APPENDIX

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Field-trip across the representative sections for the Upper Hauterivian - Barremian ammonite biostratigraphy in the Maiolica exposed at Monte Nerone, Monte Petrano and Monte Catria (Umbria-Marche Apennines)

Escursione attraverso le sezioni rappresentative per la biostratigrafia ad ammoniti dell'Hauteriviano superiore-Barremiano della Maiolica affiorante a Monte Nerone, Monte Petrano e Monte Catria (Appennino umbro-marchigiano)

FABRIZIO CECCA (*), PAOLO FARAONI (**), AGOSTINO MARINI (***) & GIOVANNI PALLINI (****)

IGCP Projects
343: Stratigraphic Correlations Basins of Peritethyan
362: Tethyan and Boreal Cretaceous

ABSTRACT - In this paper we present a part of the geological excursions which were carried out during the 3rd Workshop of the International Working Group on Lower Cretaceous Cephalopods. In particular are here reported data on recently studied sections in the Maiolica formation of Umbria-Marche Apennines providing significant information for the ammonite biostratigraphy of the Upper Hauterivian - Barremian interval.

KEY WORDS: Ammonites, Biostratigraphy, Lower Cretaceous, Hauterivian, Barremian, Umbria-Marche Apennines.

RIASSUNTO - Si propone in questa nota una parte dell'itinerario delle escursioni effettuate nel corso del 3° Workshop del Gruppo di Lavoro Internazionale sui Cefalopodi del Cretaceo inferiore. In particolare si riportano i dati relativi a quelle sezioni, recentemente studiate nella formazione della Maiolica dell'Appennino Umbro-Marchigiano, rivelatesi utili per la biostratigrafia ad ammoniti dell'intervallo Hauteriviano superiore-Barremiano.

PAROLE CHIAVE: Ammoniti, Biostratigrafia, Cretaceo inferiore, Hauteriviano, Barremiano, Appennino Umbro-Marchigiano.

(*) Servizio Geologico Nazionale Largo S. Susanna 13, I-00187 Roma, ITALY

(**) via Secchiano 16, I-61043 Cagli, ITALY

(***) via Venezia 42, I-61043 Cagli ITALY

(****) Università "La Sapienza", Dip. Scienze della Terra, piazzale Aldo Moro 5, I-00185 Roma ITALY

F. C. is responsible for the palaeontologic identifications and the biostratigraphic interpretation.

1. - INTRODUCTION

In this work we present a condensed version of the "Excursion guide-book" which was distributed to the participants of the 3rd Workshop of the Lower Cretaceous Cephalopods Team. The data on the Hauterivian-Barremian outcrops are presented here whilst information on the Valanginian ammonite-rich outcrops and the Marne a Fucoidi sections, which were visited during the excursions, have been already exposed by CECCA (this volume) and by ERBA *et alii* (1989) respectively.

The sections presented here were discovered during recent researches, whose results have been already published partly. Therefore we give here new unpublished information and a summary of the most important results as well.

2. - PREVIOUS WORKS

Apart a Barremian pulchellid cited by ZITTEL (1869) and a Hauterivian *Pseudothurmannia* figured by RAMACCIONI (1939), only the occurrence of aptychi was cited in the literature from the Maiolica of Umbria-Marche Apennines. Berriasian and Valanginian ammonites were figured for the first time by CECCA (1985). Recently, numerous Upper Hauterivian - Barremian ammonite levels have been discovered (BARTOLOCCI *et alii*, 1993; CECCA *et alii*, 1994a,b; CECCA & PALLINI, *in press*) and also the occurrence of bivalves and gastropods is now demonstrated (CECCA & PALLINI, *in press*).

3. - THE MAIOLICA FORMATION (LATE TITHONIAN - EARLY APTIAN *p. p.*)

This formation consists mainly of medium bedded white micrites with thin interbedded dark pelites, whose frequency and thickness increase markedly towards the contact with the overlying Marne a Fucoidi, and nodules and layers of dark chert. These are the characteristics of the Maiolica deposited in the basins surrounding the Jurassic structural highs, or pelagic carbonate platforms (PCP) *sensu* SANTANTONIO (1993; 1994). White to light brown nodular limestones and yellowish brown saccharoidal dolomitized limestones characterize the first portion of the Maiolica deposited on the Jurassic PCP. Its thickness varies from 40-80 metres on PCP up to 450 metres in basin areas.

There are marked differences in the fossil associations of the basin and PCP types of Maiolica. In the lower part of the latter there are ammonites that are locally abundant (CECCA, 1985; CECCA *et alii*, 1990), brachiopods, gastropods and echinoid fragments. These macrofossils are absent or rare in the equivalent Maiolica of the basin succession. The ammonites are here very rare and scattered in the sequence. Nevertheless, they allow some interesting correlations between different stratigraphic scales. Calpionellids are represented in both types of Maiolica.

In some PCP sections is possible to recognize a hiatus (see 4.2.3.) between the Upper Berriasian and the Lower Hauterivian *p. p.* (MICARELLI *et alii*, 1977) within the Maiolica. In the basin successions of Maiolica numerous slumpings are intercalated in levels whose ages are not represented on PCP because of this hiatus. This allows us to demonstrate that the existence of palaeotopographic gradients in the sea bottom persisted in the Early Cretaceous (LOWRIE & ALVAREZ, 1984), although they were less pronounced than in the Jurassic.

Recently CECCA *et alii* (1994a) have discovered an anoxic level which can be recognized at the regional scale. Because of its stratigraphic isochrony, as well as its peculiar lithologic and palaeontologic characteristics this level was formally defined and named Faraoni Level and it is the older anoxic level recognized so far from this region (among the other levels the most important are the Selli and the Bonarelli Levels). Its age is clearly established by means of ammonites: latest Hauterivian, *P. angulicostata* zone, *P. catulloi* subzone. It usually occurs 65-70 metres below the top of the Maiolica. However this distance is greater (85 m) in the southern outcrops. Due to the thickness of this level, ranging from 25 to 40 cm, its identification and consequently its detailed stratigraphic analysis strongly depends on the exposure in the field.

Because of the gradual lithologic transition from the Maiolica to the overlying Marne a Fucoidi, the boundary between these two formations has been conventionally established in coincidence with the last black chert level (COCCIONI *et alii*, 1987).

4. - THE HAUTERIVIAN - BARREMIAN OUTCROPS

The visit of the outcrops is organised following five different directions (Tab. 1):

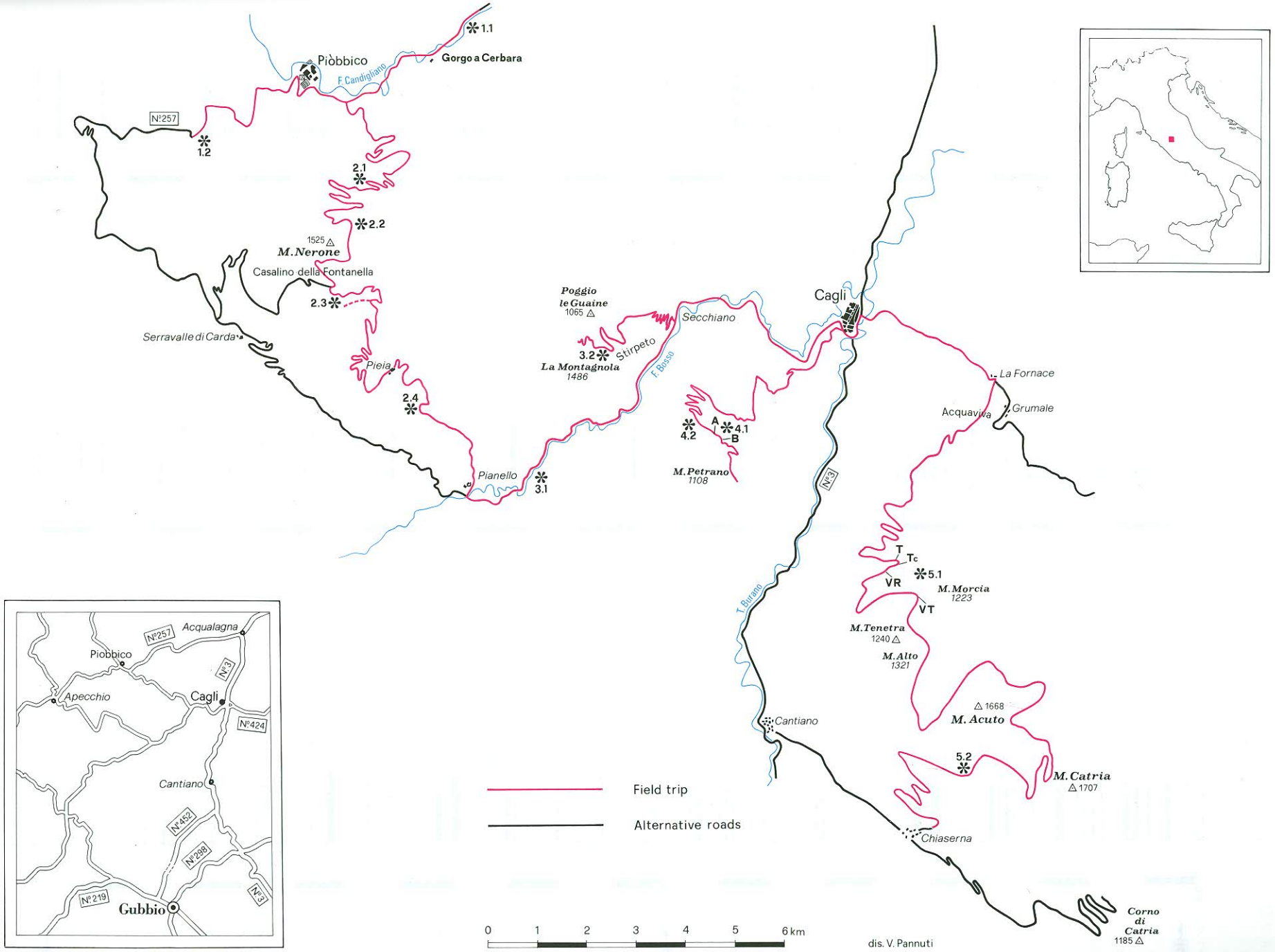
1) Gorgo a Cerbara - Sette Vene, along the road ss 257 from Acqualagna to Città di Castello with two stops at Gorgo a Cerbara (km 41.8) and Sette Vene (km 33.7) localities (8 km);

2) Piobbico - Monte Nerone-Pieia, with four stops at Ranchi, Campo al Bello, Fosso Bugarone and Pieia (25 km);

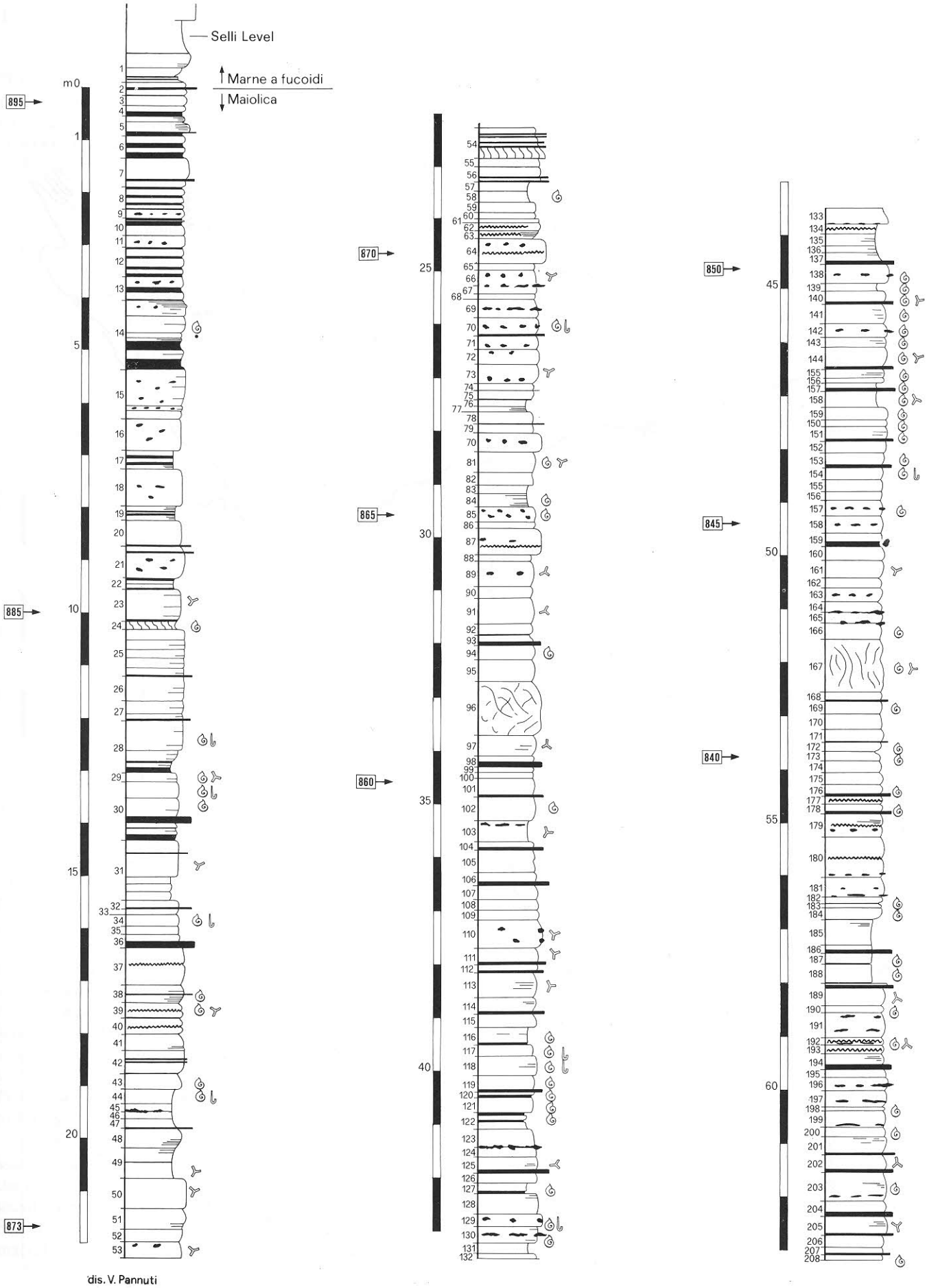
3) Pianello - Secchiano, with two stops, at the Bosso section, along the road to Cagli, and at Stirpeto (12 km);

4) Cagli - Monte Petrano, with two stops, along the northernn flank of the mountain and along the road (9 km);

5) Cagli - Chiaserna, with two stops along the road to Monte Acuto and another one on the road from there to Chiaserna (30 km).



Tab. 1 - *Itinerary of the field-trip on representative sections for Upper Hauterivian - Barremian ammonite biostratigraphy.*
- Itinerario dell'escursione attraverso le sezioni significative per la biostratigrafia ad ammoniti dell'Hauteriviano superiore - Barremiano.



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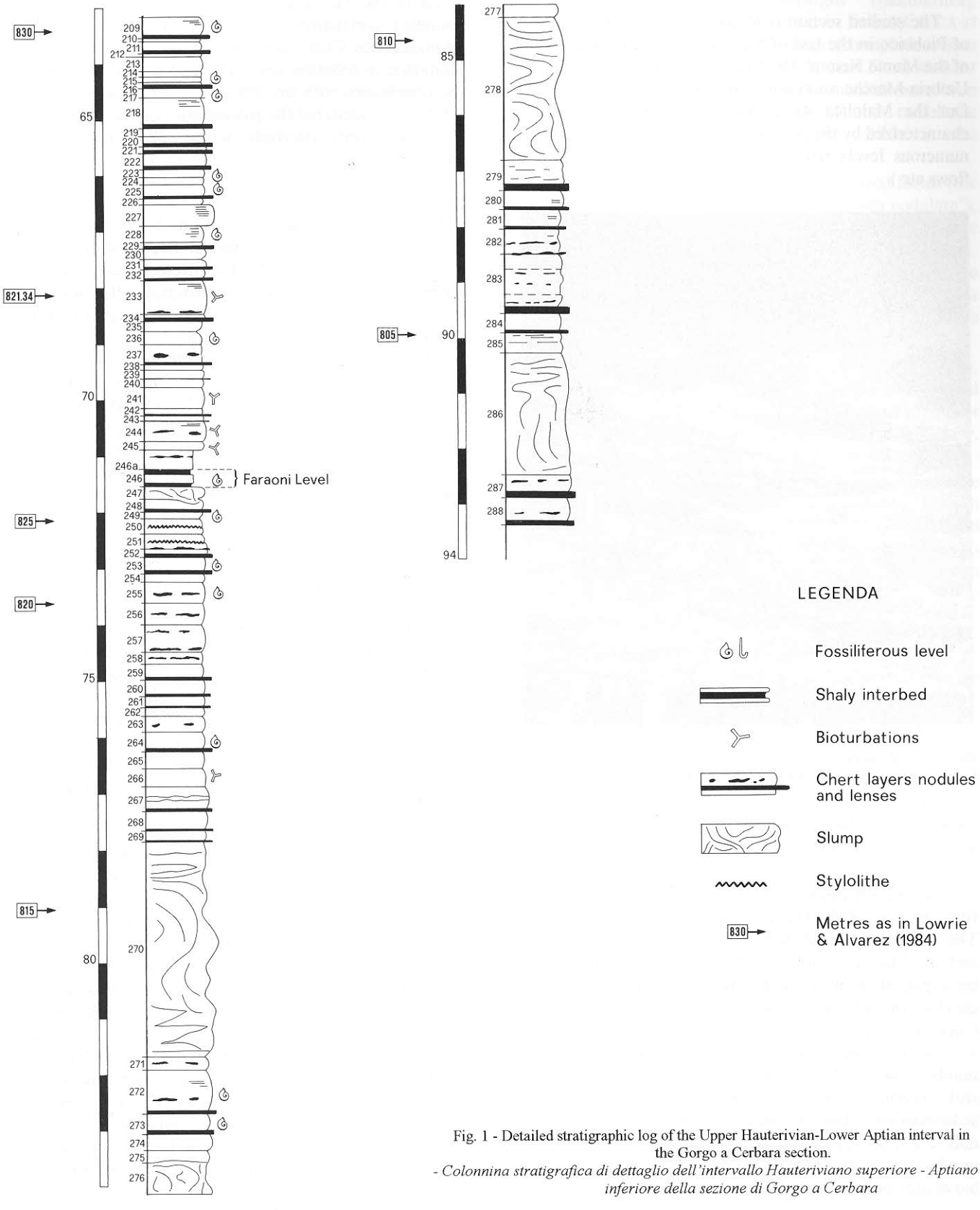

Fig. 1 - Detailed stratigraphic log of the Upper Hauterivian-Lower Aptian interval in the Gorgo a Cerbara section.
- Colonnina stratigrafica di dettaglio dell'intervallo Hauteriviano superiore - Aptiano inferiore della sezione di Gorgo a Cerbara

4.1. - Gorgo a Cerbara - Sette Vene

4.1.1 - *The Gorgo a Cerbara section: Upper Hauterivian -Lower Aptian Maiolica*

The studied section is located 4 km east of the town of Piobbico in the bed of the Candigliano river and east of the Monte Nerone. Here the typical Jurassic - Tertiary Umbria-Marche succession of basin type crops out. In fact the Maiolica succession at Gorgo a Cerbara is characterized by the occurrence of radiolarites as well as numerous levels with gravity deposits (slumps, debris flows etc.).

Fig. 2 - The Gorgo a Cerbara section exposed in the bed of the Candigliano river. M: Maiolica; F: Marne a Fucoidi. Dashed line: last bed of Maiolica.
- La sezione di Gorgo a Cerbara esposta nel letto del fiume Candigliano. M: Maiolica; F: Marne a Fucoidi. Il tratteggio indica l'ultimo strato della Maiolica.

The section has been bed-by-bed numbered starting from the base of the Marne a Fucoidi formation (Fig. 1). The lithologic boundary between the Marne a Fucoidi and the Maiolica formations is gradational and it has been placed with the uppermost occurrence of black chert in the Maiolica limestones (Fig. 2) according to Coccioni *et alii* (1987).

The beds have been correlated with the metre numbers used by Lowrie & Alvarez (1984), which are still visible. Some slumps disturb the normal sedimentation, thus the ammonites have been collected only in the autochthonous sediments. The ammonites are usually rare in the Maiolica formation. However, some biostratigraphic units can be recognized.

The Lower Cretaceous biostratigraphy based on calcareous nannofossil succession of this section has been studied by Bralower (1987) who correlated it with the magnetic stratigraphy already realized by Lowrie & Alvarez (1984). Coccioni *et alii* (1992) have studied here the uppermost levels of the Maiolica, near the Barremian-Aptian stage boundary, correlating calcareous nannofossils, forams and magnetozones. Cecca & Pallini (in print) have studied the ammonite distribution and Cecca *et alii* (1994b) defined the correlations with the different scales. Coccioni *et alii* (1994) have analyzed the palynologic content of the Upper Barremian marly interbeds in the upper portion of the Maiolica.

4.1.1.1. - Ammonites and biostratigraphy - Figure 1 presents the detailed stratigraphic log with the indication of the fossiliferous beds. Figure 3 summarizes the ammonite occurrences, the ammonite zonation and its correlation with the magnetic chrons recognized by Lowrie & Alvarez.

Hauterivian-Barremian boundary - The oldest ammonite was found in bed 277: it has been identified as *Subsaynella* sp. (pl. 1, fig. 9). In the beds 264-266 at 817.5 m, *Crioceratites* sp. gr. *duvalii* Léveillé/*villiersianus* (d'Orbigny) and *Plesiospitidiscus* sp. (pl. 1, fig. 8, 11 respectively) indicate a Late Hauterivian age, earlier than the *P. angulicostata auct.* zone and this level can be ascribed to the *B. balearis* or to the *P. ligatus* zones. The *P. angulicostata* zone, and particularly the *P. catulloi* subzone, is very well represented in bed 246 which corresponds to the guide-bed of the Faraoni Level (Cecca *et alii*, 1994a). The Hauterivian-Barremian boundary falls surely above bed 246, which contains latest Hauterivian faunas, and below beds 198-200 where we collected a typical Barremian *Spitidiscus*, i. e. an interval between metres 822 and 833 of Lowrie & Alvarez (1984). In the absence of faunas in the latter interval, the boundary is drawn between metres 824 and 828 on the basis of data from other sections (Mount Petrano). Then this stage boundary falls in chron CM4 (Fig. 3).

Lower Barremian - Typical Barremian *Spitidiscus* occur between beds 200-178 but this does not correspond to the actual *Spitidiscus* FO (pl. 1, fig. 10). This interval is assigned to the *hugii* zone, although no other significant Ammonitina have been found. At beds 151-153 occur specimens of the genus *Holcodiscus* (pl. 2, fig. 21), including the zonal index *H. caillaudi* (d'Orbigny). The fauna of beds 142-143 is also included in the *H. caillaudi* zone because of the presence of *Subpulchellia* cf. *changarnieri* (Sayn) (pl. 2, fig. 12), which is limited to the Early Barremian (Vermeulen, 1980). No significant faunas have been found in the interval between beds 177 and 154. The sediments inbetween could belong partly to the *S. hugii* and *H. caillaudi* zones and partly to the *S. nicklesi* zone. The Lower Barremian sediments of the Gorgo a Cerbara section are included in chron CM3.

Upper Barremian - The Lower/Upper Barremian boundary has been tentatively drawn around bed 130. Above the faunas of the *H. caillaudi* zone no ammonites unambiguously typical of the *A. vandenheckii* zone have been found. Typical Late Barremian ammonites occur at beds 121-119: *Heinzia* gr. *provincialis* (D'ORBIGNY), *H.* aff. *lindigi* (KARSTEN *in* UHLIG) (pl. 2, fig. 8) and *Costidiscus* sp. cf. *recticostatus* (D'ORBIGNY) (pl. 3, fig. 14). In beds 84-85 occurs *Coronites* aff. *coronatoides* (SAYN) and in bed 81 we have found *Barremites (Cassidoiceras)* cf. *cassidoides* (UHLIG), *H.* gr. *provincialis*, *C.* aff. *hoplitiformis* (SAYN) (pl. 2, fig. 5-7). The faunas of the beds between beds 130 and 81 are then included in the *A. vandenheckei* zone. The occurrence of *H. sartousi* (D'ORBIGNY) in bed 48 clearly indicate the *H. sartousi* zone; this species is rather abundant in bed 43 where it is associated with *H.* cf. *ouachensis* (SAYN) (pl. 2, fig. 9-11, 17). Above bed 43 ammonites become extremely rare and mainly represented by the *Silesites seranonis* (D'ORBIGNY) group, which is poorly significant for biostratigraphic purposes. Above bed 28, i. e. above metre 882, the beds are barren or do not contain significant fossils for biostratigraphic purposes. A single specimen, identified as *?Prodeshayesites* sp. was found in bed 5 (pl. 2, fig. 25), thus indicating the Lower Aptian.

In the upper portion of the Maiolica formation black marly interbeds occur. Their frequence increases upwards.

4.1.2 - *The Apecchiese road: the latest Hauterivian Faraoni Level*

Along the road there is a good exposure of the Faraoni Level (Fig. 4). Compared to Gorgo a Cerbara, the succession of white limestones and thin black shales is clearly visible here. The TOC content reaches 25% in some interbeds.

4.2 - PIOBBICO - MONTE NERONE-PIEIA

4.2.1 - *The Faraoni Level at the Ranchi outcrop*

From Piobbico, and in particular at km 4.8 of the road from Acquanera to the top of Monte Nerone in the locality named "i Ranchi", at the hairpin bend indicated in Tabl. 1, there is a good exposure of the Faraoni Level. The black shales are clearly visible, encompassing the ammonite-rich "guide-bed".

4.2.2 - *The Campo al Bello section: the Berriasian-Barremian Maiolica resting on to the Jurassic succession of the Monte Nerone Pelagic Carbonate Platform (PCP).*

Below the top of Monte Nerone, at km 9.5 of the road from Acquanera there is a spectacular exposure (which is better visible from km 10.3) of the Jurassic - Lower Cretaceous succession of the PCP type. This consists of nodular limestones, intensively dolomitized in the Middle and Upper Jurassic units, without any evidences of gravity deposits. There is a thin intercalation of "Calcari Diasprigni" (radiolarites), which corresponds to an onlap of basin facies (CECCA *et alii*, 1990) between Lower Bajocian (Humphriesianum Zone) and Upper Kimmeridgian (Cavouri Zone) nodular limestones. Lower Kimmeridgian ammonites have been collected in a calcareous level of the radiolarite intercalation. This hiatus is better visible in the Bugarone quarry (see 4.2.3).

The Maiolica begins with the dolomitized facies (the so called "Maiolica dolomitica" or "Maiolica nodulare"), which is typical of the PCP's successions. The calpionellid succession has been studied (CECCA *et alii*, 1990) around the Tithonian - Berriasian boundary. The ammonites are very rare and only *Fauriella (Strambergella)* cf. *carpathica* (ZITTEL) and *Spiticeras* gr. *groteanum* (OPPEL) have been identified.

Compared to the basin sections as Gorgo a Cerbara, the thickness of the Maiolica Formation is here reduced to 50 metres. In fact, there is a hiatus in the Lower Cretaceous succession of the Monte Nerone PCP sector. This is well exposed in the next stop.

An Upper Barremian section crops out along the road, just below the base of the Marne a Fucoidi Formation. The ammonites, mainly lytoceratids and "barremitids" are rare. The black marly interbeds already seen in an equivalent stratigraphic position at Gorgo a Cerbara section are well exposed and can be easily sampled.

4.2.3 - *The Fosso Bugarone quarry: 25 Ma hiatus in the Jurassic section; the hiatus in the Maiolica Formation*

From Campo al Bello we reach the locality "Casalino della Fontanella" (at km 12.1 from Acquanera) and we turn left. The Maiolica formation crops out at the left side of the road to Pianello, whilst the overlying Marne a Fucoidi formation is covered by vegetation. Above the quarry (Fig. 5), Upper Barremian beds with *Silesites seranonis* (D'ORBIGNY) crop out along the road at km 12.9 and the Faraoni Level is exposed at km 13.3 although it is difficult to recognize because the black shales lack.

At 13.7 km turn right off the road to Pianello: the two quarries of Fig. 6 are open near the "Fosso del Bugarone". Both show the typical PCP Jurassic-Lower Cretaceous succession. The second quarry is the type section of the Bugarone Formation (Early Pliensbachian - Tithonian) which includes the pelagic sediments of the PCP areas of the Umbria-Marche region. It consists of bioturbated, more or less dolomitized, and at times nodular limestones and marly limestones. No radiolarite intercalations exist here. Its thickness is 16 metres in the

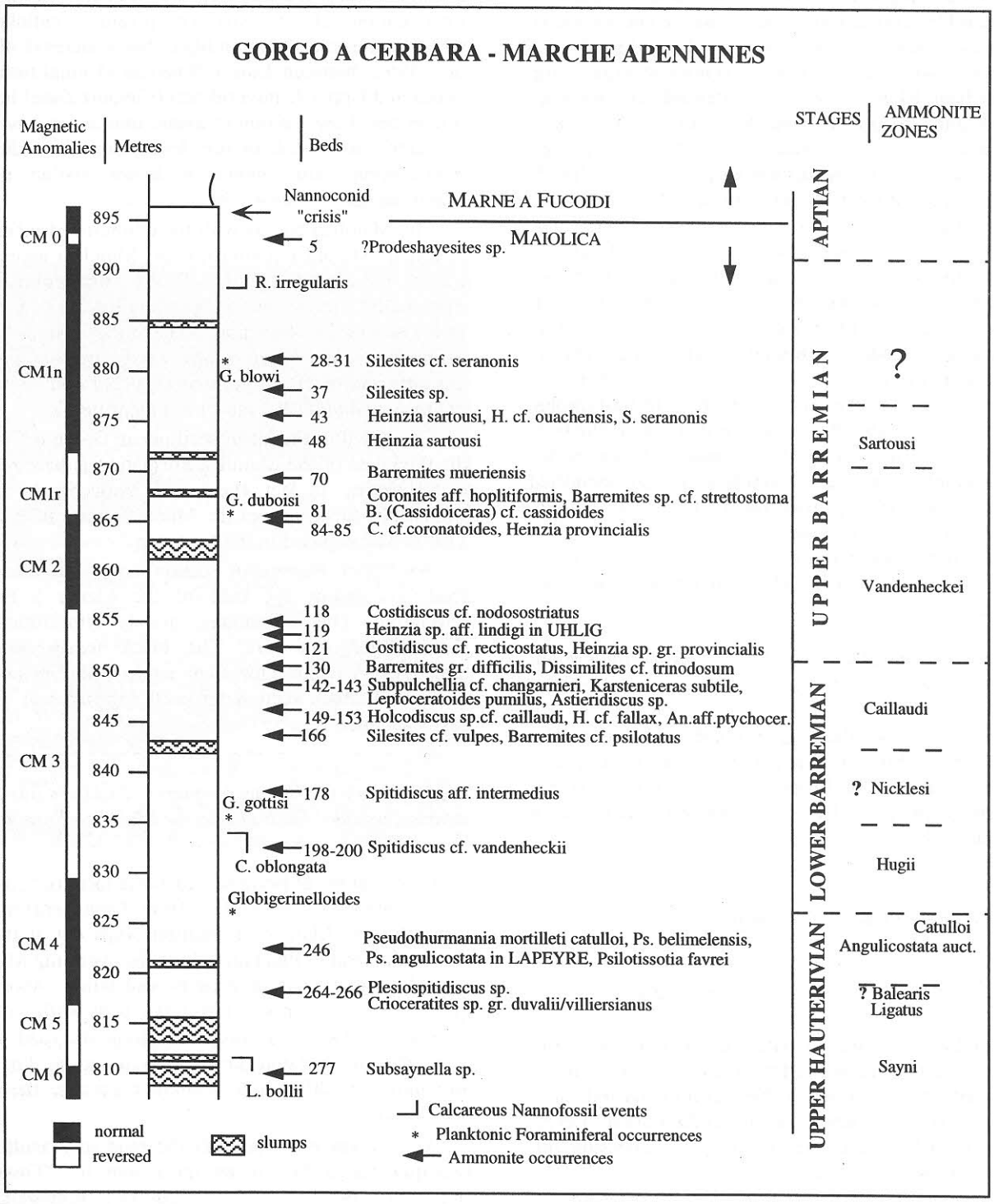

Fig. 3 - Ammonite occurrences and correlation with magnetic anomalies, calcareous nannofossils and planktonic foraminifera events in the Upper Hauterivian - Barremian interval of the Gorgo a Cerbara section (from CECCA *et alii*, 1994b, modified and updated). The metre numbers are those already used by LOWRIE & ALVAREZ (1984) and BRALOWER (1987).

- Punti di ritrovamento delle ammoniti e correlazione con le anomalie magnetiche e gli eventi a nannofossili calcarei e foraminiferi planctonici nell'intervallo Hauteriviano superiore - Barremiano della sezione di Gorgo a Cerbara. (da CECCA et alii, 1994b, modificato e aggiornato). La numerazione in metri è quella di LOWRIE & ALVAREZ (1984) e BRALOWER (1987).

Fig. 4 - The dashed lines indicate the uppermost Hauterivian Faraoni Level along the Apecchiese road, km. 33.7.
- *Le linee tratteggiate indicano il Livello Faraoni, dell'Hauteriviano sommitale, esposto lungo la strada Apecchiese, km 33,7.*

Fig. 5 - View of the quarries opened in the southern flank of Monte Nerone. M: Maiolica; F: Marne a Fucoidi. 1) Bugarone quarry; 2) *Silesites* bearing beds; 3) Faraoni Level.
- *Vista delle cave aperte nel versante meridionale di Monte Nerone. M: Maiolica; F: Marne a Fucoidi. 1) cava del Bugarone; 2) strati con* Silesites*; 3) Livello Faraoni.*

type section. On the basis of the ammonite faunal assemblages, a 25 Ma stratigraphic hiatus has been identified by CECCA *et alii* (1990). Onto the last Lower Bajocian bed conformably rests a succession of beds starting from the Lower Kimmeridgian Divisum Zone. This important hiatus has been recognized in all the PCP areas of Umbria-Marche Apennines. The upper boundary of the Bugarone Formation is difficult to define because of the transitional lithologic characters with theb ase of the Maiolica (CECCA *et alii*, 1990; CECCA, 1993).

MICARELLI *et alii* (1977) recognized a hiatus within the Maiolica. In fact an unconformity is exposed on the top of the quarry (see also CECCA, 1993, fig. 20). We interpreted it as a slump scar. However, upper Berriasian to Valanginian sediments lacks. The sediments above the hiatus have been dated to the Hauterivian p. p. by MICARELLI *et alii* (1977). We discovered the Faraoni Level (uppermost Hauterivian) 30 m above the Lower Tithonian beds in the natural cut of the Fosso Bugarone, at the left side of the quarry. Between the Faraoni Level and the base of the Marne a Fucoidi there are more or less 35 m of Maiolica.

4.2.4 - *Pieia: Upper Hauterivian-Upper Barremian Maiolica*

The Maiolica which overlies the Pieia succession is exposed along the road but faults and vegetation do not allow the study of the complete series. Nevertheless, close to the village of Pianello, at 22.5 km from Acquanera, the Upper Hauterivian - Upper Barremian part of the Maiolica Formation has been studied.

The ammonites are rare but they occur in the Faraoni Level and also in some beds above it. The preservation of the fossils is very bad and we could not distinguish the different ammonite zones. *Heinzia* and *Silesites* occur in bed 131.

4.3 - PIANELLO - SECCHIANO

4.3.1 - *The Maiolica of the Bosso river section: the type section of the Faraoni Level*

The section is a natural outcrop created by the erosion of the river. Here, along the road from Pianello to Cagli the Jurassic-Tertiary succession is exposed from the younger to the older formations. The Jurassic formations display the basin characters. Thus, facies, thicknesses and faunas differ from the coeval PCP sequence which we have seen in the Monte Nerone area. The hiatus between Bajocian and Kimmeridgian did not exist here. This interval is represented by silica-rich sediments.

The study of the younger portion, Hauterivian-Barremian, is still in progress. Sampling for magnetostratigraphy has been realized by J. CHANNELL; the results will be published in a subsequent paper. The ammonites are rare but they are abundant in the Faraoni Level, whose stratotype has been selected in this section (Fig. 6). For the detailed description of the Faraoni Level we refer the reader to the paper by CECCA *et alii* (1994a).

Fig. 6 - Reference section of the uppermost Hauterivian Faraoni Level, along the Cagli-Pianello road, km 9.8, Bosso section.
- *Sezione di riferimento del Livello Faraoni, Hauteriviano sommitale, al km 9,8 della strada Cagli-Pianello. Sezione del Bosso.*

Concerning the Lower Cretaceous, two portions of the Maiolica Formation, which are separated by faulting, have been studied. The older portion corresponds to the uppermost Tithonian - Late Valanginian interval. Biostratigraphy based on calpionellids and calcareous nannofossils has been defined (MICARELLI *et alii*, 1977; BRALOWER *et alii*, 1989). The magnetostratigraphy was published by LOWRIE & ALVAREZ (1984), who correlated it with the Calpionellid events and again by CHANNELL & GRANDESSO (1987).

4.3.2 - *The Stirpeto section (Poggio le Guaine - southern flank of Mount Nerone)*

This section is a natural exposure located in the South-East part of Mount Nerone, on the left side of the Bosso river valley below Poggio le Guaine (Fig. 7). The Marne a Fucoidi formation cropping out in this locality has been described by COCCIONI *et alii* (1987; 1990) but the Maiolica formation has not been studied so far. The good exposure of the whole Maiolica, from its upper boundary down to its lower boundary with the Upper Jurassic Calcari Diasprigni formation will allow us to study the complete Neocomian succession. Nevertheless, this natural outcrop is exposed on a quite steep slope and the worker cannot observe the stratification from the necessary distance allowing him to recognize possible slumped beds. These are quite frequent in the Maiolica outcrops of the surrounding localities.

4.3.2.1. - Ammonite distribution (Fig. 8) - We measured the section and numbered the beds starting from top (boundary with the Marne a Fucoidi). At metre 70, in bed 144b we have found the guide-bed of the Faraoni level. The first Barremian level has been found at metre 62; in bed 132 occur specimens of heteromorph ammonites which can be compared with *"Paraspinoceras" evolutum* (FALLOT & TERMIER). This species characterizes a level which is also exposed in different outcrops at Monte Petrano (see 4.4.) and indicates the basal Barremian (VERMEULEN, 1972).

At metre 41.5, in bed 114, we have found *Holcodiscus fallax* (MATHERON) (pl. 2, fig. 22). This species also occurs in the Gorgo a Cerbara section at metre 847.

The Late Barremian *Heinzia provincialis* (D'ORBIGNY) occurs at metre 24 in bed 79. Specimens of genera *Melchiorites* and *Anahamulina* are relatively frequent in beds 79, 80 and 81. *Heinzia* still occurs in bed 52 at metre 14 and just above, in bed 51, *Silesites seranonis* (D'ORBIGNY) appears.

If we do not take into account Phylloceratina, Lytoceratina, which are rare in this part of the section, and a single *Toxoceratoides* specimen found in bed 32 at metre 9, *S. seranonis* is the only species (pl. 2, fig. 13-16, 18, 19) occurring in the upper part of the Maiolica formation after the last occurrence of Pulchellids. In fact it occurs in four beds again, up to metre 7. A similar distribution has been observed in the Gorgo a Cerbara section.

Above metre 7, no significant ammonites have been found so far.

Some 300 metres East of the section we studied an auxiliary section where we found the Guide-Bed of the

Fig. 7 - View of the Stirpeto section. M: Maiolica; F: Marne a Fucoidi. The Faraoni Level is indicated with dots. The Maiolica - Marne a Fucoidi boundary is indicated with dashes.

- Vista della sezione di Stirpeto. M: Maiolica; F: Marne a Fucoidi. Il puntinato indica il Livello Faraoni. Il tratteggio indica il limite Maiolica - Marne a Fucoidi.

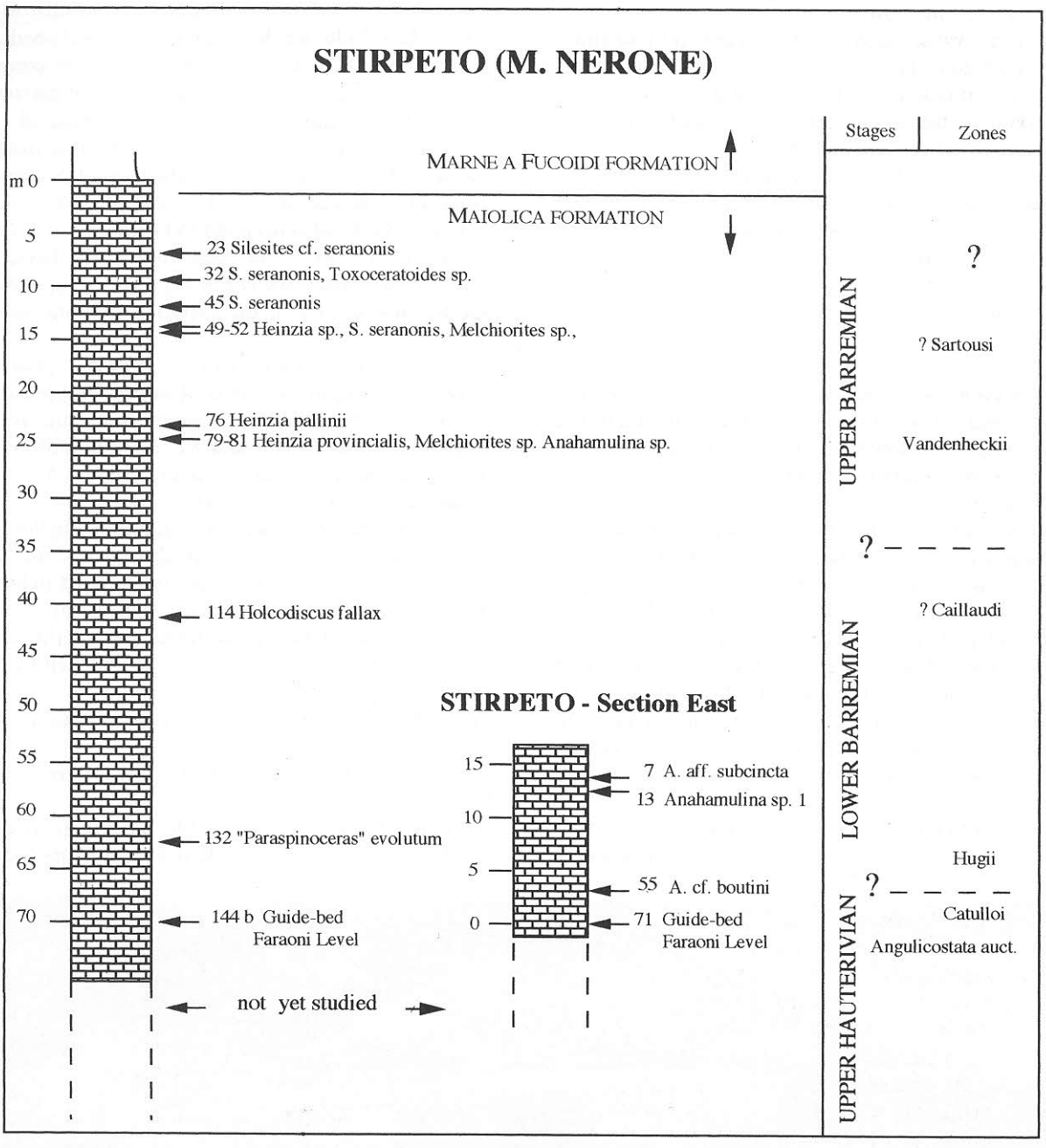

Fig. 8 - Ammonite occurrences in the Stirpeto sections.
- Punti di ritrovamento delle ammoniti nelle sezioni di Stirpeto.

Faraoni Level (CECCA *et alii*, 1994a). This bed is here particularly fossiliferous and we take the opportunity to mention the identified species collected in the different sections: *Phyllopachyceras infundibulum* (D'ORBIGNY), *Hypophylloceras tethys* (D'ORBIGNY),

Eulytoceras anisoptychum (UHLIG), *Neolissoceras grasi* (D'ORBIGNY), *Hamulinites* aff. *munieri* (NICKLÈS), *Acrioceras* cf. *tabarelli* (ASTIER), *Emericiceras imlayi* SARKAR, *Emericiceras* sp., *Pseudothurmannia angulicostata* (D'ORBIGNY) *in* LAPEYRE, 1974 (pl. 1, fig. 2), which corresponds to *P. ohmi* (WINCKLER) according to HOEDEMAEKER (in press), *P. mortilleti* (PICTET & DE LORIOL) s. str. (pl. 1, fig. 5, 6) and morphotype *catulloi* (PARONA) (pl. 1, fig. 3, 4), *P. sarasini* SARKAR (pl. 1, fig. 1), *Psilotissotia* sp. n., *P. bertrandi* (NICKLÈS), *P. reigi* (NICKLÈS), *P.* (*Buergliceras*) *favrei* (OOSTER), *Valdedorsella* sp. n. microconch / *Valdedorsella* (*Puezalpella*) cf. *haugi* (BRESKOVSKI) Macroconch, *"Valdedorsella" compsense* (KILIAN) Macroconch / *"Valdedorsella" crassidorsata* (KARAKASCH) microconch, *Paraspiticeras* sp. However, The most abundant forms are two major groups belonging to the genus *Barremites*.

Above the guide-bed of the Faraoni Level we have found in this second outcrop a succession of *Anahamulina* species (Fig. 8). An interesting form,

already figured by SIMIONESCU (1898, pl. 1, fig. 11) as "*Hamites* cf. *subcinctus*" UHLIG, is characterized by a large angle between the hook and the. It has been identified in this work as *Anahamulina* sp. 1 (pl. 3, fig. 2) and also occurs at Monte Tenetra (see 4.5.1.; pl. 3, fig. 3).

4.4 - CAGLI - MONTE PETRANO

4.4.1 - *The section along the Monte Petrano road: Upper Hauterivian-Lower Barremian ammonite biostratigraphy*

The road leads from the town of Cagli up to the top of the mountain. Numerous outcrops of the Maiolica formation are exposed. They are isolated from each other because of faulting. The complete succession is exposed on the northern flank of the mountain (see 4.4.2).

Nevertheless some of these outcrops along the road are fossiliferous. In the Outcrop A, indicated 4.1a in Tabl. 1 are exposed some beds with typical *Holcodiscus caillaudi* (D'ORBIGNY) (pl. 2, fig. as well as a pulchellid corresponding to *Nicklesia pulchella* (D'ORBIGNY) *sensu* KILIAN (1888) (pl.2, fig. 1) but probably belonging to *Subpulchellia compressissima* (D'ORBIGNY). This has been confirmed by COMPANY *et alii* (1993) and this level can be ascribed to the *caillaudi* horizon of their *S. compressissima* zone, which corresponds to the lower part of the *H. caillaudi* zone *sensu* HOEDEMAEKER & COMPANY (1993).

One of the best sections of the Faraoni Level as well as the Hauterivian-Barremian boundary is exposed in the Outcrop B (Tab. 1) where we draw this boundary on the basis of the FO of a characteristic heteromorph ammonite species corresponding to *"Paraspinoceras" evolutum* (FALLOT & TERMIER). Different specimens were collected in this bed, thus allowing to define the intraspecific variability (pl. 3, fig. 13-16). Two morphotypes are distinguished: one is characterized by simple ribs while the other by the presence of buckled ribs. Some specimens bear buckled ribs in the young stage and simple ribs in the adult.

Bed 32 is the Guide bed of the Faraoni Level. *Pseudothurmannia* specimens have been found also in the overlying calcareous beds 33 and 34. As Fig. 9 shows, ammonites are absent between beds 35 and 49 and some gastropod specimens occur. These gastropods, which are characterized by very long, fine, hook-shaped spines show some morphologic affinities with the genus *Harpagodes*. They are quite common in the studied outcrops from Gorgo a Cerbara to Mount Tenetra.

In bed 49 we have found a fauna only composed by specimens belonging to a *"Paraspinoceras" evolutum* (FALLOT & TERMIER). They occur above the *Pseudothurmannia* beds and according to VERMEULEN (1972) this species indicate the base of the Barremian. This has been confirmed by COMPANY, SANDOVAL &

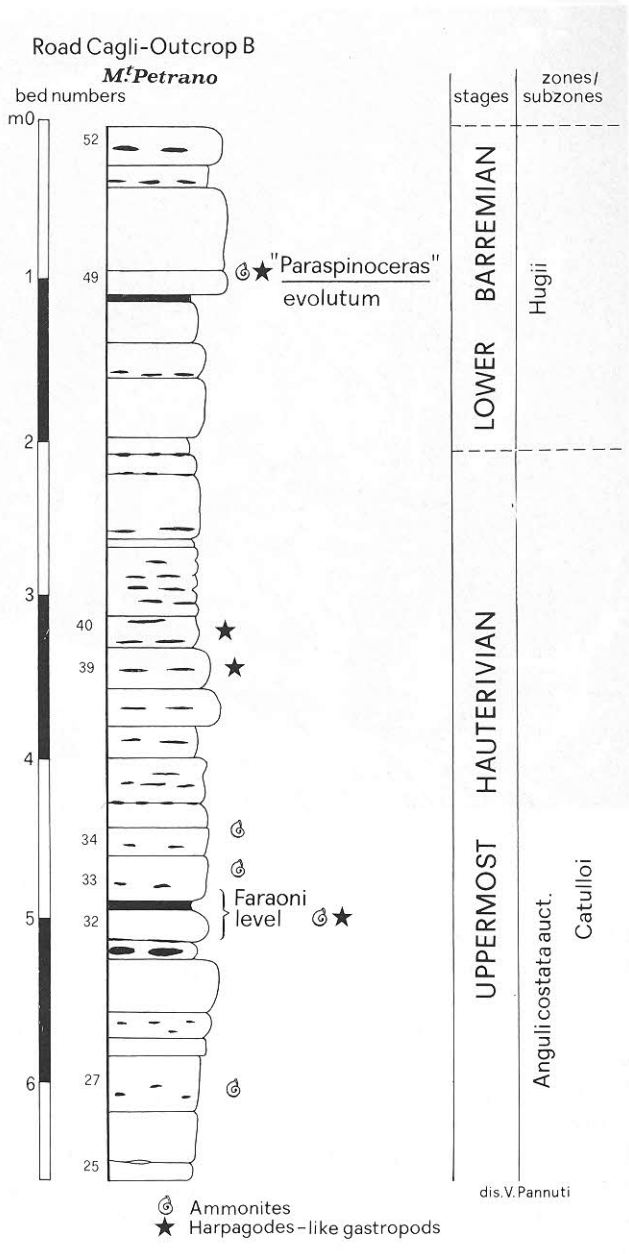

Fig. 9 - Log of a the Outcrop B, exposed along the road Cagli-Monte Petrano.
- *Colonnina stratigrafica dell'affioramento B, esposto lungo la strada Cagli-Monte Petrano.*

TAVERA (pers. comm., july 1994) who found this form slightly above the base of the Barremian. However, their detailed paleontological study must be done in order to clarify the taxonomic relationships between the different morphotypes (tuberculated with looped ribs associated with specimens bearing simple ribs only) as well as their relations with other uncoiled forms. Forms similar to "*P.*" *evolutum* have been found in Cuba and described as *Crioceratites* sp. cf. *stubelensis* DIMITROVA and *C.* cf. *C.* sp. A by MYCZYNSKI & TRIFF (1986, pl. 1, fig. 9 and 11 respectively).

Fig. 10 - The northern slope of Monte Petrano, section N: view of the Hauterivian Maiolica. The arrow indicates the Faraoni Level.
- Il versante settentrionale del Monte Petrano, sezione N: vista della Maiolica della 'Hauteriviano. La freccia indica il Livello Faraoni.

4.4.2 - *The northern slope of Monte Petrano: Upper Hauterivian-Barremian Maiolica* (Fig. 10).

The Upper Hauterivian - Lower Barremian portion of the Maiolica Formation is exposed along the northern slope of Monte Petrano. Different sections have been logged. All the sections show the Hauterivian - Barremian transition. Sections M and N have been logged from Upper Hauterivian levels below the Faraoni Level, although ammonites are rare in these levels (Fig. 11). In section D, 15 metres below the Faraoni Level a *Pseudomoutoniceras* cf. *annulare* (D'ORBIGNY) has been found (pl. 1, fig. 12); it might indicate the *S. sayni* zone.

The level with the heteromorph ammonite identified as *"Paraspinoceras" evolutum* (FALLOT & TERMIER), corresponding to bed 49 in outcrop B, exposed along the road, is represented in almost all sections. Levels characterized by *Holcodiscus* gr. *caillaudi* (D'ORBIGNY) are also frequent in all sections (pl. 2, fig. 24), though the most representative is bed 47 of section D.

In bed 62 of section M, below the level with *"Paraspinoceras" evolutum* (FALLOT & TERMIER) a *Spitidiscus* sp. was found. It should indicate the base of the Barremian although the bad presevation of the specimen does not allow us to be sure. If new findings confirm this datum, the conventional Hauterivian-Barremian boundary which we used so far in this region, e. g. the FO of *"P." evolutum*, must be lowered.

4.5. - CAGLI - CHIASERNA

4.5.1 - *Monte Tenetra road: Barremian ammonites*

Four sections, named **T**, **Tc** (the portion called Tb is stratigraphically below Tc), **VR** and **VT**, have been logged (Fig. 12, 13, 14 and 15 respectively) along the road from the locality la Fornace, SE of Cagli, up to the top of Monte Tenetra.

The first Barremian faunas of Umbria-Marche Apennines have been discovered in the beds exposed along this road. Like at Mount Petrano, Maiolica formation irregularly crops out on the road because it is often covered by vegetation and disturbed by faults. It is impossible to observe the upper boundary of the formation. The different studied sections do not give major informations on biostratigraphy because they are poorly exposed. However, the Maiolica outcrops of Monte Tenetra area are the most fossiliferous in this sector of Umbria-Marche Apennines.

Sections **T** and **Tc** show Lower Barremian levels with ammonites. Section **VR** (Fig. 16) shows the transition to Upper Barremian levels. The *A. vandenheckii* zone is well represented: *"Ancyloceras"* gr. *vandenheckii* (ASTIER) has been found in bed 8 (pl. 3, fig. 1) whilst *Heinzia* gr. *provincialis* (D'ORBIGNY), *Heinzia pallinii* CECCA and *Subpulchellia brevicostata* KOTETICHVILI (pl.2, fig. 3) are common in levels 15 and 16 (Fig. 15).

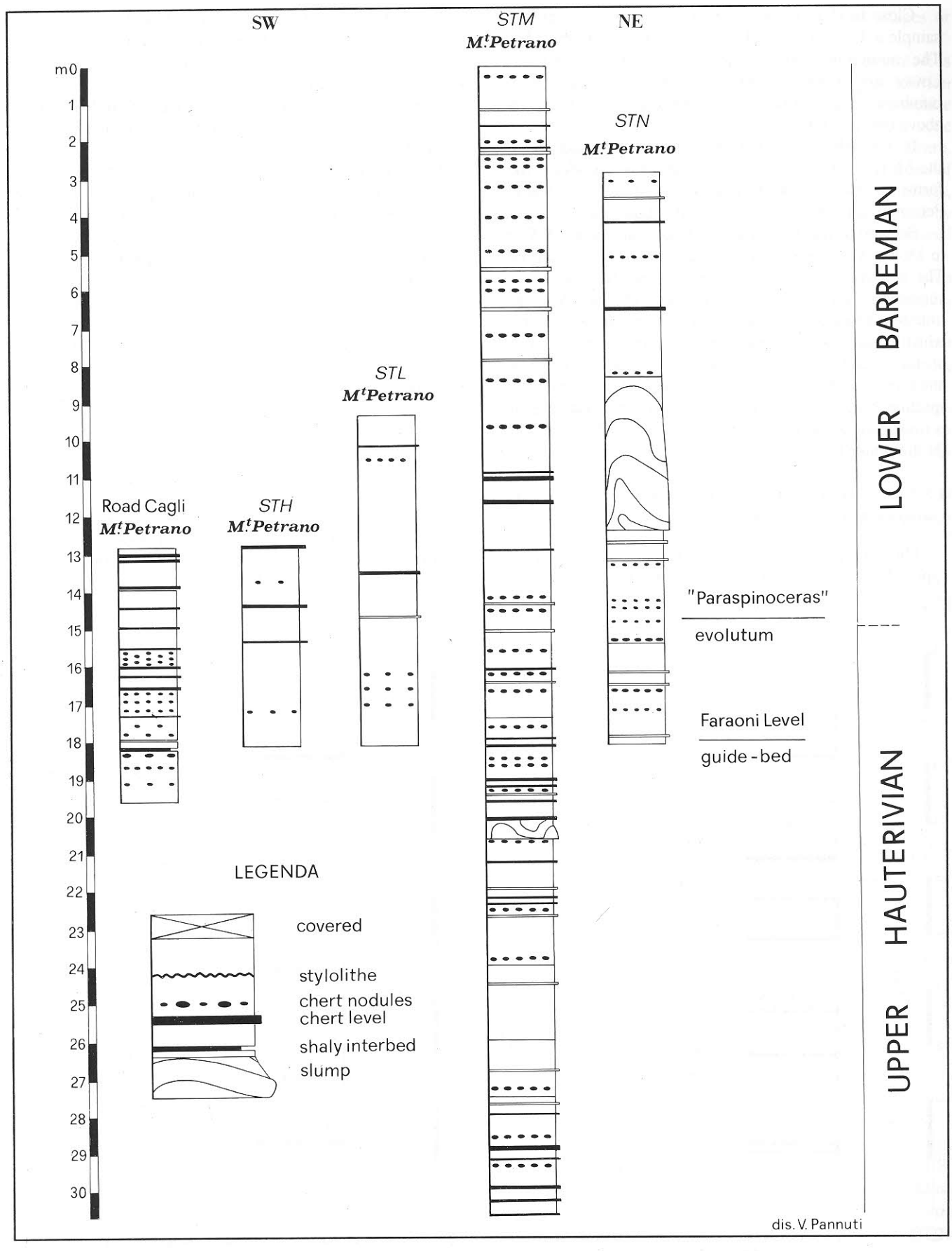

Fig. 11 - Correlation between some of the sections logged on the northern slope of Monte Petrano with the log of the Outcrop B.
- *Correlazione fra alcune delle sezioni rilevate sul versante settentrionale del Monte Petrano con la colonnina dell'affioramento B.*

Close to the top of the mountain, we were able to sample a 4.5 metres thick section (Fig. 15), named **VT**. The ammonite faunas show the transition between Lower and Upper Barremian. The beds have been numbered from the base of the outcrop, bed 0 lying just above the road level.

It is worth noting that in all the studied sections of the Monte Tenetra road gastropods (*Harpagodes* - like forms as mentioned in Outcrop B along the Monte Petrano road) and bivalves are quite abundant.

Because of the dipping of the beds from section **VT** up to Monte Alto Hauterivian to Valanginian levels crop out. The succession is not completely visible because of the vegetation, furthermore the erosion of the Maiolica limestone produces an abundant detritus of calcareous chips which hardly cover the outcrops. Only some small portions of the succession can be logged. A rich Valanginian ammonite fauna has been collected below Monte Alto; some specimens are figured by CECCA (this volume). However, it is impossible to define here the succession of the beds, then the ammonite biostratigraphy.

4.5.2 - *Southern slope of Monte Acuto: Upper Valanginian-Hauterivian Maiolica*

The complete Jurassic basin-type succession is exposed along the road from M. Catria to Chiaserna (Southern slope of Monte Acuto). Maiolica overlies the Calcari a *Saccocoma* ed Aptici Formation and the Upper Tithonian-Upper Hauterivian interval is exposed, the rest being covered by detritus.

Rare Valanginian ammonites were found by CECCA (1985) but the most interesting levels have been recently discovered in the Upper Valanginian - Upper Hauterivian interval (Fig. 17). In fact the section has been sampled for magnetostratigraphy by J. E. T. CHANNELL. The magnetic signal is reliable and the results will be published soon, together with the correlation with ammonites and calcareous nannofossils (studied by E. ERBA).

Upper Valanginian ammonites have been found in 10 metres at the base of the section sampled with CHANNELL (see CECCA, this volume). *Crioceratites* gr. *duvali* LÉVEILLÉ (pl. 1, fig. 7) and *Subsaynella* sp have been found at metres 22 and 23, thus indicating the *S. sayni* zone.

5. - CONCLUSIONS

Due to the lithologic character of the Maiolica formation, in the Umbria-Marche Apennines the Lower Cretaceous ammonites are rare and more difficult to collect than the jurassic ones. Nevertheless, the ammonite zones defined by HOEDEMAEKER & COMPANY

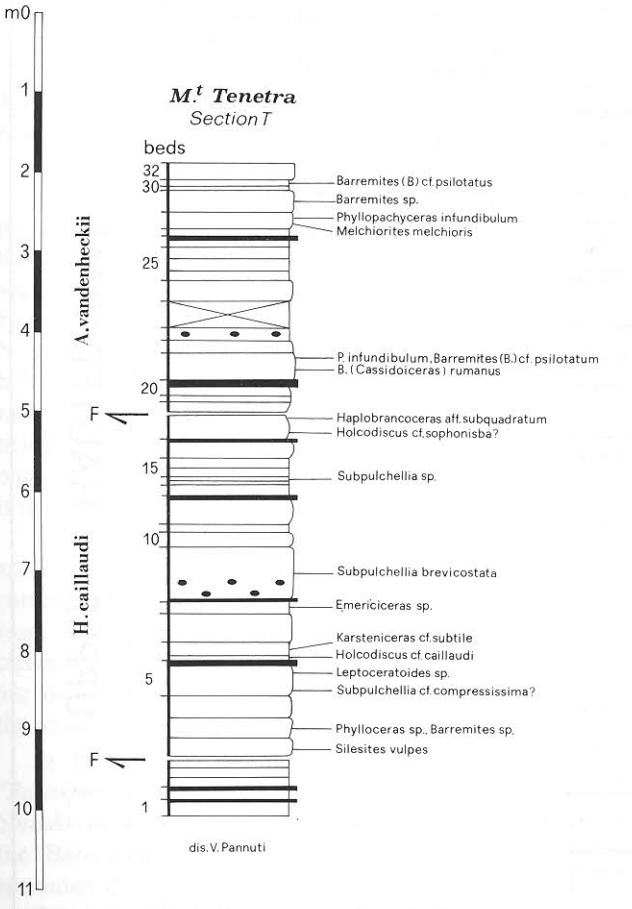

Fig. 12 - Log and ammonite occurrences in section T, Monte Tenetra. See Fig. 11 for symbols.
- Colonnina stratigrafica ed ammoniti nella sezione T, Monte Tenetra. Si veda la legenda di Fig. 11.

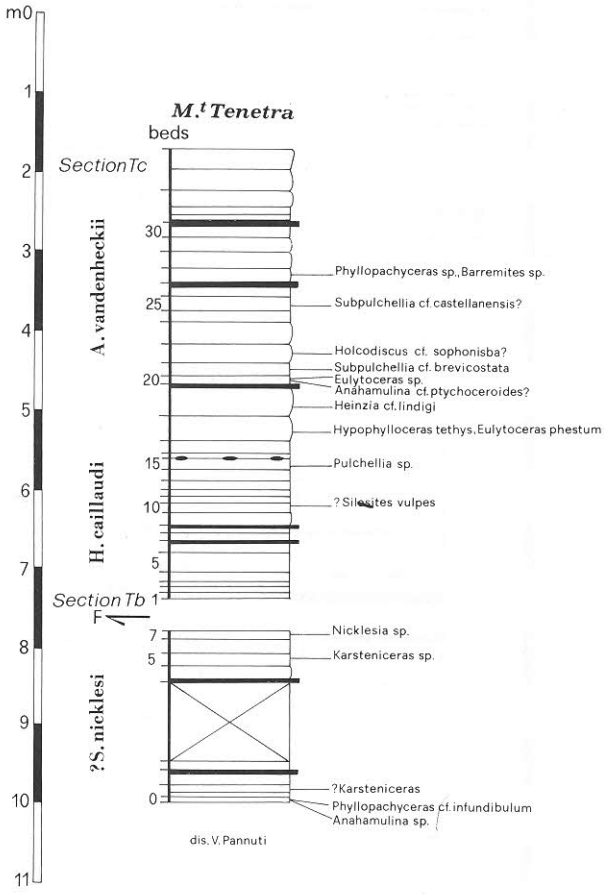

Fig. 13 - Log and ammonite occurrences in section T c/b, Monte Tenetra. See Fig. 11 for symbols.
- Colonnina stratigrafica ed ammoniti nella sezione T c/b, Monte Tenetra. Si veda la legenda di Fig. 11.

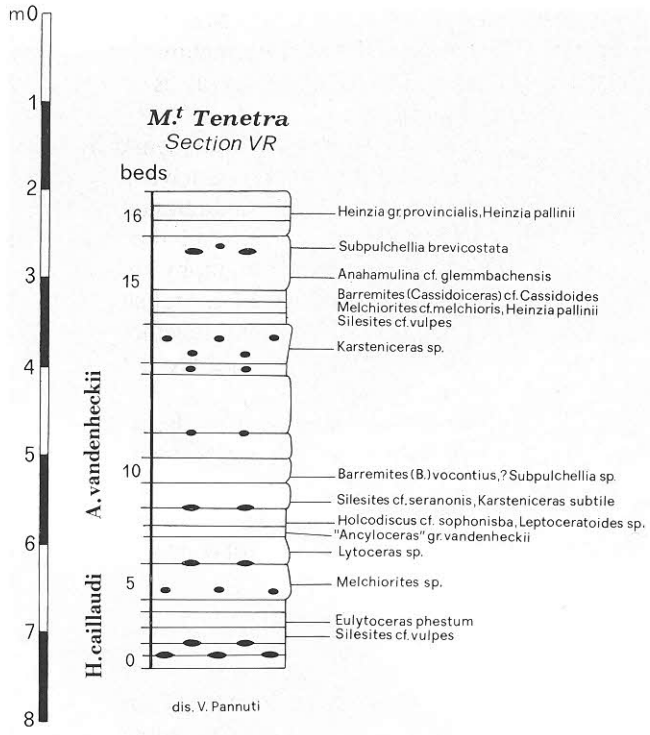

Fig. 14 - Log and ammonite occurrences in section VR, Monte Tenetra. See Fig. 11 for symbols.
Colonnina stratigrafica ed ammoniti nella sezione VR, Monte Tenetra. Si veda la legenda di Fig. 11.

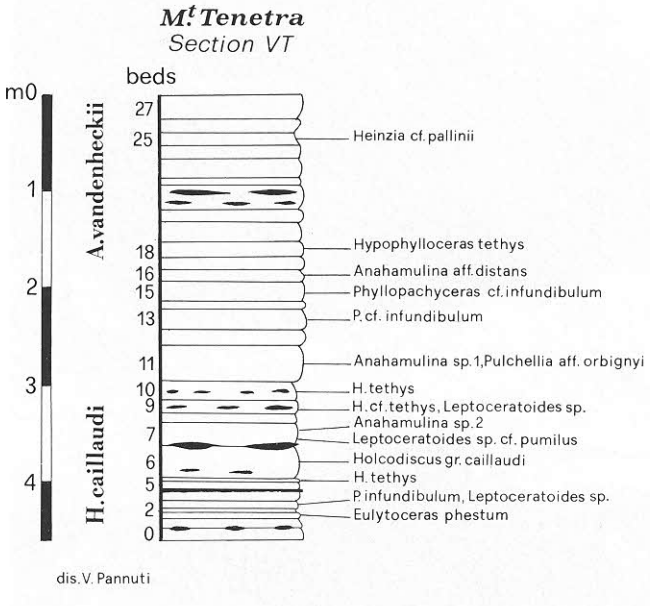

Fig. 15 - Log and ammonite occurrences in section VT, Monte Tenetra. See Fig. 11 for symbols.
- *Colonnina stratigrafica ed ammoniti nella sezione VT, Monte Tenetra. Si veda la legenda di Fig. 11.*

(1993) can be recognized, at least for some stages or substages.

Concerning the Hauterivian-Barremian interval, it is impossible to recognize so far the Lower Hauterivian and in the Upper Hauterivian it is difficult to recognize the *P. ligatus* and *B. balearis* zones. The *S. sayni* zone has been recognized in three sections (Gorgo a Cerbara, Northern slope of Monte Petrano and Southern slope of Monte Acuto) on the basis of rare ammonite findings, whilst the *P. angulicostata* zone is well represented by its upper subzone, the *P. catulloi* subzone, in the Faraoni Level.

The Barremian ammonite zones have been recognized in the Gorgo a Cerbara section whilst only some zones are represented in the other localities.

The base of the Barremian in this region is not defined by the occurrence of *Spitidiscus hugii*, because the first *Spitidiscus* appear later then their actual FO. We locally use the FO of *"Paraspinoceras" evolutum* (FALLOT & TERMIER), which is quite frequent in our outcrops. This species probably occurs slightly higher than the FO of *S. hugii* (COMPANY, SANDOVAL & TAVERA, pers. comm.) in fact in the Northern slope of Monte Petrano (section M) a fragment of *Spitidiscus* was found between the Faraoni Level and the level with. *"P." evolutum* (see 4.4.2.).

The *S. nicklesi* zone has not been recognized so far, whilst the *H. caillaudi* zone is easily recognized in all sections. The zonal succession defined for the Lower Barremian by COMPANY *et alii* (1993) in the Subbetic area is not recognizable in Umbria-Marche.

Above the levels with *H. caillaudi* we usually found *Heinzia provincialis* and *H. pallinii* which are used in our area to draw the boundary between Lower and Upper Barremian. However, in a section at Monte Tenetra (VR), *Ancyloceras* gr. *vandenheckii*, the marker species of the first ammonite zone of the Upper Barremian, was found below the first *H. provincialis*. The *H. sartousi* zone is well represented in the Gorgo a Cerbara section and it starts above the beds with *Coronites*.

The Upper Barremian *H. feraudi, I. giraudi* and *M. sarasini* zones cannot be recognized in our study area because of the lack of age diagnostic ammonites. In fact, apart the Lower Aptian *Prodeshayesites* sp. found above the last levels with *Heinzia* at gorgo a Cerbara, *Silesites seranonis* associated with Phylloceratina and Lytoceratina are the only ammonites which occur in the upper portion of the Maiolica formation.

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Fig. 16 - View of section VR, Monte Tenetra. Lower-Upper Barremian transition. The colleagues at left are working on the base of the *A. vandenheckii* zone.
- *Vista della sezione VR, Monte Tenetra. Passaggio Hauteriviano - Barremiano. I colleghi a sinistra lavorano sulla base della zona a* A. vandenheckii.

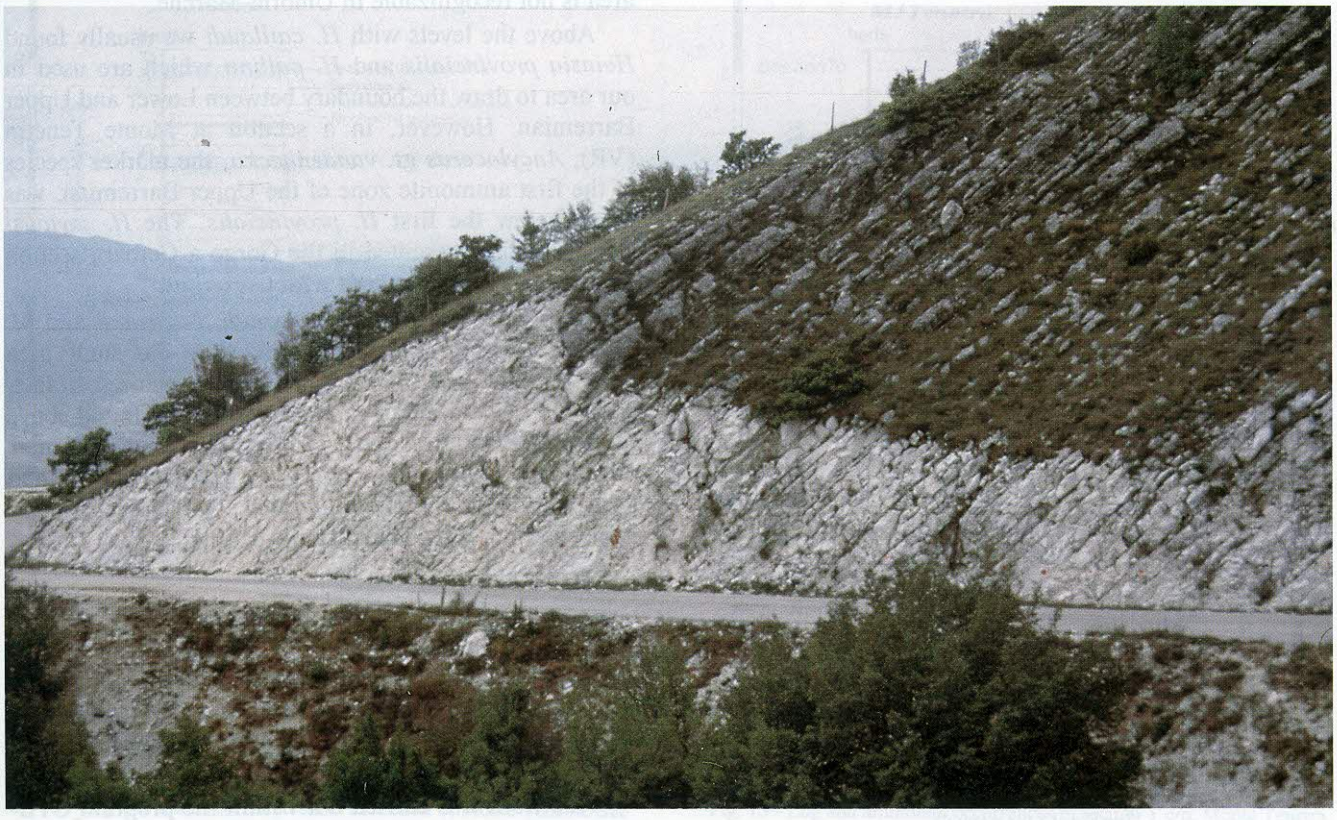

Fig. 17 - Southern slope of Monte Acuto. View of the Lower Hauterivian Maiolica.
- *Versante meridionale di Monte Acuto. Vista della Maiolica dell'Hauteriviano inferiore.*

REFERENCES

BARTOLOCCI P. , BERALDINI M., CECCA F, FARAONI P., MARINI A. & PALLINI G. (1993) - *Preliminary results on correlation between Barremian ammonites and magnetic stratigraphy in Umbria-Marche Apennines (Central Italy).* Paleopelagos, **2**: 63-68, Roma.

BRALOWER T.J. (1987) - *Valanginian to Aptian calcareous nannofossil stratigraphy and correlation with the Upper M-Sequence magnetic anomalies.* Marine Micropaleont., **11**: 293-310, Amsterdam.

BRALOWER T.J., MONECHI S. & THIERSTEIN H.R. (1989) - *Calcareous nannofossil zonation of the Jurassic-Cretaceous boundary interval and correlation with the Geomagnetic polarity time scale.* Marine Micropaleontol., **14**: 153-235, Amsterdam.

CECCA F. (1985) - *Alcune Ammoniti provenienti dalla "Maiolica" dell'Appennino Centrale (Umbria, Marche e Sabina).* Boll. Serv. Geol. It., **CIII**/1982: 133-162, Roma.

CECCA F. (1993) - *Itinerario Geologico attraverso il sistema piattaforma carbonatica pelagica-bacino nel Giurassico di Monte Nerone (Appennino marchigiano).* Boll. Serv. Geol. It., **CIX**/1990: 49-73, Roma.

CECCA F. (this volume) - *Late Valanginian ammonites from Monte Catria (Umbria-Marche Apennines, Italy).*

CECCA F., CRESTA S., PALLINI G. & SANTANTONIO M. (1990) - *Il Giurassico di Monte Nerone (Appennino Marchigiano, Italia centrale): biostratigrafia, litostratigrafia ed evoluzione paleogeografica.* In: G. PALLINI, F. CECCA, S. CRESTA & M. SANTANTONIO (Eds.): Atti II° Convegno Internazionale "Fossili, Evoluzione, Ambiente", Pergola,1987: 63-139.

CECCA F., MARINI A., PALLINI G., BAUDIN F. & BÉGOUEN V. (1994a) - *A guide-level of the uppermost Hauterivian (Lower Cretaceous) in the pelagic succession of Umbria-Marche Apennines (Central Italy): the Faraoni level.* Riv. It. Paleont. Strat., **99** (4): 551-568, Milano.

CECCA F. & PALLINI G. (in press) - *Latest Hauterivian-Barremian ammonite biostratigraphy in the Umbria-Marche Apennines (Central Italy).* In: L. BULOT & H. ARNAUD (Eds.): "Lower Cretaceous Cephalopod Biostratigraphy of the Western Tethys". Géologie alpine, vol. spéc., **20**, Grenoble.

CECCA F., PALLINI G., ERBA E., PREMOLI SILVA I. & COCCIONI R. (1994b) - *Hauterivian-Barremian chronostratigraphy based on ammonites, nannofossils, planktonic foraminifera and magnetic chrons from the Mediterranean domain.* Cretaceous Research, **15** (4): 457-467, London.

CHANNELL J.E.T. & GRANDESSO P. (1987) - *A revised correlation of Mesozoic polarity Chrons and Calpionellid zones.* Earth Planet. Sci. Letters, **85**: 222-240, Amsterdam.

COCCIONI R., ERBA E. & PREMOLI SILVA I. (1992) - *Barremian-Aptian calcareous nannoplankton biostratigraphy from the Gorgo Cerbara section (Marche, central Italy) and implications for plankton evolution.* Cretaceous Research, **13**: 517-537, London.

COCCIONI R., FRANCHI R., NESCI O., PERILLI N., WEZEL C.F. & BATTISTINI F. (1990) - *Stratigrafia, micropaleontologia e mineralogia delle Marne a Fucoidi (Aptiano inferiore - Albiano superiore) delle sezioni di Poggio le Guaine e del Fiume Bosso (Appennino Umbro-Marchigiano).* In: G. PALLINI, F. CECCA, S. CRESTA & M. SANTANTONIO (Eds.): Atti II° Convegno Internazionale "Fossili, Evoluzione, Ambiente", Pergola,1987: 163-201.

COCCIONI R., GALEOTTI S. & SANTARELLI A. (1994) - *Preliminary palynological analysis of the Maiolica-Scisti a Fucoidi transition (Barremian-Aptian) in the Gorgo a Cerbara section (central Italy).* Paleopelagos (1993), **4**, 195-201, Roma.

COCCIONI R., NESCI O., TRAMONTANA M., WEZEL C.F. & MORETTI E. (1987) - *Descrizione di un livello guida "radiolaritico-bituminoso-ittiolitico" alla base delle Marne a Fucoidi nell'Appennino umbro-marchigiano.* Boll. Soc. Geol. Ital., **106**: 183-192, Roma.

COMPANY M., SANDOVAL J. & TAVERA J. M. (1993) - *Ammonite biostratigraphy of the Lower Barremian in the Subbetic Domain (Betic Cordillera, southern Spain).* 1st Gen. Meet. IGCP Project 362: Tethyan and Boreal Cretaceous (Coimbra, October 1993), Abstracts: 8-10.

ERBA E., COCCIONI R. & PREMOLI SILVA I. (1989) - *Gli Scisti a Fucoidi nell'area Umbro-Marchigiana: Le sezioni della S. S. Apecchiese.* In: S. CRESTA, S. MONECHI, & G. PARISI (Eds): "Stratigrafia del Mesozoico e Cenozoico nell'area umbro-marchigiana; itinerari geologici sull'Appennino umbro-marchigiano (Italia)". Mem. Descr. Carta Geol. It., **39**: 146-164, Roma.

HOEDEMAEKER P. J. (1994) - *Ammonite distribution around the Hauterivian-Barremian boundary along the Rio Argos (Caravaca Spain).* In: L. BULOT & H. ARNAUD (Eds.): "Lower Cretaceous Cephalopod Biostratigraphy of the Western Tethys". Géologie alpine, vol. spéc., **20** (in press), Grenoble.

HOEDEMAEKER J., COMPANY M. (REPORTERS) AND AGUIRRE-URRETA M. B., AVRAM E., BOGDANOVA T. N., BUJTOR L., BULOT L., CECCA F., DELANOY G., ETTACHFINI M., MEMMI L., OWEN H. G., RAWSON P. F., SANDOVAL J., TAVERA J. M., THIEULOY J.-P., TOVBINA S. Z. & VASICEK Z. (1993) - *Ammonite zonation for the Lower Cretaceous of the Mediterranean region; basis for the stratigraphic correlations within IGCP-Project 262.* Rev. Esp. Paleont., **8** (1): 117-120, Madrid.

KILIAN W. (1888) - *Sur quelques fossiles du Crétacé inférieur de la Provence.* Bull. Soc. Géol. France, 3e sér., **16**: 663-691, Paris.

LAPEYRE J. - F. (1974) - *Révision de l'ammonite-index* Pseudothurmannia angulicostata *D'ORBIGNY.* Ann. Mus. Hist. Nat. Nice, **II**: 81-86, Nice.

LOWRIE W. & ALVAREZ W. (1984) - *Lower Cretaceous magnetic stratigraphy in Umbrian pelagic limestones.* Earth Planet. Sci. Letters, **71**: 315-328, Amsterdam.

MICARELLI A., POTETTI M. & CHIOCCHINI M. (1977) - *Ricerche microbiostratigrafiche sulla Maiolica della regione umbro-marchigiana.* Studi Geol. Camerti, **3**: 57-86, Camerino.

MYCZYNSKI R. & TRIFF J. (1986) - *Los ammonites del Cretacico inferior de las provincias de Pinar del Rio y Matanzas.* Bull. Pol. Acad. Sci., Earth Sci., **34** (1): 113-137, Warszawa.

RAMACCIONI, G. (1939) - *Fauna giuraliassica e cretacea di Monte Cucco e dintorni (Appennino Centrale).* Palaeont. Ital., N.S., **39**: 143-214., Pisa.

SANTANTONIO M. (1993) - *Facies associations and evolution of pelagic carbonate platform/basin systems: examples from the Italian Jurassic.* Sedimentology, **40**: 1039-1067, Oxford.

SANTANTONIO M. (1994) - *Pelagic Carbonate Platforms in the geologic record: their classification, and sedimentary and paleotectonic evolution.* AAPG Bull., **78** (1): 122-141, Tulsa.

SIMIONESCU I. (1898) - *Studii geologice si paleontologice din Carpatii Sudici. II. Studiul faunei neocomiene din basenul Dimboviciorei.* Academia Romana, Publ. fondului V. Adamachi **II**: 45-111, Bucuresti.

VERMEULEN, J. (1972) - *Considerations sur la* Psilotissotia malladae *(NICKLÈS) et l'origine du genre* Nicklesia *HYATT.* C. R. Somm. Soc. géol. France, 7, 23, Paris.

VERMEULEN J. (1980) - *Etude de la famille des Pulchelliidae.* Thèse Univ. Nice, 92 pp., unpublished.

ZITTEL K. A. (1869) - *Geologische Beobachtungen aus den Central-Apenninen.* In: E. W. BENECKE Geognostisch-Palaeontologischen Beitr., 2 (2): 91-178, München.

PLATE 1

Fig. 1 - *Pseudothurmannia sarasini* SARKAR. Outcrop B, Monte Petrano road, bed 32 ("guide-bed" of the Faraoni Level). Uppermost Hauterivian, *P. angulicostata auct.* zone, *P. catulloi* subzone; specimen A 1, coll. FARAONI.

Fig. 2 - *Pseudothurmannia angulicostata* (D'ORBIGNY) *in* LAPEYRE, 1974. Same section and same bed; specimen A 2, coll. FARAONI.

Fig. 3, 4 - *Pseudothurmannia mortilleti catulloi* (PARONA). Same section and same bed; 3, specimen A 47; 4, specimen A 6, coll. FARAONI.

Fig. 5 - *Pseudothurmannia belimelensis* DIMITROVA. Stirpeto - section East, bed 71 ("guide-bed" of the Faraoni Level). Uppermost Hauterivian, *P. angulicostata auct.* zone, *P. catulloi* subzone; specimen RS 3, coll. FARAONI.

Fig. 6 - *Pseudothurmannia mortilleti mortilleti* (PICTET & DE LORIOL). Same section and same bed; specimen RS 14, coll. FARAONI.

Fig. 7 - *Crioceratites* gr. *duvali* LÉVEILLÉ. Southern slope of Monte Acuto, metre 22. Upper Hauterivian, *S. sayni* zone; specimen MA 613.

Fig. 8 - *Crioceratites* gr. *duvalii* LÉVEILLÉ/*villiersianus* (D'ORBIGNY). Gorgo a Cerbara, bed 266. Upper Hauterivian, *B. balearis* or *P. ligatus* zones; specimen F 178.

Fig. 9 - *Subsaynella* sp. Gorgo a Cerbara, bed 277. Upper Hauterivian, *S. sayni* zone; specimen F 626.

Fig. 10 - *Spitidiscus* cf. *vandenhecki* (D'ORBIGNY). Gorgo a Cerbara, bed 199. Lower Barremian, *S. hugii* zone; specimen F 152.

Fig. 11 - *Plesiospitidiscus* sp. Gorgo a Cerbara, bed 264. Upper Hauterivian, *B. balearis* or *P. ligatus* zones; spec. F 606.

Fig. 12 - *Pseudomoutoniceras* cf. *annulare* (D'ORBIGNY). Southern slope of Monte Petrano, section D, 15 metres below the Faraoni Level. Upper Hauterivian, *S. sayni* zone; spec. P-D 455.

Fig. 13-16 - *"Paraspinoceras" evolutum* (FALLOT & TERMIER). Outcrop B, Monte Petrano road, bed 49. Lower Barremian, *S. hugii* zone. 13, spec. P 470 and 15, spec. P 471 correspond to the morphotype A, with simple ribs while 14, spec. P 469, develops buckled ribs in the young stage; 16, spec. P 472, corresponds to the morphotype B, with buckled ribs. Coll. FARAONI.

All figures natural size. The arrows indicate the beginning of the body chamber when visible.

Photos 1-6, 8 and 10 by F. ABBALLE (Servizio Geologico Nazionale); 7, 9, 11-13 by A. BUSSOLETTI.

TAVOLA 1

Fig. 1 - Pseudothurmannia sarasini *SARKAR. Affioramento B, strada di Monte Petrano, strato 32 ("guide-bed" del Livello Faraoni). Hauteriviano sommitale, zona a* P. angulicostata auct., *sottozona a* P. catulloi; *es. A 1, coll. FARAONI.*

Fig. 2 - Pseudothurmannia angulicostata *(D'ORBIGNY) in LAPEYRE, 1974. Stessa provenienza; es. A 2, coll. FARAONI.*

Fig. 3, 4 - Pseudothurmannia mortilleti catulloi *(PARONA). Stessa provenienza; 3, es. A 47; 4, es. A 6, coll. FARAONI.*

Fig. 5 - Pseudothurmannia belimelensis *DIMITROVA. Stirpeto - sezione Est, strato 71 ("guide-bed" del Livello Faraoni). Hauteriviano sommitale, zona a* P. angulicostata auct., *sottozona a* P. catulloi; *esemplare RS 3, coll. FARAONI.*

Fig. 6 - Pseudothurmannia mortilleti mortilleti *(PICTET & DE LORIOL). Stessa provenienza; es. RS 14, coll. FARAONI.*

Fig. 7 - Crioceratites *gr.* duvali *LÉVEILLÉ. Versante Sud di Monte Acuto, metro 22. Hauteriviano superiore, zona a* S. sayni; *esemplare MA 613.*

Fig. 8 - Crioceratites *gr.* duvali *LÉVEILLÉ*/villiersianus *(D'ORBIGNY). Gorgo a Cerbara, strato 266. Hauteriviano superiore, zona a* B. balearis *o* P. ligatus; *esemplare F 178.*

Fig. 9 - Subsaynella *sp. Gorgo a Cerbara, strato 277., Hauteriviano superiore, zona a* S. sayni; *esemplare F 626.*

Fig. 10 - Spitidiscus *cf.* vandenhecki *(D'ORBIGNY). Gorgo a Cerbara, strato 199. Barremiano inferiore, zona a* S. hugii; *esemplare F 152.*

Fig. 11 - Plesiospitidiscus *sp. Gorgo a Cerbara, strato 264. Hauteriviano superiore, zona a* B. balearis *o* P. ligatus; *esemplare* F 606.

Fig. 12 - Pseudomoutoniceras *cf.* annulare *(D'ORBIGNY). Versante Sud di Monte Petrano, sezione D, 15 metri sotto il Livello Faraoni. Hauteriviano superiore, zona a* S. sayni; *esemplare P-D 455.*

Fig. 13-16 - "Paraspinoceras" evolutum *(FALLOT & TERMIER). Affioramento B, strada di Monte Petrano, strato 49. Barremiano inferiore, zona a* S. hugii. *13, es. P 470 e 15, es. P 471 corrispondono al morfotipo A, con coste semplici mentre 14, es. P 469, sviluppa coste fibulate nello stadio giovanile; 16, es. P 472, corrisponde al morfotipo B, con coste fibulate. Coll. FARAONI.*

Gli esemplari sono riprodotti a granezza naturale. Quando visibile, le frecce indicano l'inizio della camera d'abitazione.

Foto 1-6, 8 e 10 di F. ABBALLE (Servizio Geologico Nazionale); 7, 9, 11-13 di A. BUSSOLETTI.

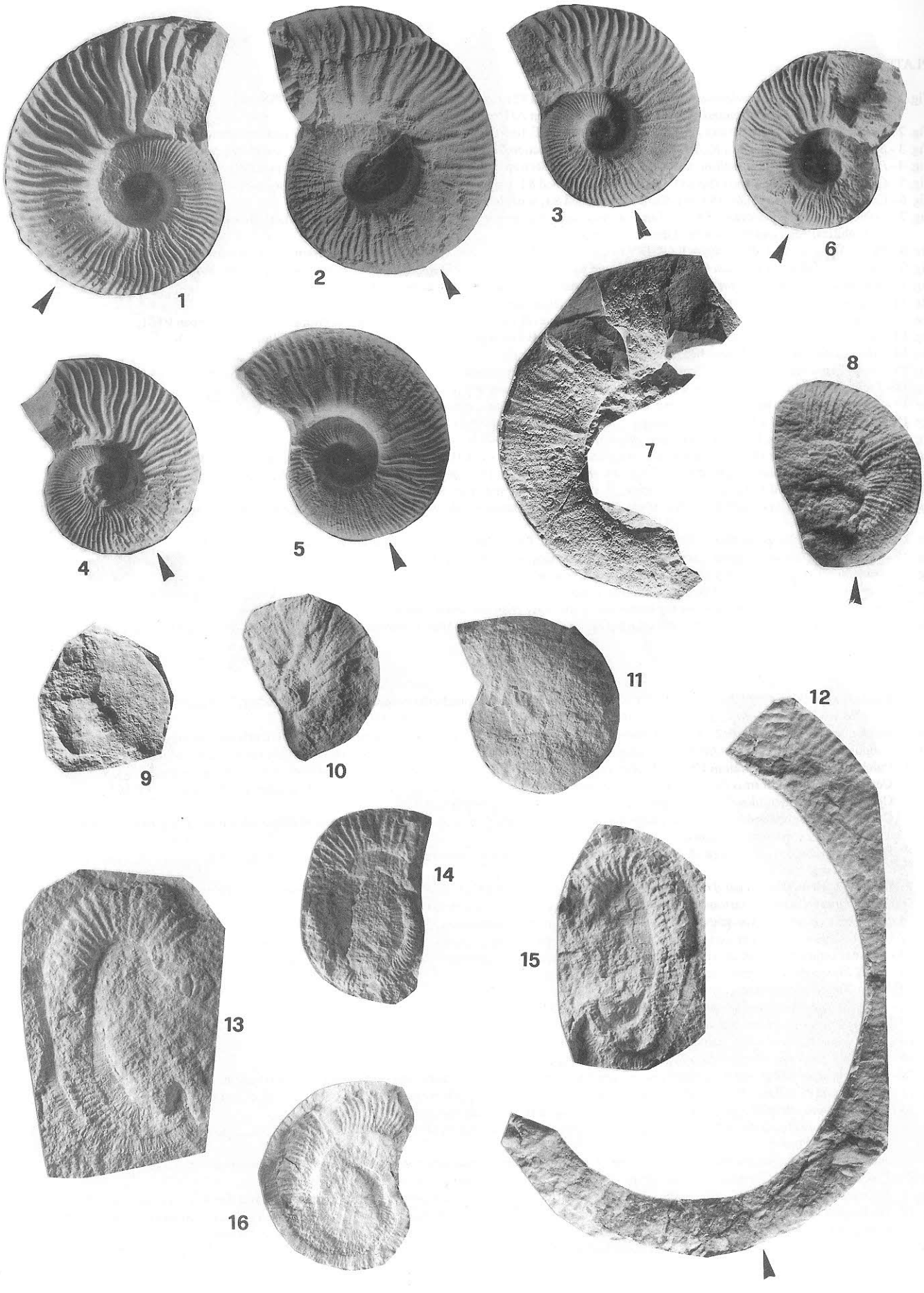
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PLATE 2

Fig. 1 - *Pulchellia (Nicklesia) pulchella* D'ORBIGNY *sensu* KILIAN 1888 (or *Subpulchellia compressissima* (D'ORBIGNY)). Monte Petrano road, Outcrop A, bed 9. Lower Barremian, *H. caillaudi* zone; specimen AH 467.
Fig. 2 - *Pulchellia* aff. *orbignyi* BÜRGL. Monte Tenetra, section VT, bed 11. Lower Barremian, *H. caillaudi* zone; specimen VT 120.
Fig. 3 - *Subpulchellia brevicostata* KOTETISHVILI. Mt. Tenetra, section VR, bed 15 top. Upper Barremian, *A. vandenheckii* zone; specimen VR 625.
Fig. 4 - *Pulchellia (Heinzia)* cf. *pallinii* CECCA. Monte Tenetra, section VT, bed 25. Upper Barremian, *A. vandenheckii* zone; specimen VT 208.
Fig. 5 - *Coronites* aff. *hoplitiformis* (SAYN). Gorgo a Cerbara, bed 81. Upper Barremian, *A. vandenheckii* zone; specimen F 171.
Fig. 6 - *Coronites* cf. *coronatoides* (SAYN). Same section, bed 84; specimen F 399.
Fig. 7 - *Coronites* aff. *coronatoides* (SAYN). Same section, same bed; specimen F 177. Note in the internal whorl the small bullae between the umbilical edge and the middle of the whorl height.
Fig. 8 - *Pulchellia (Heinzia)* aff. *lindigii* (KARSTEN *in* UHLIG, 1887). Same section, bed 119. Upper Barremian, *A. vandenheckii* zone; spec. F 176.
Fig. 9 - *Pulchellia (Heinzia) sartousi* (D'ORBIGNY). Same section, bed 43. Upper Barremian, *H. sartousi* zone; specimen F 406.
Fig. 10 - *Pulchellia (Heinzia)* cf. *sartousi* (D'ORBIGNY) - Same section, same bed; specimen F418.
Fig. 11 - *Pulchellia (Heinzia)* cf.*ouachensis* (SAYN) - Same section, same bed; specimen F419.
Fig. 12 - *Subpulchellia* cf. *changarnieri* (SAYN) - Same section, level 142-143. Lower Barremian, *H. caillaudi*. zone; specimen F161.
Fig. 13 - *Silesites seranonis* (D'ORBIGNY). Stirpeto, bed 32. Upper Barremian, ? *H. sartousi* zone; specimen S 360. Macroconch.
Fig. 14 - *Idem*. Same section and same bed; specimen S 368. Microconch.
Fig. 15 - *Idem*. Same section, bed 29 a. Same age; specimen S 367. Microconch.
Fig. 16 - *Idem*. Same section, bed 49. Same age; specimen S 366. Microconch.
Fig. 17 - *Idem*. Gorgo a Cerbara, bed 43. Upper Barremian, *H. sartousi* zone; specimen F 414.
Fig. 18 - *Idem*. Stirpeto, bed 23a. Upper Barremian, ? *H. sartousi* zone; specimen S 362. Microconch.
Fig. 19 - *Idem*. Same section, bed 29a. Same age; specimen S 365. Microconch.
Fig. 20 - *Silesites vulpes* (COQUAND). Monte Tenetra, section T, bed 4a. Lower Barremian, *H. caillaudi* zone; specimen T 343.
Fig. 21 - *Holcodiscus* cf. *fallax* (D'ORBIGNY). Gorgo a Cerbara, level 151-153. Lower Barremian, *H. caillaudi* zone; specimen F 329.
Fig. 22 - *Idem*. Stirpeto, bed 114b. Lower Barremian, *H. caillaudi* zone; specimen S 359.
Fig. 23 - *Holcodiscus caillaudi* (D'ORBIGNY). Monte Petrano road, Outcrop A, bed 9. Lower Barremian, *H. caillaudi* zone; specimen AH 468. Typical specimen.
Fig. 24 - *Idem*. Southern slope of Monte Petrano, section D, bed 47. Lower Barremian, *H. caillaudi* zone; specimen P-D 571.
Fig. 25 - *Prodeshayesites* sp. Gorgo a Cerbara, bed 5. Lower Aptian; specimen F 463.
Fig. 26 - *Barremites* cf. *mueriensis* BRESKOVSKI. Gorgo a Cerbara, bed 70. Upper Barremian, *A. vandenheckii* zone; specimen F173.
Fig. 27 - *Barremites vocontius* (LORY & SAYN). Monte Tenetra, section VR, bed 10. Upper Barremian, *A. vandenheckii* zone; specimen VR 317.
All figures natural size. The arrows indicate the beginning of the body chamber when visible.
Photos 5-8, 13, 17 by F. ABBALLE; 2, 9 by M. BALINI (Dip. Scienze della Terra, Milan University); 1, 3, 4, 10-12, 14-16, 18-27 by A. BUSSOLETTI.

TAVOLA 2

Fig. 1 - Pulchellia (Nicklesia) pulchella *D'ORBIGNY* sensu *KILIAN 1888 (or* Subpulchellia compressissima *(D'ORBIGNY)). Strada di Monte Petrano, Affioramento A, strato 9. Barremiano inferiore, zona a* H. caillaudi*; esemplare AH 467.*
Fig. 2 - Pulchellia *aff.* orbignyi *BÜRGL. Monte Tenetra, sezione VT, strato 11. Barremiano inferiore, zona a* H. caillaudi*; esemplare VT 120.*
Fig. 3 - Subpulchellia brevicostata *KOTETISHVILI. Stessa provenienza, strato 15 top. Barremiano superiore, zona a* A. vandenheckii*; es. VR 625.*
Fig. 4 - Pulchellia (Heinzia) *cf.* pallinii *CECCA. Monte Tenetra, sezione VT, strato 25. Barremiano superiore, zona a* A. vandenheckii*; es. VT 208.*
Fig. 5 - Coronites *aff.* hoplitiformis *(SAYN). Gorgo a Cerbara, strato 81. Barremiano superiore, zona a* A. vandenheckii*; esemplare* F 171.
Fig. 6 - Coronites *cf.* coronatoides *(SAYN). Stessa provenienza, strato 84; esemplare F 399.*
Fig. 7 - Coronites *aff.* coronatoides *(SAYN). Stessa provenienza; esemplare F 177. Si notino nei giri interni le piccole bullae situate fra il margine ombelicale e la metà del fianco.*
Fig. 8 - Pulchellia (Heinzia) *aff. lindigii (KARSTEN in UHLIG, 1887). Stessa provenienza, strato* 119. *Barremiano superiore, zona a* A. vandenheckii*; esemplare. F 176.*
Fig. 9 - Pulchellia (Heinzia) sartousi *(D'ORBIGNY). Stessa provenienza, strato* 43. *Barremiano superiore, zona a* H. sartousi*; esemplare F 406.*
Fig. 10 - Pulchellia (Heinzia) *cf.* sartousi *(D'ORBIGNY) - Stessa provenienza; esemplare F418.*
Fig. 11 - Pulchellia (Heinzia) *cf.*ouachensis *(SAYN) - Stessa provenienza; esemplare F419.*
Fig. 12 - Subpulchellia *cf.* changarnieri *(SAYN) - Stessa provenienza; livello 142-143. Barremiano inferiore,* zona a H. caillaudi*; esemplare F161.*
Fig. 13 - Silesites seranonis *(D'ORBIGNY). Stirpeto, strato 32. Barremiano superiore, zona a* ? H. sartousi*; esemplare S 360. Macroconco.*
Fig. 14 - Idem. *Stessa provenienza; esemplare S 368. Microconco.*
Fig. 15 - Idem. *Stessa provenienza, strato 29 a; esemplare S 367. Microconco.*
Fig. 16 - Idem. *Stessa provenienza, strato 49; esemplare S 366. Microconco.*
Fig. 17 - Idem. *Gorgo a Cerbara, strato 43. Barremiano superiore, zona a* H. sartousi*; esemplare F 414.*
Fig. 18 - Idem. *Stirpeto, strato 23a. Barremiano superiore, zona a* ? H. sartousi*; esemplare S 362. Microconco.*
Fig. 19 - Idem. *Stessa provenienza, strato* 29a*; esemplare S 365. Microconco.*
Fig. 20 - Silesites vulpes *(COQUAND). Monte Tenetra, sezione T, strato 4a. Barremiano inferiore, zona a* H. caillaudi*; esemplare T 343.*
Fig. 21 - Holcodiscus *cf.* fallax *(D'ORBIGNY). Gorgo a Cerbara, livello 151-153. Barremiano inferiore, zona a* H. caillaudi*; esemplare F 329.*
Fig. 22 - Idem. *Stirpeto, strato 114b. Barremiano inferiore, zona a* H. caillaudi*; esemplare S 359.*
Fig. 23 - Holcodiscus caillaudi *(D'ORBIGNY). Strada di M. Petrano, Affioramento A, strato 9. Barremiano inferiore, zona a* H. caillaudi*; esemplare, AH 468. Forma tipica.*
Fig. 24 - Idem.*Versante Sud di Monte Petrano, sezione D, strato 47. Barremiano inferiore, zona a* H. caillaudi*; esemplare P-D 571.*
Fig. 25 - Prodeshayesites *sp. Gorgo a Cerbara, strato 5. Aptiano inferiore; esemplare F 463.*
Fig. 26 - Barremites *cf.* mueriensis *BRESKOVSKI. Gorgo a Cerbara, strato* 70. *Barremiano superiore, zona a* A. vandenheckii*; esemplare F173.*
Fig. 27 - Barremites vocontius *(LORY & SAYN). Monte Tenetra, sezione VR, strato 10. Barremiano superiore, zona a* A. vandenheckii*; esemplare VR 317.*
Gli esemplari sono riprodotti a granezza naturale. Quando visibile, le frecce indicano l'inizio della camera d'abitazione.
Foto 5-8, 13, 17 di F. ABBALLE; 2, 9 di M. BALINI (Dip. Scienze della Terra, Univ. Milano); 1, 3, 4, 10-12, 14-16, 18-27 di A. BUSSOLETTI.

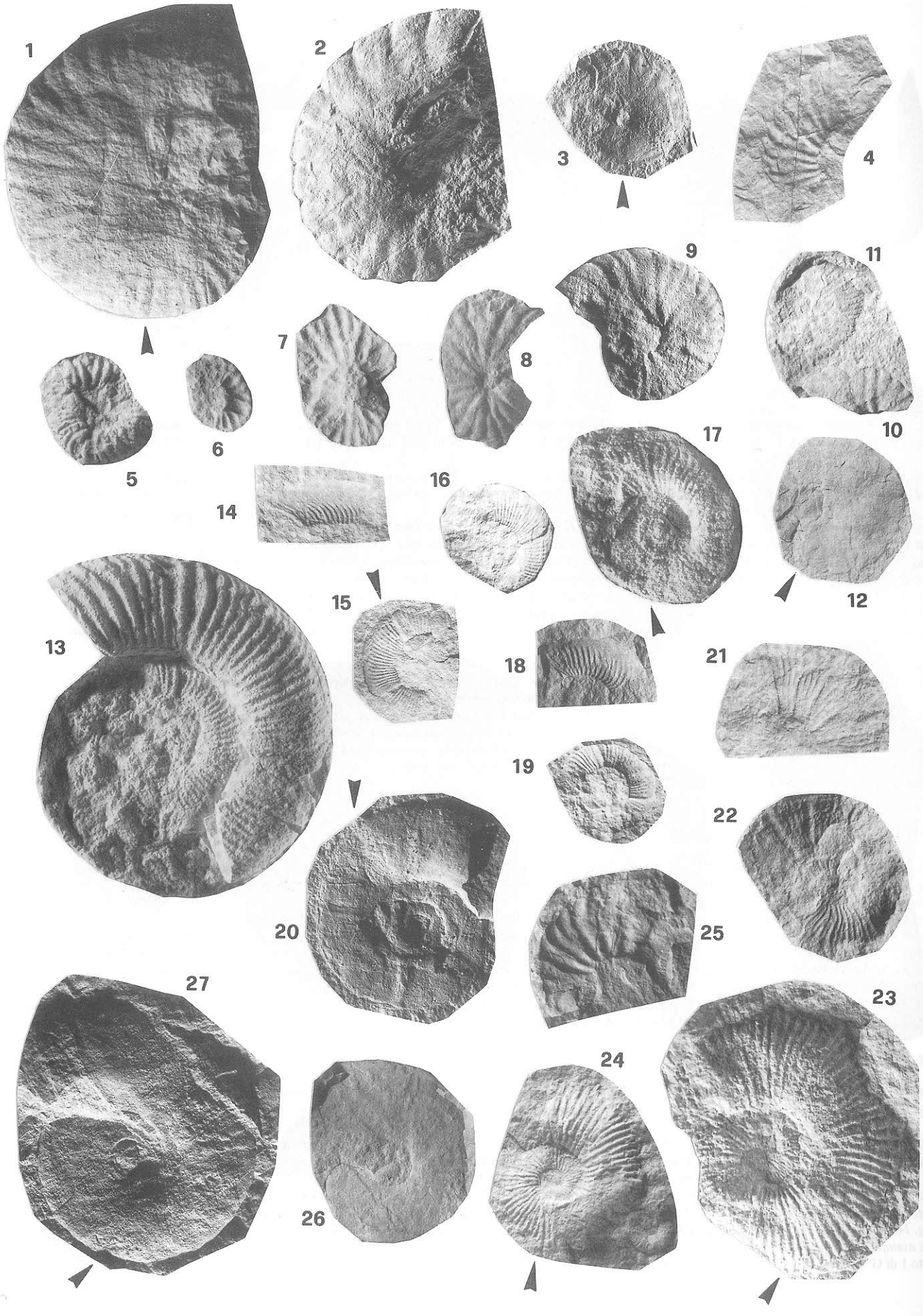
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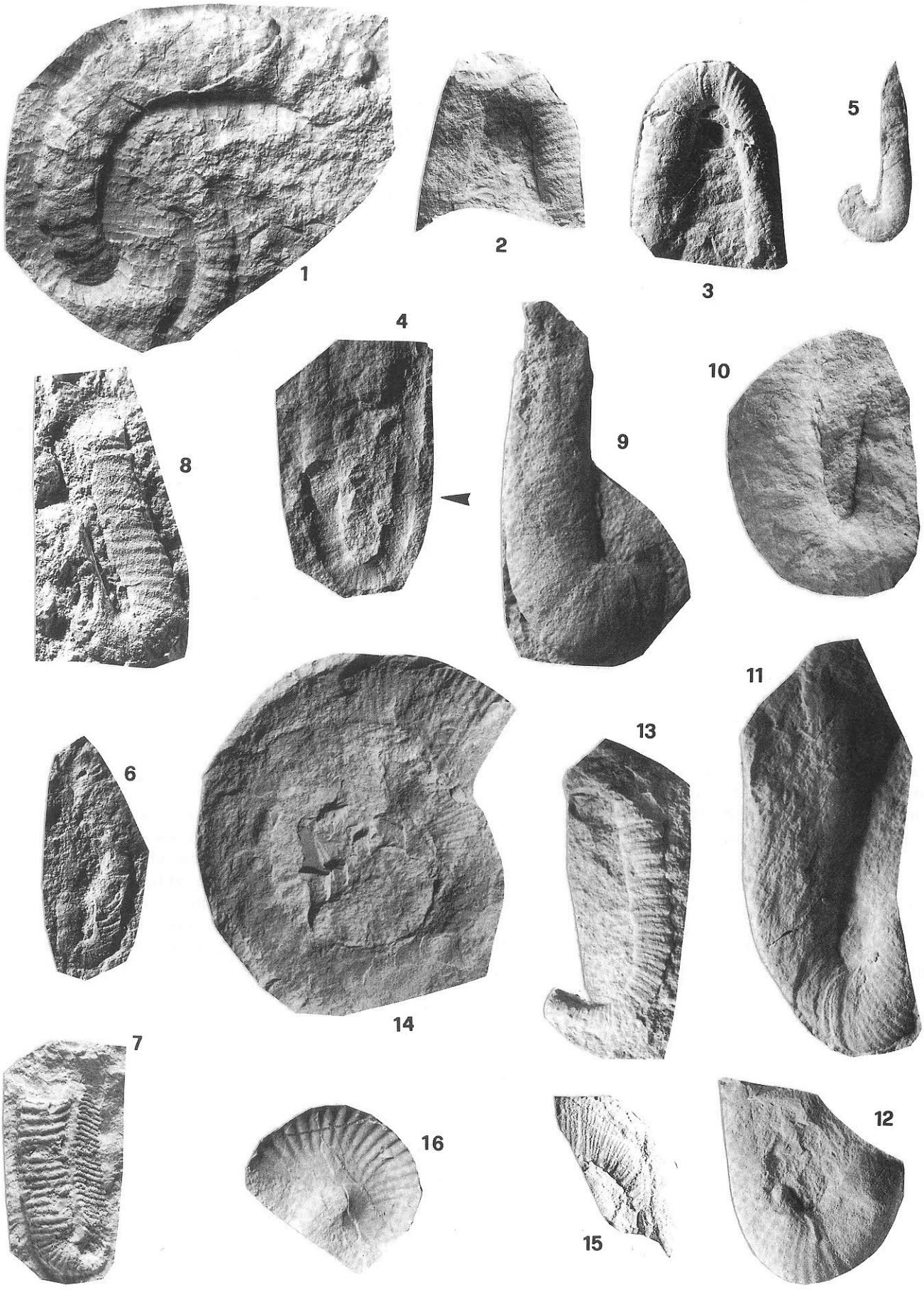
PLATE 3

Fig. 1 - *"Ancyloceras" vandenheckii* (ASTIER). Monte Tenetra, section VR, bed 8. Upper Barremian, *A. vandenheckii* zone; specimen VR 659.
Fig. 2 - *Anahamulina* sp. 1 = "*Hamites* cf. *subcinctus*" UHLIG in SIMIONESCU, 1898, pl. 1, fig. 11. Stirpeto section East, bed 13, Lower Barremian, specimen RS 97.
Fig. 3 - *Idem*. Monte Tenetra, section VT, bed 11. Lower Barremian, *H. caillaudi* zone; specimen VT 116.
Fig. 4 - *Anahamulina* sp 2. Monte Tenetra, section VT, bed 7. Lower Barremian, *H. caillaudi* zone; specimen VT 115. Specimen showing affinities with the ammonites of fig. 2 and 3.
Fig. 5 - *Anahamulina* aff. *ptychoceroides* (UHLIG). Gorgo a Cerbara, bed 153. Lower Barremian, *H. caillaudi* zone; specimen F 421.
Fig. 6 - *Idem*. Monte Tenetra, section VR, bed 10. Upper Barremian, *A. vandenheckii* zone; specimen VR 316.
Fig. 7 - *Anahamulina boutini* (MATHERON). Stirpeto section East, bed 55. Upper Hauterivian - Lower Barremian transition; specimen RS 8.
Fig. 8 - *Anahamulina* cf. *glemmbachensis* IMMEL. Monte Tenetra, section VR, bed 15 top, Upper Barremian, *A. vandenheckii* zone, specimen VR 629.
Fig. 9 - *Anahamulina* aff. *fumisuginum* (UHLIG). Monte Petrano road, Outcrop A, bed 6. Lower Barremian, *H. caillaudi* zone; specimen AH 466.
Fig. 10 - *Idem*. Gorgo a Cerbara, bed 129. Lower Barremian - Upper Barremian transition; specimen F 457.
Fig. 11 - *Anahamulina* cf. *subcincta* (UHLIG). Southern slope of Monte Petrano, section D, bed 47. Lower Barremian, *H. caillaudi* zone; specimen P-D 572.
Fig. 12 - *Anahamulina* aff. *subcincta* (UHLIG). Stirpeto section East, bed 7. Lower Barremian; specimen RS 151
Fig. 13 - Transitional form between *Acrioceras* and *Toxoceratoides* of the *karsteni/silesiacum* group. Southern slope of Monte Petrano, section DW, bed 50. Lower Barremian, 3 m below the *H. caillaudi* zone; specimen P-D 573.
Fig. 14 - *Costidiscus recticostatus* (D'ORBIGNY). Gorgo a Cerbara, bed 121. Upper Barremian, *A. vandenheckii*. zone; specimen F 155.
Fig. 15 - *Costidiscus* cf. *nodostriatus* (UHLIG). Gorgo a Cerbara, bed 118. Upper Barremian, *A. vandenheckii*. zone; specimen F 405.
Fig. 16 - *Phyllopachyceras infundibulum* (D'ORBIGNY) - Gorgo a Cerbara, bed 121, specimen F158. Upper Barremian, *A. vandenheckii*. zone.
All figures natural size. The arrows indicate the beginning of the body chamber when visible.
Photo 1 by G. PALLINI; 2-4 by M. BALINI; 5-16 by A. BUSSOLETTI.

TAVOLA 3

Fig. 1 - "Ancyloceras" vandenheckii *(ASTIER). Monte Tenetra, sezione VR, strato 8. Barremiano superiore, zona a* A. vandenheckii; *esemplare VR 659.*
Fig. 2 - Anahamulina *sp. 1,* = "Hamites *cf.* subcinctus" *UHLIG in SIMIONESCU, 1898, tav. 1, fig. 11. Stirpeto, sezione Est, strato 13, Barremiano inferiore, esemplare RS 97.*
Fig. 3 - Idem. *Monte Tenetra, sezione VT, strato 11. Barremiano inferiore, zona a* H. caillaudi; *esemplare VT 116.*
Fig. 4 - Anahamulina *sp 2. Monte Tenetra, sezione VT, strato 7. Barremiano inferiore, zona a* H. caillaudi; *esemplare VT 115. Esemplare affine alle forme di fig. 2 e 3.*
Fig. 5 - Anahamulina *aff.* ptychoceroides *(UHLIG). Gorgo a Cerbara, strato 153. Barremiano inferiore, zona a* H. caillaudi; *esemplare F 421.*
Fig. 6 - Idem. *). Monte Tenetra, sezione VR, strato 10. Barremiano superiore, zona a* A. vandenheckii; *esemplare VR 316.*
Fig. 7 - Anahamulina boutini *(MATHERON). Stirpeto sezione Est, strato 55. Passaggio Hauteriviano superiore - Barremiano inferiore; esemplare RS 8.*
Fig. 8 - Anahamulina *cf.* glemmbachensis *IMMEL. Monte Tenetra, sezione VR, strato 15 top. Barremiano superiore, zona a* A. vandenheckii; *esemplare VR 629.*
Fig. 9 - Anahamulina *aff.* fumisuginum *(UHLIG). Strada di Monte Petrano, Affioramento A, strato 6. Barremiano inferiore, zona a* H. caillaudi; *esemplare AH 466.*
Fig. 10 - Idem. *Gorgo a Cerbara, strato 129. Passaggio Barremiano inferiore - Barremiano superiore; esemplare F 457.*
Fig. 11 - Anahamulina *cf.* subcincta *(UHLIG). Versante meridionale di Monte Petrano, sezione D, strato 47. Barremiano inferiore, zona a* H. caillaudi; *esemplare P-D 572.*
Fig. 12 - Anahamulina *aff.* subcincta *(UHLIG). Stirpeto sezione Est, strato 7. Barremiano inferiore; esemplare RS 151.*
Fig. 13 - *Forma di transizione tra* Acrioceras e Toxoceratoides *del gruppo* karsteni/silesiacum. *Versante meridionale di Monte Petrano, sezione DW, strato 50. Barremiano inferiore, 3 metri sotto alla zona a* H. caillaudi; *esemplare P-D 573.*
Fig. 14 - Costidiscus recticostatus *(D'ORBIGNY). Gorgo a Cerbara, strato 121. Barremiano superiore, zona a* A. vandenheckii; *esemplare F 155.*
Fig. 15 - Costidiscus *cf.* nodostriatus *(UHLIG). Gorgo a Cerbara, strato 118. Barremiano superiore, zona a* A. vandenheckii; *esemplare F 405.*
Fig. 16 - Phyllopachyceras infundibulum *(D'ORBIGNY) - Gorgo a Cerbara,* strato 121. *Barremiano superiore, zona a* A. vandenheckii; *esemplare F158.*
Gli esemplari sono riprodotti a granezza naturale. Quando visibile, le frecce indicano l'inizio della camera d'abitazione.
Foto 1 di G. PALLINI; 2-4 di M. BALINI; 5-16 di A. BUSSOLETTI.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