Mediterranean Neocomian belemnites, part 2: the Berriasian-Valanginian boundary in southeast Spain (Río Argos, Cañada Lengua and Tornajo)

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Key words — Belemnites, Berriasian, sequence stratigraphy, Spain,Valanginian.
Belemnites have been sampled and investigated from three successions (Río Argos, Cañada Lengua and Tornajo) with different palaeobathymetries. In this way an excellent opportunity has been created to compare the distribution of belemnites, both stratigraphically and with regard to palaeo-water depth. These successions are well studied with respect to ammonites. *Pseudobelus* is abundant only in the deep water settings, contrary to *Castellanibelus*. *Hibolithes* seems to be restricted to certain strata, being relatively common in the outer platform succession (Tornajo).
The Cañada Lengua and Tornajo successions are interpreted sequence stratigraphically. Generally, the Cañada Lengua is characterised by 'highstand' stacking, while the absence of lowstand deposits and the presence of marly highstand deposits characterises the Tornajo succession.
The new genus *Gillieronibelus* (type species *Belemnites mayeri* Gilliéron, 1873) is described. The genus *Coctebelus* Weis, 1991, is regarded as a junior synonym of *Berriasibelus* Delattre, 1952. The genera *Conobelus* and *Berriasibelus* have different stratigraphical distributions. Three new species are described; *Conobelus*? *piradoensis* sp. nov., *Duvalia miravetesensis* sp. nov. and *Duvalia tornajoensis* sp. nov.
There is an important belemnite faunal change in the lower Alpillensis Zone, were the position of the Berriasian-Valanginian boundary is favoured to be placed on top of sequence Be 7.

Contents

Introduction

In this paper the distribution of belemnites in the late Berriasian (Paramimouna Zone) to early Valanginian (lower Pertransiens Zone) is discussed. The described material is derived from three different areas in the province of Murcia (southeast Spain), and was collected during several weeks in the years 1994-1996 and 1999. The Cañada Lengua section (near Cehegín) and the Río Argos succession (sections X and Y, Barranco Miravetes, near Caravaca) are situated in the Outer Subbetic zone (Fig. 1).

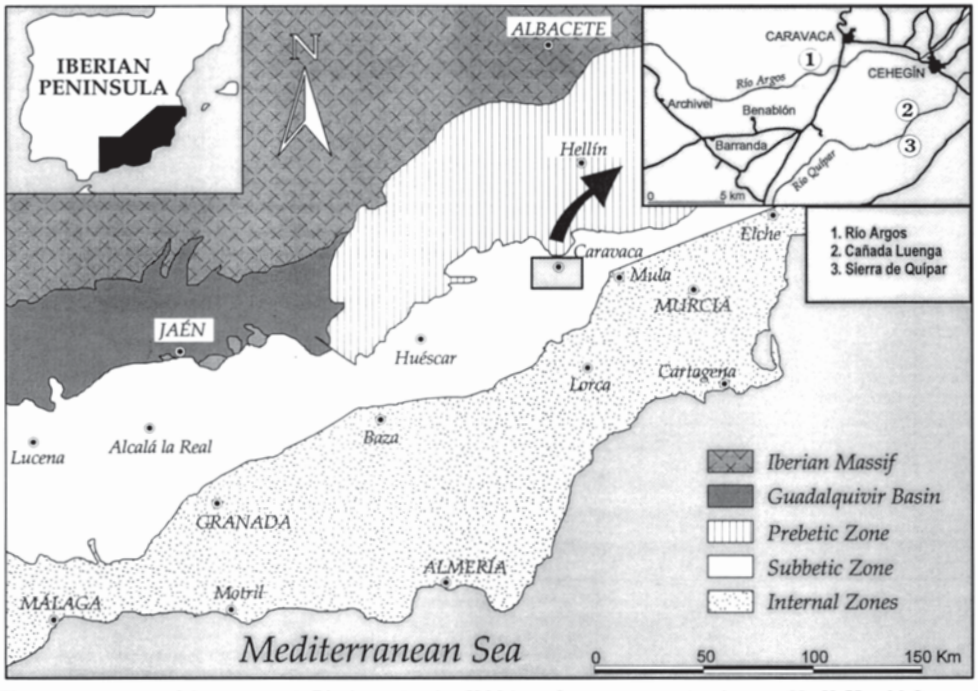


Fig. 1. Location of the sections. (1) Río Argos (X, Y, M/N); (2) Cañada Lengua (CL); (3) Tornajo mountain. Figure modified from Aguado *et al*. (2000).

The two successions represent a basinal setting, and have been investigated previously with respect to stratigraphy and palaeomagnetism. Several groups of macro- and microfossils have been analysed (Fallot, 1931; Allemann *et al*., 1973; Company & Tavera, 1982; Hoedemaeker, 1982, 1983; Tavera, 1985; Company, 1987; Janssen, 1997; Vasícek & Hoedemaeker, 1997; Aguado *et al*., 2000). The Tornajo succession (south of Almudena; Fig. 2) is situated in the Inner Subbetic zone and represents sedimentary rocks that are deposited on the outer margin of a platform.

A biostratigraphical framework has been constructed for the Río Argos and Cañada Lengua successions, mainly based on ammonites (Hoedemaeker, 1982; Aguado *et al*., 2000). Palaeomagnetic data (Ogg *et al*., 1988) are available, but are hampered by hiatuses in the sedimentary rocks of the Cañada Lengua area and by Neogene remagnetization in the Río Argos succession (Hoedemaeker *et al*., 1998). Nevertheless, these researches created an opportunity to place the investigated material in a bio- and chronostratigraphic framework. Furthermore, sequence stratigraphic interpretations in the Río Argos succession (Hoedemaeker & Leereveld, 1995) are used and modified.

Sequence stratigraphical interpretations in both the Cañada Lengua and Tornajo successions allows correlation with the Río Argos sequence. In this way a better understanding of both the stratigraphical as well as the geographical distribution of the belemnites is obtained.

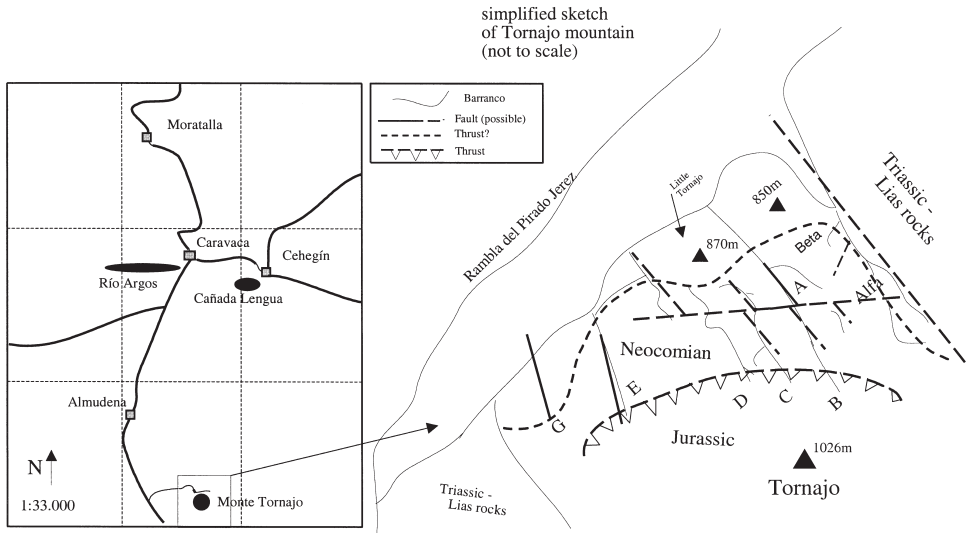


Fig. 2. The rather complex geological situation of the Tornajo mountain is worked out schematically (pers. obs.). The topographic map of the Mapa Geológico de España 1:50.000 of Zarcilla de Ramos (931/24-37) is used. Compare de Smet (1984, text-figs. 20, 21, pp. 143-145). Alpha to G represent position of sections that are exposed in the barrancos.

Material and geological context

The specimens discussed in this paper come from three different sections representing two different palaeobathymetric settings. In all settings, it appeared that the lowermost Valanginian sedimentary rocks had the largest association of belemnites, both in numbers and species. Ammonites and aptychi are the most abundant macrofossils, generally followed by belemnites and Pygopidae (Pygopinae and Triangopinae), and often accompanied by echinoids and crinoids.

Typical for the interval under investigation is the scarcity of specimens belonging to the family Mesohibolitidae (mostly *Hibolithes*) compared to Duvaliidae (*Conobelus*, *Duvalia*). All of the specimens investigated preserve only the first chambers of the phragmocone, if any. From this it seems reasonable to assume that the assemblage is autochthonous and any post-mortem drifting occured over a short distance only. Loose phragmocones are very rare and are only found in the Otopeta Zone of the Río Argos succession.

The investigated belemnites from the Río Argos is additional to those previously published (Janssen, 1997). The latter paper is partially revised (Table 1) due to the discovery of more complete specimens and the improved knowledge of belemnites.

The material collected is indicated by corresponding bed numbers in the sections. Bed numbers and letters refer to different sections, i.e., X and Y to corresponding sections in the Río Argos succession (Figs 3, 4), CL to the Cañada Lengua section (Fig. 5), and B, C and D to sections in the Tornajo (Fig. 6). Species are depicted on Plates 1-6. An alphabetic index is provided (Table 2). The material is stored in the collection of the National Museum of Natural History, Leiden, The Netherlands, under numbers

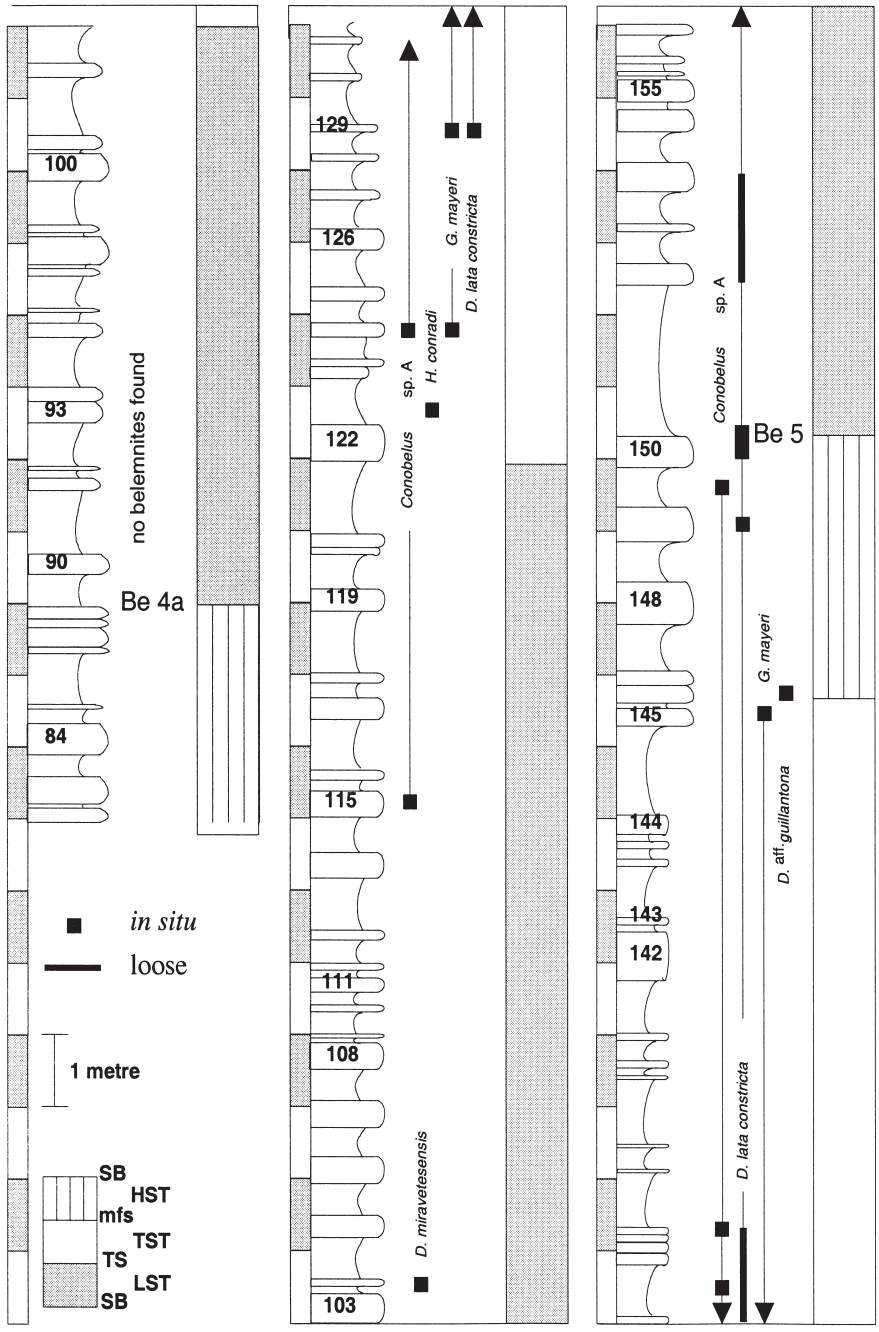
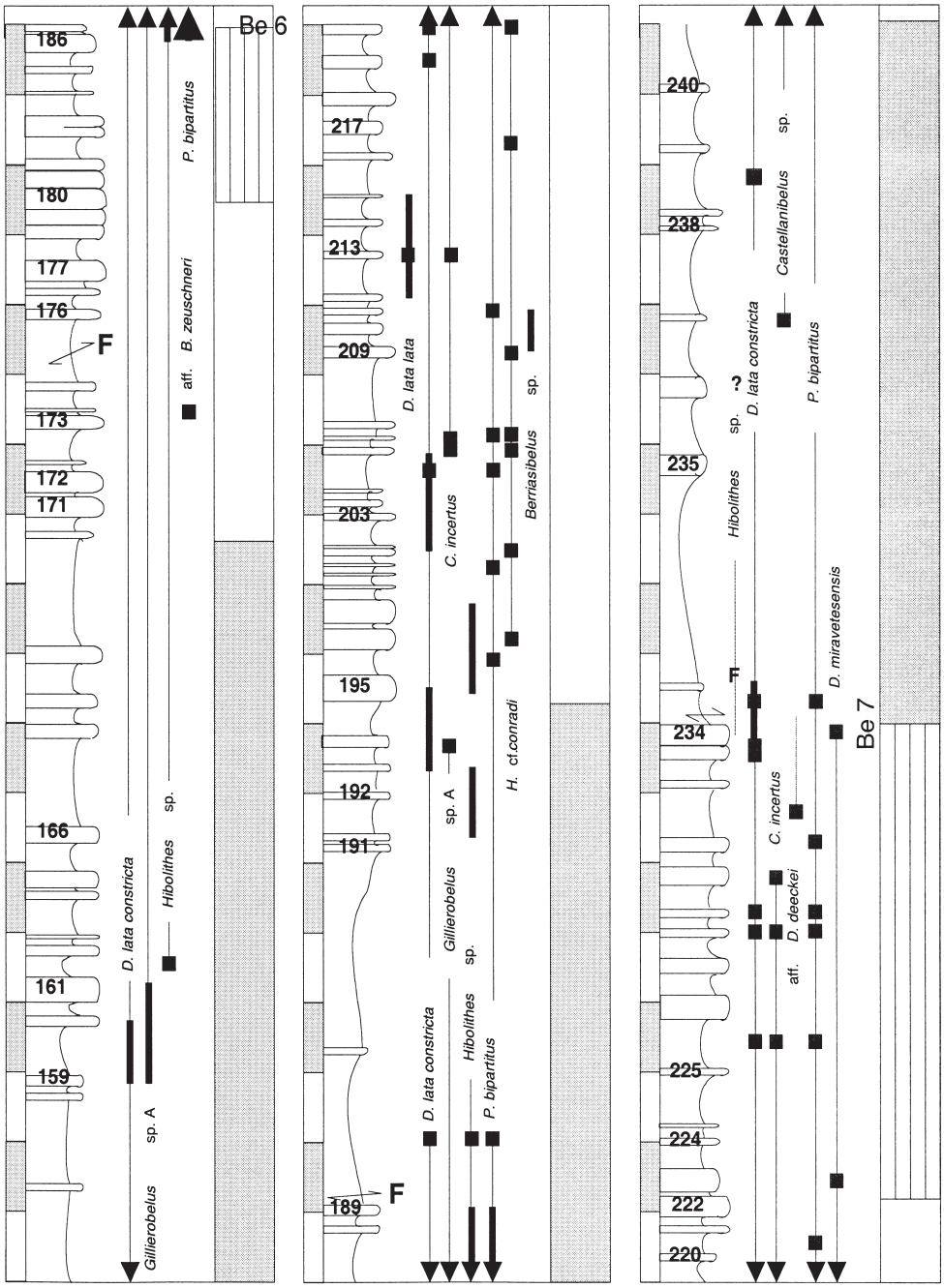


Fig. 3. Position of the belemnites in the Río Argos sections X and Y. Bold dots indicate position of *in situ* fossils, thick line indicate the interval a loose specimen was derived from. Broken lines indicate the position of the specimen to be uncertain. Indicated are bed numbers, belemnite findings and



sequence stratigraphy (modified from Hoedemaeker & Leereveld, 1995; Hoedemaeker, 1999). 'T' indicates a turbidite layer. 'F' indicates small faults (calcified strike slip).

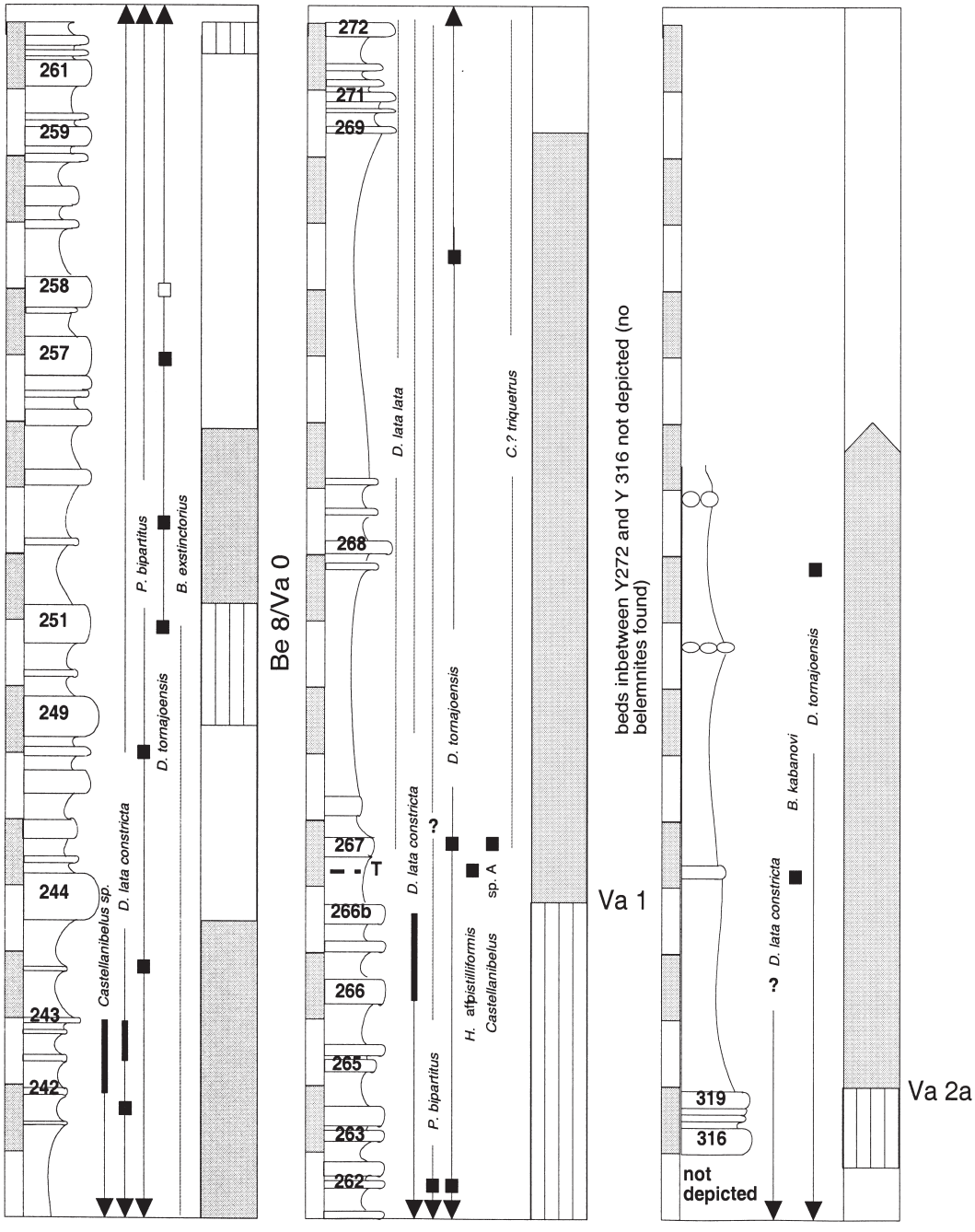

261
259
258
257
251
249
244
243
242
Castellanibelus sp.
D. lata constricta
D. tornajoensis
P. bipartitus
B. exstinctorius
Be 8/Va 0
272
271
269
268
267
T
266b
266
265
263
262
D. lata lata
D. lata constricta
D. tornajoensis
C.? triquetrus
P. bipartitus
H. aff. pistilliformis
Castellanibelus sp. A
?
Va 1
beds inbetween Y272 and Y 316 not depicted (no belemnites found)
319
316
not depicted
B. kabanovi
D. tornajoensis
D. lata constricta
?
Va 2a

Table 1
Revision of specimens in Janssen (1997).

Janssen (1997)	(this paper)	specimen no's	beds
D. lata	*D. tornajoensis*	RGM 345 200	Y262
D. lata	*D. lata constricta*	RGM 345 202	X219
H. semisulcatus	*H.* cf. *conradi*	RGM 345 203	X216-217
R. strangulata	*C.* cf. *incertus*	RGM 345 204	X225-226
D. lata	*D. lata constricta*	RGM 345 205	X229
R. strangulata	*C. incertus*	RGM 345 207	X230
R. strangulata	*C. incertus*	RGM 345 208	X230
D. dilatata	*D. miravetesensis*	RGM 345 213	Y234-244
D. cf. *haugi*	*C. incertus* (juv.)	RGM 345 215	X234-244
D. lata	*D.* gr. *lata*	RGM 345 216	Y261b
P. bipartitus	*P. bipartitus*?	RGM 345 217	Y267-267a
D. cf. *haugi*	*C.*? *triquetrus*	RGM 345 220	Y267-274
D. lata	*D. lata constricta*	RGM 345 221	Y267-274
D. lata	*D.* gr. *lata*	RGM 345 222	Y209-212
H. semisulcatus	*Belemnites* sp. indet.	RGM 345 223	Y190-191
D. lata	*D.* gr. *lata*	RGM 345 231	Y266-270
D. lata	*D. lata constricta*	RGM 345 232	Y233-(235)
D. lata	*D. lata constricta*	RGM 345 233	Y218
H. semisulcatus	*H.* cf. *conradi*	RGM 345 234	Y122
D. aff. *deeckei*	aff. *D. deeckei*	RGM 345 236	Y244-251
D. lata	*D. lata constricta*	RGM 345 237	Y266-266b
H. cf. *pilleti*	*Gillieronibelus* sp. A	RGM 345 238	Y159-161
D. lata	*D. lata constricta*	RGM 345 239	Y193-195
D. lata	*D. tornajoensis*	RGM 345 240	X258
D. lata	*D. tornajoensis*	RGM 345 241	X244-249
H. semisulcatus	*H.* cf. *conradi*	RGM 345 242	X196
H. semisulcatus	*H.* cf. *conradi*	RGM 345 276	Y(121-)122
D. lata	*D. lata constricta*	RGM 345 277	Y189-190
D. lata	*D. lata constricta*	RGM 345 278	Y189-190
D. lata	*D. lata constricta*	RGM 345 283	Y201-207
D. lata	*D.* gr. *lata*	RGM 345 284	Y209-212
R. strangulata	*Berriasibelus* sp. (imm)	RGM 345 285	Y209-212

RGM 345 200 - 345 221, 345 230 - 345 242, 345 276 - 345 285 (see Janssen, 1997), RGM 345 511 - 345 518, 345 522, 345 525, 345 527 - 345 531, 345 533 - 345 554, 345 560 - 345 564, 345 566, 345 568, 345 570, 345 572 - 345 573, 345 800 - 345 807, 345 809, 345 811 - 345 813, 345 815, 345 817 - 345 821, 345 865 - 345 879 (Río Argos), RGM 345 880 - 345 999, 361 400 - 361 430 (Cañada Lengua), and RGM 345 293 - 345 462, 361 500 - 361 504 (Tornajo).

The Río Argos succession — The Río Argos succession consists of some 180 m (Hoedemaeker & Leereveld, 1995, pp. 40-42; Hoedemaeker, 1999, pp. 429-431) of rhytmic limestone-marl alternations without any obvious erosion surfaces. The limestones are almost entirely composed of the tests of *Nannocones* (Hoedemaeker & Leereveld, 1995). Among the macrofossils, ammonites are the far most abundant group of fossils, accompanied by aptychi (Vasícek & Hoedemaeker, 1997).

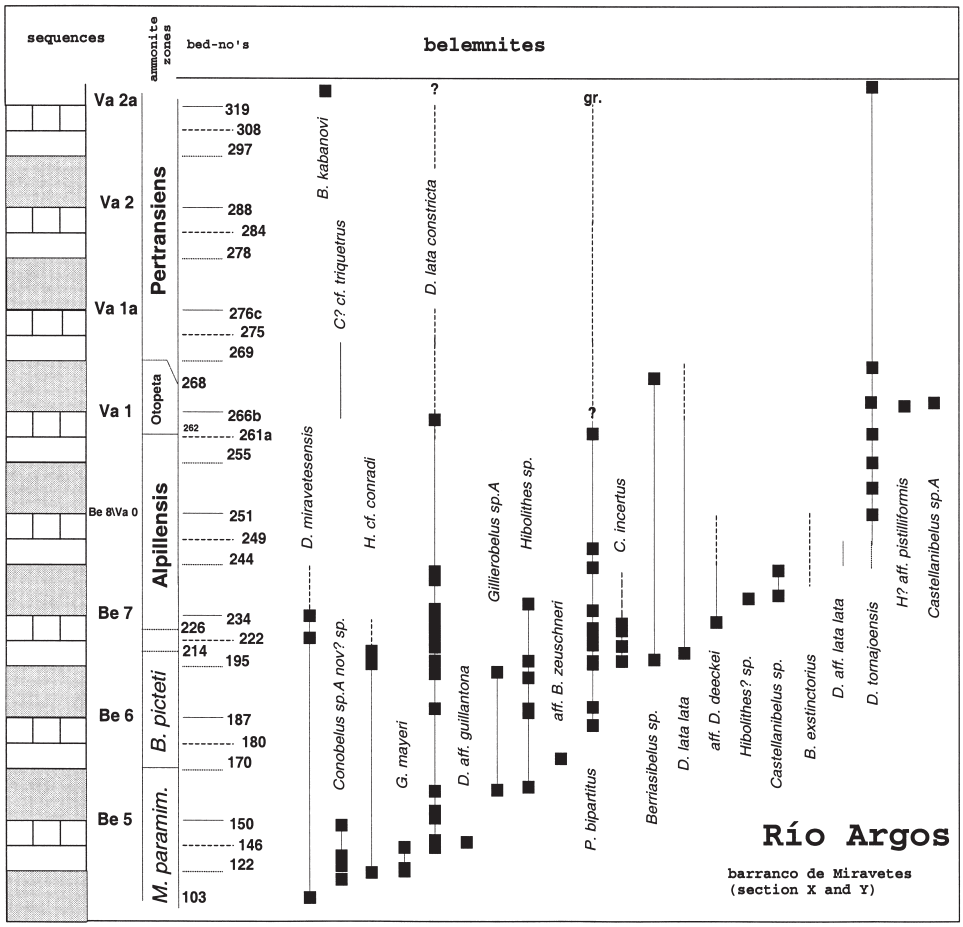


Fig. 4. Distribution of the belemnites in the Río Argos succession. Sequences, ammonite zones and bed-numbers are indicated. Ammonite zones are based on the data of both Hoedemaeker (1982) and Aguado *et al*. (2000).

Belemnites are common (Janssen, 1997), but occur in low numbers. Brachiopods belonging to the Pygopinae are particulary common in the upper Picteti and Alpillensis Zones. Rhyncholites are present, as are the remains of gastropods (*Aporrhais*) and echinoids. Sponges (*Verrucocoelia*?) can be found. Sessile organisms, generally small bivalves, are only uncommonly found attached to the belemnites.

In the investigated interval the belemnites are dominated by the *Duvalia lata*-group. *Pseudobelus* is more abundant compared to the other sections, while *Castellanibelus* is rare.

Except for one small sandy-micaceous layer in the highest part of the Otopeta Zone (bed Y266b-267), no indications of turbidites are found. With the exception of the sedimentary rocks around the Jurassic-Cretaceous boundary, belemnites are found only very sporadically between the Jacobi Subzone and the lower part of the Paramimouna Zone.

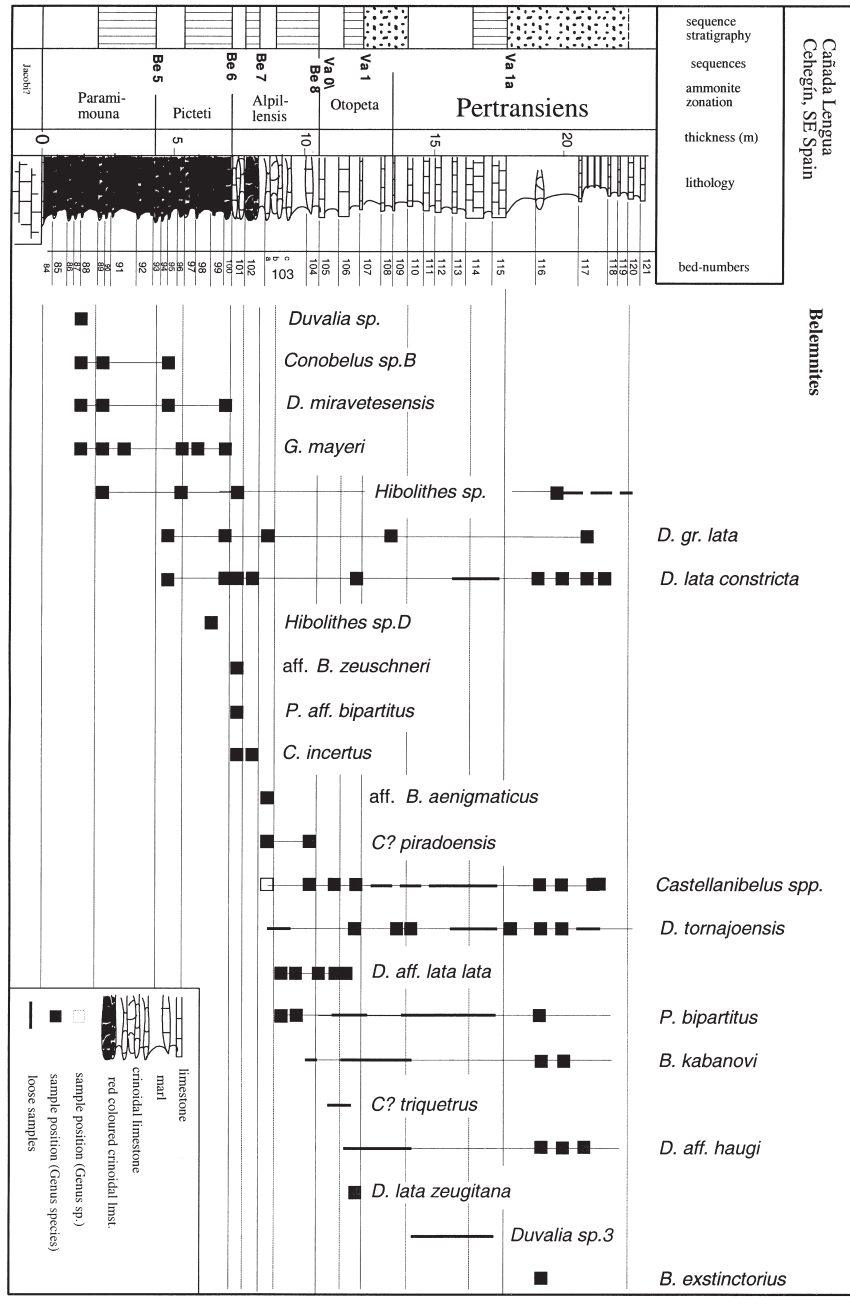


Fig. 5. Distribution of belemnites in the Cañada Lengua section. Thick solid or broken lines indicate the specimen to be derived from corresponding bed(s). Indicated are: sequences, ammonite zones, stratigraphical column and bed-numbers. This section is depicted by Allemann *et al.* (1973) and by Aguado *et al.* (2000, section M.CL).

Sequences Be 5 to Va 2a — Sequence stratigraphic interpretations are modified from Hoedemaeker & Leereveld (1995) and Hoedemaeker (1999). Lowstand deposits are well represented in the Río Argos succession, mainly as a result of increasing terrigeneous supply. This resulted in lowstands dominated by marls and more calcareous trans-

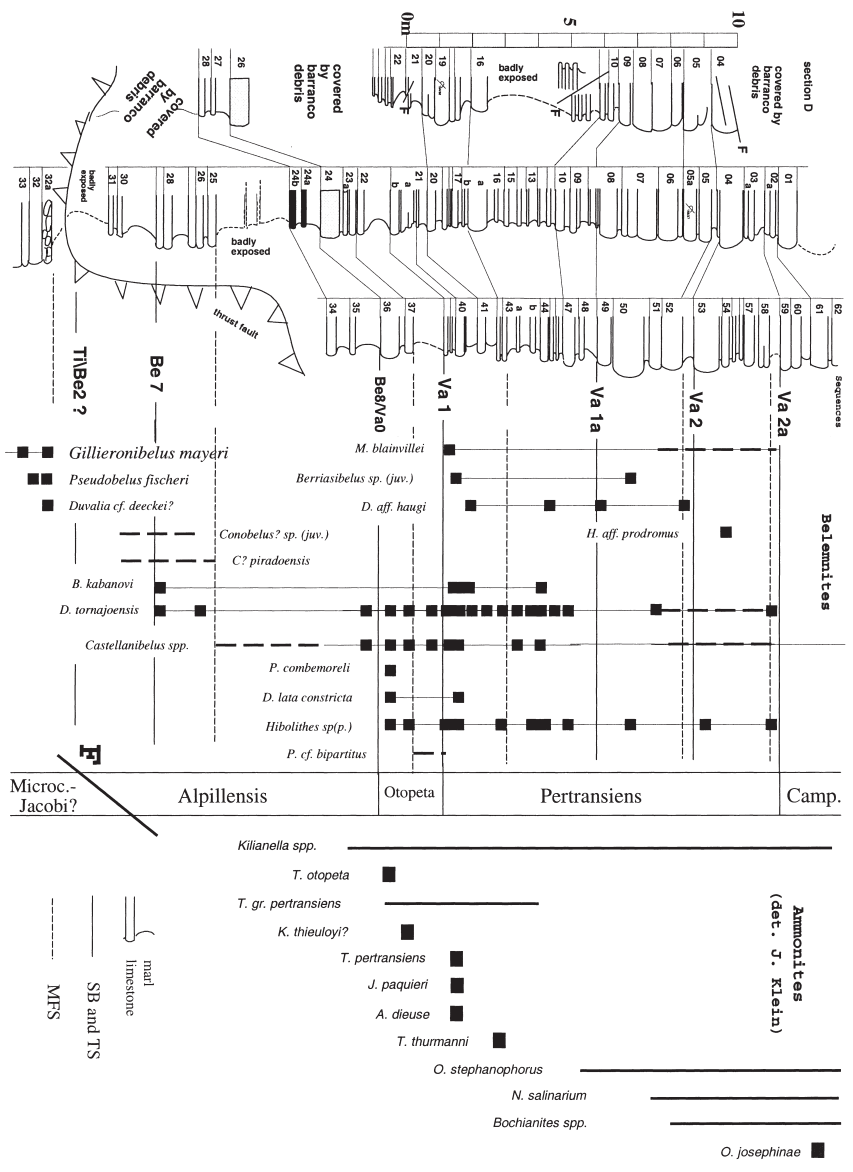


Fig. 6. Sections B, C and D of the Mount Tornajo succession, showing bed-numbers, sequences, and the distribution of belemnites and some stratigraphically important ammonites (determined by J. Klein). Broken lines indicate the specimen to be derived from corresponding stratigraphical interval.

gressive sediments. Highstands are generally represented by a mix of marls and limestones, but slightly dominated by limestone.

Sequence Be 5 is modified with respect to the interpretation of the previous authors. The boundary with the previous sequence is situated at the marls above bed Y90. In bed Y90 the first *Malbosiceras paramimouna* Mazenot is found. The maximum flooding surface (MFS) is placed in bed Y146 and the boundary with the next sequence is placed above bed Y150. Thus, it encompasses the lower part of the Paramimouna Zone *sensu* Le Hégerat & Remane (1968). Belemnites occur regularly in the transgres-

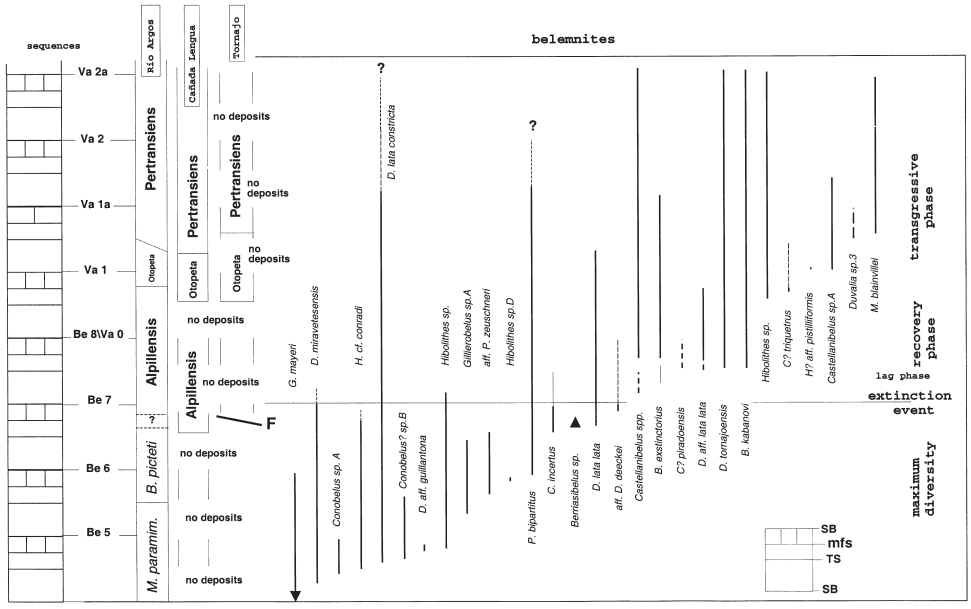


Fig. 7. Compilation of the ranges of the belemnites in the investigated sections (Río Argos, Cañada Lengua and Tornajo). Broken lines indicate a range to be uncertain in the corresponding interval. Note that the various sections are correlated (left part of figure) and the positions of the ammonite (chrono) zones are indicated, as well as the non-depositional intervals of the Cañada Lengua and Tornajo successions.

sive part of this sequence, and *Conobelus* sp. A nov.? is restricted to this interval.

Sequence Be 6 is reinterpreted with respect to its position as advocated by the previous authors. It starts with the marly interval above bed Y 150 and the transgressive surface is placed below bed Y 170. This coincides approximately with the last occurrence of *M. paramimouna* Mazenot (in Y171) and with the lower part of the Picteti Zone *sensu* Le Hégerat. The first *Pseudobelus bipartitus* is found in the top of this sequence.

Sequence Be 7 is characterised by diminished lowstand and well-developed transgressive deposits. Belemnites are abundant and diverse, dominated by members of Duvaliidae (*D.* gr. *lata* and *P. bipartitus*), although Mesohibolitidae (*Hibolithes* spp.) are common. Other faunal elements like Pygopidae and rhyncholites occur fairly commonly. A series of belemnites seems to have their last occurrence within this sequence (Fig. 4).

The next sequence, Be 8 or Va 0, is of importance for the evolutionary development of the belemnites. Some species became extinct (*Duvalia miravetesensis* sp. nov., *Conobelus incertus*) prior to this sequence and some important lower Valanginian species have their first appearance in this interval (*Castellanibelus* spp., *B. exstinctorius*). The Duvaliidae are the most common among them, limonitised gastropods are common and limonitised porifera are found sporadically.

This distribution of belemnites suggests that the boundary between the Berriasian

Table 2
Alphabetical species list

Berriasibelus exstinctorius (Raspail, 1829)
Berriasibelus kabanovi (Weiss, 1991)
Castellanibelus orbignyanus (Duval-Jouve, 1841)
Castellanibelus sp. A (*in* Janssen, 1997)
Castellanibelus sp. D
Castellanibelus? *triquetrus* (Weiss, 1991)
Conobelus incertus Weiss, 1991
Conobelus sp. A
Conobelus sp. B
Conobelus sp. aff. *Belemnites aenigmaticus* d'Orbigny, 1843
Conobelus? *piradoensis* sp. nov.
aff. *Duvalia deeckei* Kilian, 1889
Duvalia aff. *guillantona* Besairie, 1930
Duvalia aff. *haugi* Kilian, 1889
Duvalia lata constricta Uhlig, 1902
Duvalia lata lata (de Blainville, 1827)
Duvalia aff. *lata lata* (de Blainville, 1827)
Duvalia lata zeugitana Pervinquière, 1907
Duvalia gr. *lata* (de Blainville, 1827)
Duvalia miravetesensis sp. nov.
Duvalia tornajoensis sp. nov.
Duvalia sp. 3
Gillieronibelus mayeri (Gilliéron, 1873)
Gillieronibelus sp. A
Hibolithes cf. *conradi* (Kilian, 1889)
Hibolithes aff. *prodromus* Shvetsov, 1913
Hibolithes sp. D
Hibolithes? aff. *pistilliformis* (Raspail, 1829)
Mirabelobelus blainvillei Janssen & Clément, 2003
Pseudobelus bipartitus de Blainville, 1827
Pseudobelus aff. *bipartitus* de Blainville, 1827
Pseudobelus gr. *bipartitus* de Blainville, 1827
Pseudobelus combemoreli Nerodenko, 1986
Pseudobelus? *fischeri* Combémorel & Mariotti, 1990
aff. *Pseudobelus zeuschneri* Oppel, 1865

and the Valanginian should be situated near the lower part of the Alpillensis Zone (as advocated by Hoedemaeker, 1982), close to the boundary between sequence Be 7 and Be 8. In the top of sequence Be 8, an association of belemnites exists, described as Assemblage 1 by Janssen & Clément (2003), which is characteristic for the lower part of the Lower Valanginian.

Sequence Va 1 (Otopeta Zone) is mainly characterised by *Duvalia* gr. *lata* with fewer *P. bipartitus*. Of interest is a small sandy micaceous level (probably a turbidite) between bed Y266b and Y267 that yielded *Hibolithes*? aff. *pistilliformis*.

Sequence Va 1a (Pertransiens Zone) has yielded no belemnites so far, except for the marly lowstand deposits.

Neither sequence Va 2 nor Va 2a have yielded any belemnites; only in the marly sedimentary rocks above Y319 have belemnites been found. Note that the position of sequence Va 2 is modified with respect to Hoedemaeker (1999). The boundary between the two sequences is placed above bed Y276c (= M/N199), while the TS is placed below bed Y278 (= M/N203), and the MFS is placed at Y284 (= M/N213). The boundary between sequence Va 2 and Va 2a is placed above bed Y288 (= M/N216), the TS of sequence Va 2a is placed at Y297 (= M/N224), the MFS at bed Y308 (= M/N240), and the boundary is placed above bed Y319 (= M/N248). The latter is here the boundary between Va 2a and Va 3, but was chosen by Hoedemaeker as the boundary between Va 2 and Va 2a.

The Cañada Lengua succession — In the Cañada Lengua section (Fig. 5), the Berriasian and lowermost Valanginian sedimentary rocks generally have a reddish colour, are biocalcilutitic (encrinitic) and highly condensed. These reddish rocks are succeeded by grey limestone-marl alternations in the Lower Valanginian. The whole succession

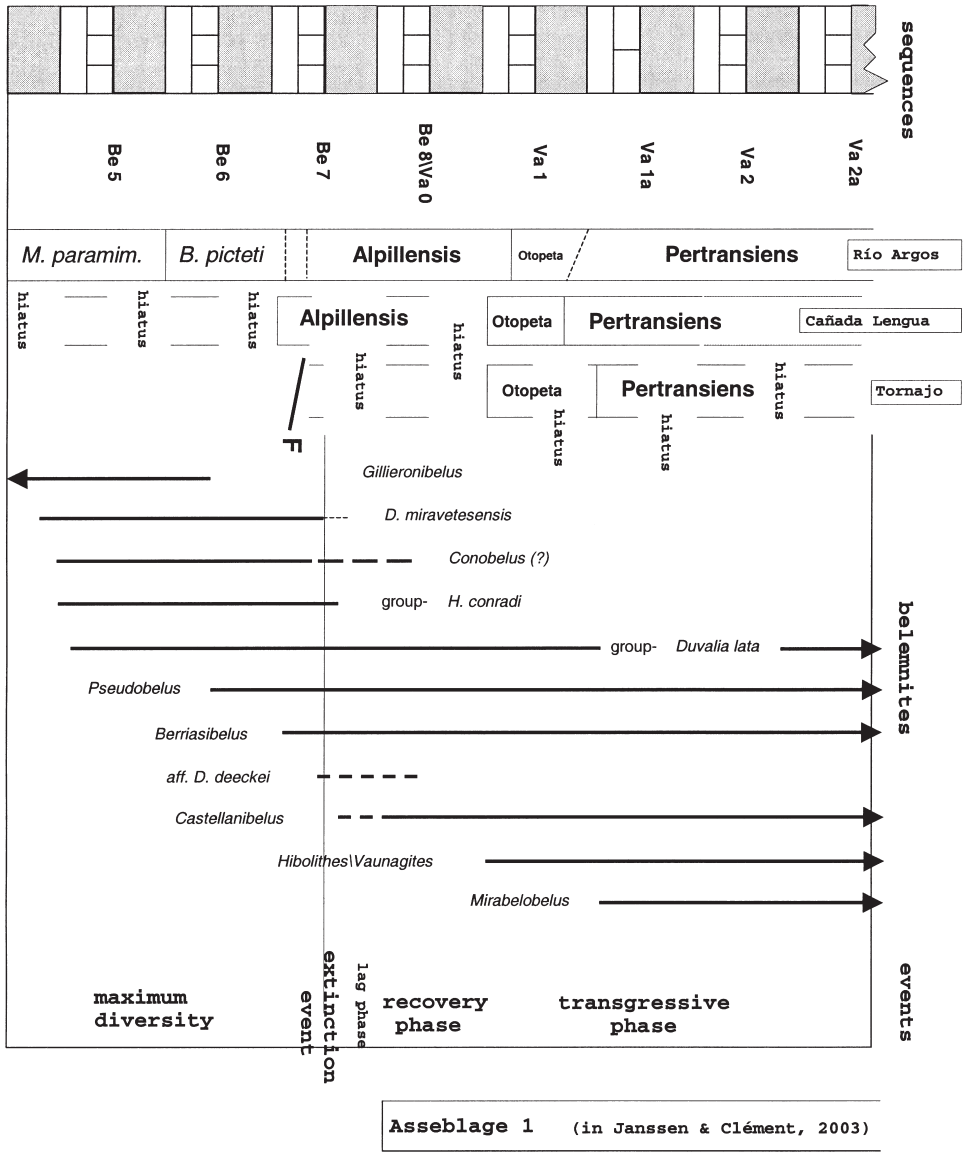


Fig. 8. Correlation of the various sections, sequence stratigraphy, the ranges of various groups of belemnites (*H. conradi* group, a group of belemnites that is best characterised as morphologically between *Hibolithes* and *Vaunagites*, and *D. lata* group (excl. *D. miravetesensis*)), and various genera (*Gillieronibelus*, *Conobelus*(?), *Pseudobelus*, *Berriasibelus*, *Castellanibelus* and, *Mirabelobelus*).

is only about 20 m thick. This is in contrast with the Río Argos succession and was caused by deposition on a topographic high (Allemann *et al*., 1973; Rey, 1995). Generally, the beds are rich in ammonites (Nicklès, 1896; Barthel *et al*., 1967; Kuhry, 1972; Alleman *et al*., 1973; Company & Tavera, 1982; Aguado *et al*., 2000), but belemnites

are also common, as are Pygpodidae, echinoids and crinoids. Small sessile organisms (bivalves, serpulids and anthozoa) can be found on some of the macrofossils, but no traces of borings are found in the belemnites. Rhyncholites and fish teeth are also present. Belemnites are dominated by species of the *Duvalia lata* group and *Castellanibelus*, while the genus *Pseudobelus* is nearly absent.

Sequences Be 5 to Va 2 — The red coloured sedimentary rocks are interpreted partially as transgressive and as highstands (highstand stacking). It is not until above sequence Va 1 (Otopeta Zone) that rocks interpreted as representing lowstands occur. This indicates that the previous generated highs became less isolated. For the first time terrigeneous sediments could become important in this area, as a result of a change in the palaeoenvironment. Also, the character of the limestone changes, becoming less encrinitic. Compared to the Río Argos succession the Cañada Lengua area is overall highly condensed (Aguado *et al*., 2000, p. 4).

In the oldest sedimentary rocks, belemnites are fairly common, consisting of a mixture of Mesohibolitidae and Duvaliidae. On the basis of the great abundance of belemnites in certain layers, these are interpreted as MFSs. Abundant pygopidae (*Pygites diphyoides* (d'Orbigny), *Pygope* sp.), and both regular and irregular echinoids occur throughout the red-beds and up to the lower part of the Pertransiens Zone.

In the top of the red-bed succession (Picteti to Alpillensis Zone) belemnites become more abundant and diverse, and characteristic species like *Conobelus incertus* are found. With the exception of bed CL101, the first greyish sedimentary rocks occur from bed CL103 onwards (with characteristic *Conobelus*? *piradoensis* sp. nov. and abundant *Duvalia* gr. *lata*). These rocks still are dominated by crinoids, while beds CL 105 and 106 (Otopeta Zone) are characterised by ammonites with a greenish patina. This phenomenum, probably caused by environmental circumstances, can also be observed in the Otopeta Zone of the surroundings of Ginestous and Vergol (southeast France).

Above the Otopeta Zone the first lowstand deposits are developed in this succession, in which limonitised ammonites can be found. The relative shallowness of the area is demonstrated by the frequent occurrences of pygopidae, and irregular and regular echinoids, up to about bed CL 115 (sequence boundary Va 1a; lower part of the Pertransiens Zone). Above this layer, a thick marly sequence with occasionally large slumps occurs, these beds being especially rich in belemnites like *Duvalia* gr. *lata* and *Castellanibelus* spp.

The Tornajo succession — Mount Tornajo is situated in the northern part of municipal Lorca, some 16 km south of Caravaca. It is in a geological sense composed of an overturned lentil of Lower Cretaceous strata, and situated within a tectonic mixture of various Mesozoic and Tertiary formations developed along a northeast-southwest-directed wrench zone (Crevillente Fault Zone) lubricated by gypsiferous Triassic rocks (van de Fliert *et al*., 1980; de Smet, 1984). Meinster (1964-1965, unpublished field report) was the first to record Lower Cretaceous sedimentary rocks from this area. Both the 'Mapa Geológico 931/24-37' (1974) as well as Seyfried (1978, p. 71) mentioned the absence of Upper Jurassic and Lower Cretaceous sedimentary rocks ("Eine Gemeinsamkeit mit den anderen Profilen .... weiterhin das Fehlen des höchsten Oberjura und der Unterkreide..."). Subsequently, Hermes (1978) and de Smet (1984, pp. 143-145) recorded Neocomian sedimentary rocks, the latter recognising the complicated

tectonic situation of Mount Tornajo and its surroundings, partially based on the unpublished observations of Meinster.

The upper part of the main rocks of Mount Tornajo consists of Upper Jurassic to lower Berriasian deposits (= Fm. Calizas Margosas del Tornajo *sensu* Rey Arrans, 1993, p. 282). The contact between the Jurassic and Neocomian is tectonized, and at least the Neocomian beds are (partially) overturned. Small blocks or slices of lower Tertiary, Lower and Upper Cretaceous, and sedimentary rocks of Triassic origin are situated to the north-northeastern side of the Tornajo. Shortening and thickening within tectonic wedges, one of the characteristic features in thin-skinned fold-and-thrust belts (Chapple, 1978), is well exposed. The tectonic contact between the various sections and the older strata is irregular, on both sides of the tectonized contact.

The Neocomian succession is mainly composed of bright white, soft calcarenites with thin marl intercalations. Less commonly yellow to brown weathered beds or bedsets occur, which contain abundant macrofossils. Parts of the various sections are covered with barranco-debris or are tectonically disturbed. From the three depicted sections (B, C and D), only section B is reasonably complete, as indicated by ammonites (determined by J. Klein). These ammonites show that almost the whole Neocomian is present, except for the Berriasian. The latter is absent due to a thrust-fault that separates the more competent Upper Jurassic from the less competent Neocomian deposits.

The main macrofaunal elements are ammonites and belemnites, the latter sometimes with 'borings' and attached sessile organisms. Stratigraphically important ammonites are present and are indicated in Fig. 5. Less abundant are Pygopinae and other brachiopods, echinoids, bivalves, bryozoa and teeth of an aquatic vertebrate. Terebratuloid brachiopods are generally found in nests attached to larger ammonites. Some *Diplocraterion* burrows are observed in certain beds. These trace-fossils appear for the first time near the TS of sequence Va 2a, in beds B53 to B55. Olóriz & Rodríguez-Tovar (2000) found the same kind of trace-fossil in Kimmeridgian sedimentary rocks, and interpreted them as representative of sequence boundaries.

Belemnites are largely dominated by the *Duvalia lata* group, notably *D. tornajoensis* sp. nov., whereas *Pseudobelus* and *Castellanibelus* occur only rarely. Mesohibolitidae occur in significantly higher numbers as compared to the other successions. Particulary striking is the high proportion of juveniles compared to adult specimens.

Sequences Be 7 to Va 2a — The Tornajo succession was deposited on the outer platform. As a result the late and latest? highstands are represented by marly deposits, whereas transgressive sedimentary rockss are represented by more calcareous deposits and lowstands deposits are absent. This contrasts with the basinal successions where lowstand deposits are represented by marly intervals, and transgressive and high-stand by calcareous sedimentary rocks.

In the sections investigated in Mount Tornajo, the older sedimentary rocks are characterised by relatively thin calcareous beds alternating with marly beds. The younger deposits (Pertransiens Zone) are characterised by an increase in thickness of the calcareous beds and the near absence of (chalky-)marls. In these deposits, the MFS is situated at the top of a calcareous set (faisceau) and usually followed by deposits with abundant marls. In sections C and D, a characteristic yellow coloured bed occurs (not well exposed in section B), whereas the dominant colour in the rest of the section is white. Not until the boundary between the lower and upper Valanginian do yellow-coloured beds and bedsets occur regularly, alternating with white sets. In section B,

the top of bed B40 is composed of packed belemnites, with some greenish colour (glauconitic?). In section C, bed C17 shows an abundance of belemnites.

The interpretation of the section in sequence stratigraphical terms is indicated in Fig. 5. Note that most sequences show a chalky succession with very subordinated marly layers, followed by a relatively thick marly interval. The boundary between these lithological units forms the MFS, while the sequence boundaries and transgressive surfaces are placed above this marly interval. In general the lithology is fairly consistent with this pattern, except for sequence Va 1a, which shows a more extensive marly bedset (latest? highstand).

Note that below the thrust-plane a fossiliferous conglomeratic layer is found that yielded 'Upper Jurassic' belemnites (*G. mayeri* (Gilliéron), *Pseudobelus*? *fischeri* Combémorel & Mariotti, *Duvalia*? cf. *deeckei* Kilian, and some *Hibolithes* and *Conobelus*).

Taxonomic considerations

The following terms, describing the flattening in the stem-region of a rostrum, are used in the text; compressed (Ic > 1, lateral flattening, e.g. in *Duvalia*), rounded (Ic = 1, no lateral nor dorso-ventral flattening) and depressed (Ic < 1. dorso-ventral flattening, as in *Castellanibelus*).

Descriptive terms like 'pseudoduvaloid' or 'rhopaloteuthoid' are used to indicate that the general appearance or morphology of the stem-region of a rostrum is in accordance with the most characteristic features that are generally ascribed to the corresponding genus. Sometimes more than one of these descriptive terms can be applied on one and the same species.

Glossary — binervioid = very compressed rostrum of medium size with strong to medium constriction in the alveolar area.

conobeloid = rounded rostrum of medium length, not club-shaped, but with near parallel lateral sides and short to deep alveolus.

dilatatoid = very compressed rostrum of medium to large size, with no or very moderate constriction in the alveolar area.

latatoid = low to moderate compressed or nearly rounded rostrum with both well developed alveolus as alveolar groove.

pseudobeloid = elongated more or less fusiform with strong to moderate lateral constrictions (octahedral cross-section).

pseudoduvalioid = rostrum with most irregular outline.

rhopaloteuthoid = generally club-shaped, depressed rostrum of medium length with short to deep alveolus.

Rhopaloteuthis versus Conobelus and Berriasibelus — There seems to be a great deal of confusion among several, at least morphologically closely related genera of the Duvaliidae (e.g., *Berriasibelus* (upper Berriasian - lower Valanginian), *Conobelus* (mid Tithonian - lowermost? Valanginian), *Rhopaloteuthis* (uppermost Bathonian - upper Oxfordian)). Moreover, the genera *Castellanibelus* (Combémorel, 1972; Duvaliidae; lower Valanginian) and *Somalibelus* (Jeletzky, 1972; Mesohibolitidae; 'Kimmeridgian') are morphologically very close to *Conobelus* and *Rhopaloteuthis*.

Lissajous (1915, pp. 27-29) introduced the genus *Rhopaloteuthis* in the following way: "Type: Bel. Sauvanaui [*sic*] d'Orbigny. Rostrum reaches a medium shape, club-shaped, more or less widening from the front to the back sometimes perfectly straight. The apex is short, on top mostly rounded, sometimes mucronate. Some species show however an elongated apex. Circular cut, oval or subquadrangular. A straight dorsal and progressively deepening sillon starts at the opening, sometimes not passing the alveolar opening in certain species (*Bel. Gillieroni* May.) and in other species, extending over the larger part of the rostrum (*Bel. spissus* Gilliér.). Alveolar slit sometimes largely open. The alveolus occupies a quarter of the length of the rostrum in some species and in others it is less then half the length of the rostrum. Apical line hardly excentric: the excentricity is sometimes so less marked that it is difficult to tell. ... The genus *Rhopaloteuthis* appears in the Bathonian with a variety of *Bel. Gillieroni* Mayer and continues in the Neocomien with *Bel. conicus* Blainville. Principle species: *Bel. Gillieroni* Mayer, – *Sauvanaui* d'Orbigny, – *spissus* Gillieron, – *conophorus* Oppel."

Subsequently, Stolley (1919, p. 49) created the genus *Conobelus* based on "the club-shaped, not or only slightly lateral compressed and deformed specimen (*Conophori*) I [Stolley] propose the new genus *Conobelus* Stolley with *C. conophorus* Oppel as type ..."

In fact, Lissajous (1915) based his generic description on belemnites that originated mainly from the upper middle Jurassic and lower upper Jurassic, while Stolley (1919) extracted that part which occured in upper strata. When saying this, I must suppose that Stolley also included *Belemnites conicus* de Blainville, as this is the only belemnite that is compressed, among the species included by Lissajous.

In the posthumous publication of Lissajous (1927), various species were gathered in *Rhopaloteuthis*, i.e., *aenigmaticus* d'Orbigny, *argovianus* Mayer, *Beneckei* Neumayr (as var. of *Belemnites conophorus* Oppel), *bzoviensis* Zeuschner, *conicus* Toucas [!], *conophorus* Oppel, *Gemmellaroi* Zittel *in* Gemmellaro, *Gillieroni* Mayer, *Jouvei* var. *Orbignyi* Toucas, *katrolensis* Waagen, *Majeri* Alth, *Mulleri* Gilliéron, *Oldhamianus* Waagen, *peregrinus* Schlippe, ?*redivivus* Mayer, *Sauvanausus* d'Orbigny, *spissus* Gilliéron, *strangulatus* Oppel and *suborbingyi* Toucas (as var. of *Orbignyi* Toucas). Unfortunately, Lissajous (1927) omitted several species (*Belemnites agricolae* Parona & Bonarelli, 1895, *Belemnites conicus* de Blainville, 1827 (although it was mentioned in his 1915 paper), and *Rhopaloteuthis etalloni* Maire, 1925).

The generic attribution of some of the above mentioned species was first questioned by Pugaczewska (1957), and subsequently by Gustomesov & Uspenskaya (1968), Riegraf (1981) and Weiss (1991). They are currently gathered in various genera (Riegraf, 1995; Riegraf *et al*., 1998).

Recently the Neocomian species were determined by Weiss (1991, 1992a). Despite this work it is still unclear whether *Rhopaloteuthis* and *Conobelus* are to be treated as synonyms, with *Conobelus* as the junior synonym (Riegraf, 1995; Riegraf *et al*., 1998).

The specimens generally included in *Rhopaloteuthis*, with type species *Belemnites sauvanausus* d'Orbigny, 1842, occur in the Upper Bathonian to Upper Oxfordian (mid to upper Bimammatum Zone). Only one species (*Belemnites beneckei* Neumayr, 1873) is described from younger strata (Acanthicum Zone *sensu lato*). These strata are partly equivalent to the Kimmeridgian, but the Upper Oxfordian may also be included (Andelkovich, 1963, p. 39).

A second group of belemnites generally included in the genus *Rhopaloteuthis* is

found in Tithonian and Berriasian strata. This group includes such species as *Belemnites conophorus* Oppel, 1865 (type species for *Conobelus*), *Belemnites gemmellaroi* Zittel, 1870 (emend. Combémorel & Mariotti, 1986), *Rhopaloteuthis siciliensis* Combémorel & Mariotti, 1986, and *Belemnites strangulatus* Oppel, 1865. Ultimately the Neocomian group of these belemnites are included in *Rhopaloteuthis* by some researchers, while included in *Conobelus* or even *Duvalia* by others.

Weiss (1991, 1992a, b) investigated those species that originated from the middle Berriasian to the Hauterivian of the Crimea. Janssen & Clément (2003) indicated that these Neocomian belemnites do not to occur higher than the Verrucosum subzone. This contradiction can be resolved by reference to Baraboshkin & Yanin (1997). Their lithostratigraphal columns generally show a typical condensed 'platform' lithology throughout the entire Valanginian and lowermost Hauterivian. In this facies reworking is common and indicative fossils appear irregularly; as a concequence 'accurate' dating is difficult.

Some of the species described by Weiss add to the confusion. For example, *Conobelus* (*Conobelus*) *propinquus* Weiss is comparable to *Belemnites conicus* de Blainville, whereas *C.* (*C.*) *conicus* (Blainville) in Weiss (1991, 1992a, b) is not *Belemnites conicus* de Blainville.

From the above facts and reflections it seems appropriate to follow some restrictions concerning the taxonomic status of the Jurassic and Neocomian *Rhopaloteuthis*. *Rhopaloteuthis* (type species *Belemnites sauvanausus* d'Orbigny, 1842) is restricted to the uppermost Bathonian to lower upper Oxfordian. A new group of rhopaloteuthid belemnites appear in the upper Danubian (middle Tithonian) possibly derived through *Belemnites benecki* Neumayr (non *Conobelus* (*Conobelus*) *beneckei* (Neumayr) *sensu* Weiss, 1991). Note that in the opinion of Lissajous (1925, p. 57) this species is only a variety of *C. conophorus* (Oppel). These belemnites are to be united in *Conobelus* (type species *Belemnites conophorus* Oppel, 1865). Whether these belemnites have *Rhopaloteuthis* as their ancestor remains unknown. The last representatives of *Conobelus* seem to vanish in the top of the Alpillensis Zone.

The belemnites that are to be united in *Berriasibelus* (type species *Belemnites exstinctorius* Raspail, 1829) appear for the first time in the upper Berriasian and can be found up to the top of the Verrucosum Subzone. They include *Belemnites alcidis* Mayer (in coll. Pictet; *nomen nudum*), *Belemnites conicus* de Blainville, 1827, *Hastites* (*Hibolites*) *elegantulus* Mayer-Eymar, 1887, *Belemnites exstinctorius* Raspail, 1829, *Conobelus* (*Coctebelus*) *propinquus* Weiss, 1991, *Conobelus* (*Coctebelus*) *heres* Weiss, 1991, and *Conobelus* (*Coctebelus*) *kabanovi* Weiss, 1991. *Conobelus* (*Coctebelus*) *triquetrus* Weiss, 1991, is thought to belong to *Castellanibelus*, based on its general morphology.

In conclusion, it is considered that *Rhopaloteuthis* and *Conobelus* are allochronic and are examples of homeomorphism. It is proposed that *Coctebelus* Weiss, 1991, is a junior synonym of *Berriasibelus* Delattre, 1952. The Valanginian *Coctebelus* shows the same ontogenetic development as *Berriasibelus*.

Systematic palaeontology

Descriptions are given for new species or where there is new information on existing species. A list of synonyms is provided where relevant, but when possible the reader is referred to previous publications. Some of the information published in Janssen (1997) is included in the following descriptions, where appropriate, and

some of the material used in that publication is revised, as indicated in Table 1.

It should be noted that a number of species could possibly be erected from the available material, because for many taxa the variations, the possibility of dimorphism, and the 'exact' stratigraphic distribution of most species are not known as yet. At this moment it was thought conservative to mention these specimens or species in open nomenclature, such as *Castellanibelus* sp. A, B, D. When they resemble described species, taxa are denoted as 'aff.' e.g., aff. *Duvalia deeckei* Kilian), but it does not mean that the generic attribution is the correct one (cf. Bengtson, 1988, p. 226). Table 2 contains a list of the specimen treated herein.

Family Mesohibolitidae Nerodenko, 1983b

Remarks — Originally *Belemnopsinae* Naef (1922, p. 247) with *Belemnopsis* Bayle, 1878, as the most characteristic element of this group of belemnites. Subsequent use of the corected name Belemnopseidae Naef (Doyle, 1993, p. 232; Doyle *et al*., 1994, p. 6) followed Jeletzky (1966, p. 147). This in turn Jeletzky followed a previous work of him (1946, cf. Jeletzky, 1966, p. 147). The genus *Belemnopsis* Bayle, 1878, and related names are *nomina dubia* as advocated by Riegraf (1999). Thus, I followed Riegraf *et al*. (1997, pp. 237-239) as they suspect Mesohibolitidae Nerodenko, 1983b, to be the next valid name available.

Genus *Hibolithes* Denys de Montfort, 1808

Hibolithes cf. *conradi* (Kilian, 1889)

1889 *Belemnites* (*Hibolites*) *Conradi* n. sp. Kilian, p. 635, pl. XXVI, fig. 4.
1890 *Belemnites* cf. *Konradi* (*sic*) Kilian - Uhlig, p. 595.
1893 *Belemnites* (*Hibolites*) *Conradi* nov. sp. Kilian, p. 593, pl. T, fig. 4.
1907 *Duvalia Conradi* Kilian - Haug, pp. 1089, 1097, 1100.
1907 *Belemnopsis Conradi* Kilian - Haug, p. 1105.
1917 *Belemnites (Aulacobelus) Conradi* Kilian - Kilian & Révil, p. 228.
1920 *Hibolites Conradi* Kilian - Bülow-Trummer, p. 137.
1925 *Belemnites (Belemnopsis) conradi* Kilian - Lissajous, p. 75.
1995 *Pseudohibolites conradi* (Kilian) - Riegraf, p. 100.
ep1997 *Hibolithes semisulcatus* (von Münster) - Janssen, pp. 12-13.

Material — Three near complete specimens, RGM 345 276 (Y(121-)122), 345 234 (Y122), 345 864 (Y122), and eight incomplete specimens, RGM 345 968 (CL96), 345 242 (X196), 345 542 (X201), 345 514 (X206), 345 817 (X207), 345 561 (X(208-)209), 345 203 (X216-217), and 345 805 (Y219(-231)).

Description - See Kilian (1889, p. 635) or Kilian (1893, p. 593). Original from the "marnes blanches à *Pygope diphya*" de Fuente de los Frailes.

Stratigraphical distribution — Paramimouna Zone to top Alpillensis Zone.

Hibolithes aff. *pistilliformis* (de Blainville, 1827)

1985 *Hibolites* aff. *pistilliformis* (Blainville): Combémorel *et al*., p. 152.
1989 *Hibolites* aff. *pistilliformis* (Blainville): Memmi *et al*., p. 149.

Material — One specimen, RGM 345 549 (Y266b-267). The following specifically indeterminable material may be conspecific: that found in the lower Valanginian of Cañada Lengua, RGM 345 967 (CL116-117), 345 964 (CL117-(119)), 345 965-966 (CL(115)-120), and one loose specimen 345 970; and from the Tornajo mountain, RGM 345 326 (C24), 345 372 (B37), 345 414 (B38), 345 382 (B39-40), 345 385-387 (B40), 345 397 (B40), 345 404-405 (B40), 345 423 (B43), 345 428 (B43b), 345 435 (B44), 345 349 (B45), 345 347 (B47), 345 410 (B50), RGM 345 412 (B53, 2x), and 345 413 (B58-59).

Description — Fusiform rostrum, rounded to sometimes slightly depressed in transverse sections. Typically very pointed apically. Posterior area slightly compressed, with no or only a very faint alveolar groove. Maximal transverse diameter situated approximately in the middle of the rostrum, thus resulting in a more or less spindle-shaped appearance.

Comparison — *Vaunagites* is characterised by a much longer and very elongated rounded rostrum without an alveolar groove. This genus is thought to be present in the uppermost Valanginian to lower Hauterivian only.

Stratigraphical distribution — From the Otopeta Zone to the Pertransiens Zone.

Remarks — The specimens mentioned here show the general characteristics of *Hibolithes*, and have no or only a very faint trace of the alveolar groove. Noteworthy is that one rostrum (RGM 345 549) has been collected in a very fine-grained sand with a mica-rich matrix.

Hibolithes aff. *prodromus* Shvetsov, 1913

Material — RGM 345 346 (B54).

Description — Small (juvenile or immature), short (30 mm) and depressed (approximately twice a broad as high) Mesohibolitidae with a faint alveolar groove, visible only for about 5 mm. Point of maximum inflation situated near to the alveolar area. No alveolus preserved. In ventral and dorsal views the rostrum is spindle-shaped; lateral views show a very flattened specimen, with near parallel sides; only in the apical area do the sides approach each other, and culminate in a pointed apex.

Stratigraphical distribution — Lower upper part of the Pertransiens Zone.

Remarks — A species very close to *H. prodromus* Shvetsov, due to the overall depressed rostrum. However, it has a much shorter groove, and is much less spindle-shaped.

Hibolithes sp. D

Pl. 1, figs. 3-4.

Material — One specimen, RGM 345 963 (CL99).

Comparison — Differs from *H.* cf. *conradi* Kilian and *H.* ex gr. *semisulcatus* (Münster) by its elongated apical region. As a result the maximum diameter is situated in the alveolar part of the rostrum and the alveolar groove appears rather short.

Stratigraphical distribution — Base of the Picteti Zone.

Remarks — This large rostrum is covered with slickensides, but the elongation of the apical area is not tectonically induced.

Hibolithes(?) sp. indet.

Material — Ten fragments, RGM 345 969 (CL89-90), 345 878 (Y161-162), 361 429 (CL96), 345 540 (Y187-189), 345 280-281 (Y189-190), 345 801 (Y191-193), 345 527 (Y195-197), 345 971 (CL101), 345 212 (X234-236) and, possibly, 345 573 (Y236).

Remarks — These specimens are found in beds that can be attributed to the upper Paramimouna to mid/upper Picteti Zone, to the lower Alpillensis Zone. This range fits with the range of the *H*. cf. *conradi* (Kilian) in this material, of which they are probably remains.

Genus *Mirabelobelus* Janssen & Clement, 2003

Mirabelobelus blainvillei Janssen & Clement, 2003

Pl. 1, figs. 5-10.

pro1827 *Belemnites bicanaliculatus* de Blainville, pp. 120-121, pl. 5, fig. 8.
1847b *Belemnites bicanaliculatus* Blainville - d'Orbigny, pl. 6, figs. 5-6, 7-8 [not to scale].
?1855 *Belemnites bicanaliculatus* Blainville - Haime, p. 747.
ep1858 *Belemnites bipartitus* Blainville - Pictet & de Loriol, pl. Ibis, fig. 5.
?1879 *Belemnites bicanaliculatus* Blainville - Hermite, pp. 174, 176.
ep1920 *Hibolites bicanaliculatus* de Blaiville - Bülow-Trummer, p. 137.
?1949 *Belemnites bicanaliculatus* Blainville - Templado Martínez & Mesegner Pardo, p. 57.
2003 *Mirabelobelus blainvillei* gen. nov. nom. nov. Janssen & Clément, pp. 521-522 (cum syn.).

Material — Three specimens, RGM 345 300 (D23-22), 345 362 (C08-01) and 345 439 (C??).

Description — See Janssen & Clément (2003, pp. 521-522).

Comparison — Juvenile specimens of *Conobelus* never show lateral incisions, but they do possess a dorsal groove. Juvenile specimens of *Hibolithes* are more rounded to depressed. They sometimes show lateral lines, but never lateral incisions. The *Pseudobelus bipartitus* group never shows such a constricted alveolar area.

Stratigraphical distribution — The oldest specimen is from the Pertransiens Zone. Specimens from southeast France (Vergol) indicate the species to be present at least from the Otopeta Zone. The stratigraphical highest specimens are found in the lower upper part of the Verrucosum Subzone (Janssen & Clément, 2003).

Genus unknown (Mesohibolitidae?)

aff. *Duvalia deeckei* Kilian, 1889

non1889 *Belemnites* (*Duvalia*) *Deeckei* nov. sp. Kilian, p. 636, pl. XXVI, fig. 5.
non1893 *Belemnites* (*Duvalia*) *Deeckei* nov. sp. Kilian, pp. 594-595, pl. T, fig. 5 [= Kilian, 1889].
1997 *Duvalia* aff. *deeckei* (Kilian *in* Bertrand & Kilian) - Janssen, pp. 15-16, pl. 5, figs. 1-4.

Material — Two specimens, RGM 345 236 (Y244-251) and 345 872 (Y231-232).

Description — See Janssen (1997, pp. 15-16).

Stratigraphical distribution — Alpillensis Zone.

Remarks — Both specimens lack the apical and alveolar regions, but most closely resemble *D. deeckei* Kilian, although they are not apparently congeneric with *Duvalia*.

Family Duvaliidae Pavlow, 1914
Genus *Castellanibelus* Combémorel, 1972

Castellanibelus orbignyanus (Duval-Jouve, 1841)
Pl. 2, figs. 5-7, 11-14.

1841 *Belemnites Orbignyanus* Duval-Jouve, p. 65, pl. 8, figs. 4-9.
1847b *Belemnites Orbignianus* (*sic*) Duval-Jouve - d'Orbigny, pl. 4, figs. 10-14, 15 [teratological], 16.
ep?1858 *Belemnites Orbignyanus* Duval-Jouve - Pictet & de Loriol, pl. Ibis, figs. 6[?], 7.
non1859 *Belemnites Orbignyanus* Duval-Jouve - von Eichwald, pl. XXXIII (1868), fig. 13 [= *Hibolithes laryi* Mayer-Eymar].
1868 *Belemnites Orbignyanus*? Duval-Jouve - Pictet, pp. 217-218, pl. 36, fig. 3.
non1873 *Belemnites Orbignyanus* Duval-Jouve - Gilliéron, pp. 204-205, pl. VIII, fig. 11 [= *Conobelus incertus*? Weis (juv.)].
1878 *Hibolites Orbignyi* (*sic*) (Duval-Jouve) - Bayle, pl. XXXI, figs. 9-12.
1887 *Hastites (Hibolites) Orbignyi* (*sic*) Duval-Jouve - Mayer-Eymar, pp. 73, 78.
1889 *Belemnites (Duvalia) Orbignyi* (*sic*) Duval-Jouve - Kilian, p. 689.
ep1890 *Belemnites Orbignyi* (*sic*) Duval-Jouve - Toucas, pl. XV, fig. 1, non figs. 2-3 [= *Conobelus* spp.].
non1915 *Belemnites Orbignyanus* Duval-Jouve - Jekelius, p. 115, pl. VIII, fig. 5.
ep1920 *Conobelus Orbignyanus* Duval-Jouve - Bülow-Trummer, pp. 177-178.
non1921 *Belemnites* cf. *Orbygnyanus* (*sic*) Duval-Jouve - Morand, p. 159.
non1960 *Conobelus orbignyanus* Duval-Jouve - Kabanov, p. 364, pl. I, figs. 3-4.
non1972 *Curtohibolites orbignyanus* (Duval-Jouve) - Ali-Zade, pp. 140-141, pl. I, fig. 7 [= *Conobelus beneckei* (Neumayr 1873) *in* Weiss, 1991], nec fig. 9 [= *Conobelus incertus* Weis].
1972 *Castellanibelus orbignyanus* (Duval-Jouve) - Combémorel, pp. 75-77, pl. A, figs. 12-15 (cum syn.).
1973 *Castellanibelus orbignyanus* (Duval-Jouve) - Combémorel, pp. 158-159, pl. 5, fig. 7.
1980 *Conobelus* (?*Conobelus*) *orbignyanus* (Duval-Jouve) - Jeletzky, pp. 6, 8, 9, pl. V, figs. 2A-D.
?1988 *Castellanibelus* ex gr. *orbignyanus* (Duval-Jouve) - Horák, p. 68, pl. II, fig. 2.
ep1995 *Curtohibolites orbignyanus* (Duval-Jouve) - Riegraf, p. 87.
?1997 *Conobelus orbignyanus* (Duval-Jouve) - Krymgol'ts, p. 149, pl. 59, fig. 7.
1999 *Castellanibelus orbignyanus* (Duval-Jouve) - Clément, pp. 9, pl. 1, fig. 7.
2003 *Castellanibelus orbignyanus* (Duval-Jouve) - Janssen & Clément, p. 520 (cum syn.).

Material — Thirty three specimens from Cañada Lengua, RGM 361 444 (CL104), 361 440-441 (CL106-109), 361 442 (CL107), 361 434 (CL110-115), 361 438-439 (CL110-115), 361 437 (CL113-115), 361 449-451 (CL116), 361 418 (CL116-117), 361 445-448 (CL116-117), 361 419 (CL117-(119)), 361 454-457 (CL117-(119)), 361 421 (CL(115)-120), 361 452 (CL(115)-120), 361 458-464 (CL(115)-120), 361 466 (CL125-126), 361 422 (CL130-131), 361 467 (CL137) and 361 468 (CL146).

Twelve specimens from Tornajo mountain, RGM 345 392 (B36), 345 389 (B37), 345 390 (B37-38), 345 379 (B39-40), 345 380-381 (B40), 345 391 (B40), 345 398 (B40), 345 430-432 (B44) and 345 344 (C08-01).

Nine juvenile rostra or parts of specimens, which could not with certainty be attributed to this species, were collected from the following levels, RGM 361 432 (CL(102)-103a), 345 316 (D28/27-26), 345 329 (C25-24), 345 993 (CL105-106), 345 416

(B39), 345 309 (D26-25), 345 424-425 (B43a) and 361 453 (CL117-118).

Description — Moderately compressed species with well-developed alveolar groove with a rounded to pointed base. Splitting surface generally well developed, except in immature to juvenile specimens; immature specimens usually break irregularly along the central plane, while mature specimens commonly break along the splitting surface (Combémorel, 1972, p. 76). Mucronate apex typical, but sometimes less well-developed in immature and juvenile specimens. Generally the apex is orientated to the dorsal side, but in exceptional cases orientates to the ventral side (RGM 361 445; Pl. 2, fig. 6). The depth of the alveolus reaches about a quarter to a third of the total length of the rostrum, or in exceptional cases (RGM 361 460) to halfway. In lateral view, dorsal side appears almost straight. In ventral view, rostrum moderately club-shaped, because the largest cross-section is situated in the apical area. However, some rostra are almost parallel sided, but depressed. Ontogeny is regular. Uncommonly, modest ventro-lateral occur in all ontogenetic stadia (see *Castellanibelus* sp. A). In the alveolar region of gerontic specimen, a crest-like elevation occurs along the alveolar groove. In all stadia of growth, lateral lines can be observed, of the same length as the alveolar groove and running up to the alveolar opening. Apical line situated in a central to weakly dorsal position.

Comparison — See *Castellanibelus* sp. A.

Stratigraphical distribution — The oldest specimen was found in the top of the Alpillensis Zone (Be 8\Va 0), while the stratigraphically youngest specimen was found in the lower upper part of the Verrucosum Subzone (cf. Janssen & Clément, 2003).

Remarks — The splitting surface of *Castellanibelus* is comparable to that of *Duvalia* (Stoyanova-Vergilova, 1970, p. 9, fig. 2f), with an irregular outer margin (Pl. 2, fig. 5). Only two juvenile specimens (*Castellanibelus* sp. juv.) were found in the Río Argos succession, RGM 345 550 (X237) and 345 870 (Y242-243), both from the mid Alpillensis Zone. Except for *Castellanibelus* sp. A, these are the only records of this genus in the Río Argos succession, while in the shallower Cañada Lengua and in the Tornajo successions, this genus is relative abundant.

Uncommonly, ventro-lateral expansions occur both in immature and mature specimens. As this feature occurs almost throughout the recorded range it is believed to be the expression of intraspecific variation (or sexual dimorphism?). These specimens are for the moment separated as *Castellanibelus* sp. A (see below).

Another specimen (RGM 361 465) from bed CL117b (Pl. 2, figs 15-16) shows an atypical development. It is provisionally referred to as *Castellanibelus*(?) sp. It is depressed over the total length with a mucronate apex. However, the alveolar region is almost round. The depth of the alveolus is comparable to *C. orbignyanus* (Duval-Jouve) *sensu stricto*, but with a somewhat shorter alveolar groove. Both from lateral view as from dorso- or ventral view, the lateral sides appear to be near parallel (conobeloid).

Castellanibelus? *triquetrus* (Weiss, 1991)

Pl. 4, figs. 3-5.

1991 *Conobelus (Coctebelus) triquetrus* Weiss, p. 30, text-figs. 2d-e, pl. II, figs. 2-3.
1992 *Conobelus (Coctebelus) triquetrus* Weiss - Barskov & Weiss, p. 72, text-fig. 3a.
1992a *Conobelus (Coctebelus) triquetrus* Weiss, pp. 34-35, pl. II, figs. 2-3.

1992b *Conobelus (Coctebelus) triquetrus* Weiss - Weiss, text-fig. 2a.
1995 *Rhopaloteuthis triquetra* (Weiss) - Riegraf, p. 117.
ep1997 *Duvalia* cf. *haugi* (Kilian in Bertrand & Kilian) - Janssen, pp. 19-20 (RGM 345 220 only), pl. 6, fig. 5.

Material — Two specimens, RGM 345 999 (CL105-106) and 345 220 (Y267-274).

Description — Elongated rostrum showing prominent dorso-lateral expansions in transverse section. As a result, these sections are pentagonal, except in the apical area. Mature specimens tend to become lozenge-shaped in the alveolar area. Alveolus very shallow. Apex pointed and clearly orientated to the dorsal side. Alveolar groove well developed and rather deep compared to its width. Dorsal side flat. No lateral lines developed. Juvenile specimens seem to be rounded and not compressed (cf. Weiss, 1991, 1992a, text-fig. 2d-e).

Comparison — Compare with Weiss (1991, 1992a).

Stratigraphical distribution — From the Otopeta Zone to ?base of the Pertransiens Zone, but probably restricted to the top of the Otopeta Zone.

Remarks — From a general point of view, and fortified by the characteristic transverse section of the described specimens, this species seems to be identical or very close to *Coctebelus triquetrus* Weiss. However, the rounded juvenile rostrum, the aberrant shallow alveolus and the characteristic development of the alveolar region, not mentioned by Weiss, seems to indicate the specimen is different from those of Weiss (1991, 1992a). Certain rhopaloteuthoid characteristics seem to be more reminiscent of *Castellanibelus*, i.e., the depressed rostrum, the shallow alveolus and flattened dorsal side, the well-developed dorsal groove, and the apical thickening. The shallow alveolus contradicts the indications in Weiss (1991, p. 24; 1992a, p. 27).

***Castellanibelus* sp. A**

Pl. 2, figs. 3-4.

1997 *Castellanibelus* sp. A - Janssen, pp. 6-8, pl. 3, figs. 7-8.

Material — Five specimens, RGM 345 230 (Y267), 345 997 (CL116), 361 417 (CL116), 345 998 (CL116-117) and 361 420 (CL(115)-120).

Description — See Janssen (1997, pp. 6-8).

Comparison — The rostrum is much more flattened compared to that of *C. orbignyanus* (Duval-Jouve). The latter shows no ventro-lateral expansions. *Castellanibelus*? *triquetrus* (Weiss) has much more strongly developed dorso-lateral expansions, with a pentagonal transverse section and a lozenge-shaped alveolar area. The alveolar area is rounded in *Castellanibelus* sp. A.

Stratigraphical distribution — From the uppermost part of the Otopeta Zone up to the lower part of the Pertransiens Zone.

Remarks — The specimen from the Río Argos was erroneously referred to as RGM 345 320 in Janssen (1997, p. 6) and should be RGM 345 230. This species may be a variant without stratigraphic value, although this is unclear at present.

Genus *Conobelus* Stolley, 1919

Conobelus? *piradoensis* sp. nov.

Pl. 5, figs. 1-4.

ep?1868 *Belemnites pilleti* Pictet - Pictet, pl. 36, figs. 8-9, non fig. 7.

Holotype — RGM 345 437 (Pl. 5, figs. 1-2) from Tornajo section C (C29-25, top Alpillensis Zone).

Paratypes — Six specimens, RGM 361 431 (CL(102)-103a), 361 433 (CL(102)-103a), 361 436 (CL(102)-103a), 361 443 (CL104), 345 365 (C29-25) and 345 437 (C29-25).

Derivatio nominis — Named after 'Rambla del Pirado Jerez', a gully north of the Tornajo mountain.

Description — Specimens of moderate length with slightly compressed to rounded or square-like transverse sections and a very shallow alveolus. Apex very sharp to mucronate, centrally orientated or to the dorsal side of the rostrum. Alveolar area more compressed, showing rounded to oval transverse section. Alveolar groove clear, shallow and relatively broad, traced for about 3/4 of total length of guard, well into the apical region. A splitting-surface is developed. Both dorsal and ventral areas tend to flatten in more mature specimens. Both in dorsal and lateral view the broadest part of the rostrum is approximately that with the alveolar groove, only diminishing in diameter from the end of the alveolar groove towards the apex. Transverse sections show that juvenile to immature specimens tend to have a broader ventral side as compared to the more mature specimens, giving rise to a slight pear-like transverse section. No lateral lines nor lateral incisions observed.

Comparison — The genus *Conobelus* generally has a conobeloid to rhopaloteuthoid rostrum with a relative small alveolar groove as compared to *Berriasibelus*. It is not expanded in the ventral area. No flattened dorsal and ventral areas are known in *Conobelus*, as transverse sections turn out to be rounded. Only the specimens that are provisionally named *Castellanibelus*? *triquetrus* show a comparably shallow alveolus and flattening. The general appearance of *Belemnites minaretoides* Vetters, 1905, seems to be very close to the specimens described here, but differs in having a much deeper alveolus (Vetters, 1905, p. 245(23)) and a more rounded transverse section. The genus *Castellanibelus* is never compressed over the total length of the guard, and shows a much deeper alveolus.

Rhopaloteuthis etalloni Maire, 1925, from the Oxfordian can be compared with the described species. It appears to be larger and tapers from alveolar opening to the apex, without near parallel dorsal and ventral sides. The dorsal area of *Co.*? *piradoensis* sp. nov. is much more flattened compared to the specimen described by Maire.

Stratigraphical distribution — Top of the Alpillensis Zone (sequence Be 8\Va 0).

Remarks — The specimen in Pictet (1868) apparently originated from the "brèche d'Aizy". This level contains ammonites (Kilian, 1896, p. 678) that are found in layers ranging from the Ardescian to the Lower Berriasian. *Belemnites minaretoides* Vetters, 1905, originated from sedimentary rocks correlated with the base of the Ardescian, based on the occurrence of the ammonite *Pseudovirgatites scruposus* (Oppel).

Conobelus incertus Weiss, 1991

Pl. 3, figs. 10-13.

?1873 *Belemnites orbignyanus* Duval-Jouve - Gilliéron, pp. 204-205, pl. VIII, fig. 11 (juvenile?).
1972 *Curtohibolites orbignyanus* (Duval-Jouve) - Ali-Zade, pp. 140-141, pl. I, fig. 9.
1991 *Conobelus (Conobelus) incertus* Weis, pp. 31-32, figs. 2a-b, 4a-h.
1992 *Conobelus (Conobelus) incertus* Weis - Barskov & Weis, p. 73, fig. 3b.
1992a *Conobelus (Conobelus) incertus* Weis, pp. 36-38, figs. 2a-b, 4a-h.
1992b *Conobelus (Conobelus) incertus* Weis - Weis, fig. 2b.
1995 *Rhopaloteuthis incerta* (Weis) - Riegraf, p. 116.
ep1997 *Duvalia* cf. *haugi* (Kilian *in* Bertrand & Kilian) - Janssen, pp. 19-20 (RGM 345 215 only).
ep1997 *Rhopaloteuthis strangulata* (Oppel) - Janssen, pp. 31-32, pl. 3, figs. 5-6, non figs. 3-4.

Material — Ten specimens, RGM 345 819 (X206), 345 522 (Y213-(222)), 345 204 (X225-226), 345 511 (X228-(229)), 345 207 (X230), 345 208 (X230), 345 215 (X234-244), 361 424 (CL101), 361 425 (CL101) and 361 426 (CL101).

Description — See Weiss (1991).

Comparison — *Conobelus incertus* Weiss differs from *Berriasibelus kabanovi* (Weiss) in the more rounded transverse sections in all growth stages, and has a different stratigraphical distribution.

Stratigraphical distribution — From the lower Picteti Zone (top of sequence Be 6) to the lowermost part of the Alpillensis Zone.

Geographical distribution — Azerbaijan (Ali-Zade, 1972), Crimea (Weiss, 1991), southeast Spain (herein) and probably Switzerland.

Remarks — Probably useful as a guide fossil for the uppermost Berriasian.

Conobelus sp. A

Material — Five specimens, RGM 345 534 (Y(115)-116), 345 538 (Y124), 345 879 (Y132-133), 345 803 (Y136) and 345 807 (Y149-150).

Description — Specimens are overall well rounded. Faint, shallow alveolar groove visible for just over half the length of the oldest rostrum. Apical line centrally situated. No special characteristics are visible, except for being well rounded. Only RGM 345 538 is complete and shows a near mucronate apex with a slightly compressed to well rounded rostrum. Alveolus very short, but alveolar groove can be traced halfway along the rostrum.

Comparison — Differs from *C. incertus* Weiss in having a much shallower alveolus, a shorter alveolar groove and a near parallel outline in both lateral and ventral-dorsal view.

Stratigraphical distribution — Base Paramimouna Zone to mid of Paramimouna Zone (in the investigated material, restricted to sequence Be 5).

Conobelus sp. B

Pl. 2, figs. 8-10.

Material — Three incomplete specimens, RGM 361 414 (CL88), 361 415 (CL89-90) and 361 416 (CL95-96).

Description — Very strongly developed mid-lateral expansions. One deformed api-

cal part just shows the beginning of the alveolus (Pl. 2, figs. 13-14), whereas in another (Pl. 2, fig. 12) the whole alveolar area is preserved. Fairly deep alveolus that reaches about halfway to the rostrum. Apical line orientated to the side where the alveolar groove is developed. Alveolar groove faint, extending well into the apical half of the rostrum. Juvenile guard with clear mid-lateral expansions and mucronate apex.

Comparison — Specimens can easily be distinguished from the other species of *Conobelus*(?) by the well expressed mid-lateral expulsions. They are reminiscent of *Castellanibelus*, but the latter genus is not known to occur in the Berriasian. In *Castellanibelus* sp. A, the lateral expulsions are less obvious and orientated more to the ventral side.

Stratigraphical distribution — Base of Paramimouna Zone.

Remarks — As the collected material is limited, it was chosen to classify this species under open nomenclature.

Conobelus(?) sp. juv.

Material — Three specimens, RGM 345 440 (C31-(27)), 361 423 (CL101) and 361 430 (CL102).

Remarks — These juvenile specimens are found in beds that can be attributed to the late Picteti or mid late Alpillensis Zone.

Conobelus sp. aff. *Belemnites aenigmaticus* d'Orbigny, 1843

Pl. 2, figs. 1-2.

non1843 *Belemnites aenigmaticus* d'Orbigny, pp. 131-132, pl. 22, figs. 1-3.
non1953 *Rhopaloteuthis* aff. *aenigmaticus* d'Orbigny - Rózycki, p. 177.

Material — One specimen, RGM 361 413 (CL103a), probably teratological.

Description — Apical area deformed and splitting-surface abnormal. Alveolus penetrates deep into the rostrum and clear alveolar groove with sharp base is visible. Transverse sections are very rounded. Apical line clearly orientated to ventral side.

Comparison — The species mostly resembles the Oxfordian *Belemnites aenigmaticus* d'Orbigny, but has a smaller alveolar angle. Moreover, the species described by d'Orbigny is from the Oxfordian.

Stratigraphical distribution — Lower part of the upper Alpillensis Zone.

Remarks — This is once more a fine example of convergence (distantly related ancestors) or allochronic homeomorphism (different ancestors) that exists between *Rhopaloteuthis* and *Conobelus*. However, this specimen is most probably a teratological specimen belonging to *Conobelus incertus* Weiss, which it most closely resembles.

Genus *Berriasibelus* Delattre, 1952

Remarks — Weiss (1991, 1992a) revised the genus *Conobelus* and erected two subgenera, *Conobelus* and *Coctebelus* (= p.p. *Koktebelibelus* Nerodenko 1983a *nomen nudum*). *Coctebelus* was separated by its more dorso-lateral growth. However, the specific description of *Coctebelus* does not justify separatation from *Berriasibelus* Delattre, 1952 (type species *Belemnites exstinctorius* Raspail, 1829). Here, *Coctebelus* is treated as being a junior synonym of *Berriasibelus*.

Berriasibelus exstinctorius (Raspail, 1829)

Pl. 3, figs. 1-4.

1829 *Belemnites exstinctorius* Raspail, p. 308, pl. 6, fig. 20.
1829 *Belemnites extinctorius* (*sic*) Raspail, p. 331 [*nom. dub.*].
1841 *Belemnites extinctorius* (*sic*) Raspail - Duval-Jouve, pp. 64-65, pl. 8, figs. 1-3.
ep1847b *Belemnites conicus* Blainville - d'Orbigny, pl. 6, figs. 9-11.
1849 *Belemnites extinctorius* (*sic*) Raspail - Quenstedt, p. 453, pl. 30, figs. 19-20.
1858 *Belemnites conicus* (de Blainville) - Pictet & de Loriol, p. 10, pl. I, fig. 5.
non1880 *Belemnites extinctorius* (*sic*) Raspail - de Sarran d'Allard, p. 338.
ep1883 *Belemnites (Hibolites) extinctorius* (*sic*) Raspail - Mayer-Eymar, p. 643.
non1883 *Belemnites* aff. *extinctorius* Raspail - Uhlig, p. 175, pl. I, fig. 12. (= *Curtohibolites wernsdorfensis* Stoyanova-Vergilova, 1963).
1904 *Belemnites (Duvalia?) extinctorius* (*sic*) Raspail - Raspail, text-figs. on p. 17.
1904 *Belemnites exstinctorius* Raspail - Raspail, p. 17a.
ep1920 *Conobelus extinctorius* (*sic*) Raspail - Bülow-Trummer, pp. 176-177.
1949 *Conobelus extinctorius* (*sic*) (Raspail) - Krymgol'ts, pp. 268-269, pl. LXXXIII, figs. 12-13.
ep1951 *Belemnites extinctorius* (*sic*) Raspail - Delattre, pp. 150-154, pl. V, figs. 65-68, non fig. 69 (= *Belemnites escragnollensis* Delattre, 1952).
1952 *Berriasibelus extinctorius* (*sic*) (Raspail) - Delattre, pp. 321-327 with text-fig.
?1963 *Conobelus biconicus* Flandrin, p. 19 [*nom. dub., nom. nud.*].
1967 *Conobelus exinctorius* (*sic*) (Raspail) - Kabanov, pp. 23, 98, 99, pl. XI, figs. 1-2.
non1972 *Conobelus extinctorius* (*sic*) (Raspail) - Ali-Zade, pp. 125-126, pl. I, figs. 8a-e (= *Berriasibelus kabanovi* (Weiss)).
1972 *Berriasibelus extinctorius* (*sic*) (Raspail) - Combémorel, pp. 71-74, pl. A, figs. 6-11, pl. B, figs. 1-3.
1973 *Berriasibelus extinctorius* (*sic*) (Raspail) - Combémorel, pp. 156-157, pl. 5, figs. 5-6.
non1978 *Berriasibelus extinctorius* (*sic*) (Raspail) - Vasícek, pp. 6-7, pl. I, fig. 4 (= *B. kabanovi* (Weiss)).
non1979 *Berriasibelus extinctorius* (*sic*) (Raspail) - Mutterlose, pp. 123-124, pl. 1, figs. 1-2 (= teratological Mesohibolitidae).
1980 *Conobelus (Berriasibelus) extinctorius* (*sic*) (Raspail) - Jeletzky, p. 8.
1986 *Berriasibelus extinctorius* (*sic*) (Raspail) - Klein, pl. VII, fig. 5.
ep?1988 *Berriasibelus extinctorius* (*sic*) (Raspail) - Horák, pp. 65-66, pl. I, fig. 4 (= *B. kabanovi* (Weiss)), pl. II, fig. 3 (?).
?1991 *Conobelus conicus* (Blainville) - Kakabadze & Keleptrishvili, pp. 35-36, pl. I, fig. 3 (juv?).
?1991 *Conobelus* ex gr. *extinctorius* (*sic*) (Raspail) - Kakabadze & Keleptrishvili, p. 36, pl. I, fig. 4.
1991 *Berriasibelus extinctorius* (*sic*) (Raspail) - Weis, text-figs. 2h, 4i-k.
1992 *Conobelus (Berriasibelus) extinctorius* (*sic*) (Raspail) - Barskov & Weis, p. 72, text-fig. 3f.
1992a *Conobelus (Berriasibelus) extinctorius* (*sic*) (Raspail) - Weis, text-figs. 2h, 4i-k.
1992b *Conobelus (Berriasibelus) extinctorius* (*sic*) (Raspail) - Weis, text-fig. 2f.
1994 *Conobelus exinctorius* (*sic*) Raspail - Zhuravleva, text-fig. 5b.
1995 *Berriasibelus extinctorius* (*sic*) (Raspail) - Riegraf, p. 108.
ep?1997 *Rhopaloteuthis strangulatus* (Oppel) - Janssen, pp. 31-32 (RGM 345 285 only = *Berriasibelus* sp. (imm.)).
1997 *Conobelus conicus* (Blainville) - Krymgol'ts, p. 150, pl. 59, fig. 8.
1998 *Berriasibelus exstinctorius* (Raspail) - Riegraf *et al.*, p. 261.
1999 *Berriasibelus exstinctorius* (Raspail) - Clément, p. 8, pl. 1, fig. 1.

Material — Two specimens, RGM 345 813 (X(240)-251) and 361 404 (CL116-117). RGM 345 285 (Y209-212) is an immature *Berriasibelus* sp. and may be conspecific.

Description — Rounded, transverse sections can be found in both immature and mature rostra. Only the apical most part is compressed. Faint dorso-lateral expansions visible in some transverse sections. Alveolus penetrates at least halfway along the ros-

trum. Splitting surface generally exceptionally well developed. Alveolar groove broad with a rounded base, can be traced over larger part of the rostrum. In ventral view both dorsal and ventral outlines straight over largest part of post-apical region. So-called 'typical' apical bending, that can be observed in dorsal or ventral view, is not always present or very faint (e.g., in the specimen figured in Quenstedt, 1849, pl. 30, fig. 19). When not apically bent, apex appears more elongated.

Comparison — In *B. kabanovi* (Weiss) the dorsal outline is almost straight, but the ventral outline tapers to the apical area. The transverse section in the apical region is triangular to rhomboidal and not compressed. Moreover, dorso-lateral expansions are well developed in immature and mature specimens. The alveolus does not reach half the length of the rostrum. Mature specimens of *Berriasibelus propinquus* (Weiss) show the base of the alveolar groove to be more flattened as compared to *B. exstinctorius*. The alveolar area tends to become less compressed and, in the apical region, the lateral area is flattened. The apex remains pointed and is generally orientated to the dorsal side. Immature specimens of *B. exstinctorius* are much more rounded and show a deeper alveolus.

Stratigraphical distribution — The oldest certain specimen from this material is derived from the middle of the Alpillensis Zone (Be 8\Va 0), while the stratigraphically highest specimens are to be found in the lowermost Biassalensis Zone (cf. Janssen & Clément, 2003, p. 514).

Remarks — This species is rather rare, but seems to be more common in the Hirsutum Subzone (top of the Pertransiens Zone) in southeast France (pers. obs.). It is believed to be present already in the Tithonian (Delattre, 1951, p. 154), but this seems to be most probably erroneous. The type specimen refigured in Raspail (1904) differs from the generally accepted typical development of this species, as it is obviously depressed. Among the specimens that have been collected by the author, depressed specimens are common only in the Hirsutum Subzone of southeast France.

It is not clear whether specimen RGM 345 285 belongs to the nominal species. However, it is of importance as it seems to be the lowest stratigraphically-controlled discovery of this genus.

***Berriasibelus kabanovi* (Weiss, 1991)**

Pl. 3, figs. 5-9; Pl. 4, figs. 11-12.

1972 *Conobelus extinctorius* (Raspail) - Ali-Zade, pp. 125-126, pl. I, figs. 8a-e.
ep1972 *Duvalia conica* (Blainville) - Combémorel, pp. 70-71, figs. 1-3, non figs. 4-5.
ep1973 *Duvalia conica* (Blainville) - Combémorel, pp. 141-142, pl. 2, fig. 8, non fig. 9.
1978 *Berriasibelus extinctorius* (*sic*) (Raspail) - Vasícek, pp. 6-7, pl. I, fig. 4.
1988 *Conobelus extinctorius* (Raspail) - Ali-Zade, p. 390, pl. 1, fig. 2.
ep1988 *Berriasibelus extinctorius* (Raspail) - Horák, pp. 65-66, pl. I, fig. 4.
1991 *Conobelus (Coctebelus) kabanovi* Weiss, pp. 29-30, pl. II, fig. 8.
1992 *Conobelus (Coctebelus) kabanovi* Weiss - Barskov & Weiss, p. 72, text-figs. 3c, g, j.
1992a *Conobelus (Coctebelus) kabanovi* Weiss, pp. 33-34, pl. II, fig. 8.
1992b *Conobelus (Coctebelus) kabanovi* Weiss - Weiss, p. 19.
1995 *Rhopaloteuthis kabanovi* (Weiss) - Riegraf, p. 117.

Material — Eighteen specimens, RGM 345 544 (Y319a), 345 545 (Y319a), 361 400 (CL103c-105), 361 403 (CL106-109), 361 407 (CL106-109), 361 409 (CL106-109), 361 408

(CL116-117), 361 410 (CL116-117), 361 401 (CL(115)-120), 361 402 (CL(115)-120), 345 335 (C29), 345 415 (B39), 345 393-396 (B40), 361 501 (D21-(20)) and RGM 345 429 (B44).

Description — Transverse sections show clear dorso-lateral expansions, in both immature and mature guards, giving transverse section a heart-shaped outline with a wide base. Immature specimens clearly compressed, somewhat less clear in mature specimens. Alveolus shallow, does not penetrate over half the length of rostrum. The splitting surface is commonly exceptionally well-developed. Alveolar groove broad with a rounded base, can be traced over larger part of rostrum. In lateral view dorsal outline is more or less straight, but ventral outline tapers from alveolar opening to apex. Apex generally dorsal in position and very pointed to slightly mucronate.

Comparison — *Berriasibelus propinquus* differs from *B. kabanovi* in having a compressed ellipsoidal transverse section and having mature guards of smaller size. Juvenile specimens are almost identical. In *B. propinquus* no dorso-lateral crests are present.

Stratigraphical distribution — Mid Alpillensis Zone (Be 8\Va 0) to upper part of the Pertransiens Zone (lowstand deposits of sequence Va 3).

Geographical distribution — Azerbaijan (Ali-Zade, 1972), Crimea (Weiss, 1991), Czech Republic (Vasícek, 1978; Horák, 1988), France (Combémorel, 1972, 1973; pers. obs.) and Spain (herein).

Berriasibelus(?) sp. juv.

Material — Six specimens, RGM 345 866 (Y268-269), 345 323 (C21a-(21)), 361 427 (CL116), 361 406 (CL116-117), 361 405 (CL117-(119)) and 345 411 (B50).

Remarks — These juvenile specimens are found in beds attributed to the Otopeta Zone and to the Pertransiens Zone.

Genus *Duvalia* Bayle, 1878

Remarks — The various subspecies of *Duvalia lata* (de Blainville) are mostly treated as morphological variations within the same species and not as geographically varieties. Herein, *Duvalia lata constricta* Uhlig, 1902, and *D. lata zeugitana* Pervinquière, 1907, are indicated to be synonyms, while *D. lata* (de Blainville, 1827) (= *D. lata lata*) is treated as a possible dimorph of the former.

Duvalia lata constricta Uhlig, 1902

Pl. 6, figs. 12-17.

ep1825 *Belemnites lata* de Blainville, p. 175 (*nomen nudum*).
ep1826 *Belemnites lata* de Blainville, p. 436 (*nomen nudum*).
ep1827 *Belemnites latus* de Blainville, p. 121, pl. 5, fig. 10 [= *D. lata lata*].
ep1841 *Belemnites latus* Blainville - Duval-Jouve, pp. 61-62, pl. 6, figs. 1-3, 6 (var. *prismaticus* [= teratological specimen]), 7 (var. *obtusus*)-11 [= teratological specimens].
non1841 *Belemnites latus* Blainville - Duval-Jouve, pl. 6, fig. 4 (var. *elongatus* [= *Berriasibelus* gr. *conicus* (de Blainville)]).
non1841 *Belemnites latus* Blainville - Duval-Jouve, pl. 6, fig. 5 (var. *subcompressus* [= *Duvalia* nov. (sub)sp., typical specimen from Hirsutus Subzone]).

ep1847b *Belemnites latus* Blainville - d'Orbigny, pl. 4, figs. 1-5, non figs. 6-9 [= var. *subcompressus* Duval-Jouve].
ep1849 *Belemnites latus* Blainville - Quenstedt, pp. 452-453, pl. 30, fig. 14 [= *D. lata lata*], *non* fig. 13 (= *Belemnites dumortieri nom. nov.* Oppel, 1865).
non1858 *Belemnites latus* Blainville - Pictet & de Loriol, pl. Ibis, figs. 9-10 [= *D*. gr. *lata*], 11 [= var. *subcompressus* Duval-Jouve].
?1859 *Belemnites latus* Blainville - von Eichwald, pl. XXXIII, figs. 8a-c [= teratological spec.].
1859 *Belemnites latus* Blainville - von Eichwald, pl. XXXIII, figs. 8d-e.
non1868 *Belemnites latus* Blainville var. comprimée Pictet, pp. 216-217, pl. 36, fig. 1 [from "couche à *Belemnites latus*" de Berrias (Otopeta-lower Pertransiens); = ?*D. tornajoensis* sp. nov.).
non1868 *Belemnites latus* Blainville var. comprimée Pictet, pp. 216-217, pl. 36, fig. 2 [from "couches à polypiers (brèche) de Lemenc"); = *D. ensifer* (Oppel) *vide* Pillet, 1871; Gilliéron, 1873; Lissajous, 1925).
1878 *Duvalia lata* (Blainville) - Bayle, pl. XXXI, figs. 3-8.
non1902 *Belemnites latus* Blainville - Noetling, p. 3, pl. I, fig. 15 (= *Hibolithes fontoynonti*? Besairie *vide* Combémorel, 1988, p. 105).
1902 *Belemnites (Duvalia) lata* Blainville var. *constricta* Uhlig, p. 19, pl. I, fig. 4.
1907 *Belemnites (Duvalia) latus* de Blainville - Lemoine, pp. 114-114a, upper left fig. (= de Blainville, 1827, pl. 5, fig. 10) and upper right fig. ([HT] = *D. lata lata*), and lower fig. ([topotype] = *lata constricta*).
1907 *Belemnites (Duvalia) lata* var. *Zeugitana* Pervinquière, p. 405, text-fig. 157.
non1917 *Belemnites (Duvalia) latus* Blainville - Kilian & Révil, pl. XV, fig. 1 (= *Duvalia* nov. sp. indet. in Janssen, 1997).
1925 *Duvalia lata* Blainville - Lissajous, text-fig. 16 [= *D. lata constricta*].
1933 *Belemnites (Duvalia) lata* Blainville - Cohen, p. 166, pl. II, fig. 17 [= *D. lata constricta*].
non1939 *Duvalia lata* Blainville - Krymgol'ts, pp. 34-35, pl. VIII, fig. 2 (= *Duvalia* n. sp.).
non1946 *Duvalia lata* Blainville - Tsankov, pl. XVII, fig. 7 (= *D*. gr. *dilatata* Blainville).
1946 *Duvalia lata* Blainville - Tsankov, pl. XVII, fig. 8 [= Stefanov, 1934: 221; = *D. lata constricta* (imm?)].
1951 *Duvalia lata* (de Blainville) - Delattre, pp. 84-88, pl. III, text-figs. 31-34, figs. 38-41 [= *D. lata constricta*].
?1951 *Duvalia lata* (de Blainville) - Delattre, text-fig. 35 [= *D. lata lata*?].
1958 *Duvalia* cf. *lata* Blainville - Aliev, pp. 123-124, pl. VIII, fig. 11 (juvenile?).
1973 *Duvalia lata* var. *constricta* Uhlig - Combémorel, p. 138, pl. I, figs. 4, 5 [= *D. lata* var. *zeugitana* Pervinquière], 6-7.
1973 *Duvalia lata* (Blainville) - Stevens, pl. I, figs. A-C [= *D. lata constricta*].
?1978 *Duvalia lata* (Blainville) - Vasícek, pp. 7-8, pl. I, fig. 5 [juv.].
non1979 *Duvalia lata* (Blainville) - Mutterlose, pp. 124-125, pl. 1, fig. 3 (= teratological Mesohibolitidae).
1996 *Duvalia lata* (Blainville) - Eliás *et al*., pp. 264, 267, pl. V, figs. 12-13 [= *D. lata constricta*].
ep1997 *Duvalia lata* (de Blainville) - Janssen, pp. 21-23, pl. 1, figs. 1-2 [= *D. lata constricta*], *non* figs. 3-4 (= *D. tornajoensis* sp. nov.).
1997 *Duvalia lata* (Blainville) - Krymgol'ts, p. 150, pl. 59, figs. 1-2 [= *D. lata constricta*].
1999 *Duvalia lata constricta* Uhlig - Clément, p. 11, pl. 2, figs. 1-2.
1999 *Duvalia lata lata* (de Blainville) - Clément, p. 11, pl. 2, figs. 3-4.
1999 *Duvalia lata zeugitana* Pervinquière - Clément, p. 11, pl. 2, figs. 5-6.

Material — Forty three '*constricta*'-specimens of various ontogentic stages, RGM 345 568 (Y129(-131)), 345 531 (Y132-136), 345 547 (Y149), 345 820 (Y150-(151)), 345 541 (Y151-153), 345 865 (Y159-160), 345 962 (CL95-96), 345 277-278 (Y189-190), 345 959 (CL100), 345 239 (Y193-195), 345 283 (Y201-207), 345 812 (Y205-206), 345 958 (CL101), 345 233 (Y218), 345 202 (X219), 345 957 (CL102), 345 873 (Y225-226), 345 513 (X228(-229)), 345 205 (X229), 345 528 (Y233-234), 345 232 (Y233-(235)), 345 536 (Y234-235), 345 211 (X234-235), 345 572

(Y238a-239), 345 871 (Y241-242), 345 815 (Y242a-243), 345 327 (C24), 345 949-950 (CL106-109), 345 237 (Y266-266b), 345 938 (CL107), 345 358 (B40), 345 221 (Y267-274), 345 943 (CL110-115), 345 934 (CL113-115), 345 909 (CL116), 345 919 (CL116), 345 928 (CL116), 345 916 (CL116-117), 345 923 (CL116-117), 345 894 (CL117-(119)), 345 907 (CL118-119), 345 930-931 (CL(115)-120) and probably 345 804 (Y319-319a).

Only three '*lata*'-specimens were collected (in the Río Argos succession), RGM 345 553 (X212-215), 345 518 (X213) and 345 546 (X267-269). The only '*zeugitana*'-specimen was collected from the Cañada Lengua succession, RGM 345 940 (CL107).

Stratigraphical distribution — Lower part of the Paramimouna Zone to the upper part of the Pertransiens Zone.

Remarks — The investigated material contained many specimens of the var. *constricta*, which seems to be more commonly figured than typical specimens (Lemoine, 1907, pp. 114-114a, upper right figure). Thereby it might be more realistic to use the description of the Uhlig specimen as typical; it was designated as topotype in Lemoine (1907, lower figure).

The Upper Berriasian (Paramimouna and Picteti Zones) and Upper Berriasian or lowermost Valanginian (base Alpillensis Zone) are mainly characterised by *D. lata constricta*, whereas the basal Valanginian (top Alpillensis, Otopeta and lower part of the Pertransiens Zone) also new members of the *Duvalia lata*-group (*D. tornajoensis* n. sp. and *D.* aff. *haugi* Kilian) are commonly found. Together they represent the most abundant occurrence (acme) of the *Duvalia lata* group in the investigated stratigraphical interval.

Duvalia aff. *lata lata* (de Blainville, 1827)

non1827 *Belemnites latus* de Blainville, p. 121, pl. 5, fig. 10.

Material — Six specimens, RGM 345 535 (Y244-249), 345 886 (CL103c), 345 944 (CL104), 345 945 (CL105), 345 946 (CL105-106) and 345 947 (CL106).

Description — Moderately sized rostrum with long, shallow alveolar groove well onto apical region. Both dorsal and ventral sides nearly parallel. Apex pointed and skewed to dorsal side. All transverse sections oval, some specimens with moderate dorso-lateral expansions in alveolar area. In dorsal view, lateral sides of immature specimens tend to taper from alveolar region to apical region. In mature rostra lateral areas tend to be more parallel. Alveolus moderately deep and does not reach half the length of the guard.

Comparison — Differs from *Duvalia* (aff.) *tornajoensis* in its less compressed cross-section, i.e., with more extended lateral sides. This feature is especially well seen in the apical area. In lateral view no parallel dorsal and ventral sides are observed, except in juveniles and/or immature specimens. *Duvalia lata lata* (de Blainville) appears to be fatter with more rhomboidal-like cross sections, and without parallel dorsal and ventral sides, whereas the alveolus is less deep.

Stratigraphical distribution — Mid Alpillensis Zone.

Duvalia miravetesensis sp. nov.

Pl. 6, figs. 8-9, 18-20.

?1892 *Belemnites* (*Duvalia*) *dilatatus* d'Orbigny - Kilian, p. 558(462).
?1895 *Belemnites dilatatus* Blainville - Tobler, pp. 264, 265.
?1896 *Belemnites dilatatus* Blainville - Tobler, p. 450.
ep1997 *Duvalia dilatata dilatata* (de Blainville) - Janssen, pl. 2, fig. 7.

Holotype — RGM 345 566, from section X in the Río Argos, bed X223, latest Picteti Zone or earliest Alpillensis Zone.

Paratypes — Nine specimens, RGM 345 529 (Y104), 345 882 (CL88), 345 883 (CL89-90), 345 885 (CL89-90), 361 411 (CL95-96), 345 884 (CL100), 361 412 (CL100), 345 554 (X234-239) and RGM 345 213 (Y234-244).

Derivatio nominis — Named after the Barranco de Miravetes, near Caravaca.

Description — Strongly compressed rostrum with short alveolar groove; atypical in the *D. lata* group. Transverse sections generally rounded to squarish (RGM 345 566) with near-parallel lateral sides. Juvenile specimens strongly elongated. Maximum transverse section in apical area. Apex orientated centrally or slightly to the dorsal side. Alveolar area compressed with flat ventral side. Alveolar groove relatively deep; as a result, bordered by two crest-like rims. Alveolus very shallow and short, due to strong constriction that separates the actual alveolar area from the rostrum solidum.

Comparison — Juvenile rostra resemble juvenile specimens of *Duvalia lata constricta*. They differ in the absence of an alveolar groove. The transverse section in the apical area resembles *D.* aff. *lata lata*, but the absence of an alveolar groove allows them to be separated easily. Moreover, the apex is orientated more dorsally in *D.* aff. *lata lata*. In general juvenile *D. miravetesensis* sp. nov. appear dilatatoid except for the strong constriction in the alveolar area and show affinities with *D.* gr. *dilatata* (de Blainville), but can be separated on their general morphology and stratigraphical position. *Duvalia* gr. *dilatata* (de Blainville) does not occur until the Upper Valanginian (cf. Janssen & Clément, 2003, p. 514).

Stratigraphical distribution — Paramimouna Zone to the base of the Alpillensis Zone.

Remarks — One dilatatoid specimen (RGM 345 551) (Pl. 6, figs 12-13) was found in the middle part of the Paramimouna Zone (bed Y 147) in the Río Argos succession, at the base of sequence Be 6. It is probably to be separated from the above described new species and is tentatively named *Duvalia* aff. *guillantona* Besairie, 1930. It is a dilatatoid rostrum with near-parallel dorsal and lateral sides, and a rather deep alveolus. A clear alveolar groove is present over the larger part of the rostrum. The anti-apical area shows a lozenge-shaped transverse section with mid-lateral expansions, unlike the ventro-lateral expansions of *D. guillantona*. *Duvalia* aff. *haugi* Kilian, 1889, differs from *D.* aff. *guillantona* due to the absence of parallel dorsal and lateral sides, in its tapering appearance and different stratigraphic occurrence.

Duvalia tornajoensis sp. nov.

Pl. 6, figs. 1-2, 6-7.

?1868 *Belemnites latus* Blainville var. comprimée Pictet, pp. 216-217, pl. 36, fig. 1.
ep1997 *Duvalia lata* (de Blainville) - Janssen, pl. 1, figs. 3-4.

Holotype — RGM 345 200 from section Y in the Río Argos, bed Y262, base of the Otopeta Zone.

Paratypes — One hundred and thirty seven specimens in total. Eight specimens from Río Argos, RGM 345 241 (X244-249), 345 517 (Y215), 345 516 (X252-253), 345 802 (X257), 345 240 (X258), 345 562 (Y267), 345 867 (Y268b-269) and 345 560 (Y319b-319c).

Thirty six specimens from Cañada Lengua, RGM 345 955 (CL103), 345 948 (CL106-109), 345 951-953 (CL106-109), 345 939 (CL107), 345 942 (CL109), 345 935 (CL110), 345 933 (CL113-115), 345 932 (CL115-116), 345 921-922 (CL116, 5 examples), 345 927 (CL116), 345 898-901 (CL116-117), 345 903-904 (CL116-117), 345 910-912 (CL116-117), 345 914 (CL116-117), 345 917-918 (CL116-117), 345 895 (CL117-118), 345 905 (CL117-118), 345 887-888 (CL117-(119)), 345 890-891 (CL117-(119)), 345 896 (CL117-(119)) and RGM 345 897 (CL122-123).

93 specimens from Tornajo, RGM 345 336-338 (C29), 345 332-334 (C29), 345 330-331 (C(27)-25), 312-314 (D28/27-26), 369-371 (B36), 345 443-445 (B36), 345 310 (D26), 345 305-308 (D26-25), 345 446-448 (B37), 345 449-450 (B37-38), 345 373-378 (B38), 345 417-422 (B39), 345 452-454 (B39-40), 345 293-295 (D23-22), 345 383-384 (B40), 345 399-403 (B40), 345 406-409 (B40), 345 455-458 (B40, 7 examples), 345 462 (B40, 2 examples), 345 321-322 (C21a-(21)), 345 324-325 (C21-20), 361 502 (D21-(20)), 345 318-320 (C17), 345 328 (C17), 345 363 (C17), 345 368 (C17, 5 examples), 345 438 (C17), 345 342 (C17?), 345 460 (B43), 345 426 (B43a), 345 427 (B43b), 345 433 (B44), 345 434 (B44, 2 examples), 345 461 (B44), 345 348 (B46), 345 357 (B47), 345 359 (B51), 345 343 (C08-(01)) and 345 360 (B58-59).

Derivatio nominis — Named after the Tornajo mountain.

Description — Moderate sized, very compressed, with long alveolar groove and shallow alveolus. Apex orientated to dorsal side. Alveolar region has a lozenge-shaped transverse section, whereas rest of rostrum strongly compressed. Rostrum never shows strong expansions and lateral lines not present. In lateral view, dorsal side straight, ventral side slightly curved. Increases in dorso-ventral and apical directions during ontogeny.

Comparison — Differs from *D. lata constricta* in the absence of expansions in all ontogenetic stages. *Duvalia lata lata* is not so much compressed. *Duvalia guillantona* Besairie has a comparable compression index, but differs in having a shorter alveolar groove, a ventrally shifted lozenge-shaped alveolar opening, a deeper alveolus and commonly having a lateral outline in the alveolar region that is more reminiscent of *Duvalia* aff. *haugi* Kilian. Moreover, *D. guillantona* is found in slightly younger strata than *D. tornajoensis* sp. nov., i.e., strata corresponding to the Campylotoxus Zone, in the so-called "marnes à *Duvalia*" of Madagascar (*vide* Barrabé, 1933; Combémorel, 1988, p. 130; Baloge *et al*., 1984, pp. 511-513).

Stratigraphical distribution — Mid Alpillensis Zone to upper part of Pertransiens Zone.

Duvalia aff. *haugi* Kilian, 1889

Pl. 6, figs. 3-5.

?1889 *Bélemnites* (*Duvalia*) *Haugi* n. sp. Kilian, p. 636, pl. XXVII, fig. 1.
?1892 *Belemnites* (*Duvalia*) *Haugi* Kilian - Kilian, pp. 551, 556, 561.
?1893 *Belemnites* (*Duvalia*) *Haugi* nov. sp. Kilian, p. 594, pl. T', fig. 1 (= Kilian, 1889).
?1907 *Duvalia Haugi* Kilian - Haug, p. 1105.
?1920 *Duvalia Haugi* Kilian - Bülow-Trummer, p. 172.
?1925 *Belemnites* (*Duvalia*) *Haugi* Kilian - Lissajous, p. 96.

?1931 *Duvalia haugi* Kilian - Fallot, p. 129.
?1951 *Duvalia haugi* Kilian - Delattre, p. 127, text-fig. 52.
?1992b *Duvalia haugi* Kilian - Weis, p. 19.
?1995 *Duvalia haugi* Kilian - Riegraf, p. 110.
non1997 *Duvalia* cf. *haugi* (Kilian *in* Bertrand & Kilian) - Janssen, pp. 19-20, pl. 6, fig. 5.

Material — Twenty five specimens from Cañada Lengua, RGM 345 936-937 (CL106-109), 345 908 (CL116), 345 920 (CL116), 345 902 (CL116-117), 345 913 (CL116-117), 345 915 (CL116-117, 2 examples), 345 929 (CL116-117), 345 906 (CL117-118), 345 889 (CL117-(119)), 345 892 (CL117-(119)) and 345 924-926 (CL(115)-120, 13 examples).

Four specimens from Tornajo, RGM 345 459 (B40-41), 345 436 (B45), 345 442 (B49) and 361 504 (D05-04).

Description — Very compressed species that shows a very deep alveolus, long alveolar groove and extensive lateral expansions in the alveolar area as a result of depth of alveolus. Ontogeny differs from *D. tornajoensis*, in part the result of the deep alveolus, but also caused by diminishing growth in the apical area.

Comparison — This species is comparable to *D. guillantona*, but it shows a much deeper alveolus, and a more or less conical dorso-ventral outline as a result of the well-developed alveolus. It lacks the constricted alveolar area that is characteristic for most of the *Duvalia*. *Duvalia haugi* Kilian, 1889, seems to be morphologically very close, but is apparently derived from the "... Zone à *Am. transitorius* et *Pyg. diphya* ..." (Upper Jurassic) at Fuente de los Frailes, Cabra.

Stratigraphical distribution — Upper part of Otopeta Zone to Pertransiens Zone.

Duvalia gr. *lata* (de Blainville, 1827) sp. indet.

Material — Fourteen specimens, RGM 345 961 (CL95-96), 345 539 (Y187-189), 345 960 (CL100), 345 222 (Y209-212), 345 284 (Y209-212), 345 869 (Y241-244), 345 956 (CL(102)-103), 345 954 (CL103C-105), 345 800 (X257-258), 345 261 (Y261b), 345 231 (Y266-270), 345 868 (Y268-268a), 345 941 (CL109) and 345 893 (CL117-118).

Remarks — Included material is fragmentary only. These specimens are included for completeness and were found in the stratigraphical interval were *D*. gr. *lata* is most common.

Duvalia sp. 3

Pl. 1, figs. 11-13.

Material — One specimen, RGM 345 881 (CL110-115).

Description — Relatively short alveolar groove which does not pass beginning of alveolus. Pseudoduvaloid in appearance, well visible in dorsal view, caused by presence of dorso-lateral constrictions between alveolar groove and apical area, and by moderate expansions on dorso-lateral side in apical area. Lateral aspects nearly parallel except in alveolar region, where small lateral expansions are present. In ventral view guard has a latatoid appearance.

Comparison — Comparable to species of *Pseudoduvalia*, but the latter are characteristic for the (Upper) Hauterivian. It most probably belongs to *Duvalia* gr. *lata* (de Blainville).

Stratigraphical distribution — Early Pertransiens Zone.

Remarks — This unique specimen is different from anything else known from the investigated interval. It is considered conservation to place it under open nomenclature for the moment.

Genus *Gillieronibelus* gen. nov.

Derivatio nominis — Named after the Swiss geologist V. Gilliéron, who was the first to describe a member of this genus.

Type species — Belemnites mayeri Gilliéron (1873, pl. IX, fig. 1).

Stratum typicum — Gilliéron recorded the type species from the "couches de Berrias." Guillaume (1957, p. 65) indicated that it probably is derived from level 5 in the Villarbeney section together with doubtful fragments of *Ammonites occitanicus* Pictet (= *Subthurmannia (Strambergella) occitanica* (Pictet, 1867)), index species of the middle Berriasian Occitanica Zone. However, in stratigraphical younger layers, calpionellids indicative for the Lower Berriasian are found together with typical Upper Jurassic ammonites. This reworking is characteristic for the upper part of the lower Berriasian and the lower part of the middle Berriasian.

Diagnosis — Specimens of moderate length. Rostrum clavate in dorsal view. Ventral area flat in mature specimens, but slightly rounded in immature and juvenile conchs. Faint, but relatively broad, lateral impressions present, but lateral lines are absent. Transverse section reminiscent of a pseudobeloid rostrum. Mucronate to an almost mucronate-like pointed apex is present on the dorsal side of the rostrum in all growth stages. Alveolar groove short, alveolus very shallow and alveolar area orientated to the dorsal side due to a slight curvature in its constricted part.

Differential diagnosis — *Gillieronibelus* differs from *Duvalia* by its ventral flattening, weak compression and the mucronate apex. Juvenile specimens of *Duvalia* are much more compressed. The genus *Conobelus* never has transverse sections comparable to those of *Gillieronibelus* gen. nov. Moreover, the constriction in the alveolar region and the very shallow alveolus with short alveolar groove are never found in *Conobelus*. *Rhopaloteuthis* differs from the described genus in its differently developed alveolar area. Moreover, the alveolar groove is generally longer, and the rostrum appears to be more robust and massive, but smaller. The transverse sections are more rounded and appear in exceptional cases, e.g., in *Rhopaloteuthis* (*Quasihastites*) *coquandus* (d'Orbigny), pseudobeloid, but never show a flat ventral area. Moreover, *Rhopaloteuthis* is restricted to the upper Bathonian to Oxfordian.

Produvalia is compressed, but has a much longer alveolar groove and generally does not have a flat ventral area. In examples with a flat ventral area, e.g., *Produvalia monsalvensis* (Gilliéron), it has no pear-shaped transverse section. *Produvalia* is restricted to the upper Bathonian to Oxfordian.

Remarks — As the position of the alveolar groove with respect to the siphon is unknown, it is difficult to judge in which family this genus should be included. In the past, most researchers thought it to be related to *Duvalia*. At least the external characteristics seem to indicate that this genus belongs to the Duvaliidae. Only teratological Mesohibolitidae sometimes show the same outer morphology.

Juvenile specimens are different from the juvenile belemnite depicted by Gilliéron (1873, pl. IX, fig. 2 = *Conobelus*? sp.). They are more rounded if compared to immature *Gillieronibelus*. The juvenile rostrum is already compressed. Lateral impressions are present, but are not as apparent as in mature conchs. The apex is not yet mucronate, but it is slightly pointed. The alveolar area is already constricted and the alveolar groove, if present, is much shorter than in the figure of Gilliéron.

Gillieronibelus mayeri (Gilliéron, 1873)

Pl. 5, figs. 5-14.

1873 *Belemnites Mayeri* Gilliéron, p. 206, pl. IX, figs. 1, 3, *non* fig. 2 (= juv. *Conobelus*? sp.).
1883 *Belemnites (Hibolites) Mayeri* Gilliéron - Mayer-Eymar, p. 643.
1890 *Belemnites Mayeri* Gilliéron - Toucas, pp. 590, 618.
1896 *Duvalia Mayeri* Gilliéron - Kilian, p. 685.
1907 *Duvalia Mayeri* Gillieron - Haug, p. 1190.
1913 *Belemnites (Duvalia) Mayeri* Gilliéron - Kilian, p. 173.
1920 *Duvalia Mayeri* Gilliéron - Bülow-Trummer, p. 173.
1925 *Belemnites (Duvalia) mayeri* Gilliéron - Lissajous, p. 109.
non1927 *Belemnites Mayeri* Alth (*sic*) - Lissajous, p. 37 [= *Rhopaloteuthis majeri* (Alth)].
1951 *Belemnites mayeri* Gilliéron - Delattre, p. 119.
1957 *Duvalia mayeri* (Gilliéron) - Guillaume, pp. 64, 66.
non1977 *Praeconobelus mayeri* (*sic*) (Alth) - Gustomesov, p. 116 [= *Rhopaloteuthis majeri* (Alth)].
1992b *Pseudoduvalia mayeri* (Gillieron) - Weiss, p. 20.
1995 *Pseudohibolites mayeri* (Gilliéron) - Riegraf, p. 103.

Material — Fifteen specimens, RGM 345 563 (Y(123)-124), 345 564 (Y129), 345 988-989 (CL88), 345 530 (Y145), 345 986 (CL89-90), 345 990-991 (CL91-92), 345 983-985 (CL96), 345 995-996 (CL97-98), 345 987 (CL100) and 345 994 (CL100).

Six specimens from Tornajo, from a conglomeratic layer C32-32a (Microcanthum-Jacobi? Zone), RGM 345 339-340, 345 351, 345 355-356 and 345 364; and four specimens above section D, RGM 345 302-304 and 345 317. Four specimen were gathered at the foot of the Tornajo mountain, in a small hill called Little Tornajo (Fig. 2), together with *Conobelus incertus* Weis, *Berriasibelus kabanovi* (Weis), echinoids and ammonites (*Tirnovella* spp.).

Description — See Gilliéron (1873) and generic diagnosis.

Comparison — The juvenile guards of *D. miravetesensis* sp. nov. are much more compressed than in *G. mayeri* and do not show lateral lines. Incomplete parts of the outer margin of the alveolar area of immature specimens are similar to those of species ascribed to the *Pseudobelus bipartitus* group. However, the latter are never constricted. *Conobelus*? *piradoensis* sp. nov. shows a more or less comparable transverse section, but possesses a much longer alveolar groove and has no flat ventral area.

Stratigraphical distribution — Microcanthum-Jacobi (Sub)Zone to the base of the Alpillensis Zone (top of sequence Be 7; two specimens were found loose in the marls that succeed bed Y234, but they are most probably derived from older strata).

Geographical distribution — France (Toucas, 1890; pers. obs.), Spain (herein) and Switzerland (Gilliéron, 1873).

Gillieronibelus sp. A

1997 *Hibolithes* cf. *pilleti* (Pictet) - Janssen, pp. 10, 12, pl. 6, figs. 6-8.

Material — Two specimens, RGM 345 238 (Y159-161) and 345 875 (Y193-194).

Description — RGM 345 238 was described in Janssen (1997, pp. 10, 12). The second specimen is probably a juvenile. Only the alveolar area is partly preserved. Rostrum almost pseudobeloid, but with a dorsal constriction at beginning of alveolar groove or alveolus. Ventral side straight and flattened. Transverse section shows an outline in which dorsal is broader than ventral side.

Comparison — Compared to *Gillieronibelus mayeri* (Gilliéron), these specimens show less well-developed lateral impressions and a broader dorsal area. *Conobelus*? sp. B shows mid-lateral crests.

Stratigraphical distribution — Top Paramimouna Zone to mid Picteti Zone.

Remarks — In the absence of better preserved specimens, it is considered conservative to document these specimens separately from *G. mayeri*, of which it may be a variety.

Genus *Pseudobelus* de Blainville, 1827

Remarks — The genus *Pseudobelus* is generally included in the Duvaliidae because of the dorsally placed alveolar groove (Kabanov, 1967). Recently, a revision of some groups of belemnites was made by Nerodenko (1983a, b, 1986) who proposed to separate the group of *Pseudobelus* de Blainville *sensu lato* from the Duvaliidae as a separate family (Pseudobelidae). Furthermore, he proposed to include the specimens related to *Pseudobelus* de Blainville *sensu lato* into a separate suborder (Pseudobelina). Unfortunately, the diagnosis of this suborder was not published and this concept is not followed herein.

Nerodenko discriminated between three separate families (including the Pseudobelidae), based on the different development of the lines and grooves. In Pseudobelidae, the lateral lines as well as the alveolar groove never reach the outer limit of the alveolar opening (Nerodenko, 1986). The most complete specimen of a pseudobelid was figured by Combémorel (1973, pl. 5, fig. 8). However, he described the dorsal groove as starting from the alveolar opening (Combémorel, 1973, p. 161). Although the genuine Neocomian species of *Pseudobelus* are generally well known, its type species, *P. bipartitus*, is insufficiently typified, being only a part of an immature rostrum figured by de Blainville (1827, pl. 5, fig. 19) and re-figured by Lissajous (1925, p. 32, text-fig. 18).

The species grouped within *Pseudobelus* are the only belemnites that possess lateral incisions that show almost the same internal structures as observed in species with a well-developed splitting-surface. It is quite possible that they had the same function, in part, as the splitting-surface, i.e., increasing the amount of living tissue that had direct contact with live-fluids. Moreover, a stronger development of the muscular tissue was probably possible in this way.

Pseudobelus bipartitus de Blainville, 1827

1827 *Pseudobelus bipartitus* de Blainville, p. 113, pl. 5, fig. 19.

ep1858 *Belemnites bipartitus* (Catullo) Blainville - Pictet & de Loriol, pp. 2-3, pl. Ibis, figs. 1a-d.

ep1920 *Pseudobelus bipartitus* de Blainville - Bülow-Trummer, pp. 178-179.
1973 *Pseudobelus bipartitus* Blainville - Combémorel, pp. 160-161, pl. 5, figs. 8-9 (cum syn.).
1995 *Pseudobelus bipartitus* de Blainville - Riegraf, p. 113.
1997 *Pseudobelus bipartitus* de Blainville - Janssen, pp. 27-28, pl. 6, figs. 1-2 (cum syn.).
non1999 *Pseudobelus bipartitus* Blainville - Moosleitner, pl. 4, fig. 7 (= *Mirabelobelus blainvillei* Janssen & Clément).

Material — Thirty one specimens, RGM 345 235 (Y186-189), 345 279 (Y189-190), 345 282 (Y189-190), 345 552 (X195-196), 345 809 (X199-(200)), 345 548 (X205-206), 345 818 (X207), 345 515 (X211), 345 806 (Y214-218), 345 874 (Y220-221), 345 533 (X225-226), 345 512 (X228-(229)), 345 206 (X229), 345 209-210 (X231, juv?), 345 537 (Y234-235), 345 821 (Y234-235), 345 811 (Y238-244), 345 570 (X243a(-244)), 345 214 (Y247-248), 345 975 (CL103c), 345 978 (CL103c-104), 345 980 (CL104), 345 972 (CL103c-105, juv.), 345 973 (CL103c-105), 345 201 (Y262), 345 981 (CL106-109), 345 217 (Y267-267a), 345 219 (Y267-274, juv.), 345 979 (CL110-115), 345 974 (CL116), 345 976 (CL(115)-120) and, possibly 345 543 (Y319-319a, juv.).

Only one poorly preserved specimen of this species (only the outer part of the alveolus is preserved) is found in the Tornajo succession, RGM 345 301 (D26-25).

Description — Pseudobeloid rostrum with long alveolar groove, short alveolus and generally central apex. Transverse sections vary, but generally slightly compressed to nearly square. Lateral incisions deep, but restricted to middle part of rostrum, i.e., they never reach the rounded alveolar opening, also most anterior part of compressed apex is not reached. In (im)mature specimens there is a tendency to break along this incision.

Comparison — *Pseudobelus sultanovkaensis* Nerodenko occurs at stratigraphically higher levels and is one of the last species of the *Pseudobelus bipartitus*-group. It differs from *P. bipartitus* in its smaller size and deeper alveolus.

Stratigraphical distribution — Mid lower Picteti Zone to Pertransiens Zone.

Remarks — Some specimens, indicated with a question mark in the material (RGM 345 209-210, 345 512, 345 217, 345 533, 345 552) are comparatively much more compressed. Whether they should be regarded as a separate species is unclear. They seem to fit the description of *P. combemoreli* Nerodenko, as far as the slender rostrum is concerned. However, they are all very incomplete and for the moment they are thought to represent juvenile to immature specimens of *P. bipartitus*.

Pseudobelus aff. *bipartitus* de Blainville, 1827

Plate 4, figs. 6-8.

non1827 *Pseudobelus bipartitus* de Blainville, p. 113, pl. 5, fig. 19.

Material — One specimen, RGM 345 982 (CL101).

Description — General features as described in *P. bipartitus*. RGM 345 982 is mature, but shows almost no pseudobeloid outline because lateral incisions are rather shallow. Alveolus very shallow, but alveolar groove exceptionally long and stretches almost over entire length of rostrum. Only the apical part is not preserved. A short ventral groove in posterior part of middle of rostrum starts at the same level as lateral incisions, but has not the same length.

Stratigraphical distribution — Upper Picteti Zone or base of Alpillensis Zone.

Remarks — This specimen shows slickensides. It might be a gerontic specimen of *P. bipartitus* de Blainville. However, as the variation of the latter species is unknown, it is described as a species close to, but not necessarily conspecific with, *P. bipartitus*.

Pseudobelus combemoreli Nerodenko, 1986

Plate 4, figs. 1-2.

non1841 *Belemnites bipartitus* Deshayes - Duval-Jouve, pp. 41-42, pl. I, figs. 3-4.
ep?1858 *Belemnites bipartitus* Blainville - Pictet & de Loriol, pl. Ibis, fig. 3d.
?1961 *Pseudobelus giziltchaensis* Ali-Zade, pp. 495-497, pl. I, fig. 1.
?1961 *Pseudobelus giziltschaensis* (*sic*) Ali-Zade, pp. 498, 499.
?1967 *Pseudobelus gisiltschaensis* (*sic*) Ali-Zade - Kabanov, p. 23.
?1972 *Pseudobelus giziltschajensis* (*sic*) Ali-Zade - Ali-Zade, p. 115.
?1972 *Pseudobelus giziltschaensis* (*sic*) Ali-Zade - Ali-Zade, pp. 129-130, pl. 1, figs. 10-11.
non1978 *Pseudobelus* ex gr. *bipartitus* Blainville - Vasícek, pp. 9-12, pl. I, figs. 6-7.
1986 *Pseudobelus combemoreli* Nerodenko, pp. 11-13, pl. V, figs. 1-4.
?1991 *Pseudobelus giziltchaensis* Ali-Zade - Combémorel & Stoyanova-Vergilova, p. 33.
1994 *Pseudobelus* cf. *giziltschaensis* (*sic*) Ali-Zade - Vasícek *et al*., p. 88, pl. 29, figs. 3-4.
1995 *Pseudobelus combemoreli* Nerodenko - Riegraf, p. 113.
1996 *Pseudobelus giziltschaensis* (*sic*) Gustomesov - Eliás *et al*., p. 263.
1996 *Pseudobelus giziltschaensis* (*sic*) Ali-Zade - Eliás *et al*., pp. 264, 267, pl. IV, figs. 10-11.
1996 *Pseudobelus giziltschaensis* (*sic*) Ali-Zade - Vasícek, p. 226.

Material — One specimen, RGM 345 388 (B36).

Description — Small *Pseudobelus* with typical curved lateral view. Transverse section of alveolar opening well rounded, whereas rest of guard shows compressed transverse section. Lateral incisions are well visible in middle of the rostrum. Alveolus appears very short as compared to length of alveolar groove, which reaches more or less halfway along specimen.

Comparison — Differs from (im)mature *P. bipartitus* de Blainville in its smaller size and the curved lateral outline. *Pseudobelus giziltchaensis* Ali-Zade seems to be comparable, but it is shorter and apparently occurs in Upper Valanginian strata; it belongs to the *Pseudobelus brevis*-group of Paquier (1900).

Stratigraphical distribution — Topmost Alpillensis Zone.

Pseudobelus? *fischeri* Combémorel & Mariotti, 1990

1990 *Pseudobelus fischeri* Combémorel & Mariotti, pp. 212-213, pl. 2, figs. 1-4.
1995 *Pseudobelus fischeri* Combémorel & Mariotti - Riegraf, p. 114.

Material — Six specimens, all from Tornajo, RGM 345 366-367 (C32\32a); and above section D, RGM 345 297-299 and RGM 345 311.

Description — See Combémorel & Mariotti (1990).

Stratigraphical distribution — Microcanthum and\or Jacobi (Sub)Zone.

Remarks — This species appears in the Tornajo succession at a level that might corresponds to the "conglomerate de Chomérac" in southeast France. This level contains mainly ammonites from the topmost Jacobi Subzone (with reworked upper Tithonian

ammonites). It might well turn out that the 'Upper Jurassic' '*Pseudobelus*' species have to be included in a different genus in the future. They differ from the Neocomian genuine *Pseudobelus*, mainly in the absence of a real pseudobeloid appearance, i.e., the absence of strong lateral incisions and lateral splitting-surfaces.

The material was collected together with *Duvalia* cf. *deeckei*? Kilian, 1889, *Gilieronibelus mayeri* (Gilliéron, 1873), *Hibolithes* gr. *semisulcatus* (von Münster, 1830) and *Conobelus* sp. juv.

aff. *Pseudobelus zeuschneri* (Oppel, 1865)

Pl. 4, figs. 9-10.

non1932 *Duvalia* ex. aff. *zeuschneri* Oppel - Ackermann, pp. 25-26.
non1935 *Belemnites* sp. aff. *zeuschneri* Oppel - Beregov, pp. 68(19), 106(56), 110(60).

Material — One specimen each from Río Argos, RGM 345 877 (Y173-174), and from Cañada Lengua, RGM 345 977 (CL101).

Description — Only two very similar apical parts were collected. Pseudobeloid or juvenile duvaloid rostrum with central lateral depressions. Specimens strongly depressed and show a dorsal groove, just visible in both specimens. Apex centrally orientated or to the ventral side. RGM 345 877 broken along a lateral plane, but no lateral 'splitting-surface' is visible. RGM 345 977 clearly shows that ontogeny was faster both dorsally and ventrally than in lateral areas. Dorsal and ventral halves appear to be of equal size; however, juvenile rostrum appears slightly thicker ventrally, resembling juvenile guards of *Pseudobelus fischeri* Combémorel & Mariotti (1990).

Comparison — Equally sized specimens belonging to *P. bipartitus* are much less compressed. Juvenile guards of *D. lata constricta* never show such clear lateral incisions or such a broad alveolar groove, and their apex is displaced to the dorsal side.

Stratigraphical distribution — Base to top of the Picteti Zone or just the base of the Alpillensis Zone.

Remarks — These specimens are reminiscent of *Belemnites zeuschneri* Oppel. However, as the specimens are fragmentary, and might even turn out to be immature, juvenile or teratological, it is prefered to retain them in open nomenclature.

Belemnite distribution

Stratigraphical distribution — The stratigraphic distribution of Upper Jurassic and Lower Cretaceous belemnites remains poorly known in many details. Recently, Janssen & Clément (2003) published extensions to the ranges of some belemnites around the boundary between the Lower and Upper Valanginian. Some of the species treated herein have their youngest occurrence near the extinction level proposed in this earlier paper, i.e., the base of the upper part of the Verrucosum Subzone.

The belemnites of the Berriasian and lowermost Valanginian are very poorly known both stratigraphically and taxonomically. Some Swiss naturalists, including Pictet & de Loriol (1858), Gilliéron (1873) and Tobler (1895, 1896), depicted, described or mentioned belemnites from these strata, but there has been little progress since the 19th century. The picture that emerges of their vertical distribution (Fig. 7) justifies the

assumption that there are different 'Berriasian' and 'Valanginian' belemnite associations. Various positions have been proposed as to the position of the boundary between these two stages. A historical review by Hoedemaeker (1982) proposed the boundary to be placed at the base of his *Tirnovella alpillensis* Biozone, i.e., bed Y230 in the Barranco de Miravetes section. Hoedemaeker (1982) placed the lower boundary of this zone at a point that coincides with an ammonite diversity minimum. However, as this is not the same level as the lowest occurrence of the nominal species, the base of the Alpillensis Zone needs to be corrected and should actually been placed at the first *in situ* finding of the nominal species, that is, bed Y226 in the Barranco de Miravetes section. Note that the oldest, but loose, specimen could be derived from bed Y214 (Hoedemaeker, 1982, enclosure 3).

More recently a different position was proposed in Brussels at the International Symposium on Cretaceous Stage Boundaries (Bulot *et al*., 1995), based on the presumed concurrent first occurrence of the calpionellid *Calpionellites darderi* and the ammonite *Thurmanniceras pertransiens* (e.g., Blanc *et al*., 1994; Aguado *et al*., 2000).

There are several species and genera of belemnites that show their youngest occurence in the stratigraphical interval from the base of the Picteti Zone to base of the Alpillensis Zone (Figs. 7, 8). Most of these belemnites do not occur above sequence boundary Be 7 (in the lower part of the Alpillensis Zone). This picture is very reminiscent of the extinction pattern as depicted in Janssen & Clément (2003) in the 'mid'-Valanginian. For this reason it seems appropriate to place the boundary between the Berriasian and the Valanginian, based on the distribution of belemnites, at this level (Figs 7, 8). This level and the 'mid'-Valanginian level are the first two Neocomian extinction levels that can be recognised in the belemnite population of the Berriasian to Valanginian interval. These levels seem to be the type-1 boundary levels with faunal extinction over 70%, as recognised by Hoedemaeker (1995).

Local palaeogeographical distribution — Most striking with respect to the lateral distribution of the belemnites is the large numbers of juvenile to immature specimens found in the Tornajo succession in comparison with the deeper water sedimentary environments of the Cañada Lengua and the Río Argos. As this seems not to be the effect of mechanical sorting, it most probably represents a natural association. This could imply that these immature belemnites favoured rather shallow water environments and only when reaching the (near-)adult stage invaded deeper waters.

Another interesting point is the relatively low abundance of members of the Mesohibolitidae in the collected faunas. They seem to be present, in particular, in the upper Berriasian (top Picteti and lowermost part of the Alpillensis Zone). Unfortunately, this part is only present in the deeper water successions. In the lower Valanginian (base of the Pertransiens Zone) of the Tornajo mountain, an increase in numbers of specimens belonging to Mesohibolitidae is noted. High abundances of Duvaliidae are already found in the upper Berriasian continuing, especially with the *lata*-group, into the basal Pertransiens Zone.

Conclusions

The position of the boundary between the Berriasian and the Valanginian is advocated to be placed in the top of the Alpillensis Zone, i.e., above sequence Be 7.

Below this level several species of belemnite are present, namely *Gillieronibelus mayeri* (Gilliéron), *Duvalia miravetesensis* sp. nov., *Conobelus* sp. A, *Conobelus* sp. B, *Duvalia* aff. *guillantona* Besairie, *Gillieronibelus* sp. A, aff. *Pseudobelus zeuschneri* (Oppel), *Hibolithes* sp. D, *Conobelus incertus* Weiss, *Pseudobelus* aff. *bipartitus* de Blainville and *Hibolithes* cf. *conradi* (Kilian). However, the latter species is still present in the base of the lowstand deposits above Be 7. The following genera and groups of belemnites disappear at this level; *Gillieronibelus*, *Conobelus* and *H.* gr. *semisulcatus* (von Münster, 1830), including *H.* cf. *conradi* and *Hibolithes* sp. D. The genus *Berriasibelus* is first encountered in the uppermost part of the Picteti Zone, while only the peculiar belemnite aff. *Duvalia deeckei* Kilian probably occurs just below the extinction event and ranges to some extent in the boundary sedimentary rocks between the base and the top of the Alpillensis Zone.

Only species such as *Pseudobelus bipartitus* de Blainville and *D. lata constricta* Uhlig are present in the Upper Berriasian, and range up to the top of the Pertransiens Zone. Here they are replaced by species that are closely related to them.

The first new species and genera that can be noted above this level (in the middle of the Alpillensis Zone, sequence Be 8 or Va 0; recovery phase), include *Castellanibelus* spp., *Conobelus*? *piradoensis* sp. nov., *Duvalia tornajoensis* sp. nov., *Duvalia* aff. *haugi* Kilian and *Berriasibelus kabanovi* (Weiss). The majority of these new species and genera appear from the top of the Alpillensis Zone and the Otopeta Zone (the transgressive phase) to the base of the Pertransiens Zone. They are largely comparable to the belemnites in faunal association 1 of Janssen & Clément (2003).

With the aid of sequence startigraphy, the various sections could be correlated and placed in a chronostratigraphic frame based on ammonites. Of importance for understanding the potential for correlation of this method are the palaeogeographic positions of the various sections. The Tornajo succession is interpreted to have been deposited in an outer-platform environment. As a consequence marls deposited in these environments correlate with limestone dominated deposits in a basin and vice versa.

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References

Ackermann, E. 1932. Die Unterkreide im Ostteil des Preslav-Sattelsystems (Ostbulgarien). Beiträge zu ihrer Fauna, Stratigraphie und Lagerung. *Balkanforschungen des geologischen Instituts der Universität Leipzig*, **9**: 1-95.

Aguado, R., Company, M. & Tavera, J.M. 2000. The Berriasian-Valanginian boundary in the Mediterranean region. New data from the Caravaca and Cehegín sections (SE Spain). *Cretaceous Research*, **21**: 1-21.

Aliev, R.A. 1958. Mollyuskovaya fauna Melovykh otlozhenie Mezhdurech'ya Tagirdzhalchae -

Gil'gil'chae (yugo-vostochnye Kavkaz). *Akademiya nauk Azerbaidzhanskoe SSR*, *Trudy Instituta Geologii*, **19**: 96-126.

Ali-Zade, Ak.A. 1961. Novye predstaviteli belemnitov iz nizhnemelovykh otlozhenie yugo-vostochnogo Kavkaza. *Doklady Akademii nauk Azerbaidzhanskoe SSR*, *Paleontologiya*, **17**: 495-499.

Ali-Zade, Ak.A. 1972. Melovye belemnity Azerbaedzhana. *Akademiya nauk Azerbaidzhanskoe SSR*: 1-279.

Ali-Zade, Ak.A. 1988. Belemnity. In: Ali-Zade, Ak.A, Aliev, G.A., Aliev, M.M., Aliyulla, Kh. & Khalilov, A.G. (eds.), *Melovaya fauna Azerbaidzhana*: 389-408. Akademiya nauk Azerbaidzhanskoe SSR, Baku.

Allemann, F., Grün, W. & Wiedmann, J. 1973. The Berriasian of Caravaca (prov. of Murcia) in the Subbetic Zone of Spain and its importance for defining this stage and the Jurassic - Cretaceous boundary. *In* Colloque sur la limite Jurassique - Crétacé. Lyon-Neuchâtel, sept., 1973. *Documents Laboratoire de Géologie de la Faculté des Sciences de Lyon*, *H.S.*, **1**: 154-155 [appeared also in *Mémoires du B.R.G.M.*, **86** (for 1975)].

Andelkovich, M. Zh. 1963. Biostratigraphie der Schichten mit Aspidoceras acanthicum im Karpato-Balkan (Ostserbien). *In Association géologique Carpato-Balkanique, V-ème Congrès, 4-19 Septembre 1961, Bucarest, III, 1. Communications scientifiques. II-ème section: Stratigraphie*: 31-41.

Baloge, P.A., Busnardo, R. & Combémorel, R. 1984. Le Jurassique supérieur et le Crétacé inférieur d'Ankilizato (bassin de Morondava, Madagascar). *Géobios*, **17**: 509-514.

Baraboshkin, E. Yu. & Yanin, B.T. 1997. Korrelyatsiya Valanzhinskikh otlozhenie yugo-zapadnogo i tsentral'nogo Kryma. *In* Milanovsky, E.E. (ed.), *Ocherki geologii Kryma*. *Trudy Krymskogo Geologicheskogo Nauchno-Uchebnogo Tsentra im. prof. A.A. Bogdanova*, **1**: 4-26.

Barrabé, L. 1933. Sur l'âge précis des marnes à *Duvalia* de la province de Maintirano (Ouest de Madagascar). *Compte Rendu Sommaire des Séances de la Société Géologique de France*, **1933**: 27-28.

Barskov, I.S. & Weiss, A.F. 1992. The ontogenesis of some Early Cretaceous belemnoids. *Paleontological Journal*, **26**: 70-85.

Barthel, K.W., Cediel, F., Geyer, O.F. & Remane, J. 1967 (for 1966). Der subbetische Jura von Cehegín (Provinz Murcia, Spanien). *Mitteilungen der Bayerische Staatssammlung für Paläontologie und historische Geologie*, **6**: 167-211.

Bayle, E. 1878. *Explication de la carte géologique de France, 4, 1. Fossiles principaux des terraines. Atlas*. Nationale, Paris: 176 pls.

Bengtson, P. 1988. Open nomenclature. *Palaeontology*, **31**: 223-227.

Beregov, R. 1935. Geologiya na zapadnata chast' na Radomirsko. *Spisanie na B'lgarskoto Geologichesko Druzhestvo*, **7**: 51-113.

Besairie, H. 1930. Recherches géologiques a Madagascar. Contribution a l'étude des ressources minérales. *Bulletin de la Société d'Histoire naturelle de Toulouse*, **60**: 345-616.

Blainville, H. M. Ducratoy de. 1825. Mémoire sur les Bélemnites. *Nouveau Bulletin des Sciences, Société philomatique de Paris,* **3**: 171-176.

Blainville, H. M. Ducratoy de. 1826. Mémoire sur les Bélemnites. *Annales des Sciences naturelles* (série 1, zoologie), **7**: 428-440.

Blainville, H. M. Ducratoy de. 1827. *Mémoire sur les bélemnites, considérées zoologiquement et géologiquement*: 136pp. F.G. Levrault, Paris & Strasbourg.

Blanc, E., Bulot, L.G. & Paicheler, J.-C. 1994. La coupe de réference de Montbrun-les-Bains (Drôme, SE France): un stratotype potentiel pour la limite Berriasien-Valanginien. *Compte Rendus de l'Academie des Sciences Paris* (série 2), **318**: 101-108.

Bülow-Trummer, E. von. 1920. Cephalopoda dibranchiata. *In* Diener, C. (ed.), *Fossilium Catalogus. 1: Animalia*, **11**: 1-313.

Bulot, L.G. (reporter) with scientific contribution of Blanc, E., Company, M., Gardin, S., Hennig, S. & Kissel, C., 1995. Valanginian Working Group. First activities report, September, 1995. *International Union of Geological Sciences. Subcommission on Cretaceous Stratigraphy (SCS)*: 1-14.

Chapple, W.M. 1978. Mechanics of thin-skinned fold-and-thrust belts. *Bulletin of the Geological Society of America*, **89**: 1189-1198.

Clément, A. 1999. Étude paléontologique et biostratigraphique des Duvaliidae (Belemnitida) du Valanginien de la région des Baronnies (bassin vocontien, Sud-Est de la France). *Mémoire de Maîtrise des Sciences de la Terre (Paléontologie et Sédimentologie)*: 1-25. Lyon [unpublished].

Cohen, E.R. 1933. Geologiya na Dervent'-Dervishkata (Eski Dzhumaeska - Preslavska) Planina. Stratigrafski, tektonichni i paleontologichni izuchvaniya. *Spisanie na B'lgarskoto Geologichesko Druzhestvo*, **5**: 131-171.

Combémorel, R. 1972. Position systématique de *Castellanibelus* nov. gen. et de trois espèces de Bélemnites du Crétacé inférieur français. *Géobios*, **5**: 67-81.

Combémorel, R. 1973. Les Duvaliidae PAVLOW (Belemnitida) du Crétacé inférieur français. *Documents des Laboratoires de Géologie Lyon*, **57**: 131-185.

Combémorel, R. 1988. Les belemnites de Madagascar. *Documents des Laboratoires de Géologie Lyon*, **104**: 1-239.

Combémorel, R. & Mariotti, N. 1986. First record of *Duvalia tithonica*, a marker of Upper Tithonian, in Central Appenines. *Bollettino della Società Paleontologica Italiana*, **25**: 35-39.

Combémorel, R. & Mariotti, N. 1990. Taxonomic and biostratigraphic remarks on Tithonian belemnites from Sicily. *In* Pallini, G., Cecca, F., Cresta, S. & Santantonio, M. (eds), *Atti del II Convegno Internazionale. Fossili, evoluzione, ambiente. Pergola 25-30 ottobre 1987*. Dimensione Grafica, Spello: 207-219.

Combémorel, R. & Stoyanova-Vergilova, M. 1991. Biostratigraphie des bélemnites du Crétacé inférieur en France et en Bulgarie. Analyse comparative. *Geologica Balcanica*, **21**: 31-39.

Combémorel, R., Donze, P., le Hégarat, G. & Memmi, L. 1985. Les dépôts du Jurassique terminal et du Crétacé basal en Tunisie Nord-Orientale. *Annales des Mines et de la Géologie*, **31** (*Actes du 1ière Congrès National des Sciences de la Terre, Tunis, Septembre 1981*): 151-160.

Company, M. 1987. *Los ammonitos del Valanginiense del sector oriental de las Cordilleras Béticas (SE de España)*. Unpublished Ph.D. thesis, University of Granada: 294 pp.

Company, M. & Tavera, J.M. 1982. Los ammonites del transito Berriasense-Valanginiense en la region de Cehegín (Prov. de Murcia, SE de España). *Cuadernos de geología Ibérica*, **8**: 651-664.

Delattre, M. 1951. *Les bélemnites du Crétacé inférieur français.* Diplom-Étude sup., Faculté Sciences Paris: 169 pp.

Delattre, M. 1952. Caractéres et position systématique de *Berriasibelus extinctorius* (RASPAIL) n.g. (Bélemnites). *Bulletin du Muséum National d'Histoire naturelle*, **24**: 321-327.

Doyle, P. 1993. Mollusca: Cephalopoda (Coleoidea). *In* Benton, M.J. (ed.), *The Fossil Record 2*. Chapman & Hall, London: 229-236.

Doyle, P., Donovan, D.T. & Nixon, M. 1994. Phylogeny and systematics of the Coleoidea. *University of Kansas Paleontological Contributions*, **5**: 1-15.

Duval-Jouve, J. 1841. *Bélemnites des terraines Crétacés inférieurs des environs de Castellane (Basses-Alpes), considérées géologiquement et zoologiquement, avec la description de ces terrains*. Fortin, Masson et Cie, Paris: 80 pp.

Eichwald, E. von. 1859. *Lethaea Rossica ou paléontologie de la Russie. Ancienne période. Atlas*. E. Schweizerbart, Stuttgart: 33 pls.

Eliás, M., Martinec, P., Rehákova, D. & Vasícek, Z. 1996. Geologie a stratigrafie kurovickych vápencu a tlumacovskych slínovcu v kurovickém lomu (svrchní jura, spodní krída, Vnejsí Západní Karpaty, Ceská republika). *Vestník Ceského geologichéko ústavu*, **71**: 259-276.

Fallot, P. 1931. Contribution à l'étude du Jurassique supérieur subbétique. *Boletin de la Real Sociedad Española de Historia Natural*, **31**: 113-133.

Flandrin, J. 1963. Remarques stratigraphiques, paléontologiques et structurales sur la région de Séderon. *Bulletin du Service de la Carte géologique de la France*, **59** (no. 272): 815-845.

Fliert, J.R. van de, Graven, H., Hermes, J.J. & de Smet, M.E.M. 1980. On stratigraphic anomalies associated with major transcurrent faulting. *Eclogae Geologicae Helvetiae*, **73**: 223-237.

Gilliéron, V. 1873. Apercu géologique sur les Alpes de Fribourg en général et description spéciale du Monsalvens en particulier. *Matériaux pour la Carte géologique de la Suisse*, **12**: 1-268.

Guillaume, H. 1957. *Géologie du Montsalvens (Préalpes fribourgeoises)*. Thèse Faculté des Sciences de l'Université de Fribourg (Suisse). Staempfli & Cie, Berne: 171 pp.

Gustomesov, V.A. 1977. K revizii Yurskikh belemnitov. *Byulleten' Moskovskogo Obshchestva Ispytately Prirody, otdel geologii*, **52**: 103-117.

Gustomesov, V.A. & Uspenskaya, E.A. 1968. O rode *Rhopaloteuthis* (Belemnitidae) i ego Krymskikh predstavitelyakh. *Byulleten' Moskovskogo Obshchestva Ispytateley Prirody, otdel geologii*, **43**: 65-78.

Haime, J. 1855. Notice sur la géologie de l'île Majorque. *Bulletin de la Société géologique de France* (série 2), **12**: 734-752.

Haug, E. 1907. *Traité de géologie. II. Les périodes géologiques*, **2**. A. Collin, Paris: 929-1396.

Hégerat, G. le & Remane, J. 1968. Tithonique supérieur et Berriasien de l 'Ardèche et de l'Hérault. Corrélation des ammonites et des calpionelles. *Géobios*, **1**: 7-69.

Hermes, J.J. 1978. The stratigraphy of the Subbetic and Southern Prebetic of the Velez Rubio - Caravaca area and its bearing on transcurrent faulting in the Betic Cordilleras of Southern Spain (I-III). *Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen* (serie B), **81**: 41(1)-72(54).

Hermite, H. 1879. *Études géologiques sur les Iles Baléares. 1 partie, Majorque et Minorque*. Pichon & Savy, Paris: 359 pp.

Hoedemaeker, Ph.J. 1982. Ammonite biostratigraphy of the uppermost Tithonian, Berriasian, and lower Valanginian along the Río Argos (Caravaca, SE Spain). *Scripta Geologica*, **65**: 1-81.

Hoedemaeker, Ph.J. 1983. Reconsideration of the stratigraphic position of the boundary between the Berriasian and the Nemausian (= Valanginian sensu stricto). *Zitteliana*, **10**: 447-457.

Hoedemaeker, Ph.J. 1995. Ammonite evidence for long-term sea-level fluctuations between the 2nd and 3rd order in the lowest Cretaceous. *Cretaceous Research*, **16**: 231-241.

Hoedemaeker, Ph.J. 1999. Berriasian-Barremian sequences in the Río Argos succession near Caravaca (southeast Spain) and their correlation with some sections in southeast France. *In* Graciansky, P.-C. de, Hardenbol, J., Jacquin, Th. & Vail, P.R. (eds), *Mesozoic and Cenozoic sequence stratigraphy of European basins*, *SEPM Special Publication*, **60** (for 1998): 423-441.

Hoedemaeker, Ph., Krs, M., Man, O., Parés, J.M., Prunner P. & Venhodová, D. 1998. The Neogene remagnetization and petromagnetic study of the Early Cretaceous limestone beds from the Río Argos (Caravaca, province of Murcia, SE Spain). *Geologica Carpathica*, **49**: 15-32.

Hoedemaeker, Ph. J. & Leereveld, H. 1995. Biostratigraphy and sequence stratigraphy of the Berriasian-lowest Aptian (Lower Cretaceous) of the Río Argos sequence (Caravaca, SE Spain). *Cretaceous Research*, **16**: 195-230.

Horák, J. 1988. Die Belemniten aus der Unterkreide-Ablagerungen im Steinbruch Kotouc bei Stramberk (Silesische Einheit, CSSR). *Acta Musei Moraviae, Scientiae naturales*, **73**: 59-70.

Janssen, N.M.M. 1997. Mediterranean Neocomian belemnites, part 1: Río Argos sequence (province of Murcia, Spain): the Berriasian-Valanginian and the Hauterivian-Barremian boundaries. *Scripta geologica*, **114**: 1-55.

Janssen, N.M.M. & Clément, A. 2003. Extinction and renewal patterns among Tethyan belemnites in the Verrucosum Subzone (Valanginian) of SE France. *Cretaceous Research*, **23** (for 2002): 509-522.

Jekelius, E. 1915. Die mesozoischen Faunen der Berge von Brassó. II. Die Neokomfauna von Brassó. *Mitteilungen aus dem Jahrbuch der königlichen ungarischen geologischen Reichsanstalt*, **23**: 114-135.

Jeletzky, J.A. 1996. Comparative morphology, phylogeny, and classification of fossil coleoidea. *University of Kansas Paleontological Contributions*, *Mollusca Article* **7**: 1-162.

Jeletzky, J.A. 1972. Morphology and taxonomic status of the Jurassic belemnite "*Rhopaloteuthis*" *somaliensis* Spath 1935. *Palaeontology*, **15**: 158-183.

Jeletzky, J.A. 1980. Dicoelitid belemnites from the Toarcian - Middle Bajocian of western and Arctic Canada. *Bulletin of the Geological Survey of Canada*, **338**: 1-71.

Kabanov, G.K. 1960. Belemnity. *In* Drushchits V.V. & Kudryavtseva, M.P. (eds), *Atlas nizhnemelovoe fauny severnogo Kavkaza i Kryma*: 356-369. Gosudarstvennoe nauchno-tekhnicheskoe, Moskva.

Kabanov, G.K. 1967. Skelet belemnitid. Morfologiya i biologicheskie analiz. *Akademiya nauk SSSR, Trudy Paleontologicheskogo Instituta*, **114**: 1-100.

Kakabadze, M.V. & Keleptrishvili, Sh.G. 1991. Stratigrafiya i belemnity Valanzhina - Goteriva Verkhnee Rachi (Gruziya). *Izvestiya Akademii nauk SSSR, seriya geologicheskaya*, **8**: 29-37.

Kilian, W. 1889. Études paléontologiques sur les terrains secondaires et tertiaires de l'Andalousie. *In* Bertrand W. & Kilian, W. (eds), *Mission d'Analousie. Mémoires de l'Académie des sciences de l'Institut National de France*, **30**: 601-751.

Kilian, W. 1892. El yacimento Titónico de la Fuente de los Frailes, Cerca de Cabra (Córdoba). *Boletín de la Comisión del Mapa Geológico de España*, **18** (for 1891): 545(449)-562(466).

Kilian, W. 1893. Estudio paleontológico acerca de los terrenos secundarios y terciarios de Andalucia.

Boletín de la Comisión del Mapa Geológico de España, **19** (for 1892): 563(263)-686(386).

Kilian, W. 1896. Notice stratigraphique sur les environs de Sisteron et contributions à la connaissance des terrains sécondaires du sud-est de la France. *Bulletin de la Société géologique de France* (série 3), **23** (for 1895): 659-803.

Kilian, W. 1913. Unterkreide (Paleocretacicum). *In* Frech F. (ed.), *Letaea geognostica. 2. Teil. Das Mesozoikum. Bd. 3. Kreide. 1 abt.* Schweizerbart, Stuttgart: 398 pp.

Kilian, W. & Révil, J. 1917. Études géologiques dans les Alpes occidentales. Contributions à la géologie des chaînes intérieures des Alpes françaises. II. Description des terraines qui prennent part à la constitution géologique des zones Intra-Alpines françaises (Suite, système jurassique). *Mémoires pour servir à l'Explication de la Carte Géologique détaillée de la France*, **1912**: 1-273.

Klein, J. 1986. Het Onder-Krijt van de Provence. *Gea*, **21**: 1-36.

Krymgol'ts, G.Ya. 1939. Belemnity Mezozoeskikh otlozhenie SSSR. Vypusk 1. Nizhnemelovye belemnity Kavkaza. *Monografii po Paleontologii SSSR*, **67**: 1-54.

Krymgol'ts, G.Ya. 1949. Podklass Endocochlia. Otryad Decapoda. Podotryad Belemnoidea. Belemnity. *In* Berg, L.S., Krymgol'ts, G.Ya. *et al*. (eds), *Atlas rukovodyashchikh form iskopaemykh faun SSSR, nizhnii otdel Melovoi sistemy*, **10**: 253-269.

Krymgol'ts, G.Ya. 1997. Belemnity. Podklass Endocochlia vnutrennerakovinnye. *In* Arkadiev, V.V. & Bogdanova, T.N. (eds), *Atlas Melovoe fauny Yugo-Zapadnogo Kryma*. Lanteya, St. Peterburg: 146-155.

Kuhry, B. 1972. Stratigraphy and micropaleontology of the Lower Cretaceous in the Subbetic south of Caravaca (province of Murcia, SE Spain). I. *Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen* (serie B), **75**: 193-208.

Lemoine, P. 1907. Belemnites [Duvalia] latus Blainville, 1827. *Palaeontologia Universalis* (série II), **3**: 114-114a.

Lissajous, M. 1915. Quelques remarques sur les belemnites jurassiques. *Bulletin de la Société d'Histoire naturelle de Mâcon*, **6**: 1-32.

Lissajous, M. 1925. Répertoire alphabétique des bélemnites jurassiques précédé d'un essai de classification. Ouvrage posthume de Marcel Lissajous. *Travaux du Laboratoire de Géologie de la Faculté des Sciences de Lyon*, **8 (Mémoire 7)**: 1-173.

Lissajous, M. 1927. Description de quelques nouvelles espèces de belemnites jurassiques. Notes posthumes de M. Lissajous. *Travaux du Laboratoire de Géologie de la Faculté des Sciences de Lyon*, (*Mémoire*, **7**; *supplément*): 3-42.

Maire, V. 1925. *Étude sur les Bélemnites. Contribution à la connaissance de la faune des "Marnes à Creniceras Renggeri" dans la Franche-Comté septentrionale*. Est, Besançon: 25 pp.

Mapa Geologíco de España, 1974. *Zarcilla de Ramos (1:50.000) 24-37 (931)* (serie 2): 24 pp. Madrid, Instituto Geologíco y Mínero de España.

Mayer-Eymar, K. 1883. Die Grundzüge der Classification der Belemniten. *Zeitschrift der deutschen geologischen Gesellschaft*, **35**: 640-643.

Mayer-Eymar, K. 1887. Systematisches Verzeichniss der Kreide- und Tertiär-Versteinerungen der Umgegend von Thun nebst Beschreibung der neuen Arten. *Beiträge zur geologischen Karte der Schweiz*, **24**: i-xxviii + 1-128.

Meinster, B. 1964-1965, 1967-1968. *Unpublished field report*. University of Amsterdam.

Memmi, L., Donze, P., Combémorel, R. & le Hégerat, G. 1989. The transition from Jurassic to Cretaceous in northeast Tunisia: biostratigraphic details and distribution of facies. *Cretaceous Research*, **10**: 137-151.

Montfort, P. Denys de. 1808. *Conchyliologie systématique, et classification méthodique des coquilles; offrant leurs figures, leur arrangement générique, leurs descriptions caracteristiques, leurs noms; ainsi que leur synonyie en plusieurs langues. Coquilles univalves, cloisonnées*, **1**. F. Schoell, Paris: 410 pp.

Moosleitner, G. 1999. Pyritisierte Fossilien aus dem Valanginium der Provence. *Fossilien*, **16**: 207-212. Goldschneck, Korb.

Morand, M. 1921. Sur les Bélemnites d'Andranosamonta (Madagascar). *Bulletin de la Société géologique de France* (série 4), **20**: 158-160.

Münster, G. Graf von. 1830. *Bemerkungen zur nähern Kenntnis der Belemniten*. Birner, Bayreuth: 18 pp.

Mutterlose, J. 1979. Vertreter de Unterfamilie Duvaliinae PAVLOW (Belemnitida) aus dem Hauterivive

(Unter-Kreisw) von NW-Europa. *In* Wiedmann, J. (ed.), *International Union of Geological Sciences, A, 6. Aspekte der Kreide Europas. Beiträge zum 1. Symposium Deutsche Kreide, Bindeglied zwischen Boreal und Tethys. Münster, April 1978*: 121-127. Schweizerbart, Stuttgart.

Naef, A. 1922. *Die fossilen Tintenfische, ein paläozoologische monographie*. G. Fischer, Jena: 322 pp.

Nerodenko, V.M. 1983a. Stratigrafichne rozpovsyudzhennya nizhn'okreidovikh belemnitiv. *Visnik Kievs'kogo Universtety, Geologiya*, **2**: 41-50.

Nerodenko, V.M. 1983b. Rannemelovye belemnity Yuga SSSR. *In* Starobogatov Ya.I. & Nesis K.N. (eds), *Sistematika i ekologiya golovonogikh mollyuskov*: 42-43. Akademiya nauk SSSR, zoologicheskii Institut, Leningrad.

Nerodenko, V.M. 1986. Krymskie predstaviteli roda *Pseudobelus* Blainville, 1827. [Crimean representatives of the genus *Pseudobelus* Blainville, 1827]. *Ministerstvo V'yushego i Srednego Spetsial'nogo Obrazovaniya Ukrainskoe SSR, Gosudarstvennye Universitet im. T.G. Shevchenko*, **1986**: 1-31.

Neumayr, M. 1873. Die Fauna der Schichten mit *Aspidoceras acanthicum*. *Abhandlungen der kaiserlich-königlichen Geologischen Reichsanstalt*, **5**: 141-257.

Nicklès, R. 1896. Sur les terrains secondaires des provinces de Murcia, Almeria, Grenada et Alicante (Espagne). *Comptes Rendus des Séances de l'Academie des Sciences*, **122**: 150(1)-153(4).

Noetling, F. 1902. Fauna of Baluchistan and N.W. frontier of India. Vol. 1. The Jurassic fauana. Part 2. The fauna of the (Neocomian) belemnites beds. *Palaeontologia Indica*. *Memoirs of the Geological Survey of India*, **16 (**for 1897): 1-5.

Ogg, J.G., Steiner, M.B., Company, M. & Tavera, J.M. 1988. Magnetostratigraphy across the Berriasian-Valanginian stage boundary (Early Cretaceous), at the Cehegin (Murcia Province, southern Spain). *Earth and Planetary Science Lettres*, **87**: 205-215.

Olóriz, F. & Rodríguez-Tovar, F.J. 2000. *Diplocraterion*: a useful marker for sequence stratigraphy and correlation in the Kimmeridgian, Jurassic (Prebetic Zone, Betic Cordillera, southern Spain). *Palaios,* **15**: 546-552.

Oppel, A. 1865. Die Tithonische Etage. *Zeitschrift der Deutschen Geologischen Gesellschaft*, **17**: 535-558.

Orbigny, A.D. de. 1842-1851. *Paléontologie française. Description zoologique et géologique de tout les animaux mollusques et rayonnés fossiles de France. Terrains Oolitiques ou Jurassiques, 1. Céphalopodes*. d'Orbigny, Paris: 1-80 (for 1842), 81-192 (for 1843), 193-312 (for 1844), 313-368 (for 1845), 369-432 (for 1846), 433-464 (for 1847a), 465-504 (for 1848), 505-520 (for 1849), 521-632 (for 1850), 633-642 (for 1851). *Atlas*. V. Masson, Paris. pl. 1-5 for (1842), pl. 6-23 (for 1843), pl. 24-34 (for 1844-1849).

Orbigny, A.D. de. 1847b. *Paléontologie française. Description zoologique et géologique de tous les animaux mollusques et rayonnées fossiles de France. Terrains Crétacés. Supplément*. A. Bertrand, Paris: 28 pp.

Paquier, V. 1900. Recherches géologiques dans le Diois et les Baronnies orientales. *Annales de l'Université de Grenoble*, **12**: 373-516, 551-806, i-viii.

Parona, C.F. & Bonarelli, G. 1895. Sur la faune du Callovien inférieur (Chanasien) de Savoie. *Mémoires de l'Academie des Sciences Belles-Lettres et Arts de Savoie* (série 4), **6**: 179 pp.

Pavlow, A.P. 1914. Yurskiya i Nizhnemelovyya Cephalopoda severnoe Sibiri. *Zapiski Imperatorskoe Akademyi Nauk'*, **8**, *fiziko-matematicheskomu otdeleniyu*, **21** (no. 4): 68 pp.

Pervinquière, L. 1907. Études de paléontologie tunisienne. I. Céphalopodes des terraines sécondaires. 1. Texte. 2. Atlas. *In* de Rudeval, F.R. (ed.), *Carte géologique de la Tunisie*, **1907-1912**: 438 pp.

Pictet, F.-J. 1867. Études paléontologique sur la fauna à Terebratula diphyoides de Berrias (Ardèche). *Mélanges paléontologiques*, **1**: 43-130.

Pictet, F.-J. 1868. Étude provisoire des fossiles de la Porte-de-France, d'Aizy et de Lémenc. *Mélanges paléontologiques*, **4**: 207-312.

Pictet, F.-J. & de Loriol, P. 1858. Description des fossiles contenus dans le terrain néocomien des Voirons. Description des animaux invertèbres. *Matériaux pour la paléontologie suisse ou recueil de monographies sur les fossiles du Jura et des Alpes*, (série 2), **2**: 64 pp.

Pillet, L. 1871. L'étage tithonique a Lémenc (Savoie). *Archives des Sciences Physiques et Naturelles*, **2** (no. 42): 135-146.

Pugaczewska, H. 1957. O dwóch gatunkach belemnitów rodzaju *Rhopaloteuthis* z jury Polski. *Acta Palaeontologica Polonica*, **2** (no. 4): 383-404.

Quenstedt, F.A. 1849. *Atlas zu den Cephalopoden*. L.F. Fues, Tübingen: 36 pls.

Raspail, F.V. 1829. Histoire naturelle des Bélemnites, accompagnée de la description et de la classification des espèces que M. Emeric, de Castellane, a recuillies dans les Basses-Alpes de Provence. *Annales des Sciences d'Observation*, **1**: 271-331.

Raspail, J. 1904. Belemnites [Duvalia?] extinctorius Raspail, 1829. *Palaeontologia Universalis* (série I), **2**: 17-17a.

Rey Arrans, F.J. 1993. *Analisis de la Cuemca subbetica durante el Jurassico y el Cretacico en la transversal Caravaca Velez-Rubio*. Tesis Doctoral, Universita de Granada: 460 pp.

Rey, J. 1995. Sedimentation answers to local tectonic events in a pelagic swell (Subbetic zone, province of Murcia, Spain). *Bulletin de la Société géologique de France*, **166**: 479-493.

Riegraf, W. 1981. Revision der Belemniten des Schwäbischen Jura. Teil 8. *Palaeontographica* (serie A), **173**: 64-139.

Riegraf, W. 1995. Cephalopoda dibranchiata fossiles (Coleoidea). *In* Westphal, F. (ed.), *Fossilium Catalogus. I: Animalia*, **133**: 411 pp.

Riegraf, W. 1999. Taxonomic status of the belemnite genus *Belemnopsis* Bayle 1878. *Paläontologische Zeitschrift*, **73**: 59-76.

Riegraf, W., Janssen, N.M.M. & Schmitt-Riegraf, C. 1998. Cephalopoda dibranchiata fossiles (Coleoidea) II. *In* Westphal, F. (ed.), *Fossilium Catalogus Animalia*, **135A**: 512 pp.

Rózycki, S.Z. 1953. Górny Dogger i dolny Malm jury Krakowsko - Czestochowskiej (opis odstoniec). *Prace Instytut Geologiczny*, **17**: 3-142.

Sarran d'Allard, L. de. 1880. Note sur une course géologique aux environs d'Alais. *Bulletin de la Société géologique de France* (série 3), **8** (for 1879-1880): 335-354.

Seyfried, H. 1978. Der subbetische Jura von Murcia (Südost-Spanien). *Geologisches Jahrbuch* (serie B), **29**: 1-204.

Shvetsov, M.S. 1913. Nizhne-Melovye belemnity Abkhazyi (Gagry-Sukhum'). Les Bélemnites infracrétacées de l'Abkhasie (Gagry-Soukhoum). *Ezhegodnik po Geologii i Mineralogii Rossii*. *Annuaire Géologique et Minéralogique de la Russie*, **15** (no. 2-3): 43-74.

Smet, M.E.M. de. 1984. *Investigations of the Crevillente Fault Zone and its role in the tectogenesis of the Betic Cordilleras, Southern Spain*. Unpublished Ph.D. thesis, Vrije Universiteit Amsterdam.

Stefanov, A. 1934. Geologiya na Elenskiya predbalkan' (Stratigrafski, tektonski i paleontolozhki izuchvaniya). *Izvestiya na Tsarskity Prirodonauchni Instituti v' Sofiya*, **7**: 189-224.

Stevens, G.R. 1973. Cretaceous belemnites. *In* Hallam, A. (ed.), *Atlas of palaeobiogeography*, 385-401, Elsevier, Amsterdam.

Stolley, E., 1919. Die Systematik der Belemniten. *Jahresbericht des Niedersächsischen geologischen Vereins*, **11**: 1-59.

Stoyanova-Vergilova, M. 1963. *Curtohibolites* gen. nov. (Belemnitida) ot dolnokrednite otlozheniya v Bulgariya. *Trudy v'rkhu Geologiyata na Bulgariya, seriya Paleontologiya*, **5**: 211-227.

Stoyanova-Vergilova, M., 1970. Les fossiles de Bulgarie. IVa Crétacé inférieur. Belemnitida. *Académie Bulgare des Sciences*, **1970**: 1-72.

Tavera Benitez, J.M. 1985. *Los ammonites del tithonico superior - Berriasense de la Zona Subbetica (Cordilleras Beticas)*. Tesis Facultad de Ciencias, Departemento de Paleontologia, Universidad de Grenada, 381 pp.

Templado Martínez, D. & Meseguer Pardo, J. 1949. Mapa geológico de España. Explicación de la hoja no. 871. Elda. *Instituto Geologico y Minero de España*, 1-97.

Tobler, A. 1895. Berriasschichten der Axenstrasse. *Eclogae Geologicae Helvetiae*, **4**: 251-265.

Tobler, A. 1896. Die Berriasschichten an der Axenstrasse. *Verhandlungen der Naturforschenden Gesellschaft*, **11**: 183-197.

Toucas, A. 1890. Étude de la faune des couches tithonique de l'Ardèche. *Bulletin de la Société Géologique de France* (série 3), **18**: 560-630.

Tsankov, V. 1946. Biostratigrafsko i paleoekolozhko prouchvane na geolozhkite formatsii v Bulgariya. *In* Cohen, E.R., Dimitroff, T. & Kamenoff, B. (eds), *Osnovi na geologiiata na B'lgariya*. *Annuaire de la Direction pour les Recherches Géologiques et Minières en Bulgarie* (série A), **4**: 239-335.

Uhlig, V. 1883. Die Cephalopodenfauna der Wernsdorfer Schichten. 2. *Denkschriften der kaiserlichen Akademie der Wissenschaften, mathematisch-naturwissenschaftliche Classe*, **64**: 127-290.

Uhlig, V. 1890. Ergebnisse geologischer Aufnahmen in den westgalizischen Karpathen. 2. Theil. Der pieninische Klippenzug. *Jahrbuch der Kaiserlichen Geologischen Reichsanstalt Wien*, **40**: 559-822.

Uhlig, V. 1902. Über die Cephalopodenfauna der Teschener und Grodischter Schichten. *Denkschrift der kaiserlichen Akademie der Wissenschaft, mathematisch-naturwissenschaftliche Classe*, **72**: 1-87.

Vasícek, Z. 1978. Untersuchungen an Kreide-Belemniten der schlesischen Einheit (Äussere Karpaten, Tschechoslowakei) I. Teil. *Casopsis Slezského muzea* (serie A), **27**: 1-16.

Vasícek, Z. 1996. Aptychi and stratigraphy of the Lower Cretaceous in the Western Carpathians. *Mitteilungen aus dem Geologisch-Paläontologischen Institut der Universität Hamburg*, **77**: 221-241.

Vasícek, Z. & Hoedemaeker, Ph.J. 1997. Aptychi from the Lower Cretaceous strata along the Río Argos (Caravaca, SE Spain). *Scripta Geologica*, **115**: 29-45.

Vasícek, Z., Michalík, J. & Réhaková, D. 1994. Early Cretaceous stratigraphy, palaeogeography and life in Western Carpathians. *Beringeria*, **10**: 1-169.

Vetters, H. 1905. Die Fauna der Juraklippen zwischen Donau und Thaya. *Beiträge zur Paläontologie Österreich-Ungarn*, **17(4)**: 223-259.

Weiss, A.F. 1991. Krevizii belemnitov roda *Conobelus* Stolley, 1919. *Paleontologicheskie Zhurnal*, **1991** (no 2): 18-33.

Weiss, A.F. 1992a. Revision of the belemnite genus *Conobelus* STOLLEY, 1919. *Palaeontological Journal*, **25**: 21-40.

Weiss, A.F. 1992b. *Pozdneyurskie-rannemelovye belemnity Krima (semeistva Duvaliidae i Dicoelitidae) [Late Jurassic - Early Cretaceous belemnites of the Crimea (family Duvaliidae and Dicoelitidae)]*. Rossiyskaya Akademiya Nauk Paleontologicheskiy Institut. Autoreferat. Dissertatsii na soiskanie uchenoy stepeni kandidata biologicheskikh nauk. [Candidates Thesis Biological Sciences], Moskva: 3-21.

Zhuravleva, F.A. 1994. Peregopodounye trubki v evoljuzii tsephalopod. *Paleontologicheskie Zhurnal*, **1994** (no 3): 55-69.

Zittel, K.A. von. 1870. Die Fauna der aeltern Cephalopodenfuehrenden Tithonbildungen. *Palaeontographica, Supplement*, **2** (no 2): 1-192.

Plate 1

RGM 345 441 - *Hibolithes* sp.
Tornajo, C08-01, Pertransiens Zone
Fig. 1, ventral view.
Fig. 2, lateral view.

RGM 345 963 - *Hibolithes* sp. D
Cañada Lengua, CL99, base Picteti Zone
Fig. 3, ventral view.
Fig. 4, ventral view.

RGM 361 510 - *Mirabelobelus blainvillei* Janssen & Clément, 2003
Chateau Mirabel, Pompignan, France, MIR34b-34c, Pertransiens Zone
coll.no. 4559
Fig. 5, ventral view.
Fig. 6, ventral view.

RGM 345 362 - *Mirabelobelus blainvillei* Janssen & Clément, 2003
Tornajo, C08-(01), Pertransiens Zone
Fig. 7, ventral view.
Fig. 8, ventral view.

RGM 345 300 - *Mirabelobelus blainvillei* Janssen & Clément, 2003
Tornajo, D22-23, base of Pertransiens Zone
Fig. 9, lateral view.
Fig. 10, ventral view.

RGM 345 881 - *Duvalia* sp. 3
Cañada Lengua, CL110-115, base Pertransiens Zone
Fig. 11, dorsal view.
Fig. 12, lateral view.
Fig. 13, ventral view.

All specimen are printed on natural size.


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Plate 2

RGM 361 413 - *Conobelus* sp. aff. *Belemnites aenigmaticus* d'Orbigny, 1843
Cañada Lengua, CL103a, mid-top Alpillensis Zone
Fig. 1, dorsal view (x2).
Fig. 2, internal view.

RGM 345 998 - *Castellanibelus* sp. A immature
Cañada Lengua, CL116-117, Pertransiens Zone
Fig. 3, ventral view.
Fig. 4, lateral view.

RGM 361 460 - *Castellanibelus orbignyanus* (Duval-Jouve, 1841)
Cañada Lengua, CL(115)-120, Pertransiens Zone
Fig. 5, internal view with splitting surface.

RGM 361 445 - *Ca. orbignyanus* (Duval-Jouve, 1841) immature
Cañada Lengua, CL116-117, Pertransiens Zone
Fig. 6, lateral view (note dorsal position of mucron).
Fig. 7, ventral view.

RGM 361 414 - *Conobelus* sp. B
Cañada Lengua, CL88, Paramimouna Zone
Fig. 8, internal lateral view.

RGM 361 416 - *Conobelus* sp. B
Cañada Lengua, CL95-96, base of Picteti Zone
Fig. 9, dorsal view.
Fig. 10, ventral view.

RGM 361 422 - *Ca. orbignyanus* (Duval-Jouve, 1841) immature
Cañada Lengua, CL130-131, Pertransiens Zone
Fig. 11, dorsal view.
Fig. 12, lateral view.

RGM 345 381 - *Ca. orbignyanus* (Duval-Jouve, 1841)
Tornajo, B40, base of Pertransiens Zone
Fig. 13, dorsal view.
Fig. 14, lateral view.

RGM 361 465 - *Castellanibelus*(?) sp.
Cañada Lengua, CL117b, Pertransiens Zone
Fig. 15, dorsal view.
Fig. 16, lateral view.

All specimen are printed on natural size, unless otherwise indicated.

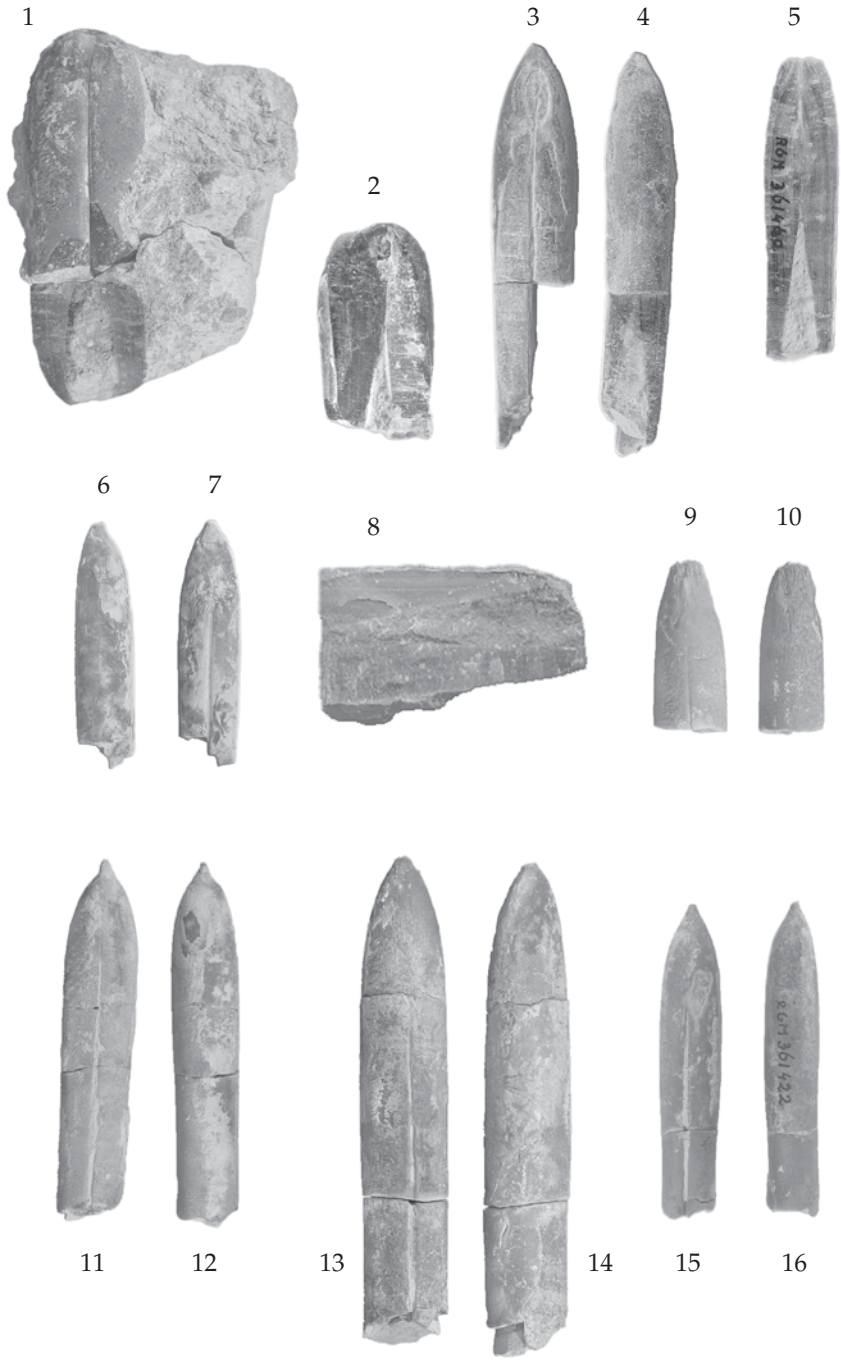
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Plate 3

RGM 345 813 - *Berriasibelus exstinctorius* (Raspail, 1829)
Río Argos, X(240)-251, mid Alpillensis Zone
Fig. 1, dorsal view.
Fig. 2, left ventral view.

RGM 361 400 - *Berriasibelus kabanovi* (Weiss, 1991)
Cañada Lengua, CL103-105, top Alpillensis\base Otopeta Zone
Fig. 3, dorsal view.
Fig. 4, internal view (from ventral side).

RGM 361 501 - *Berriasibelus kabanovi* (Weiss, 1991) immature
Tornajo, D(20)-21, Pertransiens Zone
Fig. 5, dorsal view.
Fig. 6, lateral view.
Fig. 7, ventral view.

RGM 361 407 - *Berriasibelus kabanovi* (Weiss, 1991)
Cañada Lengua, CL106-109, Otopeta\base Pertransiens Zone
Fig. 8, dorsal view.
Fig. 9, ventral view.

RGM 345 819 - *Conobelus incertus* Weiss, 1991
Río Argos, X206, Picteti Zone
Fig. 10, dorsal view.
Fig. 11, lateral view.

RGM 361 426 - *Conobelus incertus* Weiss, 1991 immature
Cañada Lengua, CL101, topmost Picteti Zone
Fig. 12, dorsal view.
Fig. 13, lateral view.

RGM 345 440 - *Conobelus*? sp. juvenile
Tornajo, C(31)-27, Alpillensis Zone
Fig. 14, dorsal view.
Fig. 15, lateral view.

All specimen are printed on natural size.

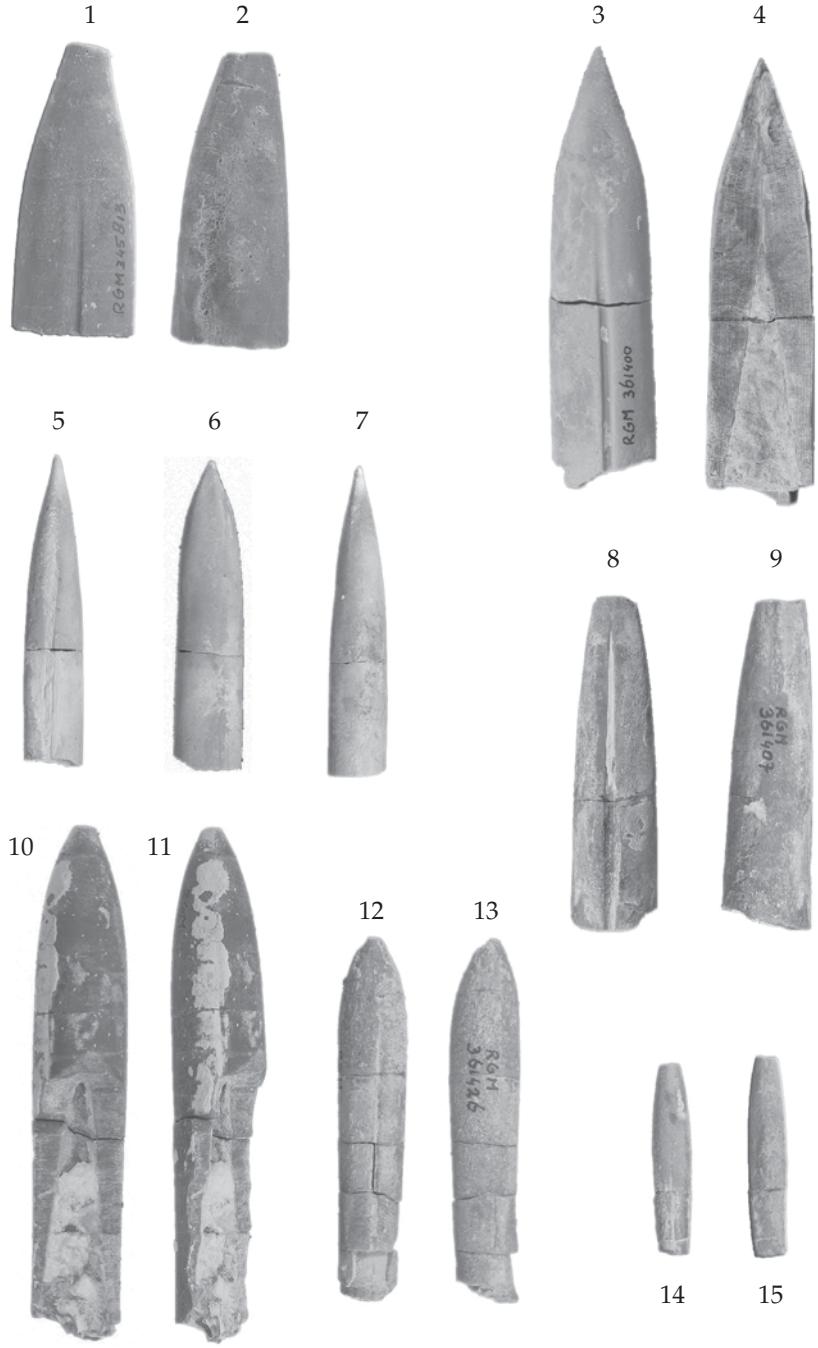
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Plate 4

RGM 345 388 - *Pseudobelus combemoreli* Nerodenko, 1986
Tornajo, B36, Otopeta Zone
Fig. 1, dorsal view.
Fig. 2, lateral view.

RGM 345 999 - *Castellanibelus*? *triquetrus* (Weiss, 1991)
Cañada Lengua, CL105-106, Otopeta Zone
Fig. 3, dorsal view.
Fig. 4, lateral view.
Fig. 5, ventral view.

RGM 345 982 - *Pseudobelus* aff. *bipartitus* de Blainville, 1827
Cañada Lengua, CL101, topmost Picteti Zone\Alpillensis Zone
Fig. 6, dorsal view.
Fig. 7, lateral view.
Fig. 8, ventral view.

RGM 345 877 - aff. *Pseudobelus zeuschneri* (Oppel, 1865)
Río Argos, Y173-174, Picteti Zone
Fig. 9, dorsal view.
Fig. 10, lateral view.

RGM 345 396 - *Berriasibelus kabanovi* (Weiss, 1991) immature
Tornajo, B40, Pertransiens Zone
Fig. 11, dorsal view.
Fig. 12, laterl view.

All specimen are printed on natural size.

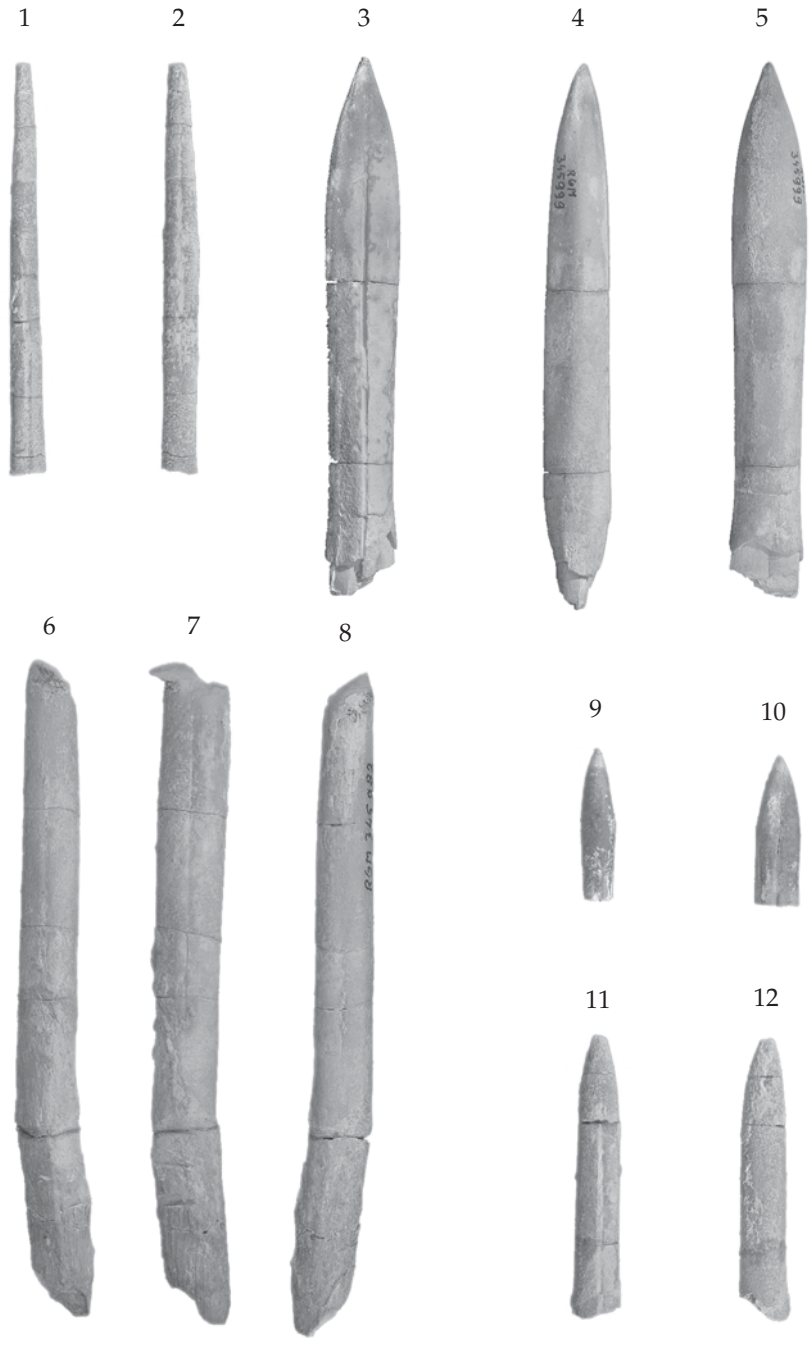
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Plate 5

RGM 345 437 - *Conobelus*? *piradoensis* sp. nov.
Tornajo, C29-25, mid Alpillensis Zone
Fig. 1, dorsal view.
Fig. 2, lateral view.

RGM 361 433 - *Conobelus*? *piradoensis* sp. nov.
Cañada lengua, CL(102)-103a, mid Alpillensis Zone
Fig. 3, dorsal view.
Fig. 4, lateral view.

RGM 345 339 - *Gillieronibelus mayeri* (Gilliéron, 1873) immature
Tornajo, C32(-31), Microcanthum-Jacobi? Subzone
Fig. 5, dorsal view.
Fig. 6, lateral view.

RGM 345 990 - *Gillieronibelus mayeri* (Gilliéron, 1873)
Cañada Lengua, CL91-92, Paramimouna Zone
Fig. 7, dorsal view.
Fig. 8, lateral view.
Fig. 9, ventral view.

RGM 345 355 - *Gillieronibelus mayeri* (Gilliéron, 1873)
Tornajo, C32(-31), Microcanthum-Jacobi? Subzone
Fig. 10, dorsal view.
Fig. 11, lateral view.
Fig. 12, ventral view.

RGM 345 987 - *Gillieronibelus mayeri* (Gilliéron, 1873) immature
Cañada Lengua, CL100, Picteti Zone
Fig. 13, dorsal view.
Fig. 14, ventral view.

All specimen are printed on natural size.

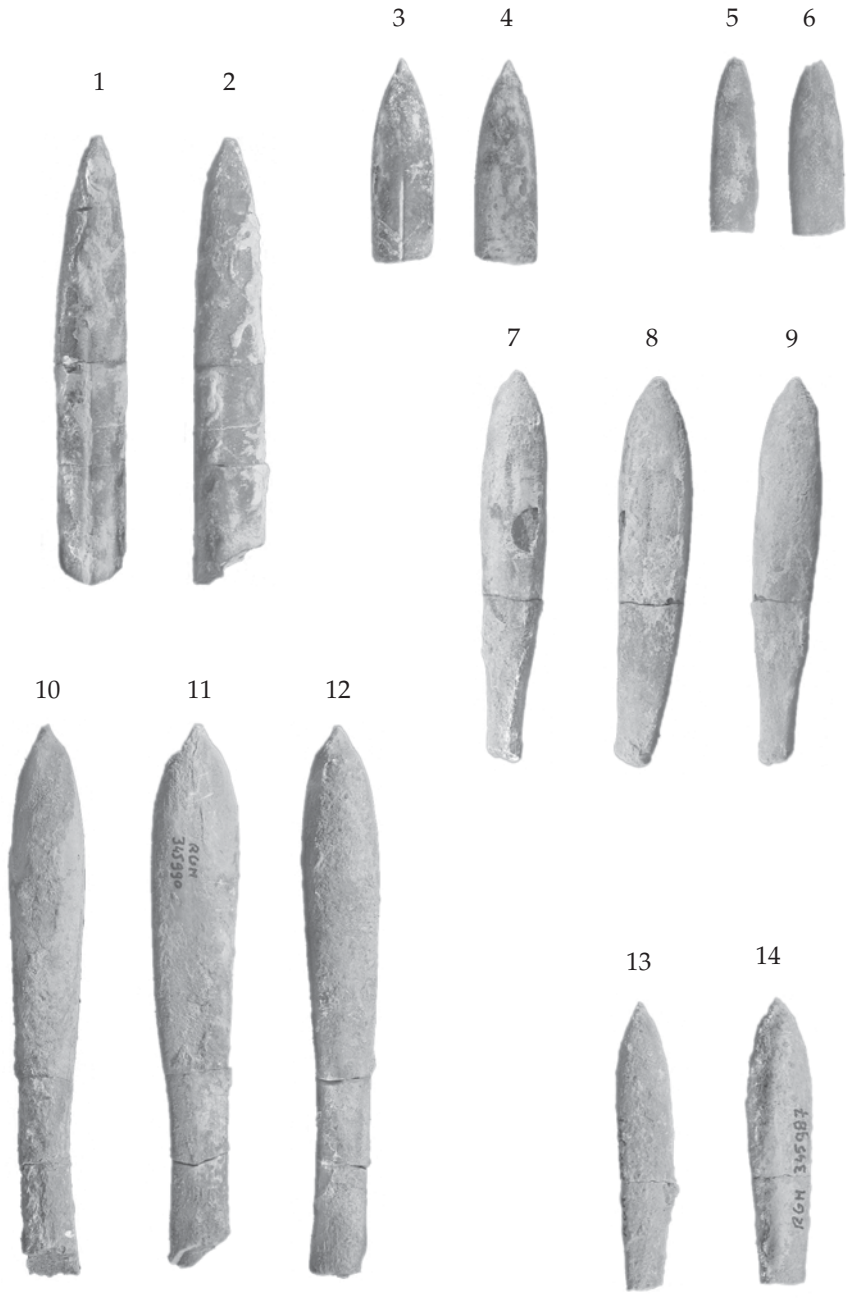
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Plate 6

RGM 345 200 - *Duvalia tornajoensis* sp. nov.
Río Argos, Y262, Otopeta Zone
Fig. 1, dorsal view.
Fig. 2, lateral view.

RGM 345 920 - *Duvalia* aff. *haugi* Kilian, 1889
Cañada Lengua, CL116, base Pertransiens Zone
Fig. 3, dorsal view.
Fig. 4, lateral view.
Fig. 5, internal view (from dorsal side).

RGM 345 942 - *Duvalia tornajoensis* sp. nov. immature
Cañada Lengua, CL109, base Pertransiens Zone
Fig. 6, dorsal view.
Fig. 7, lateral view.

RGM 345 882 - *Duvalia miravetesensis* sp. nov.
Cañada Lengua, CL88, Paramimouna Zone
Fig. 8, dorsal view.
Fig. 9, lateral view.

RGM 345 551 - *Duvalia* aff. *guillantona* Besairie, 1930
Río Argos, Y147, Paramimouna Zone
Fig. 10, dorsal view.
Fig. 11, lateral view.

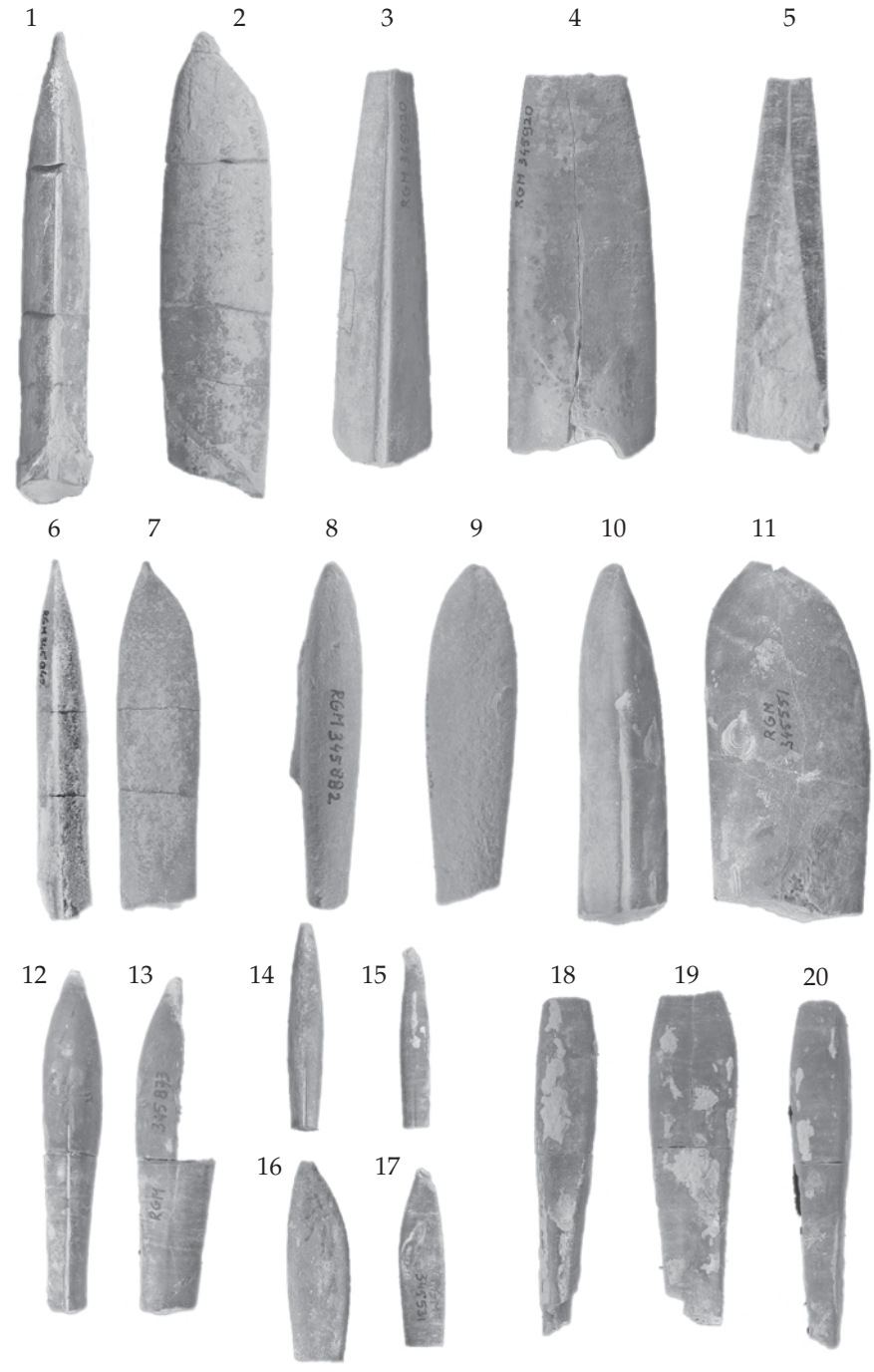
RGM 345 873 - *Duvalia lata constricta* Uhlig, 1902 immature
Río Argos, Y225-226, top Picteti Zone\Alpillensis Zone
Fig. 12, dorsal view.
Fig. 13, lateral view.

RGM 345 958 - *Duvalia lata constricta* Uhlig, 1902 juvenile
Cañada Lengua, CL101, topmost Picteti\Alpillensis Zone
Fig. 14, dorsal view.
Fig. 15, lateral view.

RGM 345 531 - *Duvalia lata constricta* Uhlig, 1902 juvenile
Río Argos, Y132-136, base Paramimouna Zone
Fig. 16, dorsal view.
Fig. 17, ventral view.

RGM 345 566 - *Duvalia miravetesensis* sp. nov.
Río Argos, X223, top Picteti Zone\Alpillensis Zone
Fig. 18, dorsal view.
Fig. 19, lateral view.
Fig. 20, ventral view.

All specimen are printed on natural size.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