

Ammonitina (Hammatoceratidae) of the Toarcian and Aalenian in the Serra de Llevant (Isle of Mallorca, Spain)

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(2 figures and Plates 12-13)

Abstract

For the first time Hammatoceratidae characteristic to the Upper Toarcian and Lower Aalenian from the Serra de Llevant in Majorca (Spain) are recorded and described. They come from a level of redeposition, situated at the base of the Gorg Blau Formation (ALVARO et al., 1989), which contains many reworked fossils with ferruginous, phosphatic and ferromanganese incrustations. They are found associated with Harpoceratinae, Grammocerotinae, Bouleiceratinae? and Leiocerotinae characteristic, in their majority, of the Mediterranean Province; some specimens characteristic of Northwest Europe also exist in the recorded assemblage.

Key words: Ammonoidea, systematics, biostratigraphy, Lower Jurassic, Middle Jurassic, Balearic Islands, Spain

Introduction

Majorca Island sits on a continental promontory, which extends north-west in the Mediterranean, as a prolongation of the Cordilleras Béticas. According to the stratigraphical and structural characteristics of the material, two domains have been identified: the Domain of Sierra Norte and the Domain of Serra de Llevant, whose boundaries do not coincide exactly with the physiographic boundaries of either range (ALVARO & DEL OLMO, 1984).

The carbonate sediments of the Lower and Middle Jurassic in the Domain of the Serra de Llevant have been described by many authors since the last century. However, there are very few projects in which the ammonoids

in the series are recorded or their study undertaken (NOLAN, 1895; DARDER, 1915, 1925; FALLOT, 1922, 1945; COLOM, 1947, 1975; BOURROUILH, 1983; ALVARO et al., 1984, 1989; Fornos et al., 1984, 1988; GOY & URETA, 1988; PRESCOTT, 1988; SANDOVAL, 1994).

The studied Hammatoceratidae came from the northern part of Serra de Llevant, from a section situated at Puig Cutri, near Artá (Fig. 1). The assemblages are of great paleogeographic interest, because there are very few data about this group, and in particular, hammatoceratids from the Lower Jurassic in the Balearic Islands have rarely been described.

Stratigraphy

The stratigraphic successions and the sedimentary development of the Jurassic in Majorca were recently synthesized by ALVARO et al. (1989). These authors reorganised the data on lithostratigraphic units which have been defined a few years before (ALVARO et al., 1984), and define five new formations, among others the Gorg Blau Formation, which yielded the studied ammonoids. They also take into account biostratigraphical and biochronological considerations.

In the Puig Cutri Section, the oldest outcropping rocks are massive tabular dolomiticrites of the Felanitx Formation which recall those of the Imón Formation in eastern Spain, attributed to the uppermost part of the Upper Triassic (GOY et al., 1976; BARRON & GOY, 1994).

Simplifying, the following lithostratigraphic units are found in ascending order (Fig. 2):

- Dolomite Formation and crevices of Mal Pas (100-150 m),
- Carbonate Formation of Soller (250 m),

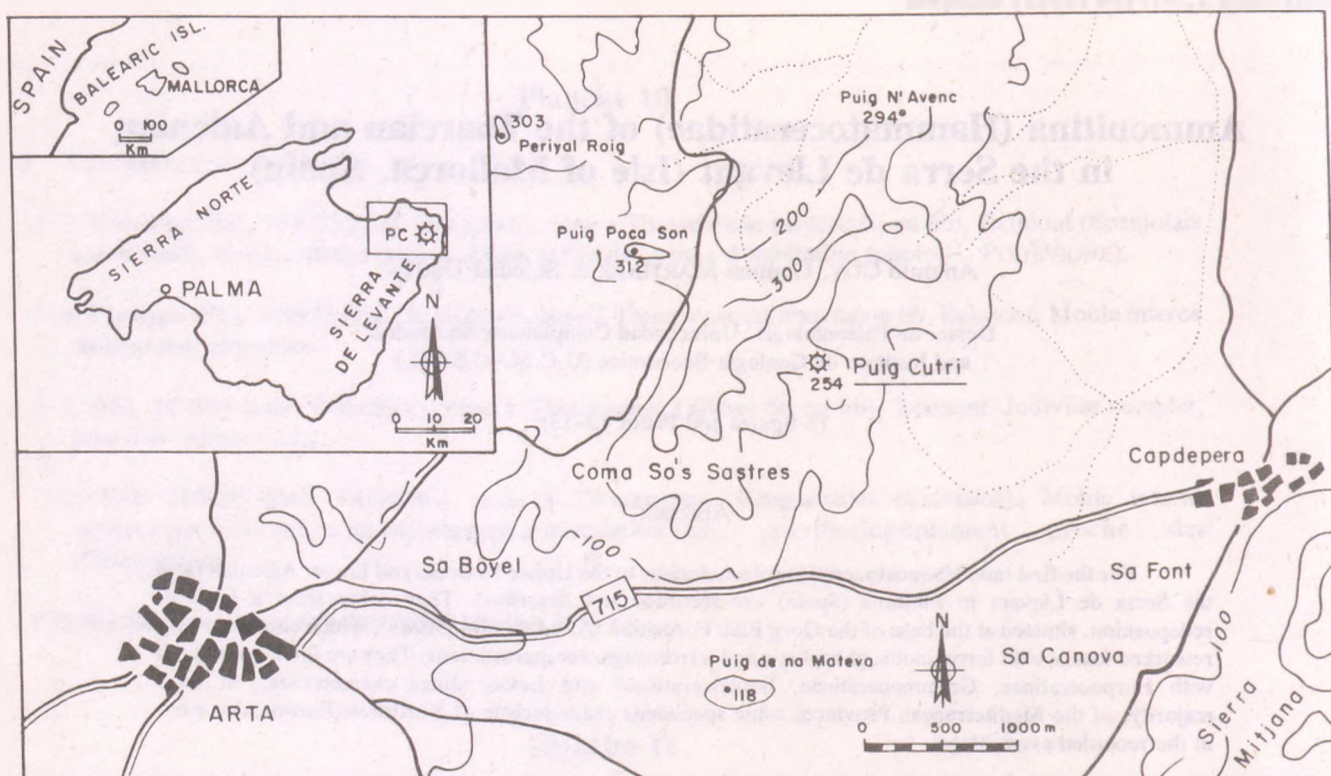


Fig. 1. Geographical situation of studied outcrop in the Puig Cutri area. Serra de Llevant of Majorca.

- Encrinitic Limestone Formation of Es Cosconar (5 m),
- Nodulose Marl-limestone Formation of Gorg Blau (30–40 m).

The first three correspond to the Lower Jurassic, up to the Toarcian, and the fourth to Toarcian (pro parte), Aalenian and Lower Bajocian (up to the Humphriesianun Zone).

In general the Gorg Blau Formation has three levels, a lower one formed by a ferruginous stage which contains reworked ammonoids, an intermediate marl-calcareous stage and an upper stage of nodular and platy limestones. However, in Serra de Llevant the intermediate stage may be very small and even be absent as in Puig Cutri.

The ferruginous stage, from which nearly all the studied Hammatoceratidae came, was described by BARNOLAS & SIMÓ (1984) and by PRESCOTT (1988). It is a stage of movement, generally developed on a hard ground which existed at the top of the previous unit, and contains numerous remains of reworked Ammonoids, ferruginous, phosphatic and ferromanganese incrustations. Their formation corresponds to a relatively complex process, with important local variations. Thus in the model area of the Gorg Blau Formation, the recorded faunal lists indicate the Toarcian (Bifrons Zone, Variabilis Zone and possibly Thouarsense Zone) according to GOY & URETA (1988). They probably correspond to the UTS VII.2 and UTS VII.3 of YEBENES et al. (1988); equivalent of the USD II and USD III of the Toarcian of GOY et al. (1994).

In the marly-calcareous layers situated almost immediately above, various associations of ammonites, suggesting the Pseudoradiosa Zone, the Aalenis Zone of the Toarcian, have also been identified (GOY & URETA, 1988).

In Puig Cutri the ferruginous stage contains the following Hammatoceratinae:

- Geczyceras* cf. *bonarelli* (PARISCH & VIALE)
- Geczyceras costulosus* (MERLA)
- Geczyceras* aff. *costulosus* (MERLA)
- Geczyceras* cf. *speciosum* (JANENSCH)
- Geczyceras* cf. *allobrogense* (DUMORTIER)
- Hammatoceras* cf. *insigne* (SCHLÜBLER in ZIETEN)
- Hammatoceras praefallax* (MONESTIER)
- Planammatoceras* cf. *planinsigne* (VACEK)
- Erycites elaphus* MERLA

Associated with these fossils there are different species of *Oxyparoniceras*, *Polyplectus*, *Osperlioceras*, *Pseudogrammoceras*, *Pseudolillia*, *Gruneria*, *Catulloceras*, *Dumortiera*, *Pleydellia* and *Leioceras* (see ALVARO et al., 1989).

The faunal lists indicate the Toarcian (Thouarsense Zone?, Insigne Zone, Pseudoradiosa Zone and Aalenis Zone) and Aalenian (Opalinum Zone). They probably correspond to the UTS.VII.4 of YEBENES et al. (1988) equivalent to the USD. IV and USD. V of GOY et al. (1994) and to the I sequence of the topmost Toarcian-lower Aalenian of GOY et al. (1991).

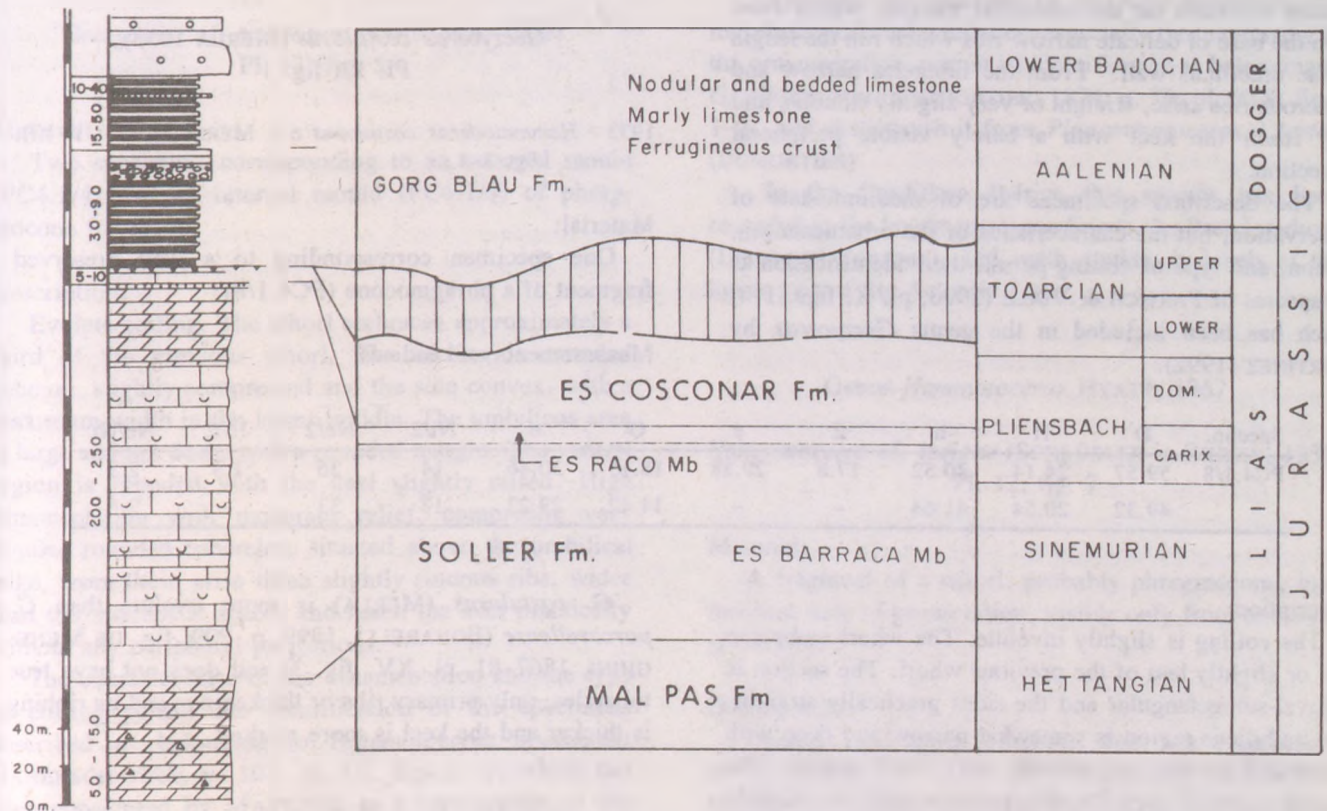


Fig. 2. Synthetic stratigraphical section of the Lower and Middle Jurassic sediments from Serra de Llevant Domain including the chronostratigraphic scale and the recognised lithostratigraphic units.

Systematic description

For the systematic study and taxonomic classification of the specimens, the morphological characteristics of the shell have taken into account, with the following dimensions and indices:

- D = diameter of shell (mm),
- H = height of whorl (mm),
- E = thickness of section (mm),
- O = umbilicus width (mm),
- h = relative value of height in relation to the diameter,
- e = relative value of thickness in relation to the diameter,
- o = relative value of the umbilicus size in relation to the diameter,
- $Ni/2$ = number of internal ribs in half a whorl,
- $Ne/2$ = number of external ribs in half a whorl,
- H/E = relation between the height and thickness,
- NE/NI = relation between the number of external and internal ribs.

Family Hammatoceratidae, BUCKMAN, 1887⁴

Genus *Gecyceras* MARTINEZ, 1992

Gecyceras cf. *bonarelli* (PARISCH & VIALE, 1906)

Pl. 12, figs. 3-4

Material:

Two specimens, one of them (PC4.1/1) very deformed (flattened), the other (PC4.1/2) corresponds to a fragment of whorl, only visible from one of its sides. Probably phragmocones.

Description:

The coiling is evolute, the whorl embraces a third of the previous one. In the inner whorls of the undeformed specimen the section is suboval, slightly compressed, and in the last visible whorl is strongly compressed. It has convex sides, with the maximum width at the lower third.

The umbilical region is wide and not very deep, with slightly convex margin and wall straight and slanting wall. The ventral area is rounded with a narrow, little raised keel. The ornamentation is fine and of moderate to gentle relief; it comprises very small, numerous, round and

Suborder Ammonitina HYATT, 1889

Superfamily Hildocerataceae HYATT, 1867

pointed tubercles on the umbilical margin, which arise from the base of delicate narrow ribs which run the length of the umbilicus wall. From the tubercles narrow and numerous ribs arise, straight or very slightly sinuous, and they reach the keel with a barely visible peripheral projection.

The described specimens are of medium state of preservation, but the characteristics of the ornamentation, section, and type of coiling permit their identification as the species of PARISCH & VIALE (1906, pl. X, figs. 1-4) which has been included in the genus *Geczyceras* by MARTINEZ (1992).

Specim.	D	H	h	E	e	O	o	Ni/2	Ne/2	H/E	Ne/Ni
PC4.1/8	59.57	24.14	40.52	17.8	29.88	18.15	30.46	14	36	1.3	2.5
	49.32	20.54	41.64	-	-	14.42	29.23	13	33	-	2.5

Description:

The coiling is slightly involute. The whorl embraces half or slightly less of the previous whorl. The section is suboval-subrectangular and the sides practically straight. The umbilicus region is somewhat narrow and deep with a rounded margin and smooth, very slanting wall. The ventral region is very flat with a narrow and very slightly raised keel. Ornamentation is of moderate to low relief, formed by thick primary ribs or thickenings which arise at the edge of the umbilicus, and before ending in a third of sides, they divide and redivide in thick ribs wider than the space in between. These ribs are numerous and quite straight reaching the keel with a scarcely visible peripheral projection.

Specim.	D	H	h	E	e	O	o	Ni/2	Ne/2	H/E	Ne/Ni
PC4.1/9	62.49	25.18	40.29	16.99	27.18	19.91	31.86	14	46	1.48	3.28
	50.26	21.55	42.87	15.47	30.77	15.86	31.55	13	45	1.39	3.46

Description:

Coiling moderately evolute, the last visible whorl embraces half or slightly less of the previous whorl. Section suboval-subrectangular, side practically straight, although there is hardly any difference in width, it is somewhat wider in the lower part of the sides. The umbilicus region is wide with a rounded margin and smooth, slightly inclined wall. The ventral region is rounded with a narrow, little raised keel. Ornamentation is of high and of moderate to high relief, formed by not very marked constant and narrow primary ribs which arise from the umbilicus edge and immediately thicken to form rounded tubercles; these redivide before ending in the lower half of the side in numerous, narrow ribs, some-

Geczyceras costulosus (MERLA 1933) Pl. 12, fig. 1

1933 *Hammatoceras costulosus* n.f. MERLA, p. 13; 1. I(I), figs 3-4.

Material:

One specimen corresponding to a well preserved fragment of a phragmocone (PC4.1/8).

Measurements and indices:

G. costulosus (MERLA) is more evolute than *G. porcarellense* (BONARELLI, 1899, p. 209, fig. DE MENE- GHINI, 1867-81, pl. XV, fig. 3) and does not have true tubercles, only primary ribs or thickenings and its ribbing is thicker and the keel is more marked.

Geczyceras aff. costulosus (MERLA, 1933) Pl. 12, fig. 2

Material:

One specimen corresponding to a well preserved phragmocone (PC4.1/9).

Measurements and indices:

what wider than the space between, they are straight, or slightly "proverse", and reach the keel practically without peripheral projections.

The tubercles recall those in *G. allobrogense* (DUMORTIER, 1874; p. 79, pl. XIX, figs. 1-2), however the here described specimen is more involute and the section more compressed and the keel is less thick and raised. It differs from *G. porcarellense* (BONARELLI) because the tubercles are in a lower position and the ventral region is more rounded with the keel being less marked. *G. costulosus* (MERLA, 1933; p. 13, pl. I(I), figs. 3-4) is more involute and does not have true tubercles, it has a less marked keel and the ventral region is more rounded.

Gecyceras cf. *speciosum* (JANENSCH, 1902)

Pl. 12, fig. 5

Material:

Two specimens corresponding to an external mould (PC4.1/4) and an internal mould (PC4.1/5) of phragmocone fragments.

Description:

Evolute coiling. The whorl embraces approximately a third of the previous whorl. The section is rounded suboval, slightly compressed and the side convex, with a maximum width in the lower middle. The umbilicus area is large and not deep, with a rounded margin. The ventral region is rounded with the keel slightly raised. High ornamentation with moderate relief, comprising very regular rounded tubercles, situated above the umbilical edge, from these arise three slightly sinuous ribs, wider than the intercostal spaces and reach the keel practically without any peripheral projections.

The characteristics of the ornamentation and the type of coiling permit the identification of the specimens described as belonging to *Hammatoceras speciosum* (JANENSCH 1902; p. 102, pl. IV, figs 1-1a) which has been considered by MARTINEZ as a type-species of the genus *Gecyceras*. *H. insigne* (SCHL. in ZIETEN) has a less distinct ribbing and its section is less compressed in similar stages. *H. capuccinum* BUCKMAN has very similar internal whorls except that it has a more gentle relief in the ornamentation and a wider section for similar stages.

In the Cordillera Ibérica, in the east of peninsular Spain, this species has been recorded in levels corresponding to the Insigne Zone (GOY, 1974; MARTINEZ, 1992).

Gecyceras cf. *allobrogense* (DUMORTIER, 1874)

Pl. 12, fig. 6

Material:

A fragment of whorl, probably phragmocone. Medium state of preservation and only visible from one of the sides (PC4.1/3).

Description:

Coiling moderately evolute, the whorl embraces slightly less than half of the previous whorl. The section is suboval, compressed, with the sides slightly convex. The umbilicus is large, not deep, with the whorls visible, and the margin rounded. It has a narrow, slightly raised keel. Ornamentation comprises tubercles situated near the middle of the sides, in its lower part, prominent, rounded and pointed, specially in the innermost visible whorl. From these arise two secondary ribs and a lobe, thick with moderate to low relief, straight and reaching the ventral region with short, scarcely visible peripheral projections.

Although the specimen is not well preserved, the morphological characteristics, especially those referring to the ornamentation, permit its identification as belonging to *G. allobrogense* (DUMORTIER, 1874; p. 79, pl. XIX, figs. 1-2), and distinguish it from *Planammatoceras ? lorteti* (DUMORTIER).

In the Cordillera Ibérica this species has been recorded in the levels corresponding to the Pseudoradiosa (Levesquei Subzone), and, with doubts, in levels of the lower part of the Aalensis Zone.

Genus *Hammatoceras* HYATT, 1967*Hammatoceras* cf. *insigne* (SCHLÜBLER in ZIETEN, 1830)

Pl. 12, fig. 7

Material:

A fragment of a whorl, probably phragmocone, in a medium state of preservation, visible only from one side. (PC4.1/7).

Description:

Coiling moderately involute. The whorl embraces approximately half of the previous whorl. Section subrounded and slightly compressed in the last visible whorls. The sides are convex and maximum width is in the lower third. The umbilicus is narrow with a rounded margin. The ventral region is not visible. Ornamentation is high and dense, comprising thick rounded tubercles situated above the umbilicus margin. From these arise ridges wider than the spaces in between, slightly concave towards the opening.

Although the specimen does not show a good state of preservation, there are no doubts, due to its morphological characteristics, as to its inclusion in *H. insigne* (SCHLÜBLER in ZIETEN, 1830; p. 30, pl. 15, figs. 2a-c). It is distinguished from other *Hammatoceras* such as *H. semilunatum* (QUENSTEDT) because it has clear tubercles and less sinuous ribbing.

In the Cordillera Ibérica this species has been recorded in levels corresponding to the the Insigne Zone (Insigne Subzone).

Hammatoceras praefallax MONESTIER, 1921

Pl. 12, fig. 8

1921 *Hammatoceras praefallax* n. sp. MONESTIER; p. 36, pl. III, figs. 11, 20-21.

Material:

One specimen corresponding to a well preserved phragmocone (PC4.1/6).

Measurements and indices:

Specim.	D	H	h	E	e	O	o	Ni/2	Ne/2	H/E	Ne/Ni
PC.1/6	13.77	6.40	46.47	9.06	65.79	3.55	25.78	12	22	0.7	1.83

Description:

Coiling involute, the last visible whorl embraces two thirds of the previous one. Cadicone section, with maximum width in the middle lower-part of the sides. Umbilicus is deep and narrow, with a convex edge and vertical wall. Ventral region is rounded with narrow and slightly raised keels. Ornamentation of moderate relief, comprising narrow primary and "proverse" ribs, above the umbilicus margin. They divide into secondary ribs of minor relief which almost reach the keel, with short peripheral projections.

In the description of the species of MONESTIER different types or varieties are distinguished. The specimen described in this study shows a clearly depressed section in the visible whorls. *H. praefallax* MONESTIER, in contrast to *H. insigne* (SCHLÜBLER in ZIENTEN) does not have well defined tubercles; it is more involute and the ribbing is denser than *H. fasciatum* JANENSCH and it shows clear differences in the ornamentation from *H. simulator* MONESTIER.

In the Cordillera Ibérica, this species has been recorded in the levels corresponding to the Insigne Zone (Insigne Subzone)-Pseudoradosa Zone (Levesquei Subzone).

Genus *Planammatoceras* BUCKMAN, 1922

Planammatoceras cf. *planinsigne* (VACEK, 1886) Pl. 13, fig. 1

Material:

Two fragments of whorl, possibly phragmocones (PC4.1/14,15).

Description:

Coiling moderately evolute. The whorl embraces approximately half of the previous one. Oval section with slightly convex sides and maximum width in the lower part of the sides. The umbilicus is large and not deep, with a rounded margin, wall somewhat convex and vertical. Ventral region sharp with thick, very raised keel. Ornamentation thick and of moderate relief, comprising straight primary ribs, approximately the same as the intercostal spaces, which arise from the umbilical edge and at the end of the lower third part a small tubercle and from this two slightly narrower ribs arise, somewhat porsiradiate and straight, reaching the keel with very short peripheral projection.

Planammatoceras planinsigne (VACEK, 1886; p. (33)89; pl. XIII, figs. 1, 1a, 2-4) differs from other *Planammatoceras* such as *P. planiforme* BUCKMAN or *P. romani* ELMI with the presence of tubercles and its oval section and high keel.

This species has not been recorded in the East or North of Spain, where a register of other species of *Planammatoceras* (URETA, 1985; MARTÍNEZ, 1992) exists. However it is relatively frequent in the Cordilleras Béticas, where LINARES & SANDOVAL (1994) found it in materials from the Opalinum Zone (Comptum Subzone) in Cerro Méndez, Granada, and from the Murchisonae Zone (Bradfordensis Subzone) in Montillana, Jaén.

Family Erycitidae SPATH, 1928 Genus *Erycites* GEMMELLARO, 1886

Erycites elaphus MERLA, 1933 Pl. 13, fig. 2,3,4

1933 *Erycites elaphus* n. sp. MERLA; p. 25 (25); l. IV (IV), fig. 5.

Material:

Four specimens corresponding to fragments of phragmocones in a medium state of preservation (PC4.1/10, 11, 12, 13).

Description:

Coiling evolute. The whorl embraces somewhat more than a third of the previous one. Section is subrounded, slightly compressed in the visible whorls, and slightly oval, with maximum width situated in the lower part of the strongly convex sides. Umbilicus is large, not deep, with the internal whorls of the section more globular than the external whorls. The margin is rounded and the wall smooth and inclined. The ventral region is slightly oval with a thick, hollow, little raised keel. Ornamentation is thick and of low relief, comprising thick elongated tubercles, rounded and thick, which arise in the umbilical edge, reaching almost the middle of the side, where they divide into numerous ribs, wider than the spaces between, and also more proradiate and straight. They reach the keel with the barely visible peripheral projections.

It is distinguished from *E. reussi* (HAUER) because this species has a more rounded section and its width is in the middle part of the sides and the ribbing is less thick.

E. rotundiformis MERLA also differs in the section which is less oval and the ribbing is less marked. GÉCZY (1966) points out the differences between this species and

E. crassiventris MERLA, in reference to the style of involution and ribbing and suggests the possibility of the latter being included as a subspecies of the former. This same author points out the differences with *E. intermedius* HANTKEN in PRINZ in respect to the ornamentation, the type of involution and above all the suture line, for which the possibility of including (suggested by DONOVAN,

1958) *E. elaphus* MERLA in this latter species is excluded. This species has not been recorded in the Cordillera Ibérica. In the Cordilleras Béticas, LINARES & SANDOVAL (1994) found it in material from the Reynesi Zone in Cerro Méndez, probably equivalent to the upper part of Insigne Zone or the lower part of Pseudoradosa Zone in the Cordillera Ibérica (cf. GOY et al., 1988).

Conclusions

In Puig Cutri, in the Gorg Blau Formation, above the ferruginous belt *Ancolloceras opalinoides* (MAYER) (ALVARO et al., 1989) have been recorded at the base of a belt of nodular, platy limestones. This species in the Cordillera Ibérica is characteristic at the top of the Opalinum Subzone and of the Haugi Subzone (URETA, 1985) from which it seems possible that the removal level was formed at one or various stages after the Variabilis Zone and before the Murchisonae Zone.

From the point of view of sedimentary evolution, the intra-Toarcian discontinuity, in the Sierra Norte, and Upper Toarcian-Aalenian of Puig Cutri in the Serra de Llevant is marked, in both cases, by the change of the facies characteristic of a shallow platform (Es Cosconar Formation) to a facies of an exposed platform (Gorg Blau Formation). The recommencing of sedimentation and the development of new beds in wider environments occurred at the end of the Toarcian and the beginning of the Aalenian, on a local and discontinuous level, beginning with the ferruginous level which contains reelaborated fossils. In agreement with ALVARO et al. (1989) the materials from the Gorg Blau Formation present a relationship to the "onlap" type with those underneath.

From the paleobiogeographic point of view, in the taxoregisters the transition Toarcian-Aalenian of the Serra de Llevant, the relative abundance of *Polyplectus discoides* (ZIETEN) stands out. This species is characteristic to Mediterranean areas but with certain frequency it is present in the outcrops in Northwest Europe. Also, one finds more *Geczyceras* than *Hammatoceras*, numerous *Oesperlioceras*, *Catullocceras*, *Tmetoceras* and occasionally *Vacekia*, as occurs in Llodrá (ALVARO et al., 1989). On the other hand, there is also a record of species of the genera *Cotteswoldia* and *Pleydellia*, such as *P. costulata* and *P. leura*, which have been identified from material proceeding from England, such as *Oxyparoniceras telemachi* (RENZ), very rare and absent in close Mediterranean areas (Cordilleras Béticas) and of *Leioceras*. The faunas from the upper Toarcian and lower Aalenian of the Puig Cutri can be said to be characteristic of the Mediterranean Province, but they also contain elements of Northwest Europe. With respect to the Hammatoceratidae, while a wide taxonomic diversity exists, the numbers of specimens for each species are very low. Evidence of paleobiocenosis does not exist, and it is possible that in the majority or in all of the cases the shells were transported from distant areas.

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Plate 12

- Fig. 1. *Geczyceras costulosus* (MERLA, 1933). PC4.1/8. Phragmocone. ×1
- Fig. 2. *Geczyceras* aff. *costulosus* (MERLA, 1933). PC4.1/9. Phragmocone. ×1
- Fig. 3. *Geczyceras* cf. *bonarelli* (PARISCH & VIALE, 1906). PC4.1/2. Phragmocone. ×2
- Fig. 4. *Geczyceras* cf. *bonarelli* (PARISCH & VIALE, 1906). PC4.1/1. Phragmocone. ×1
- Fig. 5. *Geczyceras* cf. *speciosum* (JANENSCH, 1902). PC4.1/4. Phragmocone. ×1
- Fig. 6. *Geczyceras* cf. *allobrogense* (DUMORTIER, 1874). PC4.1/3. Phragmocone. ×2
- Fig. 7. *Hammatoceras* cf. *insigne* (SCHLÜBLER in ZIETEN, 1830). PC4.1/7. Phragmocone. ×2
- Fig. 8. *Hammatoceras praefallax* (MONESTIER, 1921). PC4.1/6. Phragmocone. ×2

Plate 13

- Fig. 1. *Planammatoceras* cf. *planinsigne* VACEK, 1886. PC4.1/14. Phragmocone. ×1
- Fig. 2. *Erycites elaphus* MERLA, 1933. PC4.1/12. Phragmocone. ×1
- Fig. 3. *Erycites elaphus* MERLA, 1933. PC4.1/10. Phragmocone. ×1
- Fig. 4. *Erycites elaphus* MERLA, 1933. PC4.1/11. Phragmocone. ×1