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Cingolites n.gen., a new lower Toarcian Hildoceratinae (Ammonitina) from the Marchean Apennines (Cingoli, Macerata, Italy)

Stefano SASSAROLI & Federico VENTURI

S. Sassaroli, Via S. Michele 33, I-60030 Rosora (AN), Italy; dtocsa@tin.it
F. Venturi, Dipartimento di Scienze della Terra, Università degli Studi di Perugia, Piazza Università, I-06100 Perugia, Italy; venturi@unipg.it

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ABSTRACT - New biostratigraphic data are provided from the Marchean Apennines (Marconessa quarry, near Cingoli, Macerata, Italy) where a lower Jurassic outcrop yielded a remakable Toarcian ammonite assemblage, very rich in early Hildoceratinae (Ammonitina). The site is historically meaningful, because in the past two centuries Italian palaeontologists have figured ammonoid specimens from "Marconessa". Here, the nodular limestone and grey marl of the Bugarone Formation have recorded a great amount of well preserved Toarcian inner moulds of ammonoids sometimes large sized. From the lower and middle Toarcian layers of the Marconessa quarry sections we collected several ammonite genera, such as Hildaites, Orthildaites, Hildoceras, Harpoceras, Taffertia, Rakusites, Martanites, Praemercaticeras, Mercaticeras, Leukadiella, Frechiella, Phymatoceras, Rarenodia, Praepolyplectus, Polyplectus, Orthodactylites, Mesodactylites, Nodicoeloceras, *very rare* Dactylioceras *and* Nejdia, Lytoceras, Calliphylloceras, Phylloceras. *We establish herein a new genus* Cingolites, *to which we ascribe three new species (*C. clavatus, C. picenus *and* C. spiralis*) and an already established species (*C. stefaninii*), which was previously assigned by Merla (1932) to the genus* Mercaticeras. *To the present-day the genus* Cingolites *seems to have a Mediterranean Tethys dispersal, mainly in the Apennines, where it occurs with other endemic Hildoceratinae fauna. These ammonite assemblages found in our Apennines sections seem to show a certain amount of provincialism that affected some Hildoceratinae lineages of the lower Toarcian.*

*RIASSUNTO - [*Cingolites, nuovo genere di Hildoceratinae (Ammonitina) del Toarciano inferiore dell'Appennino Marchigiano (Cingoli, Macerata, Italia)*] - Questo lavoro tratta un nuovo genere di ammoniti Hildoceratinae del Toarciano inferiore raccolti con criterio stratigrafico nella Cava della Marconessa di Cingoli (Macerata). I numerosi fossili di ammoniti e altri molluschi collezionati in questa località sono stati oggetto di interesse da parte dei paleontologi italiani fin dalla fine dell'Ottocento. Negli anni più recenti l'attività estrattiva, condotta dalla ditta SIELPA, ha denudato un vasto fronte di cava in cui affiora la successione giurassica ridotta, che va dal Calcare Massiccio (Sinemuriano-Hettangiano) al Calcare Maiolica del Cretaceo. Nelle sezioni della Marconessa di Cingoli il Toarciano si presenta in facies grigia (calcare nodulare e marne), litologicamente equivalente ai coevi calcari nodulari rossi del Rosso Ammonitico Umbro-Marchigiano. Dai livelli fossiliferi del fronte di cava, così come dalla notevole quantità di detriti rimossa dall'attività estrattiva, è stata raccolta una grande quantità di esemplari di ammoniti del Toarciano, spesso ottimamente conservati e anche di grandi dimensioni. Negli orizzonti del Toarciano inferiore delle zone a Serpentinum/Levisoni e della base della Zona a Bifrons (secondo la vigente zonazione standard delle paleoprovincie della Tetide mediterranea e sub-mediterranea) abbiamo collezionato un'interessante associazione faunistica, notevole per quantità di esemplari, il loro ottimo stato di conservazione e il numero di taxa rappresentati. Oltre al nuovo genere* Cingolites *oggetto del presente lavoro, abbiamo collezionato forme appartenenti ai generi più tipici del Toarciano inferiore:* Hildaites, Orthildaites *e* Hildoceras, *con nuovi taxa ancora in studio, e inoltre* Harpoceras, Taffertia, Neotaffertia, Martanites, Praepolyplectus, Polyplectus, Phymatoceras, Mercaticeras, Leukadiella, Frechiella, Rarenodia, Rakusites, Orthodactylites, Mesodactylites, Nodicoeloceras, Lytoceras, Calliphylloceras, Phylloceras, *e infine anche* Nejdia *e* Dactylioceras *(molto rari). Al nuovo genere* Cingolites *attribuiamo 3 nuove specie (*C. clavatus, C. picenus *e* C. spiralis*) e una specie già nota (*C. stefaninii*), ma inclusa da Merla (1932) nel genere* Mercaticeras. *Fra queste forme, alcune sembrano endemiche del bacino Tosco-Umbro-Marchigiano, altre forme sembrano distribuite anche in altri bacini della Tetide mediterranea. Allo stato attuale della ricerca il genere* Cingolites *sembra essere distribuito principalmente nell'Appennino ed essere associato ad altre forme di Hildoceratinae ancora inedite, che sembrano essere confinate nella Tetide mediterranea. Il ritrovamento di queste forme, il cui resoconto dettagliato richiede ulteriori pubblicazioni, sembrerebbe quindi comprovare l'esistenza di un certo grado di provincialismo nella fauna ammonitica del Toarciano inferiore.*

FOREWORD

This work concerns the ammonites of the new genus *Cingolites* (Hildoceratinae), which were collected in the lower Toarcian of the Apennines (Marchean Apennines, Italy). We found the earliest *Cingolites* specimens near the top of the *Hildaites serpentinus* Zone (*sensu* Mouterde, 1967; Pelosio, 1968; Elmi et al., 1974; Gabilly, 1976) or the *Hildaites levisoni* Zone (*sensu* Guex, 1976 and Elmi et al., 1994). In the Apennines the occurrence of both indexes *H. serpentinus* and *H. levisoni* is, nevertheless, very questionable and our new biostratigraphic data need a revised early Toarcian ammonite zonation for the Mediterranean Province (or West Tethyan), being in our opinion the Standard Zonation (Page, 2003, 2004) unsuitable to correlate this Province with Submediterranean and Subboreal Provinces. On the other hand, according to Donovan (1958) *Harpoceras serpentinum* and *Harpoceras falciferum*, which are the typical index species for the early Toarcian of NW Europe, are not suitable for the Apennines.

We carried out a bed-by-bed biostratigraphic sampling of ammonite specimens from the Liassic outcrop of the Marconessa quarry near Cingoli (Macerata, Italy). This outcrop is located on the orographic left side of the valley cut by Rudielle creek in the Jurassic sequences, between Carcatora Mt. and S. Angelo Mt. (see Fig. 1; Carta IGM F°124 I NO-F°117 II SO; Carta Geologica d'Italia F°124

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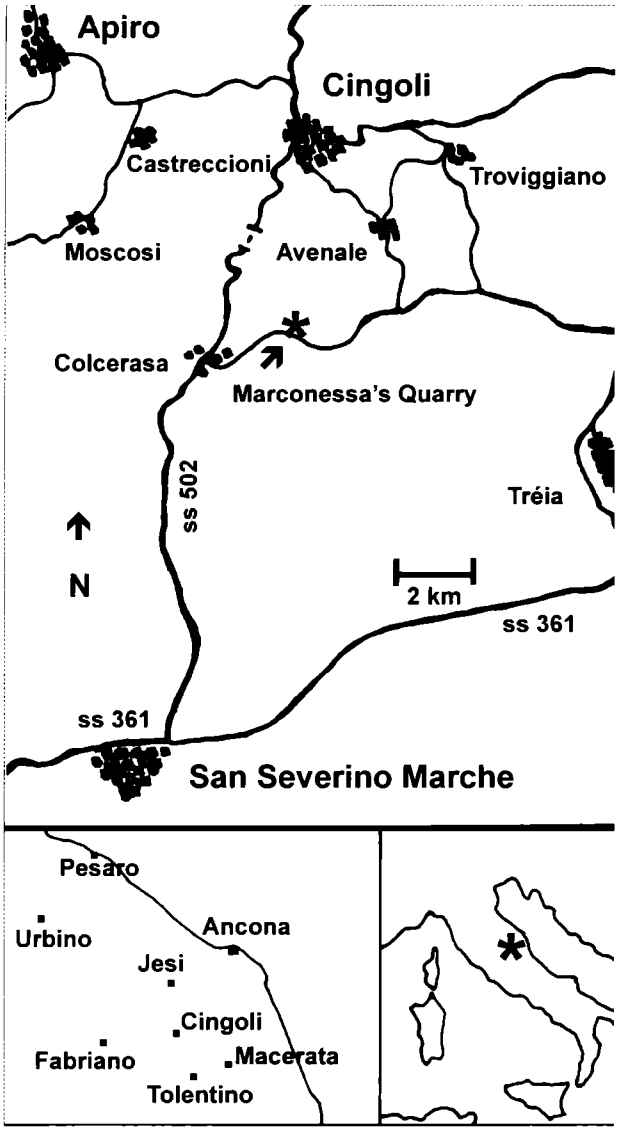


Fig. 1 - Location map of the Marconessa quarry, Cingoli (Macerata), Italy.

MC and Geological Field Trip n° 9, in Passeri, 1994, Ed.). This outcrop starts with the Calcare Massiccio Formation (Pozza, 1989, 1992) and finishes with the Calcare Maiolica Formation. Between the Calcare Massiccio and the Calcare Maiolica a condensed rock succession comparable to the Bugarone Formation of the Umbrian-Marchean Apennines occurs (Cecca et al., 1990).

The site is known as Marconessa quarry of the Romitorio of S. Angelo Mt. This denomination possibly originated from the ancient quarrying of ornamental stone, which is locally called "Marconessa stone". The current quarrying, carried out by the SIELPA Company, has uncovered a large portion of the Jurassic rock sequences, typical of the tectonic structural highs of the Umbrian-Marchean Apennines. The strata of the Toarcian stage, which are in a grey marly-nodular limestone *facies* lithologically and chronologically comparable to the well-known Rosso Ammonitico Umbro-Marchigiano Formation, yielded over the years a very rich fossil fauna, mainly of ammonites and other molluscs. Several earlier ammonite specialists, such as Meneghini (1867-1881), Bonarelli (1899, 1899), Merla (1932) and Ramaccioni (1939), have often quoted and figured specimens coming from the "Marconessa" of Cingoli. Over the years a number of amateurs collected in the detritus of the Marconessa quarry a remarkable amount of ammonites, which are often well preserved and sometimes very large sized as calcareous inner moulds. More recently some ammonites of the Marconessa quarry were studied by Dezi & Ridolfi (1975, 1978) and Sassaroli & Venturi (2005).

All specimens of the Sassaroli-Venturi collection here studied and figured are temporarily housed in the Department of the Earth Sciences – Perugia University.

BIOSTRATIGRAPHY OF THE MARCONESSA QUARRY SECTIONS

The ammonites described here were collected from two sections of Marconessa quarry. In the logs of the sections 2 and 3 (Figs. 2-4) a numbered arrow indicates the fossiliferous beds where the specimens were found. In sections 2 and 3, above the black shales of the oceanic anoxic event (OAE) a calcareous layer of variable thickness occurs: here we have observed the first occurrence of the genus *Hildaites*. Above this layer the nodular limestone and grey marl occur, with several beds yielding the genera *Taffertia*, *Rakusites*, *Martanites*, *Harpoceras*, *Praepolyplectus*, *Polyplectus*, *Neotaffertia*, *Phymatoceras*, very rare *Dactylioceras* and *Nejdia*, *Mesodactylites*, *Nodicoeloceras*, *Rarenodia*, *Mercaticeras*, *Leukadiella*, *Frechiella*, *Phylloceras*, *Calliphylloceras*, *Lytoceras* and the new genus *Cingolites*, as well as several *Hildaites* and *Orthildaites*, which are genera that are here recorded with already described species and some new ones. We observed the first occurrence of the genus *Hildoceras* at the bottom of the Bifrons Zone. Because the Mediterranean Tethys Standard Zonation is very difficult to apply to our Marconessa quarry sections for the lower Toarcian, we propose here a provisional zonation based on two typical *Hildaites* taxa collected in the Apennines sections, both shapes are already well-known such as *Hildaites striatus* Guex, 1973 and *Hildaites undicosta* (Merla, 1932). Both early Toarcian Striatus and Undicosta chronozones could be provisionally compared to the Levisoni Zone of the Tethys Mediterranean Standard Zonation (Elmi et al., 1994). We provisonally subdivide our Bifrons chronozone, commonly characterized from the first occurrence to the disappearance of *Hildoceras*, in four sub-chronozones (*H. sublevisoni*, *H. lusitanicum*, *H. angustisiphonatum* and *H. semipolitum*) being this genus broadly dispersal both in the West Tethyan Province and in the European Province, which may be easily thus correlated. Hildoceratinae may be also useful to correlate the earliest Toarcian (excluding the Tenuicostatum and Polymorphum or Mirabile zones) of these Provinces, being the early Toarcian post-OAE characterized in our section from the sudden appearance of *Hildaites*. Thus, we subdivide our Undicosta Zone in a *Hildaites crassus*

sub-chronozone and an *Orthildaites douvillei* sub-chronozone, although the real *O. douvillei* is very rare or probably absent in the Appennines where, nevertheless, the oldest samples of this genus occur (which we collected, but unfortunately still unnamed and unpublished). We cannot here subdivide our Striatus Zone being both index species still unpublished.

In our Marconessa outcrop we observe a gap in the fossil record with regard to the underlying early Toarcian beds pre-OAE, ascribed to the Tenuicostatum Zone by the NW European Standard Zonation (Page, 2003, 2004) or Polymorphum Zone by the "Tethyan Standard" (Elmi et al., 1994). In fact, it seems that the dark marly layers which record the OAE lay on a calcareous bed of the top of the Domerian (upper Pliensbachian) where a hardground surface occurs (see logs, Figs. 2, 4). About 20 cm under this hardground, a calcareous bed into the Corniola Formation has recorded the last occurrence of *Jaraphyllites* sp. indet. and *Neolioceratoides schopeni* (Gemmellaro, 1886), which are forms commonly believed occurring in the uppermost Pliensbachian (Cantaluppi, 1970; Ferretti, 1975), although the latter

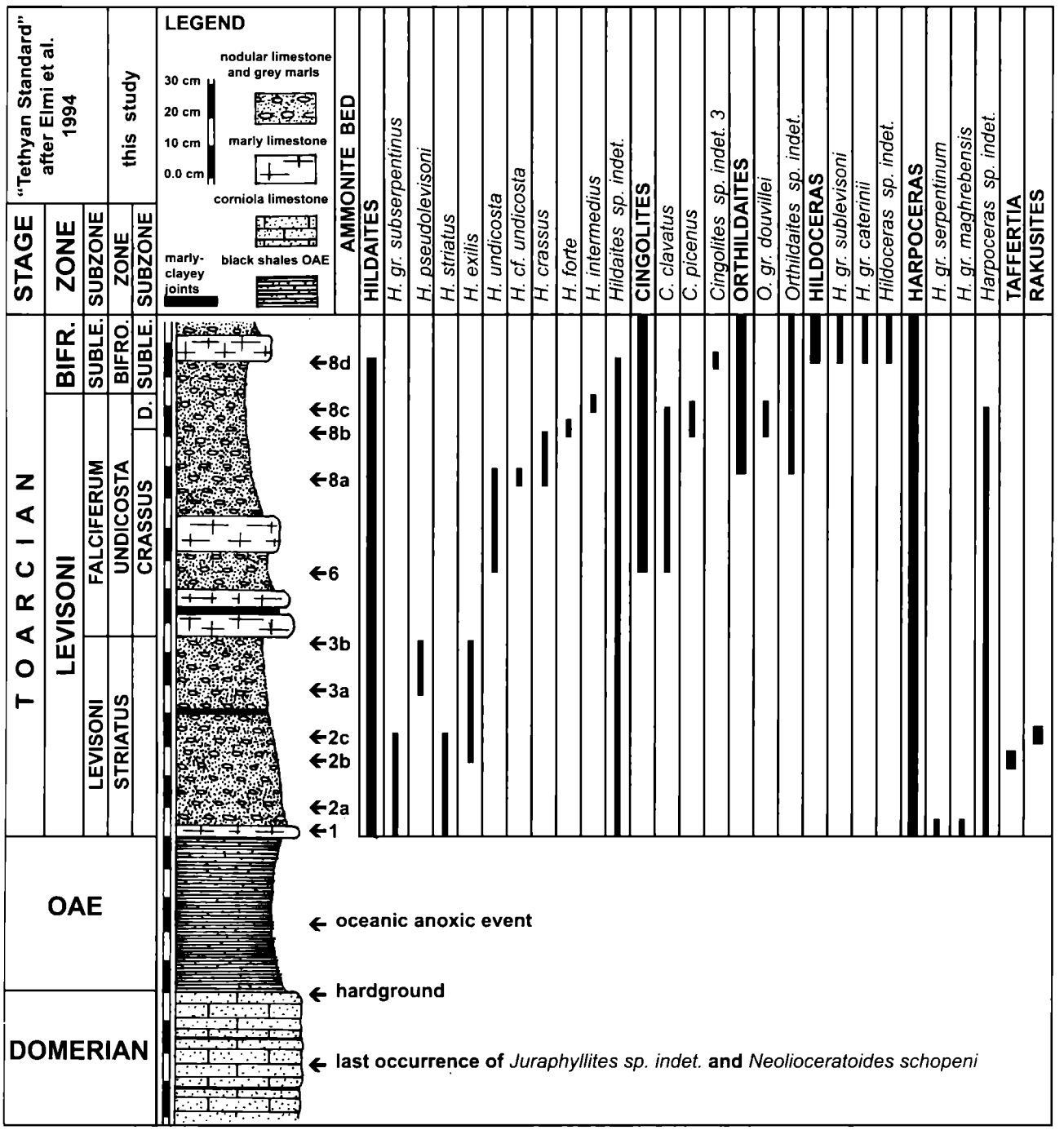


Fig. 2 - Log of the Marconessa quarry section 2 (part 1) and ranges of *Cingolites* and other ammonites, chiefly Hildoceratinae, in the early Toarcian.

STAGE	ZONE	Subzone	Marconessa quarry - section 2
TOARCIAN	BIFRONS	Sublevisoni	**bed 10e**: *Hildoceras* gr. *caterinii*; *Hildoceras sublevisoni*; *Hildoceras sublevisoni* var. *sulcosa*; *Hildoceras acarnanicum*; *Hildoceras* sp. indet.; *Phymatoceras elegans*; *Mercaticeras rursicostatum*; *Mercaticeras* sp. indet.; *Polyplectus pluricostatus*; *Harpoceras* sp. indet.; *Nodicoeloceras* gr. *angelonii*; *Mesodactylites* gr. *sapphicus* (Renz, 1912); *Mesodactylites* sp. indet.; *Phylloceras doderleinianum*; *Phylloceras heterophyllum*; *Phylloceras* sp. indet.; *Calliphylloceras nilssoni*; *Calliphylloceras capitanei*.
			bed 10d: *Hildoceras* gr. *caterinii*; *Hildoceras sublevisoni*; *Hildoceras* cf. *sublevisoni*; *Hildoceras sublevisoni* var. *sulcosa*; *Hildoceras acarnanicum*; *Phymatoceras* cf. *elegans*; *Polyplectus pluricostatus*; *Nodicoeloceras* gr. *angelonii*; *Nodicoeloceras* sp. indet.; *Mesodactylites* sp. indet.; *Mercaticeras rursicostatum*; *Audaxlytoceras dorcadis* (Meneghini, 1867-1881); *Lytoceras sepositum* (Meneghini, 1867-1881); *Phylloceras doderleinianum*; *Phylloceras heterophyllum*; *Phylloceras* sp. indet; *Calliphylloceras nilssoni*; *Calliphylloceras capitanei*.
			bed 10c: *Hildoceras* gr. *caterinii*; *Hildoceras sublevisoni*; *Hildoceras acarnanicum* Mitzopoulos, 1930; *Hildoceras* sp. indet.; *Mercaticeras rursicostatum*; *Mercaticeras* sp. ind.; *Pseudomercaticeras* sp. indet.; *Harpoceras* sp. indet.; *Phymatoceras* cf. *elegans*; *Phymatoceras* sp. indet.; *Mesodactylites mediterraneus* (Meister, 1913); *Lytoceras cornucopia*; *Lytoceras* sp. indet.; *Phylloceras heterophyllum*; *Phylloceras doderleinianum*; *Phylloceras* sp. indet.; *Calliphylloceras capitanei*; *Calliphylloceras* sp. indet.
			bed 10b: *Hildoceras caterinii*; *Hildoceras sublevisoni*; *Hildoceras sublevisoni* var. *sulcosa* Mitzopoulos, 1930; *Hildoceras* sp. indet.; *Mercaticeras rursicostatum*; *Mercaticeras* gr. *umbilicatum* Buckman, 1913; *Phymatoceras* cf. *elegans* (Merla, 1932); *Nodicoeloceras* cf. *angelonii* (Ramaccioni, 1939); *Nodicoeloceras* sp. ind.; *Harpoceras* gr. *mediterraneum* Pinna, 1968; *Phylloceras heterophyllum*; *Phylloceras doderleinianum*; *Phylloceras* sp. indet.; *Calliphylloceras capitanei* (Catullo, 1853); *Calliphylloceras nilssoni*.
			bed 10a: *Hildoceras caterinii* Merla, 1932; *Hildoceras cf. caterinii; Hildoceras sublevisoni* Fucini, 1922; *Hildoceras* gr. *sublevisoni*; *Hildoceras* sp. indet.; *Cingolites stefaninii* (Merla, 1932); *Mercaticeras rursicostatum* Merla, 1932; *Mercaticeras* sp. indet.*; Polyplectus pluricostatus; Nodicoeloceras* gr. *angelonii*; *Mesodactylites* sp. indet.*; Polyplectus pluricostatus*; *Phylloceras* sp. indet.; *Calliphylloceras nilssoni* (Hébert, 1866); *Calliphylloceras* sp.indet.
			bed 8d: *Hildaites* sp. indet.; *Orthildaites* sp. indet; *Cingolites* sp. ind. 3; *Hildoceras* gr. *caterinii*; *Hildoceras* gr. *sublevisoni*; *Hildoceras* sp. indet.; *Harpoceras* sp. indet.; *Nodicoeloceras* gr. *lobatum*; *Lytoceras* sp. indet.; *Phylloceras* sp. indet. ; *Callyphilloceras* sp. indet.
	UNDICOSTA	Douvillei	**bed 8c**: *Hildaites* cf. *intermedius* (Guex, 1973); *Hildaites* sp. indet.; *Cingolites clavatus* n. sp.; *Cingolites picenus* n. sp.; *Orthildaites* gr. *douvillei*; *Orthildaites* sp. indet.; *Urkutites* sp. indet.; *Phymatoceras* sp. ind.; *Polyplectus pluricostatus* (Haas, 1913); *Nodicoeloceras* gr. *lobatum*; *Nodicoeloceras* sp. indet.; *Harpoceras* sp. indet; *Lytoceras* sp. indet.; *Phylloceras selinoides*; *Phylloceras heterophyllum* (Sowerby, 1820); *Phylloceras doderleinianum*.
		Crassus	**bed 8b**: *Hildaites forte* (Buckman, 1921); *Hildaites crassus*; *Hildaites* sp. indet.; *Cingolites clavatus* n. sp.; *Cingolites picenus* n. sp.; *Orthildaites* gr. *douvillei* Haug, 1884 ; *Orthildaites* sp. indet.; *Nodicoeloceras* gr. *lobatum* (Buckman, 1927); *Mesodactylites* sp. indet.; *Urkutites* sp. indet.; *Phymatoceras* sp. indet; *Lytoceras* sp. indet.; *Lytoceras cornucopia* (Young & Bird, 1822)*; Phylloceras* sp. indet.; *Calliphylloceras* sp. indet.; *Aptycus* sp. indet.
			bed 8a: *Hildaites undicosta* (Merla, 1932); *Hildaites* cf. *undicosta*; *Hildaites crassus* (Guex, 1973); *Hildaites* sp. indet.; *Cingolites clavatus* n. sp.; *Orthildaites* sp. indet.; *Nodicoeloceras* sp. ind.; *Mesodactylites* sp. ind.; *Lytoceras francisci* (Oppel, 1865); *Lytoceras* sp. indet.; *Phylloceras* sp. indet.; *Calliphylloceras* sp. indet.
			bed 6: *Hildaites undicosta* (Merla, 1932); *Hildaites* sp. indet. *Cingolites clavatus* n. sp.; *Nodicoeloceras* sp. indet; *Mesodactylites* sp. indet.; *Rarenodia* sp. indet.; *Harpoceras* sp. indet.; *Phylloceras doderleinianum* (Catullo, 1853); *Phylloceras selinoides* (Meneghini, 1867-1881); *Phylloceras* sp. indet.
	STRIATUS		**bed 3b**: *Hildaites exilis*; *Hildaites pseudolevisoni*; *Hildaites* sp. indet.; *Harpoceras* sp. indet.; *Praepolyplectus* sp. indet; *Nodicoeloceras* sp. indet; *Mesodactylites* sp. indet.; *Phylloceras* sp. indet.
			bed 3a: *Hildaites exilis*; *Hildaites pseudolevisoni*; *Hildaites* sp. indet.; *Taffertia* sp. indet.; *Praepolyplectus epiroticus*; *Nodicoeloceras* sp. indet.; *Mesodactylites gr. annulatiformis* (Bonarelli, 1899); *Phylloceras* sp. indet.
			bed 2c: *Hildaites* gr. *subserpentinus*; *Hildaites striatus*; *Hildaites pseudolevisoni* Venturi, 1981; *Hildaites* sp. indet.; *Mesodactylites* (?) sp. indet.; *Rakusites* cf. *tuberculatus* Guex, 1973; *Phylloceras* sp. indet.
			bed 2b: *Hildaites* gr. *subserpentinus*; *Hildaites striatus*; *Hildaites exilis* Venturi, 1973; *Hildaites* sp. indet; *Praepolyplectus epiroticus*; *Nodicoeloceras* sp. indet.; *Mesodactylites* (?) sp. indet.; *Taffertia* sp. ind.; *Harpoceras* sp. indet.; *Phylloceras* sp. indet.
			bed 2a: *Hildaites* gr. *subserpentinus*; *Hildaites striatus*; *Hildaites* sp. ind.; *Nodicoeloceras* gr. *crassoides* (Simpson, 1855); *Mesodactylites* sp. indet.; *Orthodactylites* sp. indet.; *Praepolyplectus epiroticus*; "*Harpoceratoides*" sp. indet; *Phylloceras* sp. indet.
			bed 1: *Hildaites* gr. *subserpentinus* Buckman, 1921; *Hildaites striatus* Guex, 1973; *Hildaites* sp. indet.; *Harpoceras* gr. *serpentinum* (Schlotheim, 1813), *Harpoceras* gr. *maghrebensis* Guex, 1973; *Harpoceras* sp. indet.; *Praepolyplectus epiroticus* (Renz, 1925); *Mesodactylites* (?) sp. indet.; *Orthodactylites* (Buckman, 1926) sp. indet.; *Phylloceras* sp. indet.; *Lytoceras* sp. indet.
			Early Toarcian Oceanic Anoxic Event

Tab. 1 - Ranges of *Cingolites* and other ammonites in the Marconessa quarry section 2, part 1: from Levisoni Zone (Striatus and Undicosta zones) to lowermost Bifrons Zone.

form is believed by few authors occurring also in the earliest Toarcian (Polymorphum or Mirabile zones) (see Macchioni, 2002). (For an updated review and new data on the ammonites in relation to OAE and across the Pliensbachian-Toarcian boundary in the Apennines, see Bilotta et al., 2010).

The stratigraphic occurrence of the ammonoid fauna across both sections of the Marconessa quarry studied is here broadly displayed in the tables (Tabs. 1, 2 and 3), but these data are incomplete and provisional being our sampling and study still in progress (a more detailed report with a formal description of new collected taxa

STAGE	ZONE	Subzone	Marconessa quarry - section 2
TOARCIAN	BIFRONS	Semipolitum	**bed 13c**: *Hildoceras semipolitum*; *Hildoceras* cf. *angustisiphonatum*; *Hildoceras* sp. indet.; Phymatoceras iserense (Oppel, 1856) *Furloceras cornucopia* (Merla,1932); *Mercaticeras dilatum*; *Mercaticeras* sp. indet.; *Crassiceras* sp. indet.; *Harpoceras subexaratum*; *Harpoceras* cf. *falciferum*; *Harpoceras subplanatum* (Oppel, 1856); *Polyplectus discoides*; *Nodicoeloceras* sp. indet.; *Mesodactylites sapphicus*; *Mesodactylites* sp. indet.; *Lytoceras* sp. indet.; *Phylloceras doderleinianum*; *Phylloceras* sp. indet.; *Calliphylloceras capitanei*; *Calliphyloceras nilssoni; Calliphylloceras* sp. indet.
			bed 13b: *Hildoceras semipolitum*; *Hildoceras* sp. indet.; *Mercaticeras dilatum*; *Mercaticeras* cf. *mercati*; *Harpoceras* gr. *falciferum* (Sowerby, 1820); *Pseudomercaticeras* sp. indet.; *Mesodactylites* sp. indet.; *Telodactylites* sp. indet.; *Lytoceras kténasi* Mitzopoulos, 1930; *Alocolytoceras dorcadis*; *Phylloceras heterophyllum*; *Phylloceras doderleinianum*; *Calliphylloceras nilssoni*; *Callyphylloceras capitanei*; *Calliphylloceras* sp. indet.
		Angustisiphonatum	**bed 13a**: *Hildoceras semipolitum* Buckman, 1902; *Hildoceras* cf. *angustisiphonatum*; *Hildoceras* sp. indet.; *Mercaticeras* sp. indet.; *Pseudomercaticeras* sp. indet.; *Harpoceras* sp. indet.; *Polyplectus discoides* (Zieten, 1831); *Mesodactylites* sp. indet.; *Telodactylites* sp. indet.; *Peronoceras* sp. indet.; *Lytoceras cornucopia*; *Phylloceras doderleinianum*; *Phylloceras* sp. indet.; *Calliphylloceras capitanei*; *Calliphylloceras* sp. indet.
			bed 12f: *Hildoceras* gr. *bifrons; Hildoceras* cf. *apertum*; *Hildoceras* gr. *angustisiphonatum*; *Hildoceras* sp. indet.; *Mercaticeras mercati*; *Mercaticeras dilatum* (Meneghini, 1885); *Harpoceras* sp. ind.; *Rarenodia* sp. indet.; *Phymatoceras* sp. indet.; *Lytoceras cornucopia*; *Phylloceras doderleinianum*; *Phylloceras* sp. indet.; *Calliphylloceras capitanei; Calliphylloceras* sp. indet.
			bed 12e: *Hildoceras* gr. *bifrons*; *Hildoceras apertum*; *Hildoceras* gr. *angustisiphonatum*; *Mercaticeras mercati*; *Pseudomercaticeras* sp. indet.; *Polyplectus pluricostatus*; *Frechiella* sp. indet.; *Nodicoeloceras* sp. indet.; *Phylloceras heterophyllum*; *Phylloceras doderleinianum*; *Phylloceras* sp. indet. ; *Calliphylloceras nilssoni.*
		Lusitanicum	**bed 12d**: *Hildoceras* gr. *lusitanicum*; *Hildoceras bifrons* (Bruguière, 1789); *Harpoceras* sp. indet.; *Phylloceras doderleinianum*; *Phylloceras* sp. indet.; *Calliphylloceras nilssoni*; *Calliphylloceras* sp. indet.
			bed 12c: *Hildoceras lusitanicum*; *Hildoceras* cf. *bifrons*; *Hildoceras angustisiphonatum* Prinz, 1904; *Hildoceras apertum* Gabilly, 1976; *Hildoceras* sp. indet.; *Nodicoeloceras* sp. indet.; *Lytoceras* sp. indet.; *Calliphylloceras nilssoni.*
			bed 12b: *Hildoceras* sp. indet.; *Polyplectus pluricostatus*; *Mesodactylites* sp. indet.; *Phylloceras heterophyllum*; *Phylloceras* sp. indet.; *Calliphylloceras nilssoni*; *Calliphylloceras* sp. indet.
			bed 12a: *Hildoceras lusitanicum*; *Hildoceras* cf. *lusitanicum*; *Hildoceras* sp. indet. *Frechiella* sp. indet.; *Rarenodia* n. sp.; *Mercaticeras* sp. indet.; *Mesodactylites* sp, indet.; *Phylloceras* sp. indet.; *Calliphylloceras* sp. indet.
			bed 11c: *Hildoceras* sp. indet.; *Hildoceras* n. sp. indet.; *Harpoceras subexaratum*; *Harpoceras* gr. *mediterraneum*; *Polyplectus pluricostatus*; *Frechiella subcarinata*; *Frechiella* n. sp.; *Mercaticeras* sp. indet; *Pseudomercaticeras* sp. indet.; *Lytoceras* gr. *cornucopia*; *Lytoceras sepositum; Phylloceras* sp. indet.; *Calliphylloceras* sp. indet.
			bed 11b: *Hildoceras lusitanicum* Meister, 1913; *Hildoceras* sp. indet.; *Mercaticeras* gr. *thyrrenicum*; *Phymatoceras* sp. indet.; *Frechiella* sp. indet. *Nodicoeloceras* sp. ind.; *Mesodactylites mediterraneus*; *Lytoceras* sp. indet.; *Phylloceras* sp. indet.; *Calliphylloceras capitanei.*
		Sublevisoni	**bed 11a**: *Hildoceras* gr. *sublevisoni*; *Hildoceras sublevisoni* var. *sulcosa*; *Hildoceras* gr. *acarnanicum*; *Hildoceras* sp. indet.; *Mercaticeras thyrrenicum*; *Mercaticeras* gr. *mercati*; *Pseudomercaticeras* sp. indet.; *Harpoceras subexaratum* Bonarelli, 1899; *Phylloceras doderlenianum*; *Phylloceras* sp. indet.; *Calliphylloceras capitanei*; *Calliphylloceras nilsoni*; *Calliphylloceras* sp. indet.
			bed 10g: *Hildoceras* cf. *sublevisoni*; *Hildoceras sublevisoni* var. *sulcosa*; *Hildoceras* cf. *acarnanicum*; *Cingolites stefaninii*; *Phymatoceras elegans*; *Mercaticeras umbilicatum*; *Mercaticeras* gr. *rursicostatum*; *Mercaticeras* cf. *hellenicum* (Renz, 1905); *Mercaticeras* gr. *thyrrenicum* (Fucini, 1905); *Mercaticeras* gr. *mercati* (Hauer, 1856); *Frechiella subcarinata* (Young & Bird, 1922); *Audaxlytoceras dorcadis*; *Lytoceras sepositum*; *Phylloceras doderleinianum*; *Phylloceras heterophyllum*; *Phylloceras* sp. indet.; *Calliphylloceras capitanei*; *Calliphylloceras nilssoni*; *Callyphylloceras* sp. indet.
			bed 10f: *Hildoceras sublevisoni; Hildoceras sublevisoni* var. *sulcosa*; *Hildoceras acarnanicum*; *Phymatoceras* cf. *elegans*; *Mercaticeras umbilicatum*; *Mercaticeras* sp. indet.; *Polyplectus pluricostatus; Harpoceras* sp. indet.; *Nodicoeloceras* gr. *angelonii*; *Mesodactylites* sp. indet.; *Phylloceras doderleinianum*; *Phylloceras heterophyllum*; *Phylloceras* sp. indet.; *Calliphylloceras nilssoni.*
			to be continued from bed 10e

Tab. 2 - Ranges of *Cingolites* and other ammonites in the Marconessa quarry section 2, part 2: Bifrons Zone.

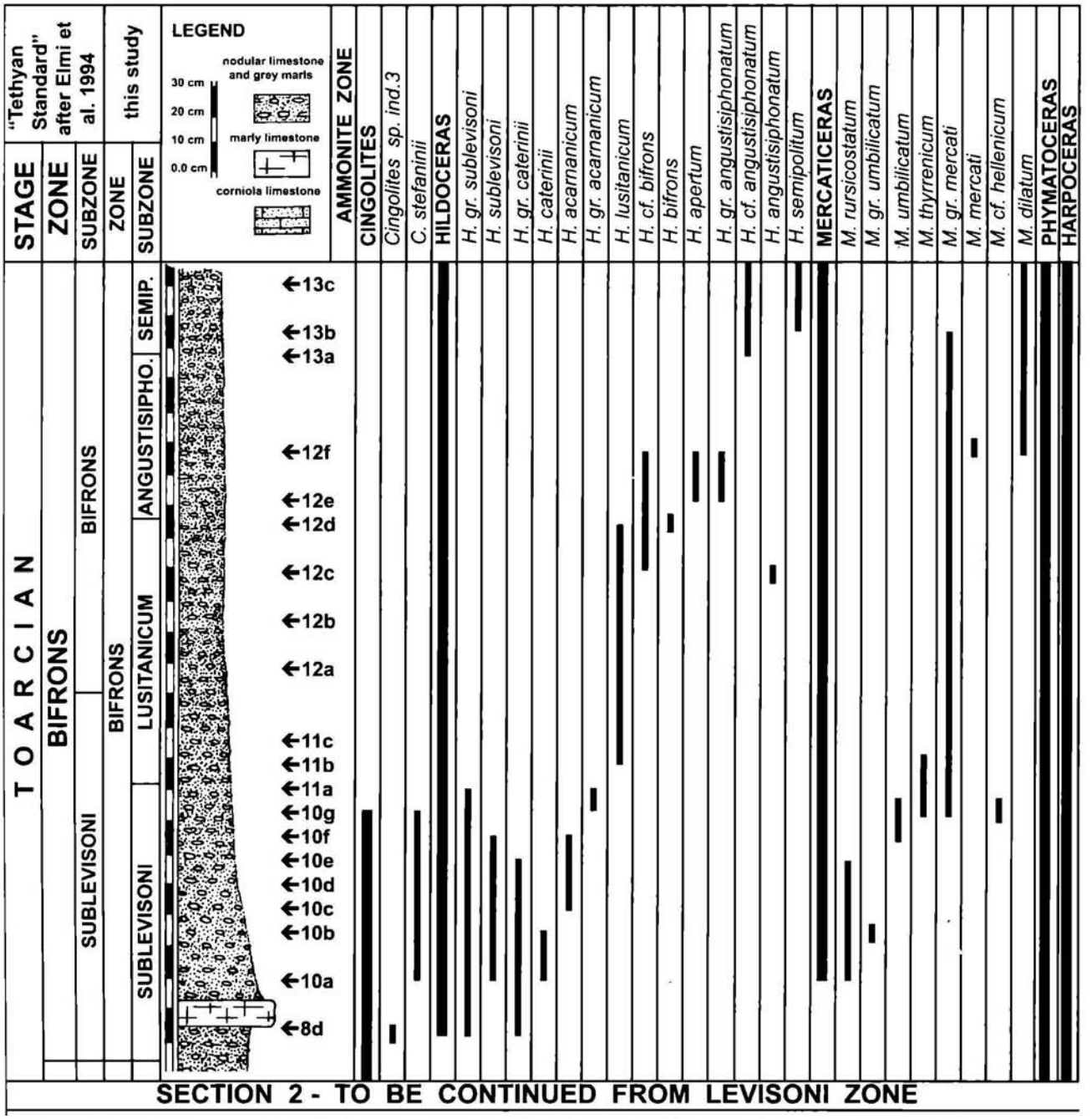


Fig. 3 - Log of the Marconessa quarry section 2 (part 2) and ranges of *Cingolites* and other ammonites, chiefly Hildoceratinae, in the early Toarcian.

will be provided by us in further papers). Furthermore, some meaningful ammonite taxa for biostratigraphy, chiefly the ranges of Hildoceratinae, Mercaticeratinae, Harpoceratinae are plotted against the logs (Figs. 2, 3 and 4).

SYSTEMATIC PALAEONTOLOGY

Order Ammonoidea Zittel, 1884
Suborder Ammonitina Hyatt, 1889

Superfamily Hildocerataceae Hyatt, 1867
Family Hildoceratidae Hyatt, 1867

Subfamily Hildoceratinae Hyatt, 1867

According to Arkell et al. (1957, p. L259) the Hildoceratinae are characterized by shells «*Evolute planulates with quadrate whorl section, tricarinate-bisulcate venter, and falcate ribs which may be interrupted by longitudinal groove on whorl side*». Gèczy (1967, p. 127) has reviewed Schindewolf's (1963)

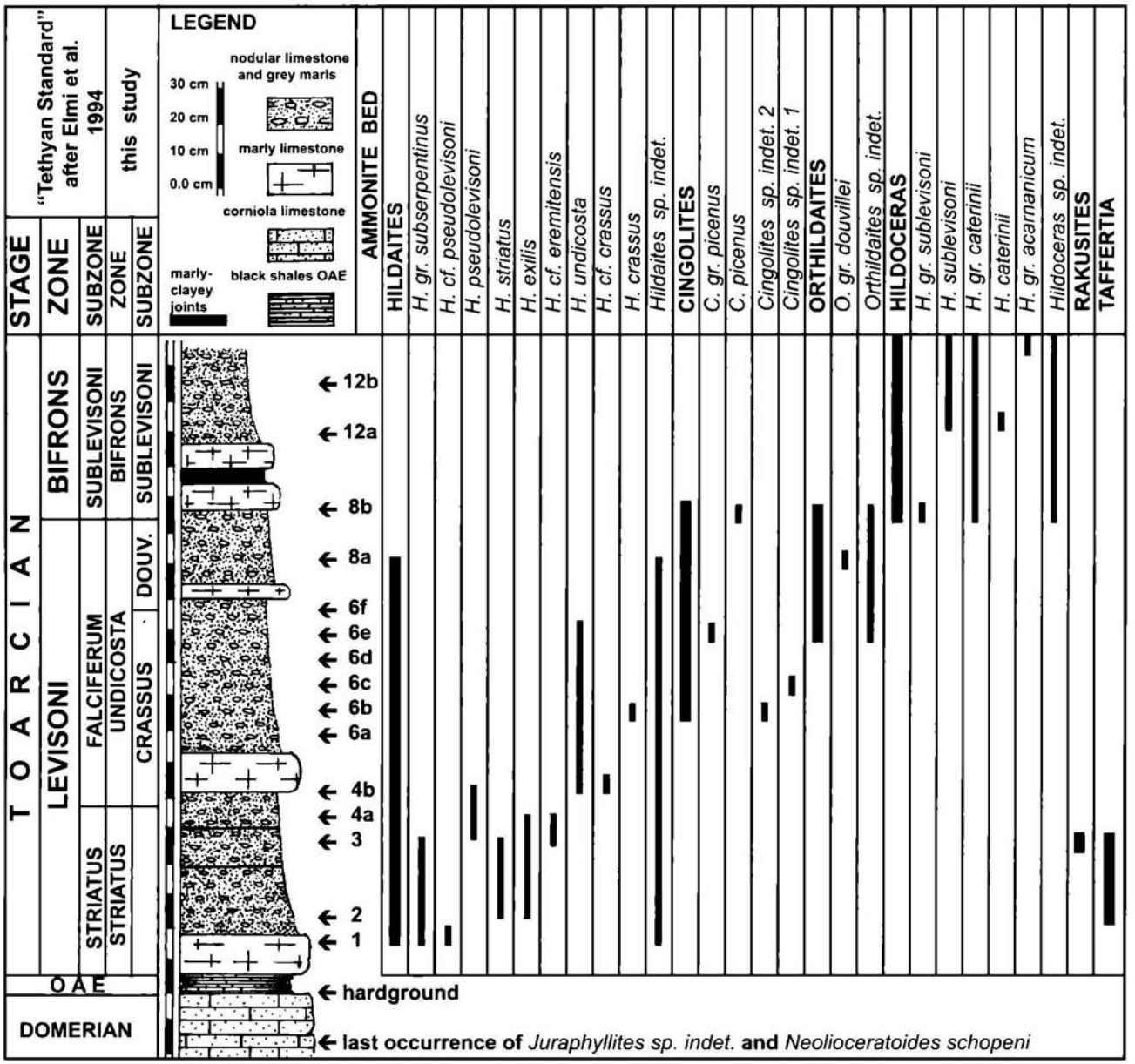


Fig. 4 - Log of the Marconessa quarry section 3 and ranges of *Cingolites* and other ammonites, chiefly Hildoceratinae, in the early Toarcian.

(1963) diagnosis of the subfamily, which includes the suture line in diagnosis, and he wrote that this group is characterized by a «nombre réduit de lobes ombilicaux et par une selle externe sans incision médiane». Howarth (1992, p. 165) provided a broader diagnosis than above quoted authors, and for the first time he emphasizes the variability of the whorl section, which is «quadrate or elliptical» with «keeled or tricarinate-bisulcate venter», and of the ornament, which shows «Ribs vary from fine to strong, and from straight to falcate or strongly angled». Howarth includes into this subfamily eight genera: *Hildaites*, *Orthildaites*, *Hildoceras*, *Mercaticeras*, *Renziceras*, *Parahildaites*, *Hildaitoides*, *Atacamiceras*.

We think that the genus *Renziceras*, which is a shape typical of the West Mediterranean Tethys characterized by an evolute coiling and wider than high whorl section with tricarinate-bisulcate venter and strong, straight and spiny ribs, should be excluded from the Hildoceratinae subfamily. According to Macchioni & Venturi (2000) *Renziceras* must be included in the subfamily *Leukadiellinae*. According to Guex (1974) the Mediterranean genus *Mercaticeras*, characterized by small sized shapes, should be included in the subfamily *Mercaticeratinae*. We agree with these authors.

We are unable to carry out a critical evaluation about the taxonomic range of the genus *Parahildaites* (Blaison, 1967), found in the Arabian Palaeoprovince, because we have not enough data. The genera *Hildaitoides* and *Atacamiceras* of the South America Palaeoprovince described by Hillebrandt (1987) show, in our opinion, only a seeming affinity with European Hildoceratinae. These American taxa, in fact, have rectiradiate, or gently

STAGE	ZONE	Subzone	Marconessa quarry - section 3
TOARCIAN	BIFRONS	Sublevisoni	**bed 12b**: *Hildoceras sublevisoni*; *Hildoceras sublevisoni* var. *sulcosa*; *Hildoceras* gr. *caterinii*; *Hildoceras* gr. *acarnanicum*; *Cingolites* sp. ind.; *Harpoceras* gr. *mediterraneum*; *Nodicoeloceras angelonii*; *Lytoceras* sp. indet.; *Phylloceras doderleinianum*; *Callyphylloceras nilssoni*; *Calliphylloceras capitanei*; *Calliphylloceras* sp. indet.
			bed 12a: *Hildoceras sublevisoni*; *Hildoceras caterinii*; *Hildoceras* cf. *caterinii*; *Hildoceras* sp. indet.; *Pseudomercaticeras* sp. indet.; *Nodicoeloceras angelonii*; *Dactylioceras* cf. *commune* (Sowerby, 1815); *Nejdia* (Arkell, 1952) sp. ind.; *Lytoceras* sp. indet.; *Alocolytoceras dorcadis*; *Phylloceras heterophyllum*; *Phylloceras* sp. ind.; *Calliphylloceras nilssoni*; *Calliphylloceras* sp. indet.
			bed 8b: *Hildoceras* gr. *sublevisoni*; *Hildoceras* gr. *caterinii*; *Cingolites picenus*; *Orthildaites* sp. indet.; *Phymatoceras* cf. *elegans*; *Phymatoceras*. sp. indet.; *Harpoceras* gr. *mediterraneum*; *Harpoceras* sp. indet., *Phylloceras doderleinianum*; *Phylloceras selinoides*; *Phylloceras* sp. indet.; *Calliphylloceras nilssoni*; *Calliphylloceras capitanei*.
	UNDICOSTA	Douvillei	**bed 8a**: *Hildaites* sp. indet.; *Orthildaites* sp. indet.; *Orthildaites* gr. *douvillei*; *Phylloceras* sp. indet.; *Calliphylloceras* sp. indet.
			bed 6f: *Hildaites* sp. indet.; *Orthildaites* sp. indet.; *Nodicoeloceras lobatum*; *Lytoceras* sp. indet.; *Phylloceras* sp. indet.; *Callyphilloceras* sp. indet.
		Crassus	**bed 6e**: *Hildaites undicosta*; *Hildaites crassus*; *Orthildaites* sp. indet.; *Cingolites* gr. *picenus*; *Lytoceras* sp. indet.; *Phylloceras* sp. indet.
			bed 6d: *Hildaites* sp. indet.; *Nodicoeloceras lobatum*.
			bed 6c: *Hildaites* sp. indet.; *Cingolites* sp. indet. 1; *Polyplectus pluricostatus*; *Nodicoeloceras lobatum*; *Lytoceras francisci*; *Calliphylloceras* sp. indet.
			bed 6b: *Hildaites undicosta*; *Hildaites crassus*; *Cingolites* sp. indet. 2; *Harpoceras* gr. *serpentinum*; *Nodicoleloceras* gr. *lobatum*; *Lytoceras francisci*; *Calliphylloceras capitanei*; *Calliphylloceras* sp. indet.
			bed 6a: *Hildaites undicosta*; *Hildaites* sp. indet.; *Harpoceras* sp. indet.; *Polyplectus* sp. indet.; *Nodicoeloceras lobatum*; *Phylloceras selinoides*; *Calliphylloceras* sp. indet.
			bed 4b: *Hildaites pseudolevisoni*; *Hildaites undicosta*; *Hildaites* cf. *crassus*; *Nodicoeloceras* gr. *lobatum*; *Praepolyplectus epiroticus*; *Phylloceras* sp. indet.
	STRIATUS		**bed 4a**: *Hildaites exilis*; *Hildaites* cf. *eremitensis*; *Hildaites* sp. indet.; *Mesodactylites* sp. indet.; *Praepolyplectus epiroticus*; *Phylloceras* sp. indet.
			bed 3: *Hildaites* gr. *subserpentinus*; *Hildaites striatus*; *Hildaites exilis*; *Hildaites pseudolevisoni*; *Hildaites* cf. *eremitensis* Venturi, 1973; *Hildaites* sp. indet.; *Taffertia taffertiensis* Guex, 1973; *Taffertia* sp. indet.; *Rakusites* sp. indet.; *Nodicoeloceras crassoides*; *Nodicoeloceras* sp. indet.; *Mesodactylites annulatiformis*; *Mesodactylites* (?) sp. indet.; *Praepolyplectus epiroticus*; *Lytoceras francisci*; *Phylloceras* sp. indet.; *Calliphylloceras* sp. indet.
			bed 2: *Hildaites* gr. *subserpentinus*; *Hildaites striatus*; *Hildaites exilis*; *Hildaites* sp. indet.; *Praepolyplectus epiroticus*; *Taffertia* sp. indet.; *Mesodactylites* (?) sp. indet.; *Phylloceras* sp. indet.
			bed 1: *Hildaites* gr. *subserpentinus*; *Hildaites* cf. *pseudolevisoni*; *Hildaites* sp. indet.; *Lytoceras* sp. indet.; *Harpoceras* sp. indet.; *Praepolyplectus epiroticus*; *Mesodactylites* (?) sp. indet.; *Orthodactylites* sp. indet.; *Lytoceras francisci*; *Phylloceras* sp. indet.
Early Toarcian Oceanic Anoxic Event			

Tab. 3 - The ranges of *Cingolites* and other ammonites in the Marconessa quarry section 3: from Levisoni Zone (Striatus and Undicosta zone) to lowermost Bifrons Zone.

arched, and very thin ribs with rounded section. These shells, moreover, have an evolute ovoidal-rounded whorl section, and they have also a rounded or sub-acute venter, never bisulcate. Since the genera *Parahildaites* and *Hildaitoides* do not have the typical traits described by Arkell, Gèczy and Howarth, we think that they should be excluded from the subfamily Hildoceratinae. Therefore, we suggest an amended diagnosis of this subfamily, which includes only the genera that show a geographic dispersal in Subboreal, Submediterranean and Mediterranean Palaeoprovinces, such as *Hildaites*, *Orthildaites*, *Cingolites* (new genus) and *Hildoceras*.

Amended diagnosis of Hildoceratinae - From very evolute to moderately involute shells. Variable whorl section, which may be sub-quadrate, low or high sub-rectangular and sub-trapezoidal, with wide or narrow venter, which may be sub-rounded (mainly in the body chamber) sub-tabulate, bisulcate and tricarinate-bisulcate. The keel is more or less raised, strong or fine. The ornament varies showing ribs from fine to coarse; they are usually falcate-falcoid or sigmoidal (sinuous-§flexuous) in the inner whorls, more or less retroverted near the umbilical edge and more or less projected on the ventro-lateral edge, and sometimes moderately falcate,

almost straight and rectiradiate in the grown-up stage (mainly in *Orthildaites* and *Cingolites*). Usually, the ribs are single, but sometimes they are also bifurcating or bundled showing near the umbilical edge fine tubercles or bullae and dimples. The ending of the ribs on the ventro-lateral edge varies also: in *Hildaites* the ribs usually come until the ventro-lateral edges; among *Orthildaites* and a few *Hildoceras* as well the ribs disappear before the ventro-lateral edges; whereas, in *Cingolites* the ribs come until the ventro-lateral edge enlarged and swollen, forming a typical coronate venter.

Among the genera of this subfamily only *Hildoceras* shows, both in the juvenile stage and in the grown-up stage, a spiral groove that cuts the ribs, forming a typical more or less wide dorsal smooth band.

The sutures are typically ammonitic, i.e. usually simple, poorly indented (jagged) and showing spaced lobes. The ratio of the E/L lobes varies, but normally the ES saddle is wider than LS_1 saddle. The sutures show also two umbilical lobes (U_3 and U_2), one of which (U_3) is usually small sometimes dentiform. The hidden internal lobe (I) is simple, long and narrow.

Genus *Cingolites* n. gen.

Type species - *Cingolites clavatus*, n. sp.

Material - *Cingolites* new genus includes the following species: *C. clavatus* n. sp., *C. picenus* n. sp., *C. spiralis* n. sp. and *C. stefaninii* (Merla, 1932).

Derivatio nominis - From the location of the Marconessa quarry near Cingoli (Macerata, Italy), where this taxon was found.

Stratus typicus - Nodular limestone and grey marl of the upper Undicosta Zone and the lowermost Bifrons Zone.

Diagnosis - Very evolute shell with a sub-quadrate whorl section and wide tricarinate-bisulcate venter, having more or less deep sulci. The umbilical edge is rounded; the umbilical wall is more or less high, sloped or vertical.

The ornament shows spaced, coarse, swollen and unevenly risen ribs, which are as wide as the interspace between ribs. These more or less coarse and flexuous ribs start from the umbilical wall, they are gently retroverted in the umbilical-proximal segment, stretched in the median segment and more or less projected on the ventro-lateral edges, where they reach the maximum growth forming a very swollen, enlarged and like a clavus area. Therefore, from the ventral view a typical coronate area can be observed.

The suture is simple, poorly jagged, with distanced lobes; it shows a narrow E lobe, as long as the L lobe or only just longer than L; a short U_2 lobe, a dentiform U_3, which is placed on the umbilical wall. The ES saddle is about twice as wide than LS_1 showing an almost dentiform A lobe.

Remarks - At a glance this taxon may be confused with some *Orthildaites* shells, mainly *O. douvillei* Haug, 1884 and *O. orthus* Buckman, 1923, but a closer examination reveals remarkable differences, which justify the establishment of this new Hildoceratinae genus. In fact, *Orthildaites* has typically straight and rectiradiate ribs, regularly raised, faded in the proximal and in the distal segments; besides, they start near the umbilical edge and they disappear completely near the ventro-lateral edge. On the contrary, *Cingolites* has typically sinuous and projected ribs even in the outer whorls, characteristically enlarged and swollen on the ventro-lateral edges, thus giving rise to the clavi and a coronate ventral area; besides, the ribs start from umbilical wall and they have not a regularly raised appearance. The sub-quadrate whorls section, differently from *Orthildaites*, is very wide, swollen and it always shows a strongly tricarinate-bisulcate venter with deep sulci. The suture distinguishes also *Cingolites* from *Orthildates*. In fact, the former genus shows a very simple suture, similar to *Mercaticeras*, whilst *Orthildaites* has a suture resembling both the latest *Hildaites* and the earliest *Hildoceras* shells.

Nevertheless, *Cingolites* is distinguished from *Mercaticeras* in having a coarser ornamentation with clavate, irregularly raised and not falcoid ribs and a more evolute, swollen and wide whorl section. Besides, they differ in size, being *Cingolites* larger sized, and in stratigraphic occurrence. The later taxon *Cingolites stefaninii* is the most similar to *Mercaticeras*; in fact, it was assigned by Merla (1932), Pinna (1963) and Zanzucchi (1963) to this well-known and typical Mediterranean genus.

Cingolites also differs from the taxa figured by Hillebrandt (1987) as *Atacamiceras* and *Hildaitoides*. These American ammonoids, in fact, have a rounded or sub-elliptical whorl section, without sulci, and straight ribs, which are neither flexuous nor clavate.

Cingolites has some degree of similarity with *Hildaites crassus* (Guex, 1973) in having a wide tricarinate-bisulcate venter with deep sulci and a strong keel and a simple suture line, with short E and L lobes. However, *H. crassus* shows coarser ribs with a hildaitic rursiradiate-falcate appearance and they are also not clavate. In any case, the earlier shapes of *Cingolites* have the same stratigraphic occurrence of *H. crassus*. These likeness and affinity make plausible a common evolutionary descent.

Palaeogeographic dispersal - At the present state of knowledge, three of the four species of *Cingolites* (namely, *C. clavatus*, *C. picenus* and *C. spiralis*) occur in the Apennines only. The fourth species *C. stefaninii*, already described by Merla (1932), occurs in Southern Alps (Entratico, Alpe Turati, Alta Brianza) and Greece (Lefkas Island).

Cingolites clavatus n. sp.
(Figs. 5, 7, 11; Pl. 1, figs. 1-4)

Material - Eight well preserved specimens of medium and small size (MSA: 86, 87, 259, 431, 432, 433, 802 and 804), all from Marconessa quarry.

Derivatio nominis - Because of its typical strongly clavate and coarser ribs.

Label	D	U	Wh	Wb	U/D	Wb/Wh
MSA87	75	39	20	20	0,52	1
MSA86	61	31	16,5	16,5	0,51	1
MSA259	58	31	17	17	0,53	1
MSA431	60	30,5	18	18	0,51	1
MSA432	32	15,5	10	13,5	0,48	1,35
MSA433	51	26,5	14	18	0,52	1,29
MSA802	----	----	9,5	11	----	1,12
MSA804	50	25	12,5	13	0,50	1

Tab.4 - Measurements of the holotype and paratypes of *Cingolites clavatus*. (Legend: D = whorl diameter; U = umbilical width; Wh = whorl height; Wb = whorl breadth; ratio U/D; ratio Wb/Wh = Wb/Wh. The measures are in mm; they are usually taken at the maximum shell size).

Holotype - A well preserved specimen MSA 87 of medium size with a portion of body chamber (Figs. 5 a-b; Pl. 1, figs. 1a-b), collected from Marconessa quarry, section 2, bed 6.

Stratus typicus - Nodular limestone and grey marl of the Undicosta Zone.

Diagnosis - Platycone very evolute shell, sub-quadrate whorl section, wide tricarinate-bisulcate venter with keel. The sinuous, coarse and sparse ribs are characterized by clavi forming a coronate venter. The ammonitic suture is simple. It differs from other *Cingolites* for the strongly clavate appearance of the ornament, for the coarser ribs and for the sub-quadrate whorl section wider than high.

Holotype description - Very evolute shell characterized by a slow growth of coiling, with a sub-quadrate whorl section noticeably wider than high. The wide tricarinate-bisulcate venter shows deep and wide sulci, with a strong and moderately raised keel. The swollen sides show an almost vertical umbilical wall with rounded edges.

The flexuous, coarse and spaced ribs have a moderately retroverted proximal segment, a long stretched medial segment and a short and gently projected distal segment. The ribs end enlarged and swollen on the ventro-lateral edges, here reaching the maximum thickness; thus, they take on a typical claviform appearance and forming a coronate area viewed from the venter. Besides, the ribs of *C. clavatus* are unevenly raised, more or less swollen; they are 24 in number in the last whorl of the phragmocone.

The suture is simple, showing distanced lobes; an E lobe as long as L lobe, which is short and wide; a moderately developed U_2 lobe and a dentiform U_3 lobe, which is placed on the umbilical wall. The ES saddle is about twice as wide than LS_1 with an almost dentiform A lobe.

Paratypes - The variously sized paratypes are very similar to the holotype, so that see the holotype diagnosis. They all show the typical characters of the ornament, which clearly distinguish *C. clavatus* from other *Cingolites* and furthermore both from the various shapes of *Orthildaites* and from *Hildaites crassus*.

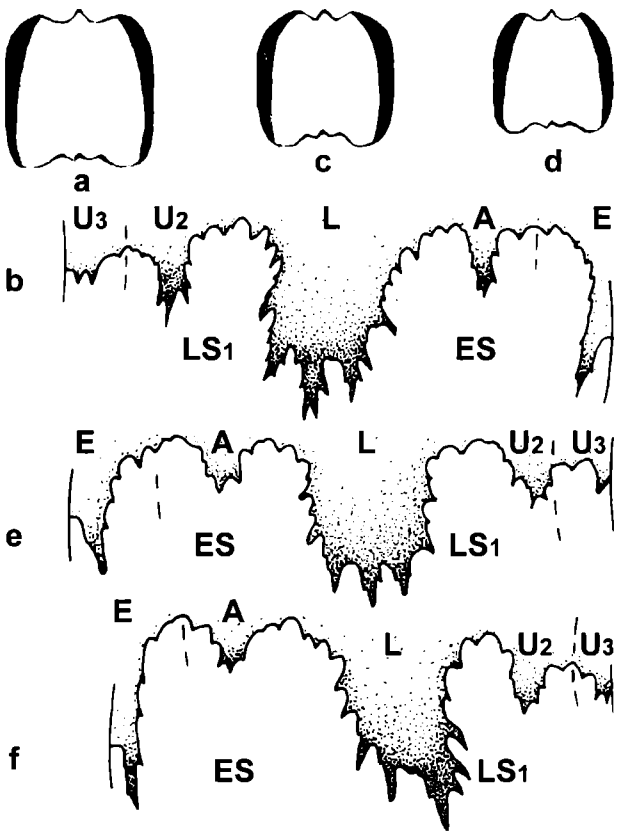


Fig. 5 - *Cingolites clavatus* n. sp.: a) section (x 1) and b) suture (x2) of holotype MSA 87; c) section (x1) and e) suture (x3) of paratype MSA 259; d) section (x1) and f) suture (x4) of paratype MSA 86.

Occurrence - Undicosta Zone.

Cingolites picenus n. sp.
(Figs. 6 a-f, i-l, n; Pl. 1, figs. 5-8; Pl. 2, figs. 1-5, 9)

Material - Nine specimens of medium-large size from Marconessa quarry, some of which well preserved (MSA: FV1, 88, 91, 105, 207, 359, 434, 855 and 870). Two specimens of medium size (SAF 9 and SAF 18) were collected *ex-situ* from the celebrated S. Anna quarry of Furlo Pass (Pesaro).

Derivatio nominis - From the location of recording, the Marchean Apennines, which long ago was inhabited by the ancient people named "Piceni".

Holotype - A well preserved specimen MSA FV1 of medium-large size with the body chamber (Figs. 6 a-b; Pl. 1, figs. 7a-b), collected from Marconessa quarry, section 2, bed 8b.

Stratus typicus - Nodular limestone and grey marl of the upper Undicosta Zone.

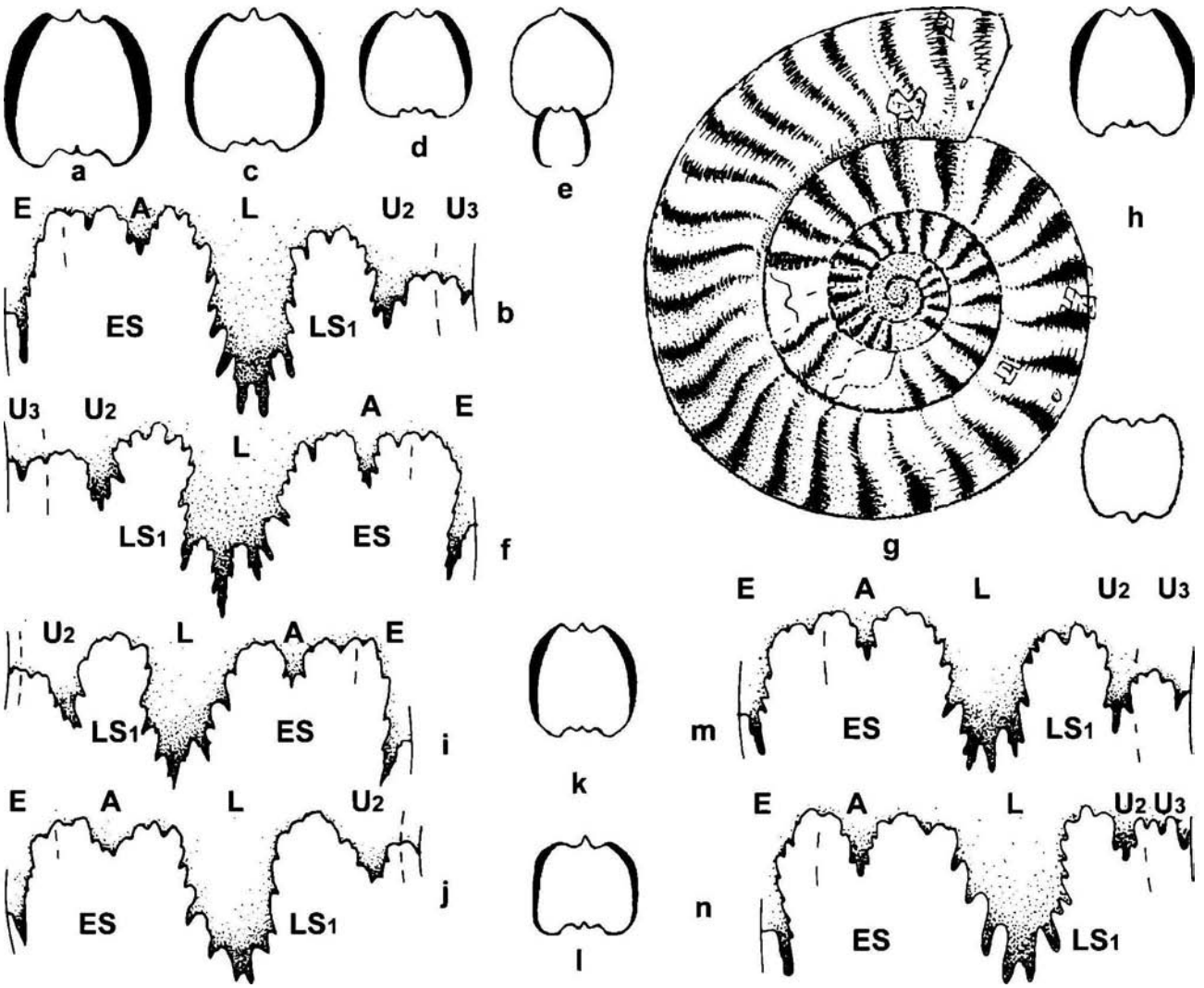


Fig. 6 - *Cingolites picenus* n. sp.: a) section (x1) and b) suture (x3) of holotype MSA FV1; c) section (x1) and f) suture (x3) of paratype MSA 88; d) section (x1) and i) suture (x4) of paratype MSA 6; e) section (x1) and j) suture (x4) of paratype MSA 105; k) section of paratype SAF 9; l) section (x1) and n) suture (x4) of paratype MSA 359. *Cingolites* gr. *picenus*: g) drawing (x1); h) section (x1) and m) suture (x3).

Diagnosis - Platycone evolute shell, sub-quadrate whorl section, tricarinate-bisulcate venter with keel. The strong, gently clavate and sparse ribs are almost rectiradiate in the inner whorls and they become more sinuous in the outer ones. The ammonitic suture is simple.

Holotype description - Evolute shell with a sub-quadrate whorl section. The venter is tricarinate-bisulcate with deep sulci and moderately strong keel. The umbilical wall is moderately high and rounded in the inner whorls, almost vertical and higher in the outer whorls.

The ribs are strong, spaced, almost rectiradiate in the inner whorls, more flexuous in the outer whorls, when they appear slightly retroverted in the proximal segment, stretched or gently arched in the medial segment and moderately projected with short distal segment on the ventro-lateral edges. In the phragmocone the rib termination appears gently claviform, but the clavi disappear on the body chamber,

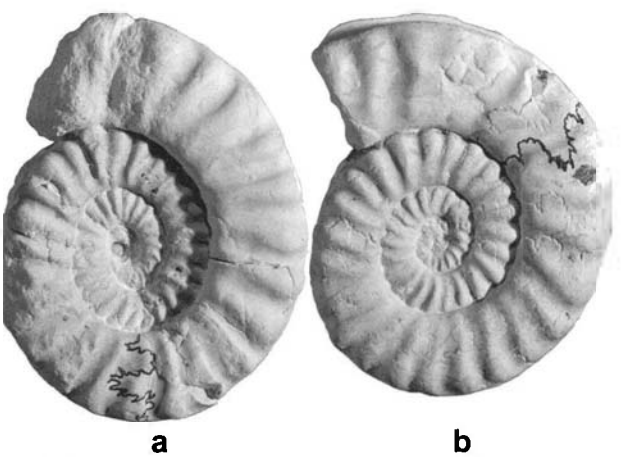


Fig. 7 - *Cingolites clavatus* n. sp.: a) specimen MSA 433 (x1), from Undicosta Zone; b) specimen MSA 804 (x1), section 2, bed. 8b.

Label	D	U	Wh	Wb	U/D	Wb/Wh
MSAFV1	81	42	21	21	0,52	1
MSA88	76	43	17	16,5	0,56	0,97
MSA91	62	33,5	15	14	0,54	0,93
MSA105	49	26	14	14	0,53	1
MSA207	51	27	13,5	13,5	0,53	1
MSA359	48,5	25	13,5	16	0,52	1,20
MSA434	39	19,5	11	11	0,50	1
MSA855	51	26	13	15	0,51	1,15
MSA870	49	24	15	16	0,49	1,06
MSA157	70	35	18	18	0,50	1
MSA844	65	34	18	18	0,52	1

Tab. 5 - Measurements of holotype and paratypes of *Cingolites picenus* and of specimens of *Cingolites* gr. *picenus*.

when the ribs progressively become faded. We count 29 ribs in the last whorl of the phragmocone.

The suture is simple with a L lengthened, which is longer than E lobe; moderately developed umbilical lobes and a short A lobe.

Paratypes - The paratypes show some variances in the ornament, with more or less strong ribs, which sometimes appear more falcoid than in the holotype, mainly in the outer whorls. The suture also shows a variance in the L lobe, usually shorter than that of the holotype.

Remarks - This species differs from *C. clavatus* in having a narrover and less swollen whorl section; a narrower venter; more regularly risen and less coarse ribs and the appearance of gentle clavi in the phragmocone only. It differs from *C. spiralis* in having less arched and coarse ribs, a less wide venter and more flattened sides. It finally differs from *C. stefaninii* in having a wider tricarinate-bisulcate venter and less swollen and more flexuous ribs in the outer whorls too.

Occurrence - From uppermost Undicosta Zone to the lowermost Bifrons Zone.

Cingolites gr. *picenus*
(Figs. 6 g-h, m; Pl. 2, figs. 6-7)

Material - A very well preserved specimen MSA 157 of medium size with the body chamber and a badly preserved specimen of the same size MSA 844, both from Marconessa quarry.

Remarks - Very evolute shell with a sub-quadrate whorl section in the phragmocone, only just higher than wide in the body chamber. The venter is typically tricarinate-bisulcate, but less wide than *C. clavatus*, with raised and thin keel.

The specimen MSA 157 is very interesting for its stratigraphic occurrence, which is lower than *C. picenus*, and for its undoubted transitional traits between *C. clavatus* and *C. picenus*. In fact, the ornament of this specimen shows almost rectiradiate ribs in the inner whorls, which are unevenly risen and strongly clavate like *C. clavatus*; whereas, in the outer whorl, which is including the body chamber, the ornament shows a more regularly risen and more coarse and flexuous ribs, which become progressively falcoid and faded in the body chamber, like *C. picenus* and they lose the clavi. The collected from detritus specimen MSA 884 has the same ornament.

The suture shows the E lobe as long as lobe L, which is wide and short; a dentiform A lobe and a long and narrow U_2 lobe.

Occurrence - Upper Undicosta Zone.

Cingolites spiralis n. sp.
(Fig. 8; Pl. 2, figs. 8, 10-11)

Material - One well preserved specimen MSA 21 from Marconessa quarry; two fragments collected from Maranghi quarry section (Burano Valley, Pesaro) and from Lecceti section (Bosso Valley, Pesaro): BU1 and LE1 respectively.

Derivatio nominis - For its typical evolute coiling with serpenticone appearance.

EXPLANATION OF PLATE 1

Figs. 1-4 - *Cingolites clavatus* n. sp.
1 - holotype MSA 87, section 2, bed 6.
2 - paratype MSA 86, section 2, bed 8b.
3 - paratype MSA 259, section 2, bed 8a.
4 - paratype MSA 431, section 2, bed 8c.

Figs. 5-8 - *Cingolites picenus* n. sp.
5 - paratype MSA 207, collected form detritus of the uppermost *Undicosta* zone (section 2).
6 - paratype MSA 105, collected from detritus of the uppermost *Undicosta* zone (section 3).
7 - holotype MSA FV1, section 2, bed 8b.
8 - paratype MSA 91, section 2, bed 8c.

All photographs are natural size provided.

1a

1b

2a

2b

5

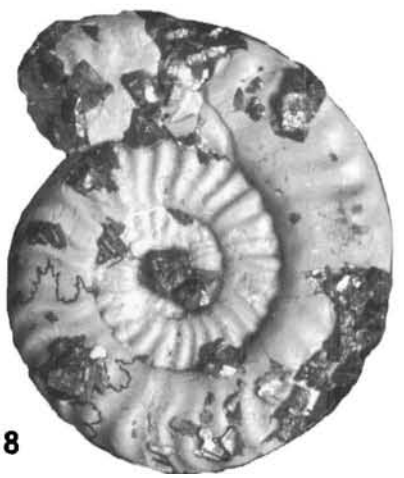
3

4

6

7a

7b



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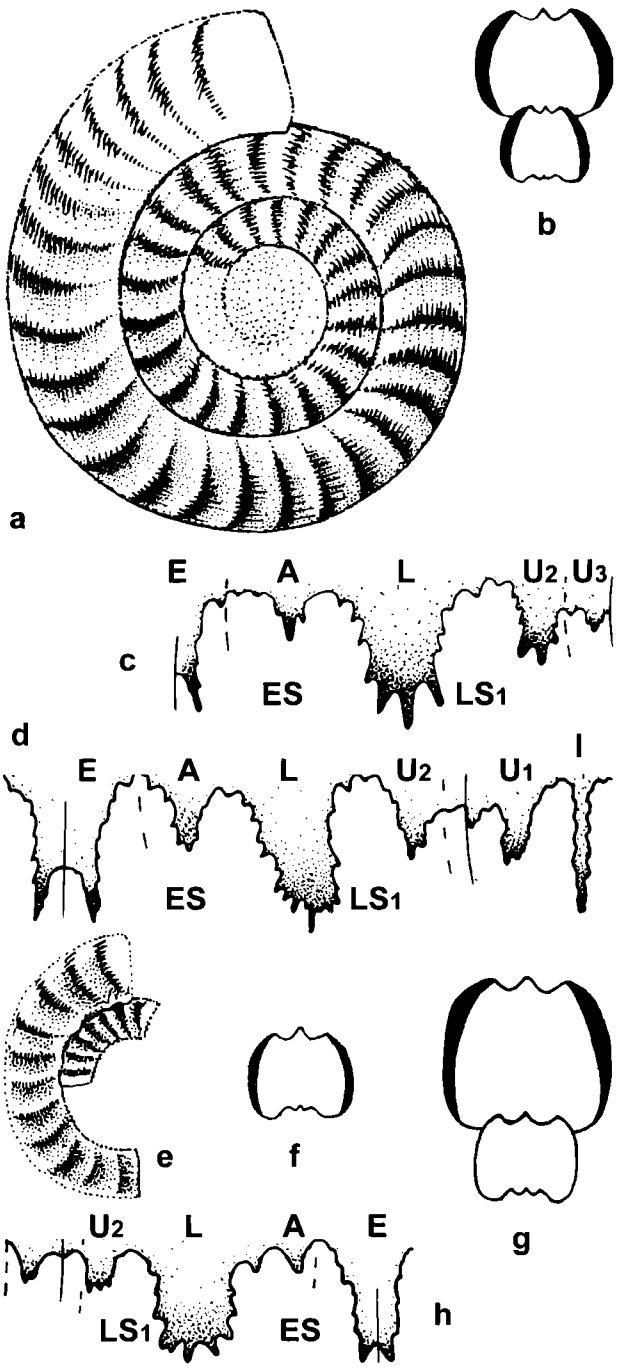


Fig. 8 - *Cingolites spiralis* n. sp.: a) drawing (x1), b) section (x1) and c) suture (x3) of holotype MSA 21; d) suture (x3) and f) section (x1) of paratype LE1; e) drawing (x1), g) section (x1) and h) suture (x4) of paratype BU1.

Label	D	U	Wh	Wb	U/D	Wb/Wh
MSA21	68	41	14	18	0,60	1,30
BU1	35,2	19	9,5	10,5	0,54	1.12
LE1	----	----	11,5	13,5	----	1.17

Tab. 6 - Measurements of the holotype and paratypes of *Cingolites spiralis*.

Holotype - Specimen MSA 21 collected *ex situ* from the detritus of the upper Undicosta Zone (Figs. 8 a-c; Pl. 2, figs. 8 a-b), coming from Marconessa quarry.

Stratus typicus - Nodular limestone and grey marl of the upper Undicosta Zone.

Diagnosis - Very evolute almost serpenticone compressed shell, sub-quadrate whorl section, tricarinate-bisulcate venter with keel. The coarse, gently clavate, very sparce ribs are characterized by an almost concave-prorsiradiate appearance. The ammonitic suture is very simple.

Holotype description - Very evolute shell with serpenticone appearance and sub-quadrate whorl section, which is wider than high, characterized by a slow growth coiling. The wide venter is tricarinate-bisulcate with wide and moderately deep sulci. The sides are rounded and the low umbilical wall is rounded too.

The ornament shows coarse and spaced ribs, which are broader than the interspace between ribs. The ribs start from the umbilical wall, with stretched proximal and medial segments, characterized by an almost prorsiradiate appearance; they are swollen and enlarged near the moderately projected distal segment, where they have a gently claviform appearance, ending on the ventro lateral edges and forming a coronate ventral area. We count 23 ribs in the last whorl of phragmocone.

The suture is very simple, showing a short and wide L lobe; an E lobe as long as L, a little developed A lobe, and the umbilical lobes with a dentiform U_3. The saddle ES is about twice as wide than LS_1 saddle.

Paratypes - The two fragmented paratypes are very similar to the holotype in the ornament, whorl section and venter; they differ in the suture line only, where the E lobe is longer than L lobe.

Remarks - This species differs from *Orthildaites* and *Hildaites* shells for its typical strongly serpenticone evolute appearance. Besides, the claviform coarser ribs and the strongly tricarinate-bisulcate venter reveal its close affinity with *Cingolites clavatus*. Furthermore, some traits of the ribs appearance and of the suture are similar to *Hildaites crassus*.

Occurrence - Upper Undicosta Zone.

Cingolites stefaninii (Merla, 1932)
(Fig. 9; Pl. 3, figs. 1-4, 6, 8-9)

? 1930 *Hildoceras (Lillia) Mercati* (Hauer) var. *ellenica* (Renz) - Mitzopoulos, Pl. 6, figs. 6a-b.
1932 *Mercaticeras stefaninii* Merla, Tav. 6, figs. 8-9.
1963 *Mercaticeras stefaninii* Merla - Zanzucchi, Tav. 19, fig.1.
1963 *Mercaticeras stefaninii* Merla - Pinna, Tav. 10, fig. 14.
1995 *Praemercaticeras* sp. indet. Pettinelli et al., Pl. 2, fig. 5.

Material - Nine well preserved specimens of medium and small size (MSA: 264, 281, 388, 435, 843, 845, 847,

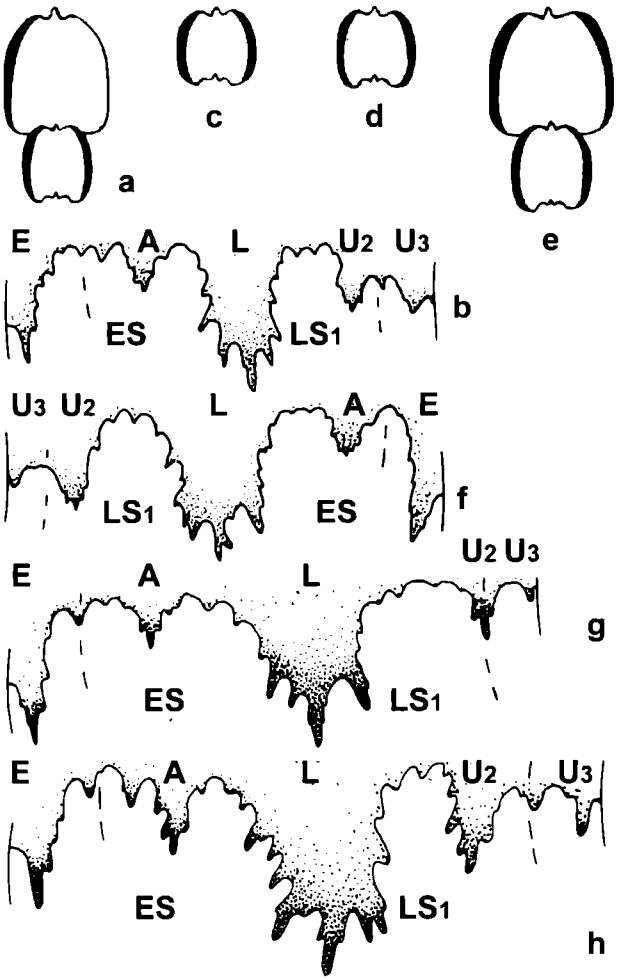


Fig. 9 - *Cingolites stefaninii* (Merla, 1932): a) section (x1) and b) suture (x3) of specimen MSA 264; c) section (x1) of specimen MSA 485; d) section (x1) and f) suture (x3) of specimen MSA 281; e) section (x1) and h) suture (x3) of specimen MSA 886; g) suture (x4) of the specimen MSA 388.

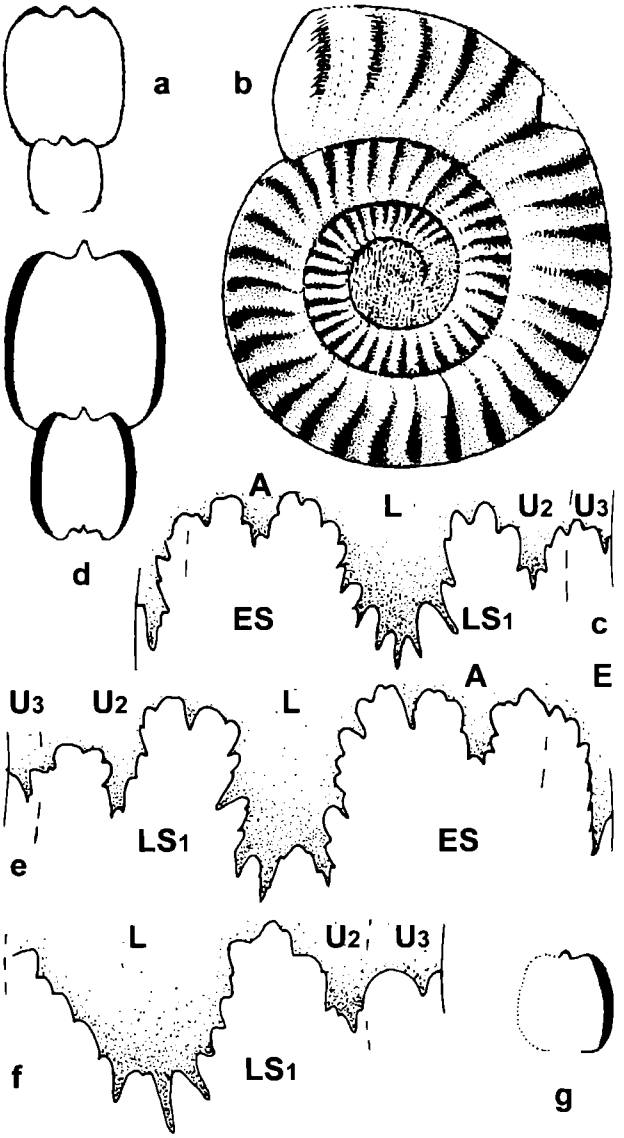


Fig. 10 - *Cingolites* sp. indet. 1: a) section (x1), b) drawing (x1) and c) suture (x3) of specimen MSA 150. *Cingolites* sp. indet. 2: d) section (x1) and e) suture (x3) of specimen MSA 155. *Cingolites* sp. indet. 3: f) suture (x6) and g) section (x1) of the specimen MSA 280.

846, 886 and two fragmented specimens (MSA: 411 and 485), all from Marconessa quarry.

Remarks - These specimens are very close to Merla's species *stefaninii*, which was ascribed to the genus *Mercaticeras*. Nevertheless, the characters of the whorl section and the ornament are typical of *Cingolites*, to which both the Merla's specimen and the Marconessa quarry specimens must be ascribed.

Amended diagnosis - Very evolute shell with a sub-quadrate whorl section from tricarinate-bisulcate venter. The sulci are not much wide and moderately deep. The sides are flattened or barely rounded. The umbilical wall is low with rounded edge.

The strong and spaced ribs are almost straight and rectiradiate; they are gently flexuous in the outer whorl of medium sized specimen. The ribs start from the umbilical wall and they end clavate on the ventro-lateral edges, here forming a coronate area in the inner whorl, which is visible among small specimens only. The clavi disappear on the body chamber and in the outer whorl of the medium sized specimens.

Label	D	U	Wh	Wb	U/D	Wb/Wh
MSA264	55	27,5	13	13	0,50	1
MSA281	36	18	10	12	0,50	1.20
MSA388	52,5	26,5	15	15	0,50	1
MSA435	43	21	13	13	0,49	1
MSA485	43	22	9	9	0,51	1
MSA843	42	20,5	12	15	0,49	1,25
MSA845	49	24	13	12	0,49	0,92
MSA846	43,5	20	11	----	0,46	----
MSA847	44	19,5	12	15	0,44	1,25
MSA886	65	34,5	17	17	0,53	1

Tab. 7 - Measurements of the specimens of *Cingolites stefaninii*.

The simple suture shows the E lobe as long as L lobe, the A lobe moderately developed and umbilical lobes with a more or less developed lanciform U_2 and a dentiform U_3, which is placed on the umbilical wall.

Our specimens, variously located in the stratigraphic column, show some variances in having a more or less evolute whorl section and more or less strong ribs. The larger specimen MSA 886 shows the main diagnostic characters of this species in the inner whorls, but in the outer whorl the ribs become finer, arched and almost prorsiradiate. Unfortunately, this specimen was not collected *in situ*.

Occurrence - From lower Bifrons Zone (Sublevisoni Subzone).

Cingolites sp. indet. 1
(Figs. 10 a-c; Pl. 3, fig. 5)

Material - One specimen MSA 150 with a portion of the body chamber, coming from Marconessa quarry.

Remarks - Evolute shell with a sub-quadrate whorl section and tricarinate-bisulcate venter. The moderately strong and almost rectiradiate ribs show gentle clavi on the ventro-lateral edges, mainly in the outer whorls. The simple suture shows the E lobe as long as L lobe, which is low and wide; the umbilical lobes and the A lobe moderately developed.

It differs from *C. clavatus* by having a lesser shell evolution, finer and denser ribs, which are gently clavate never forming a real coronate ventral area. Some traits of the ornament and of the suture line reveal a certain affinity with *Cingolites*. On the other hand, the coiling, the whorl section appearance and the ribs course of the inner whorls are more similar to the later specimens of *Hildaites pseudolevisoni* (Venturi, 1981) and the earlier specimens of *Hildaites crassus*. Therefore, it is a clearly transitional shape.

Occurrence - Lower Undicosta Zone.

Label	D	U	Wh	Wb	U/D	Wb/Wh
MSA150	60	30,5	13,5	13,5	0,53	1
MSA155	92	49	22	22	0,53	1
MSA280	61	32	14	14	0,52	1

Tab. 8 - Measurements of the specimens of undetermined *Cingolites*.

Cingolites sp. indet. 2
(Figs. 10 d-e; Pl. 3, fig. 7)

Material - A medium-large specimen with the body chamber, MSA 155, coming from Marconessa quarry.

Remarks - Evolute shell with a sub-quadrate whorl section, only just higher than wide, and a broad tricarinate-bisulcate venter. The ribs are flexuous in the inner whorls; more straight and strong in the outer whorls. The suture is simple, poorly jagged, with A lobe not much developed and a long lobe L.

It differs from *C. clavatus* and *C. spiralis* in having more rectiradiate not clavate ribs in the outer whorls. Thus, it is for some traits similar to *Hildaites crassus*. It is another transitional shape.

Occurrence - Lower Undicosta Zone.

Cingolites sp. indet. 3
(Figs. 10 f-g)

Material - A fragment of the phragmocone and of the body chamber, MSA 280, coming from Marconessa quarry.

Remarks - Evolute shell with a sub-quadrate whorl section. The rectiradiate ribs, starting from the umbilical wall, are weakly projected on the ventro-lateral edges, not really clavate. The suture is simple with a wide and short L lobe.

EXPLANATION OF PLATE 2

Figs. 1-5, 9 - *Cingolites picenus* n. sp.
1 - paratype MSA 88, section 2, bed 8b.
2 - paratype MSA 870, collected from detritus of the uppermost *Undicosta* zone (section 2).
3 - paratype MSA 359, collected from detritus of the uppermost *Undicosta* zone (section 3).
4 - paratype MSA 855, collected from detritus of the uppermost *Undicosta* zone.
5 - paratype SAF 9, collected *ex situ*.
9 - paratype SAF 18, collected *ex situ*.

Figs. 6-7 - *Cingolites* gr. *picenus*
6 - specimen MSA 157, section 3, bed 6e.
7 - specimen MSA 844, collected from detritus of the uppermost *Undicosta* zone (section 2).

Figs. 8, 10-11 - *Cingolites spiralis* n. sp.
8 - holotype MSA 21, collected from detritus of the uppermost *Undicosta* zone (section 3).
10 - paratype BU 1, collected *ex situ* from detritus of the uppermost *Undicosta* zone.
11 - paratype LE 1, collected *ex situ* from detritus of the uppermost *Undicosta* zone.

All photographs are natural size provided.

1

2

3a

3b

4

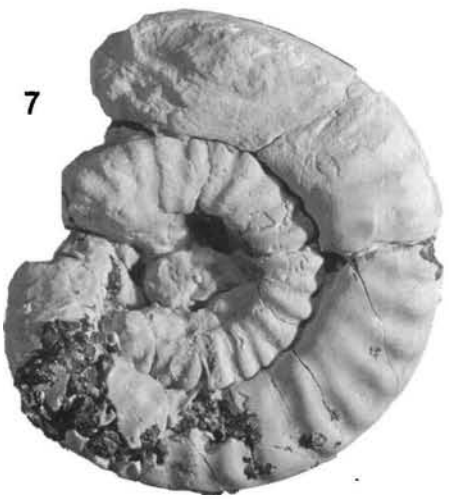
5

6a

6b

8a

8b



7

9

10

11

It noticeably differs from the other *Cingolites* sp. indet. 1 and 2 for its stratigraphic occurrence.

Occurrence - Lower Bifrons Zone (Sublevisoni Subzone).

THE DESCENT OF *CINGOLITES*

A more detailed account of the evolutionary trends of the lower Toarcian Hildoceratinae would need a separate study. However, we propose here some provisional questions into the evolutionary framework shown by the above treated fossil record evidences.

In the fossil record of studied Apennines sections, after the occurrence of the black shales of the OAE, we observe a remarkable adaptive radiation of the ammonoid fauna when new genera and species of Hildoceratinae appear to replace the taxa that had become extinct in the previous anoxic biological crisis of the early Toarcian (see Bilotta et al., 2010). The descent of Hildoceratinae from the late Domerian Protogrammoceratinae is very likely, although there are no direct evidences provided by the fossil record, being unfortunately the ammonoid collections of the European and Mediterranean sections usually poor or missing across the Domerian (late Pliensbachian)-Toarcian transition. For instance, the OAE black shales of Marconessa quarry sections have not preserved any ammonites, thus in the lowermost Levisoni Zone (our Striatus Zone) the appearance of Hildoceratinae seems to be sudden. However, this sudden appearance of Hildoceratinae is not due to a "punctuation" *sensu* Eldredge & Gould (1972), but clearly to the incompleteness of the fossil record. In fact the Hildoceratinae occurring in our sections above the OAE black shales are already well differentiated in many species and varieties. These evolutionary changes from the common ancestors, which were maybe located in the Apennines or elsewhere, clearly occurred in a time span between the fall (see the hardground surface in figs. 2 and 4) and the rise of the sea level (see the OAE recording in figs. 2 and 4) when the fossil record is missing.

In fact, we have found in the lower Toarcian (*Hildaites striatus* zone) of the Marconessa quarry several new and unfortunately still unpublished taxa of the genus *Hildaites*: some shapes are moderately involute, with flat and narrow venter and fine ribs whereas other forms are instead evolute, with bisulcate or tricarinate venter and strong ribs. These last robust ones become more abundant in the stratigraphic sequence, and they replace totally the former gentle ammonites in the *Hildaites undicosta* zone, when the genera *Orthildaites* and *Cingolites* appear. This remarkable evolutionary event occurred in the middle-late portion of the Undicosta chron, when firstly *Cingolites* and later *Orthildaites* originated, probably from a group of *Hildaites* characterized by tricarinate-bisulcate venter and coarser ribs in the ornament, like those of the group of *Hildaites crassus* (Guex, 1973). Finally, in the earliest Bifrons chron the genus *Hildoceras* appears. It is possible that at the bottom of this zone the genus *Mercaticeras* originated from *Cingolites*, probably from the small sized shapes of *C. stefaninii* group. Considering the growing biostratigraphic data from the Apennines outcrops, we hope we will be able to prove that all Hildoceratinae taxa are linked by a common descent, as shown by several transitional specimens of our collection. A new and exhaustive phylogenetic framework for this subfamily will be attempted by us in a forthcoming paper.

REMARKS AND DISCUSSION ON THE PALAEOGEOGRAPHIC DISPERSAL OF *CINGOLITES* IN THE MEDITERRANEAN TETHYS REALM

The richness of our collection coming from Marconessa quarry allowed us to establish the new genus *Cingolites*, which we include in the subfamily Hildoceratinae. We have also established three new species of *Cingolites* (namely, *C. clavatus*, *C. picenus* and *C. spiralis*) and we ascribed to this genus an already recognized species as *C. stefaninii* (Merla, 1932), which was previously assigned to the genus *Mercaticeras* by Merla (1932). We have furthermore collected some transitional and undetermined shells referable to *Cingolites*. *Cingolites stefaninii* is reported in the Apennines, the Southern Alps (Zanzucchi, 1963, Tav. 19, fig. 1; Pinna, 1963, Tav. 10, fig. 14) and Greece (Lefkas Island) (Pettinelli et al., 1995, Pl. 2, fig. 5), where the same pelagic depositional *facies* of red or grey marly nodular limestone occurring in the Tuscan-Umbrian-Marchean basin has been observed. To the present-day

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EXPLANATION OF PLATE 3

Figs. 1-4, 6, 8-9 - *Cingolites stefaninii* (Merla, 1932)
1 - specimen MSA 264, section 2, bed 10a.
2 - specimen MSA 388, collected *ex situ* from detritus of the uppermost Undicosta Zone (section 3).
3 - specimen MSA 845, collected *ex situ* from detritus of lowermost Bifrons Zone (section 2).
4 - specimen MSA 886, collected from detritus of the lowermost Bifrons Zone (section 2).
6 - specimen MSA 485, section 2, bed 10a.
8 - specimen MSA 843, section 2, bed 10g.
9 - specimen MSA 435, collected from *detritus* of the lowermost Bifrons Zone (section 2).

Fig. 5 - *Cingolites* sp. indet. 1, specimen MSA 150, section 3, bed 6c.

Fig. 7 - *Cingolites* sp. indet. 2, specimen MSA 155, section 3, bed 6b.

All photographs are natural size provided.

1

2a

2b

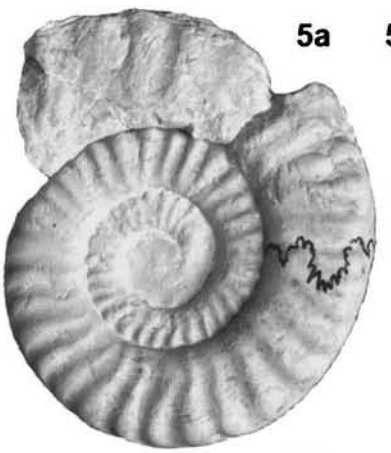
3

4a

4b

4c

5a



5b

6

7a

7b

8a

8b

9

the other species of *Cingolites* herein designed, i.e. *C. clavatus*, *C. picenus* and *C. spiralis*, seem to be endemic of the Apennines. On the other hand, *C. stefaninii* seems to have only a Western Mediterranean Tethys dispersal (Apennines, Southern Alps, Greece).

At species and genus level, our data related to the stratigraphic occurrence and geographical dispersal of the early Hildoceratinae therefore seem to confirm the existence of different ammonoid faunal realms and provinces in the European and the Mediterranean areas during the early Toarcian. Furthermore, our data about the endemic occurrence of these taxa allow to conjecture a certain degree of provincialism for the ammonite faunas of the Apennines. For these reasons the concepts of centre of origin and spreading therefore cannot be rejected *a priori*.

Page (1996, 2003, 2004, 2008) has recently provided an useful synthesis of the current palaeogeographical knowledge on Jurassic ammonoids, adopting simple hierarchical biogeographic units (Realm, Subrealm and Province) and distinguishing two European Realm, the Boreal and the Tethyan. During the late Pliensbachian-early Toarcian the Boreal Realm includes a Subboreal Province (northern Britain, Russian Platform) and in the same substages the Tethyan Realm includes a West Tethyan Subrealm, which was divided in several Provinces: a Mediterranean (or West Tethyan) Province (southern Spain, Italy, Austria, Hungary, Bulgaria, North Africa); a Submediterranean Province (northern Spain, southern and central France, southern Germany, Switzerland) and an Ethiopian (or Arabo-Malgach) Province (Ethiopia, Arabia, Turkey, Madagascar). Obviously, the boundaries and the same *status* of these Provinces are changing in space and time, being affected by plate tectonics, eustasy, ecology and climate change.

Westermann (2000a, 2000b; see also Cecca, 2002) provided an updated framework of biogeographical units in the light of the new concept of biochore, defined by the overall endemism of its biota within a geographic area (chorotype) and within a temporal limit (chronotype). However, any definition has its problems. For instance, the choice of the quality and quantity of taxa to define a biogeographic unit is somehow subjective. Cecca's (2002) effort to solve the question leads him to establish a difference between a long temporal scale, when provincialism occurred in relation to vicariance processes, and a short temporal scale (i.e. ammonite biozones), when different taxa occurred in relation to the ecology, and hence endemism is limited to the species or genus level. Nevertheless not only physical barriers, but also ecological and climatic factors obstruct the fauna dispersal and both plate tectonics and eustasy affect on these factors. Thus, a sharp distinction between a long and a short temporal scale (i.e. between the vicariance and the historical issues in palaeobiogeography) seems to be not practically possible. The role of the centres of origin and spreading therefore is not yet ruled out.

Rosen's (1992) warning on some constraints of the palaeobiogeographical data, such as those related to the incompleteness of the fossil record or the stratigraphical correlation and the mistake in taxonomic judgements, is useful. It is possible that the short biostratigraphic and palaeobiogeographic account provided in this paper could be conditioned by the incompleteness of the fossil record. Nevertheless, we believe that there are some evidences for the claim of provincialism and endemism between the European and Mediterranean Hildoceratinae ammonoid faunas of the early Toarcian.

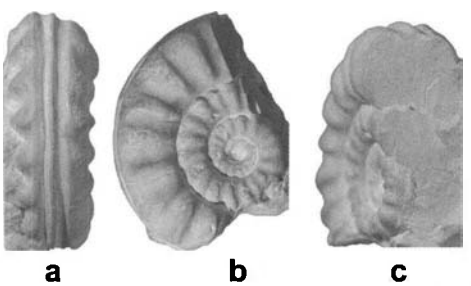


Fig. 11 - *Cingolites clavatus* n. sp.: a-b-c) specimen MSA 802 (x1), microconch from *Undicosta* zone.

CONCLUSIONS

The lower Toarcian Apennines outcrops preserved a remarkable early Hildoceratinae fossil record in the layers of the Marconessa quarry near Cingoli (Macerata, Italy), where we collected several species of *Hildaites*, *Orthildaites*, plus three new species which we ascribed to the new genus *Cingolites*. We collected also several undetermined and transitional specimens attributable to these genera. To the present-day knowledge *Cingolites* includes four species: *C. clavatus*, *C. picenus* and *C. spiralis* (all collected from the beds of the Undicosta Zone), which have been described for the first time in this paper and a later species C. *stefaninii* (collected from the beds of the Bifrons Zone), which was previously assigned by Merla (1932) to the genus *Mercaticeras*.

The genus *Cingolites* seems to have its descent from a group of *Hildaites* of the Undicosta Zone characterized by evolute shells with tricarinate-bisulcate venter and coarser ribs; the same group has probably originated the later genera *Orthildaites*, *Hildoceras* and *Mercaticeras*.

Many of these taxa show a clear provincialism like *Cingolites*, being this new genus confined chiefly to the Apennines or anyway to the Mediterranean Tethys (Southern Alps and Lefkas Island, Greece). Generally speaking, several ancient Hildoceratinae seem to have an early occurrence in the Mediterranean Tethys, as shown by the recording of our Apennines sections. However a more detailed account for this early Toarcian fauna sampled by us in the Apennines outcrop of the Marconessa quarry will be provided in further papers.

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