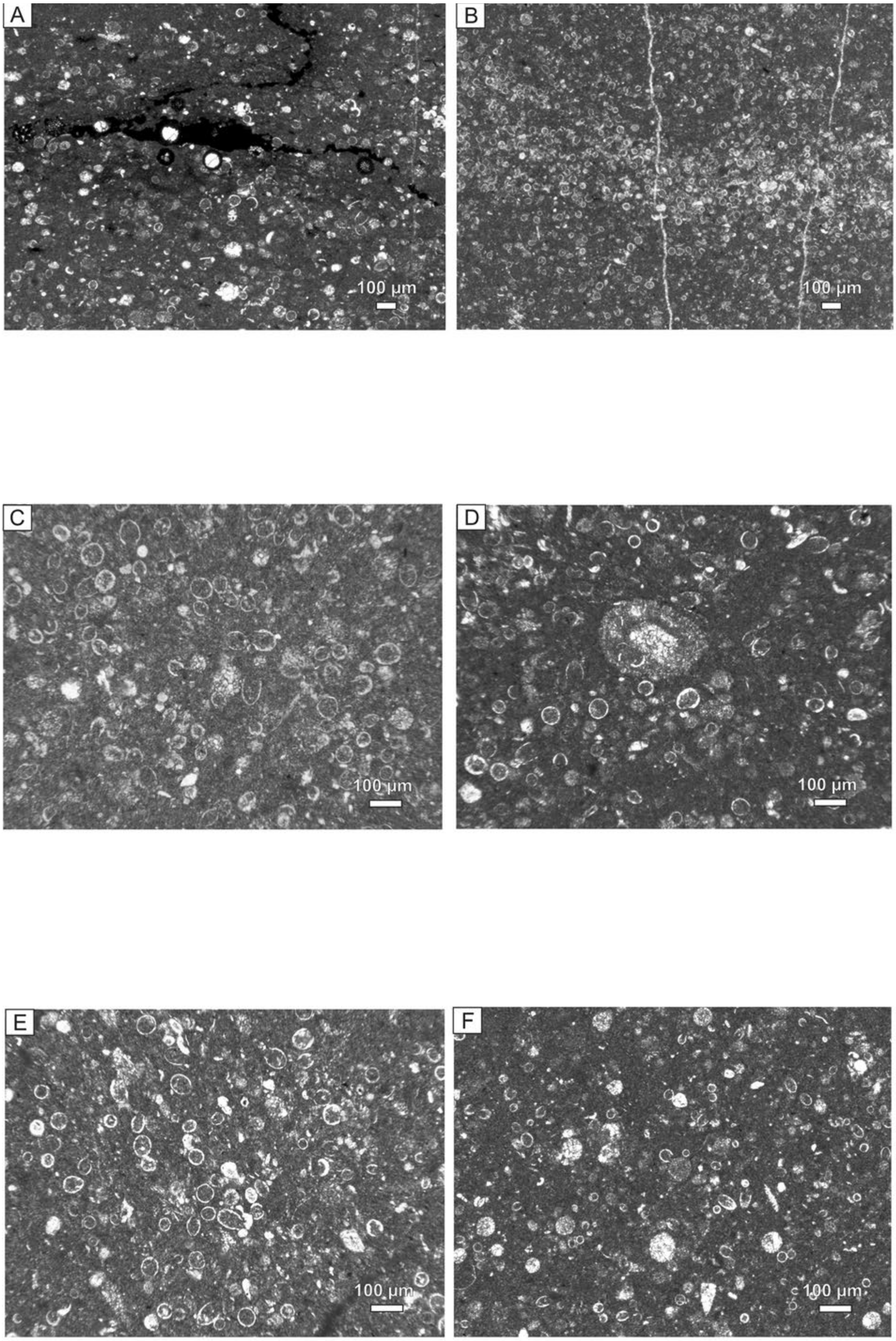

Plate XXVI

Microfossils of the Elliptica Subzone of the Calpionella Zone
Scale bar 100 µm.
Figs A, B: *Calpionella elliptica* (Cadisch). Samples Z144, Z150.
Fig. C: *Remaniella catalanoi* Pop. Sample Z191.
Fig. D: *Remaniella durandelgai* Pop. Sample Z213.
Figs E, F: *Remaniella filipescui* Pop. Sample Z182.
Fig. G: *Remaniella cadischiana* Pop. Sample Z205.
Figs H, I: *Tintinnopsella carpathica* (Murgeanu & Filipescue). Samples Z201, Z237.
Figs J, K: *Lorenziella hungarica* Knauer & Nagy. Sample Z219.
Fig. L: *Colomisphaera heliosphaera* (Vogler). Sample Z192.
Fig. M: *Colomisphaera conferta* Řehánek, Sample Z192.
Fig. N: *Stomiosphaera wanneri* Borza. Sample Z196.
Fig. O: *Cadosina semiradiata cieszynica* (Nowak). Sample Z194.

Plate XXVI

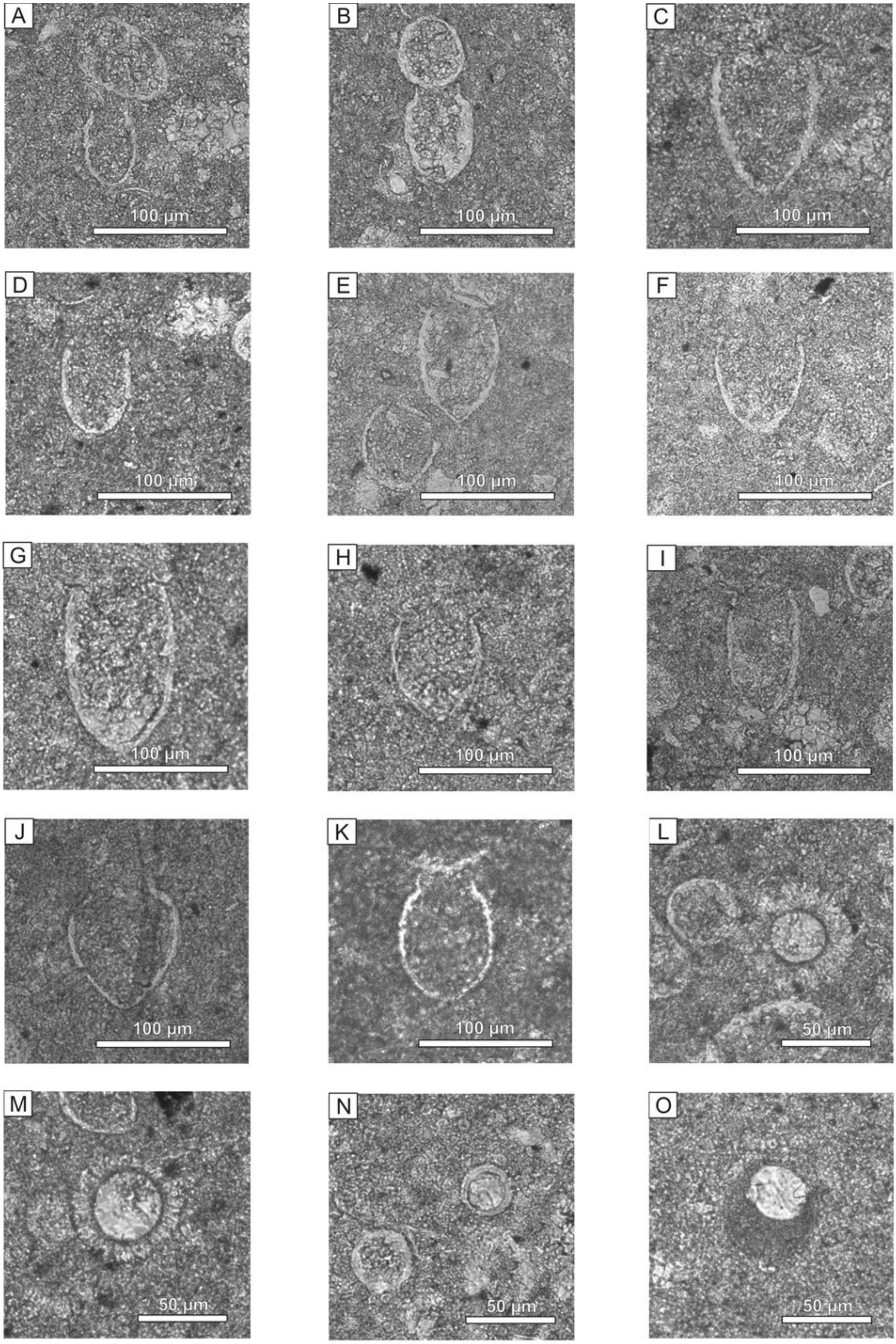
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Plate XXVII

Calcareous nannofossil taxa. All micrographs are under crossed nicols except 14, 16, 17. Scale bar = 5 µm

Fig. 1: *Retacapsa angustiforata*; sample Z256.
Fig. 2: *Rhagodiscus nebulosus*; sample Z188.
Fig. 3: *Cretarhabdus octofenestratus*; sample Z215.
Fig. 4: *Eiffellithus primus*; sample Z243.
Fig. 5: *Cruciellipsis cuvillieri*; sample Z226.
Fig. 6: *Rhagodiscus asper*; sample Z65.
Fig. 7: *Umbria granulosa granulosa*; sample Z215.
Fig. 8: *Umbria granulosa minor*; sample Z215
Fig. 9: *Hexalithus geometricus*; sample Z13.
Fig. 10: *Polycostella senaria*; sample Z37.
Fig. 11: *Tubodiscus jurapelagicus*; sample Z215.
Fig. 12: *Cretarhabdus surirellus*; sample Z206.
Fig. 13: *Nannoconus erbae*; sample Z7.
Fig. 14: *Nannoconus puer*; sample Z13.
Fig. 15: *Nannoconus wintereri*; sample Z83.
Fig. 16: *Nannoconus steinmannii minor*; sample Z147.
Fig. 17: *Nannoconus globulus globulus*; sample Z206.
Fig. 18: *Nannoconus kamptneri kamptneri*; sample Z147.
Fig. 19: *Nannoconus steinmannii steinmannii*; sample Z147.

Plate XXVII