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New Carixian ammonite assemblages of Central Apennines (Italy), and their impact on Mediterranean Jurassic biostratigraphy

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ABSTRACT - Several Carixian ammonite levels were discovered in the whitish pelagic limestones of the Corniola Fm., cropping out in the Mt Nerone - Mt Catria area (Central Apennines). Our samplings started from the *Paltechioceras* levels of the *E. raricostatum* zone and ended at the first occurrence of Domerian forms such as *Fuciniceras lavinianum* (Fucini). *Aegolytoceras* Spath, *Galaticeras* Spath, *Radstockiceras* Buckman, *Catriceras* Venturi, *Polymorphites* Haug, *Tetraspidoceras* Spath, *Epideroceras* Spath, *Miltoceras* Wiedenmayer, *Gemmellaroceras* Hyatt, *Farinaccites* n. gen., *Holcolytoceras* Spath are the most important forms in the lower Carixian. *Tropidoceras* Hyatt, *Dubariceras* Dommergues, Mouterde & Rivas, *Metaderoceras* Spath, "*Acanthopleuroceras*" Hyatt, *Dayiceras* Spath, *Diaphorites* Fucini, are typical of the middle Carixian. *Reynesocoeloceras* Geczy, L. (*Becheiceras*) Trueman, *Protogrammoceras* Spath, *Fieldingiceras* Wiedenmayer, *Fuciniceras* Haas and *Audaxlytoceras* Fucini are well represented in the late Carixian. *Phylloceras* Suess, *Partschiceras* Fucini, *Calliphylloceras* Spath, *Juraphyllites* Muller, *Lytoceras* Hyatt are ubiquitous through the studied sections. This fauna permits us to propose four zones (Oppel zones and taxon range zones) for the Carixian of the Mediterranean palaeoprovince: *Tetraspidoceras quadrarmatum* Oppel zone and *Miltoceras sellae* taxon range zone (correlated with the *U. jamesoni* zone), *Metaderoceras gemmellaroi* Oppel zone (correlated with the *T. ibex* zone) and *Protogrammoceras dilectum* taxon range zone (correlated with the *P. davoei* zone). The new taxa *Farinaccites clavatus* n. gen. n. sp., *Polymorphites appenninicus* n. sp., *Polymorphites calensis* n. sp., *Polymorphites flexicostatus* n. sp. and *Tropidoceras bossense* n. sp. were found in the lower Carixian.

KEY WORDS: Carixian, biostratigraphy, ammonites, systematics, Central Apennines, Italy.

INTRODUCTION

We report herein the results of extensive ammonite sampling carried out in several localities through the Liassic deposits of the Umbria-Marche Apennines: Bosso River Valley, Pallareto Quarry (Mt Acuto) and westernmost Bugarone Quarry (Mt Nerone) (fig. 1). New data emerge, that have an impact on the Carixian biostratigraphy of our study area.

We are now able to propose a zonal scheme for our region that may also serve for

correlation to the western Pre-Alps (Cantaluppi & Montanari, 1968; 1971) and to Sicily (we have undertaken a revision of the faunas described by Gemmellaro, 1884).

For NW Europe the standard zonation by Dean, Donovan & Howarth (1961) is currently used (Mouterde *et alii*, 1971; Schlatter, 1980; Meister, 1986; Dommergues, 1987). For the Mediterranean Tethys the data collected by Geczy (1976) in Hungary are available. This latter author recognizes two bio-horizons within the *U. jamesoni* zone: the *Tetraspidoceras quadrarmatum* and *Protogrammoceras hungaricum* horizons; also, he correlates his *P. mellahense* zone with the *T. ibex* zone, and his *Fuciniceras costicillatum* zone with the *P. davoei* zone. Geczy (1976) also proposes that hildoceratid markers *P. mellahense* and *F. costicillatum* may be interchangeable with dactylioceratid markers *C. (Reynesocoeloceras) fischeri* and *P. (Aveyroniceras) italicum.*

For the Mediterranean Province, Braga *et alii* (1982) propose three zones established in the Subbetic Cordillera of Spain: *G. aenigmaticum, T. demonense* and *P. dilectum.* We have however noticed that correlation with this scheme is unpractical in the Apennines, due to the different stratigraphic range of two of the markers (*G. aenigmaticum* and *T. demonense*).

A brief preview of our new data is in press in the proceedings of the Granada's Cephalopod Conference (July 1996) (Faraoni *et alii*, in press).Fig. 2 shows a correlation chart among zones, subzones, bio-horizons and bio-events of selected recently published schemes.

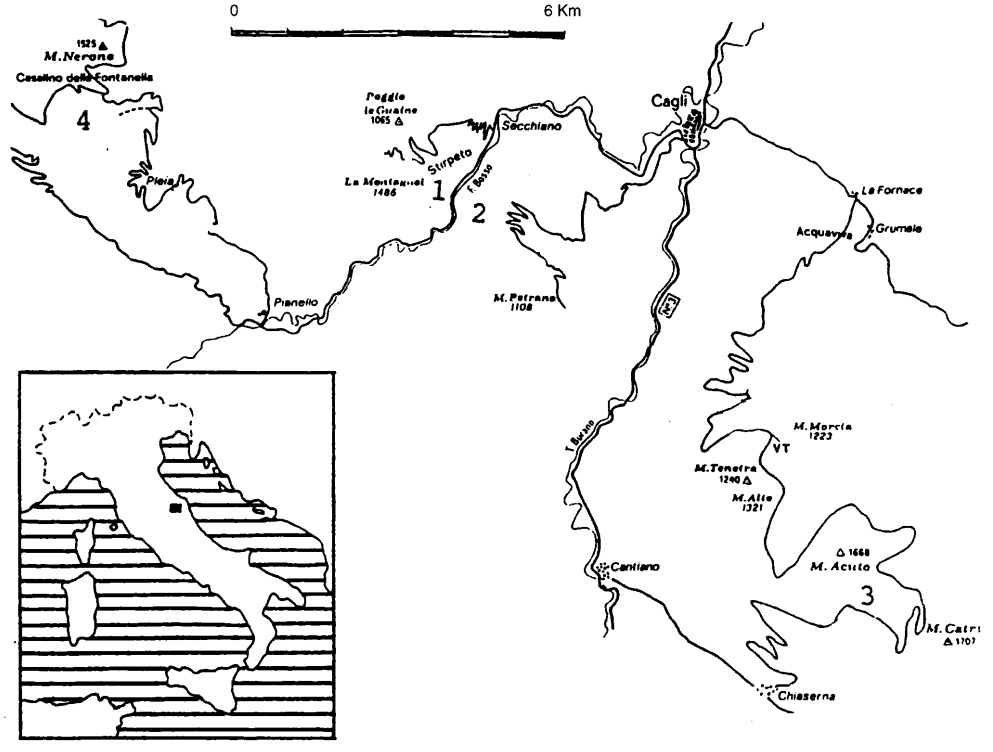

Fig. 1 - Location map of the investigated area. 1) Stirpeto section (Bosso River Valley); 2) Bosso River section (Bosso River Valley); 3) Pallareto Quarry (Mt Acuto); 4) Bugarone Quarry (Mt Nerone).

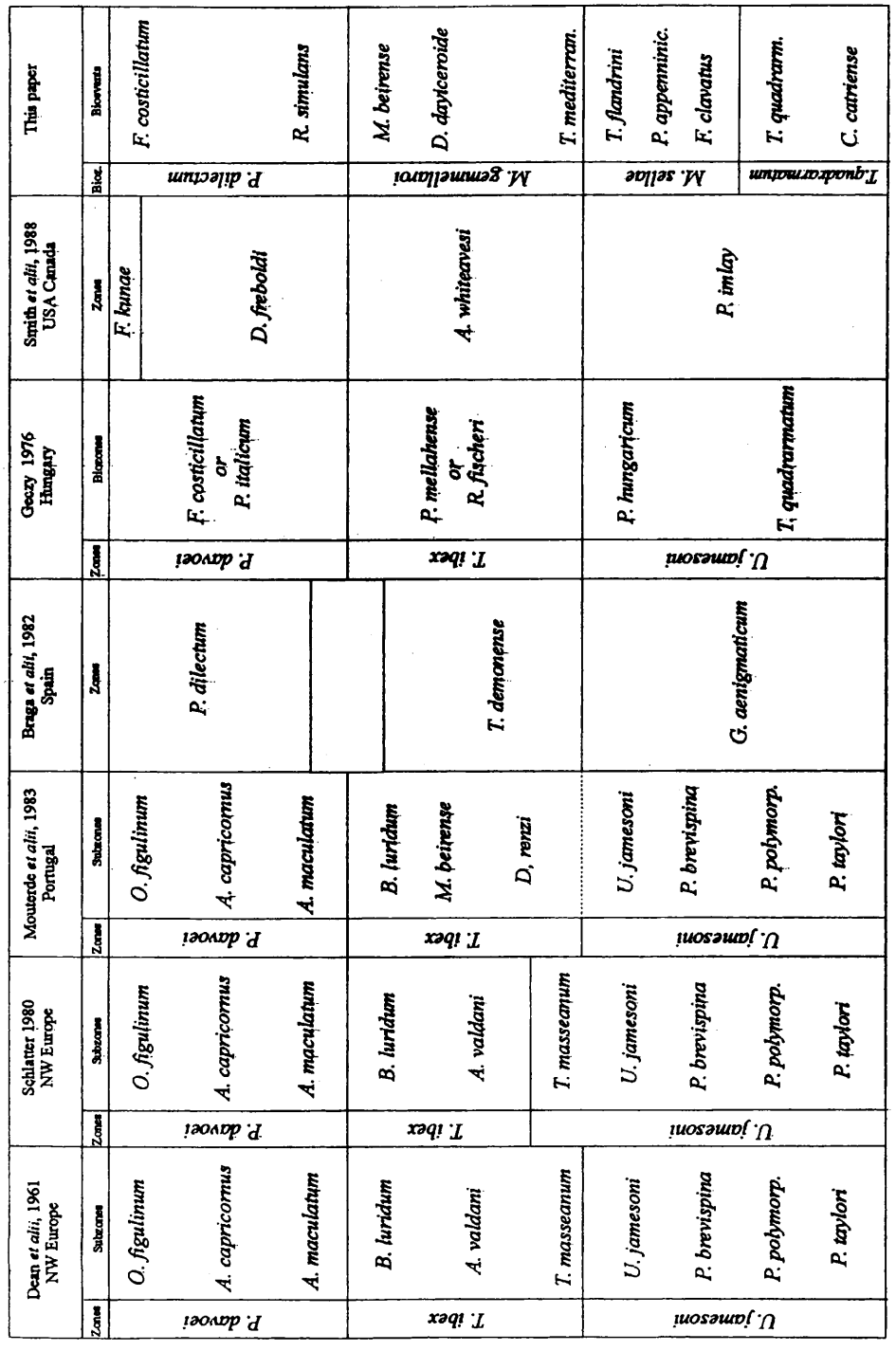

Fig. 2 - Correlation chart of zones, subzones, biohorizons and bioevents of the American, Boreal and Mediterranean Palaeoprovinces.

LIST OF SPECIES QUOTED IN TEXT

In this list the species quoted in text are shown with the formal complete writing; inverted commas evidence dubious generic attributions of identified species.

Acanthopleuroceras Hyatt, 1900,
Acanthopleuroceras whiteavesi Smith & Tipper, 1988,
"Acanthopleuroceras" sp.;

Aegolytoceras Spath, 1924,
Aegolytoceras varicosum (Venturi, 1978);

Audaxlytoceras Fucini, 1923,
Audaxlytoceras sp.;

Calliphylloceras Spath, 1927,
Calliphylloceras alontinum (Gemmellaro, 1884);

Catriceras Venturi, 1978,
Catriceras catriense Venturi, 1978;

Dayiceras Spath, 1920,
Dayiceras amaltheiforme Mouterde, 1967,
Dayiceras baltzeri Rakus, 1972,
Dayiceras sp. *aff. D. dayiceroide* (Mouterde, 1951),
Dayiceras nanum Mouterde, 1967,
Dayiceras polymorphoide Spath, 1920,
Dayiceras renzi (Meister, 1913),
Dayiceras splendens Mouterde, 1967;

Diaphorites Fucini, 1896,
Diaphorites vetulonius Fucini, 1896;

Dubariceras Dommergues, Mouterde & Rivas, 1984,
Dubariceras dubari Dommergues, Mouterde & Rivas, 1984;

Epideroceras Spath, 1923,
"Epideroceras" gr. *ancyrense* Bremer, 1965,
"Epideroceras" latinodosum Bremer, 1965;

Fanninoceras Mc Learn, 1930,
Fanninoceras kunae Mc Learn, 1930;

Farinaccites n. gen.,
Farinaccites clavatus n. sp.,
Farinaccites kondai (Geczy, 1976);

Fieldingiceras Wiedenmayer, 1980,
Fieldingiceras fieldingii (Reynes, 1868);

Fuciniceras Haas, 1913,
Fuciniceras boscense (Reynes, 1868),
Fuciniceras costicillatum (Fucini, 1902),
Fuciniceras detractum (Fucini, 1900),
Fuciniceras dubari (Cantaluppi & Montanari, 1968),

Fuciniceras giemmense Braga & Rivas, 1980,
Fuciniceras lavinianum (Fucini, 1900),
Fuciniceras normanianum (d'Orbigny, 1844),
Fuciniceras portisi (Fucini, 1900),
Fuciniceras volubile (Fucini, 1900);

Galaticeras Spath, 1938,
Galaticeras aegoceroide (Gemmellaro, 1884),
Galaticeras catriense (Venturi, 1978),
Galaticeras flexistriatum (Gemmellaro, 1884),
Galaticeras harpoceroide (Gemmellaro, 1884),
Galaticeras marianii (Gemmellaro, 1884);

Gemmellaroceras Hyatt, 1900,
Gemmellaroceras aenigmaticum (Gemmellaro, 1884);

Holcolytoceras Spath, 1924,
Holcolytoceras quadrijugum (Rosenberg, 1909);

Juraphyllites Müller, 1939,
Juraphyllites diopsis (Gemmellaro, 1884),
Juraphyllites libertus (Gemmellaro, 1884),
Juraphyllites nardii (Meneghini, 1853),
Juraphyllites planispira (Reynes, 1868);

Liparoceras (Becheiceras) Trueman, 1918,
L. (Becheiceras) bechei (Sowerby, 1921);
Lytoceras Hyatt, 1865,
Lytoceras fimbriatum (Sowerby, 1817);

Metaderoceras Spath, 1925,
Metaderoceras atlantis Dubar & Mouterde, 1978,
Metaderoceras beirense Mouterde, 1970,
Metaderoceras evolutum (Fucini, 1821),
Metaderoceras gemmellaroi (Levi, 1896),
Metaderoceras muticum (d'Orbigny, 1842),
Metaderoceras submuticum (Oppell, 1856),
Metaderoceras venarense (Oppell, 1862);

Miltoceras Wiedenmayer, 1980,
Miltoceras seguenzae (Gemmellaro, 1884),
Miltoceras sellae (Gemmellaro, 1884);
Paltechioceras Buckman, 1924,
Paltechioceras solaroide (Costa, 1855);

Paramicroderoceras Dommergues Ferretti & Meister, 1994,
Paramicroderoceras sp.;

Partschiceras Fucini, 1923,
Partschiceras striatocostatum (Meneghini, 1853);

Phylloceras Suess, 1865,
Phylloceras sp.;

Phricodoceras Hyatt, 1900,
Phricodoceras sp. *aff. P. taylori* (Sowerby, 1826);

Polymorphites Haug, 1887,
Polymorphites acanthobronni Mouterde, Dommergues & Rocha, 1983,
Polymorphites calensis n. sp.,
Polymorphites sp. *aff. P. costatus* (Quenstedt, 1845),
Polymorphites bronni (Roemer, 1836),
Polymorphites echioceratoides Geczy, 1976,
Polymorphites evolutus Dommergues & Mouterde, 1978,
Polymorphites appenninicus n. sp.,
Polymorphites flexicostatus n. sp.,
Polymorphites interruptus (Quenstedt, 1845),
Polymorphites lineatus (Quenstedt, 1846),
Polymorphites muellensis Mouterde, 1951,
Polymorphites polymorphus (Quenstedt, 1845);

Prodactylioceras Spath, 1923,
Prodactylioceras gr. *colubriforme* (Bettoni, 1900),
Prodactylioceras davoei (Sowerby, 1822),
Prodactylioceras (Aveyroniceras) italicum (Fucini, 1900);

Protogrammoceras Spath, 1913,
Protogrammoceras carixiense Cantaluppi & Montanari, 1971,
Protogrammoceras dilectum (Fucini, 1900),
Protogrammoceras gr. *exiguum* (Fucini, 1904),
Protogrammoceras gr. *hungaricum* Geczy, 1976,
Protogrammoceras mellahense Dubar, 1961,
Protogrammoceras wiedenmayeri Braga & Rivas, 1980;

Pseudoskirroceras Wiedenmayer, 1980,
Pseudoskirroceras imlayi Smith & Tipper, 1988;

Radstockiceras Buckman, 1918,
Radstockiceras gemmellaroi (Pompecki, 1907),
Radstockiceras sp. *aff. R. numismale* (Oppel, 1853);

Reynesocoeloceras Geczy, 1976,
Reynesocoeloceras fischeri (Geczy, 1976),
Reynesocoeloceras preincertum Dommergues & Mouterde, 1982,
Reynesocoeloceras simulans (Fucini, 1905),
"Reynesocoeloceras" gr. *obesum* (Fucini, 1905);

Tetraspidoceras Spath, 1926,
Tetraspidoceras quadrarmatum (Dumortier, 1869);
Traghophylloceras Hyatt, 1900,
Traghophylloceras ibex (Quenstedt, 1848);

Tropidoceras Hyatt, 1867,
Tropidoceras bossense n. sp.,
Tropidoceras calliplocum (Gemmellaro, 1884),
Tropidoceras demonense (Gemmellaro, 1844),
Tropidoceras erythraeum (Gemmellaro, 1884),
Tropidoceras gr. flandrini (Dumortier, 1869),
Tropidoceras flandrini densicosta (Futterer, 1893),
Tropidoceras galatense (Gemmellaro, 1884),
Tropidoceras masseanum (d'Orbigny, 1844),
Tropidoceras mediterraneum (Gemmellaro, 1884),
Tropidoceras cf. *obtusum* (Futterer, 1893),

Tropidoceras stahli (Oppel, 1856),
Tropidoceras zitteli (Fucini, 1899);

Uptonia (Buckman, 1898),
Uptonia jamesoni (Sowerby, 1827),
Uptonia regnardi (d'Orbigny, 1844).

LITHOSTRATIGRAPHY AND BIOSTRATIGRAPHY

Bosso River section (Bosso River Valley)

The section was sampled along the Bosso River bed, below the level of the Cagli-Pianello road, about 1, 5 km from the village of Secchiano (Sheet 116 Gubbio, IV SE, 1: 25000 topographic map) (fig. 1). The total thickness of lower Carixian sediments is 41 m (fig. 3).

The Corniola Fm. lithology is the same of the Stirpeto section (see below). Geologically, the Bosso section belongs to the Mt Nerone-Mt Catria anticline, where Jurassic rocks are beautifully displayed (Centamore *et alii*, 1971). The Bosso section contains 21 fossiliferous levels. These yielded 280 ammonites (fragments included).

The Bosso River beds were deposited in a structural low, and therefore make up a thick, continuous succession.

Fossiliferous levels

Bed 39) *Galaticeras* sp. (2), *Lytoceras* sp. (1);
Bed 45) *Radstockiceras* sp. *aff. R. numismale* (5), *Catriceras catriense* (2), *"Catriceras"* sp. (1), *Lytoceras fimbriatum (11), Juraphyllites diopsis* (1), *Partschiceras striatocostatum* (2), *Polymorphites calensis* n. sp. (6), *Aegolytoceras varicosum (6), Radstockiceras* sp. (3), *Juraphyllites libertus* (4);
Bed 46) *Lytoceras fimbriatum* (1), *Tetraspidoceras* sp. (1);
Bed 51) *Galaticeras marianii* (1), *Tetraspidoceras quadrarmatum* (1);
Bed 52) *Tetraspidoceras quadrarmatum* (6), *Radstockiceras* sp. (2), *Radstockiceras* sp. *aff. R. numismale* (1), *Galaticeras* sp. *(9), Galaticeras marianii* (3), *"Epideroceras" gr. ancyrense* (2), *"Epideroceras" latinodosum* (1), *Gemmellaroceras* sp. (2), *Juraphyllites* sp. (2), *Juraphyllites libertus* (3), *Aegolytoceras varicosum* (2), *Phylloceras* sp. (1), *"Catriceras"* sp. (1);
Bed 53) *Radstockiceras* sp. (1), *Tetraspidoceras quadrarmatum* (3), *Galaticeras marianii* (3), *Juraphyllites libertus* (1);
Bed 54) *Tetraspidoceras quadrarmatum* (4), *Galaticeras* sp. (1);
Bed 55) *Tetraspidoceras quadrarmatum* (3), *Phylloceras* sp. (2), *Galaticeras marianii* (1), *Aegolytoceras varicosum* (1), *Galaticeras* sp. (1), *Juraphyllites libertus* (1);
Bed 58) *Galaticeras* sp. (4);
Bed 82) *Miltoceras* sp. (5), *Gemmellaroceras* sp. (1), *Juraphyllites libertus* (2), *Juraphyllites diopsis* (1), *"Catriceras"* sp. (1), *Aegolytoceras varicosum* (1), *"Reynesocoeloceras"* gr. *obesum* (2), *Tropidoceras* sp. (2);
Bed 84) *Miltoceras sellae* (1), *Juraphyllites* sp. (2), *Galaticeras* sp. (1), *Aegolytoceras varicosum* (1);
Bed 85) *Galaticeras* sp. (1), *Juraphyllites libertus* (3), *Miltoceras sellae* (3), *Miltoceras* sp. (10), *Polymorphites flexicostatus* n. sp. (5), *Galaticeras harpoceroide* (1), *"Catriceras"* sp. (2);
Bed 88) *Miltoceras sellae* (19), *Polymorphites flexicostatus* n. sp. (1), *Aegolytoceras varicosum* (1), *Gemmellaroceras* sp. (4), *Juraphyllites* sp. (3), *Juraphyllites libertus* (1), *Galaticeras* sp. (2);
Bed 89) *Galaticeras* sp. (1), *Miltoceras sellae* (2), *Tropidoceras* sp. (1);
Bed 90) *Galaticeras harpoceroide* (2), *Farinaccites clavatus* n. sp. (5), *Juraphyllites libertus* (1), *Tropidoceras* sp. (1);

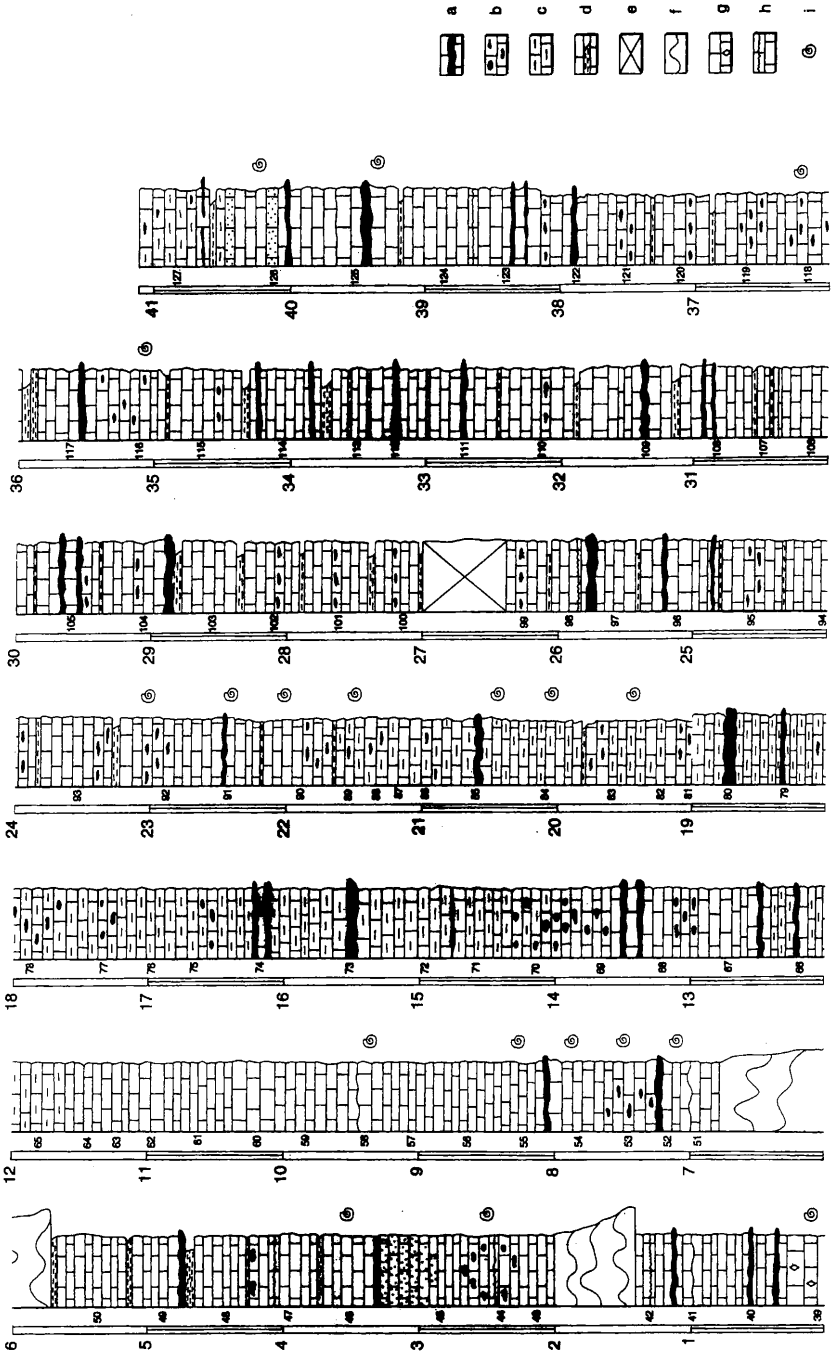

Fig. 3 - Bosso River section (Bosso River Valley), lower Carixian: *T. quadrarmatum* (beds 39-81), *M. sellae* (beds 82-125) and middle Carixian *M. gemmellaroi* (bed 126) zones. a) chert bed, b) chert nodules, c) marly limestone, d) clayey bed, e) covering, f) slump g) dolomitic limestone, h) stylolite; i) ammonite occurrence, 69: bed.

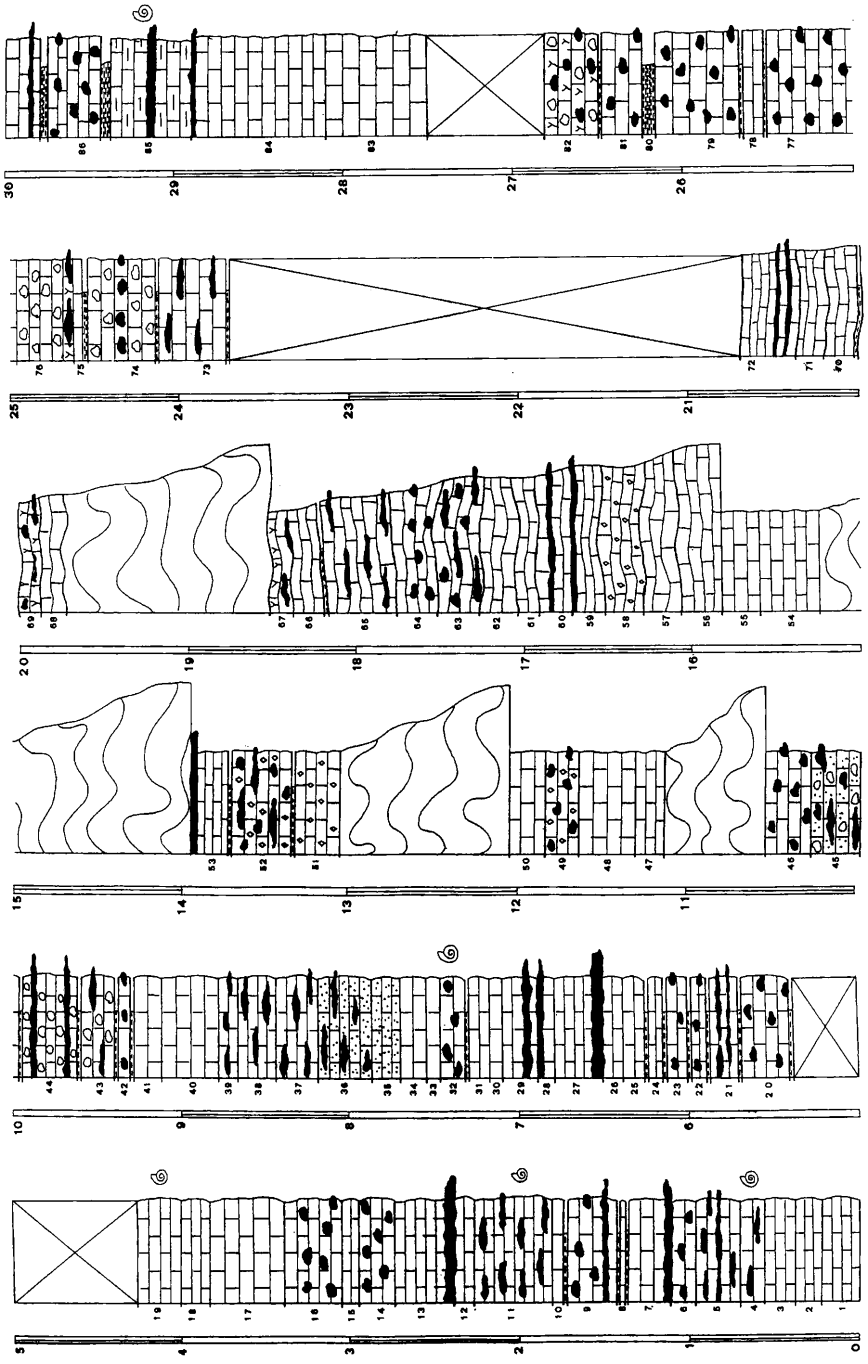

Fig. 4 a - Stirpeto section (Bosso River Valley), lower Carixian, *T. quadrarmatum* and *M. sellae* zones. a) Chert bed, b) chert nodules, c) clayey bed, d) covering, e) slump, f) dolomitic limestone, g) bioturbation, h) marly limestone, i) detritic limestone, l) marly nodules, m) stylolite, n) ammonite occurrence, 69: bed.

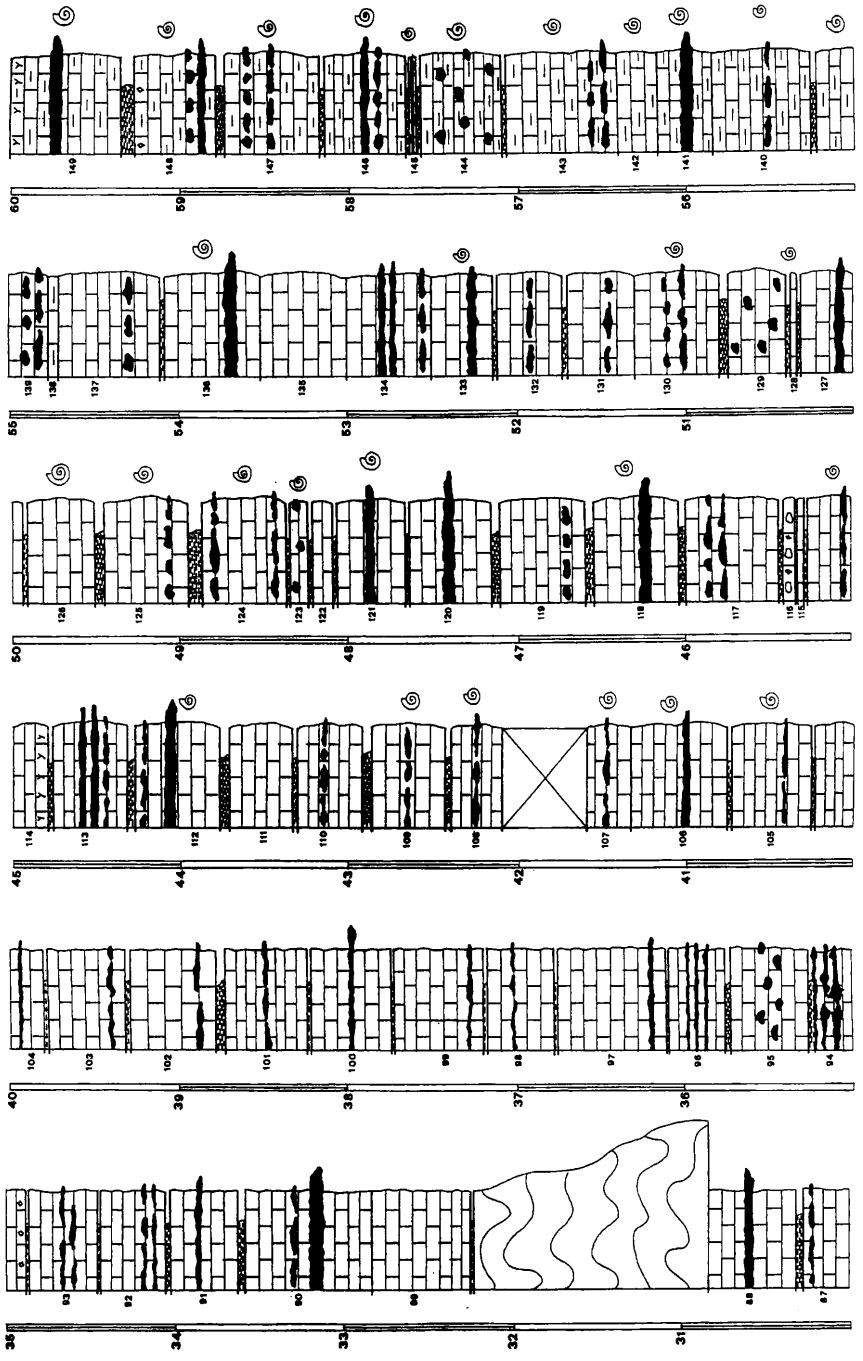

Fig. 4 b - Stirpeto section (Bosso River Valley), middle and upper Carixian, *M. gemmellaroi* and *P. dilectum* zones. a) Chert bed, b) chert nodules, c) clayey bed, d) covering, e) slump, f) dolomitic limestone, g) bioturbation, h) marly limestone, i) detritic limestone, l) marly nodules, m) stylolite, n) ammonite occurrence, 69: bed.

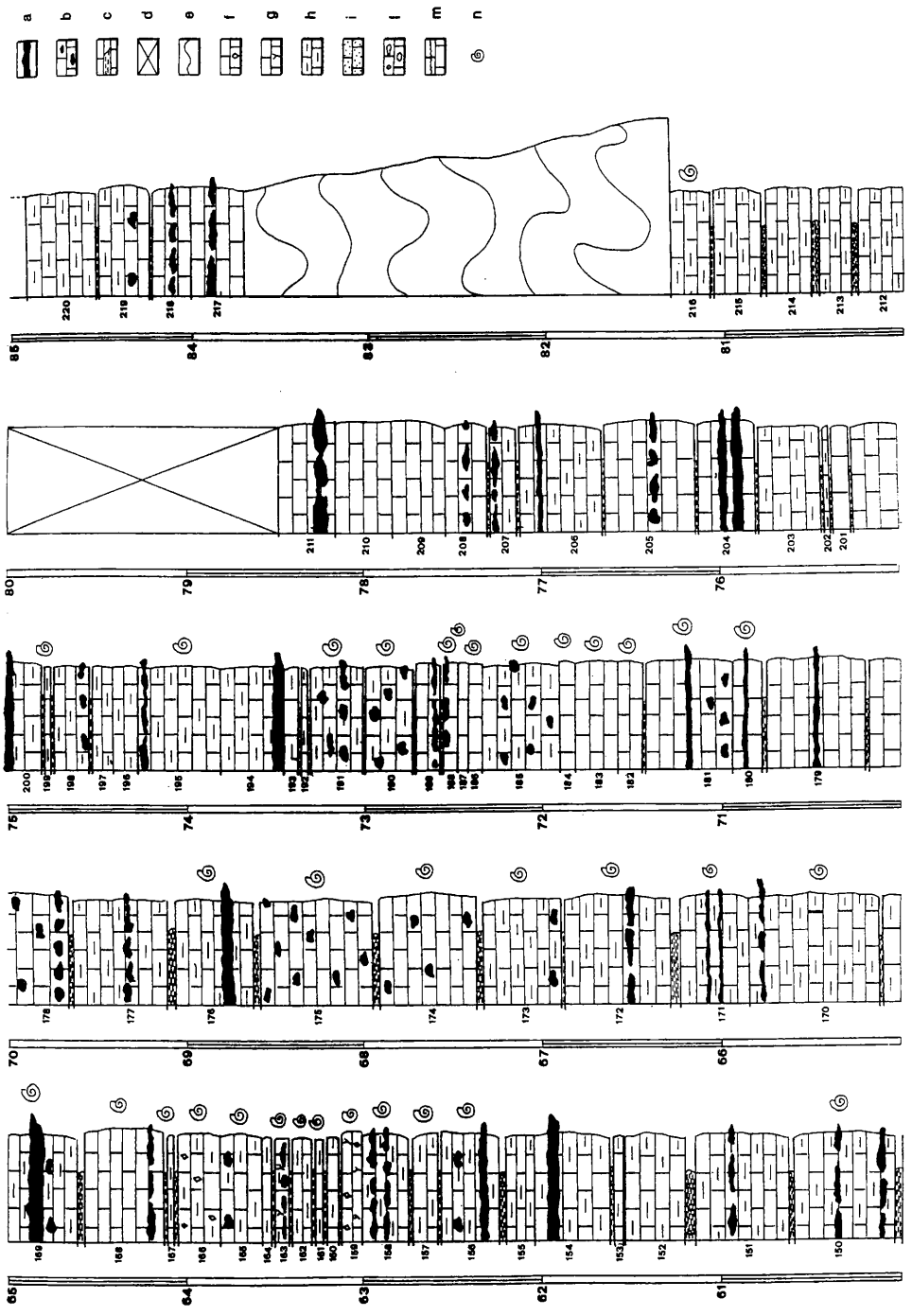

Fig. 4 c - Stirpeto section (Bosso River Valley), upper Carixian, *P. dilectum* zone. a) Chert bed, b) chert nodules, c) clayey bed, d) covering, e) slump, f) dolomitic limestone, g) bioturbation, h) marly limestone, i) detritic limestone, l) marly nodules, m) stylolite, n) ammonite occurrence, 69: bed.

Bed 91) *Galaticeras harpoceroide* (1), *Juraphyllites libertus* (3), *Galaticeras* sp. (1);
Bed 92) *Farinaccites clavatus* n. sp. (3), *Farinaccites kondai* (1), *Holcolytoceras quadrijugum* (1), *Miltoceras* sp. (1), *Juraphyllites libertus* (1), *Lytoceras fimbriatum* (1), *Tropidoceras* sp. (2);
Bed 116) *Miltoceras seguenzae* (3), *Tropidoceras bossense* n. sp. (8), *Polymorphites appenninicus* n. sp. (45), *Polymorphites* sp. (2), *Juraphyllites libertus* (3), *Aegolytoceras varicosum* (1), *Tropidoceras* sp. (1);
Bed 118) *Tropidoceras* gr. *flandrini* (1);
Bed 125) *Tropidoceras* gr. *flandrini* (1), *Metaderoceras* sp. (4), *Pseudoaganites* sp. (1), *Galaticeras* sp. (1);
Bed 126) *Tropidoceras mediterraneum* (1), *Metaderoceras* sp. (1), *Juraphyllites libertus* (1).

Stirpeto section (Bosso River Valley)

The full analytical data from this structural low section are found in Faraoni, Marini & Pallini (1994). The studied Corniola section (80 m thick, 220 beds, 600 ammonites) was measured along the same road mentioned for the Bosso River section (but above the road level) and is in fact just tens of meters away from it (fig. 1). However we took care to use a different bed numbering even though the bed package is largely the same, because we expected lateral differences (e. g. in total number of beds) even over short distances due to the effects of submarine sliding - which, in fact, we detected.

We report herein the new litho-biostratigraphic columns along with bed - by - bed occurrences of ammonite species (fig. 4).

Fossiliferous levels

Bed 4) *Paltechioceras* sp. (18), *Paltechioceras solaroide* (5);
Bed 11) *Lytoceras fimbriatum* (1), *Paltechioceras* sp. (5), *Paramicroderoceras* sp. (1);
Bed 19) *Phylloceras* sp. (1);
Bed 32) *Radstockiceras gemmellaroi* (1), *Galaticeras* sp. (1);
Bed 85) *Juraphyllites libertus* (1), *Partschiceras striatocostatum* (1);
Bed 105) *Juraphyllites libertus* (1);
Bed 106) *Radstockiceras* sp. *aff. R. numismale* (1), *Miltoceras sellae* (4), *Gemmellaroceras* sp. *G.* gr. *aenigmaticum* (4), *Galaticeras harpoceroide* (1), *Galaticeras flexistriatum* (2), *Galaticeras* sp. (2);
Bed 107) *Miltoceras sellae* (7), *Gemmellaroceras* sp. *G.* gr. *aenigmaticum* (5), *Phylloceras* sp. (1), *Galaticeras* sp. (2);
Bed 108) *Galaticeras* sp. (1);
Bed 109) *Gemmellaroceras aenigmaticum* (1);
Bed 112) *Miltoceras sellae* (2), *Gemmellaroceras* sp. *G.* gr. *aenigmaticum* (2), *Phylloceras* sp. (2);
Bed 114) *Miltoceras sellae* (1);
Bed 118) *Juraphyllites libertus* (1);
Bed 121) *Juraphyllites libertus* (1);
Bed 123) *Juraphyllites libertus* (1);
Bed 124) *Juraphyllites libertus* (1);
Bed 125) *Juraphyllites libertus* (1);
Bed 126) *Tropidoceras bossense* n. sp. (1);
Bed 128) *Tropidoceras* sp. (1);
Bed 130) *Tropidoceras* sp. (1);
Bed 133) *Tropidoceras* sp. (1);
Bed 136) *Metaderoceras* sp. (2);
Bed 139) *Juraphyllites libertus* (1), *Metaderoceras* sp. (1), *Galaticeras* sp. (1);
Bed 140) *Lytoceras* sp. (1);
Bed 141) *Juraphyllites libertus* (1), *Dubariceras dubari* (1);
Bed 142) *Juraphyllites libertus* (5), *Juraphyllites diopsis* (2), *Tropidoceras mediterraneum* (9), *T.*

demonense (2), *T. calliplocum* (2), *Tropidoceras* sp. (1), *Protogrammoceras* sp. A (35), *Protogrammoceras* gr. *hungaricum (4);*
Bed 143) *Galaticeras* sp. (1), *Protogrammoceras* sp. A (1), *Galaticeras* sp. A (2);
Bed 144) *Tropidoceras mediterraneum* (4), *Juraphyllites libertus* (1), *Galaticeras* sp. A (2), *Protogrammoceras* sp. A (1);
Bed 145) *Tropidoceras mediterraneum* (2), *T. demonense* (2), *Galaticeras* sp. (2), *Galaticeras* sp. A (1), *Protogrammoceras* sp. A *(3);*
Bed 146) *Tropidoceras demonense* (2), *Tropidoceras* sp. (1), *Galaticeras* sp. (2);
Bed 147) *Juraphyllites libertus* (1), *"Acanthopleuroceras"* sp. (10), *Metaderoceras gemmellaroi* (4);
Bed 148) *Juraphyllites libertus* (1), *"Acanthopleuroceras"* sp. (1), *Phylloceras* sp. (1);
Bed 149) *Juraphyllites libertus* (2), *"Acanthopleuroceras"* sp. (2), *Phylloceras* sp. (1);
Bed 150) *"Acanthopleuroceras"* sp. (1);
Bed 156) *Metaderoceras gemmellaroi* (1);
Bed 157) *Metaderoceras gemmellaroi* (7), *Galaticeras* sp. (1);
Bed 158) *Metaderoceras gemmellaroi* (3);
Bed 159) *"Acanthopleuroceras"* sp. (1);
Bed 161) *Metaderoceras gemmellaroi* (1).
Bed 162) *Calliphylloceras alontinum* (2), *Metaderoceras gemmellaroi* (4), *Metaderoceras* sp. (1), *Dayiceras* sp. *aff. D. dayiceroide* (1);
Bed 163) *Metaderoceras gemmellaroi* (1), *Dayiceras* sp. (1);
Bed 165) *Diaphorites vetulonius* (2), *Juraphyllites libertus* (1), *"Acanthopleuroceras"* sp. (1);
Bed 166) *Metaderoceras gemmellaroi* (1), *Juraphyllites libertus* (4), *"Acanthopleuroceras"* sp. (33), *Phylloceras* sp. (1), *Dayiceras* sp. *aff. D. dayiceroide* (30);
Bed 167) *"Acanthopleuroceras"* sp. (2), *Dayiceras* sp. (4);
Bed 168) *"Acanthopleuroceras"* sp. (2), *Metaderoceras gemmellaroi* (2), *Dayiceras* sp. (1);
Bed 169) *Juraphyllites libertus* (1), *Metaderoceras gemmellaroi* (1), *Dayiceras* sp. (1);
Bed 170) *Metaderoceras gemmellaroi* (1), *Protogrammoceras* sp. (2), *"Acanthopleuroceras"* sp. (4), *Phylloceras* sp. (1), *Metaderoceras* sp. (1), *Dayiceras* sp. (1);
Bed 171) *Metaderoceras gemmellaroi* (1);
Bed 172) *Lytoceras fimbriatum* (1), *Metaderoceras gemmellaroi* (12), *Galaticeras aegoceroide* (1), *Protogrammoceras* sp. (37), *Juraphyllites diopsis* (1), *Fieldingiceras* sp. (9), *Phylloceras* sp. (2);
Bed 173) *Protogrammoceras* sp. (2), *"Acanthopleuroceras"* sp. (2);
Bed 174) *Juraphyllites diopsis* (3), *J. planispira* (5), *J. libertus* (2), *"Acanthopleuroceras"* sp. (21), *Fieldingiceras* sp. (8), *Metaderoceras gemmellaroi* (9), *M. beirense* (2), *Protogrammoceras* sp. A (5), *Protogrammoceras* sp. (46), *Phylloceras* sp. (1);
Bed 175) *Calliphylloceras alontinum* (1), *Metaderoceras gemmellaroi* (8), *Juraphyllites libertus* (1), *Protogrammoceras* sp. A (7), *"Acanthopleuroceras"* sp. (2), *Lytoceras* sp. (1);
Bed 176) *Protogrammoceras* sp. (1);
Bed 180) *Reynesocoeloceras* sp. (2);
Bed 181) *Juraphyllites libertus* (1), *Protogrammoceras* sp. (1), *L. (Becheiceras) bechei* (1), *Reynesocoeloceras* sp. (2), *Gemmellaroceras aenigmaticum* (25);
Bed 182) *Protogrammoceras* sp. (2), *Reynesocoeloceras* sp. (2), *L. (Becheiceras) bechei* (2), *Phylloceras* sp. (1);
Bed 183) *Protogrammoceras* sp. (5), *Reynesocoeloceras simulans* (1), *Phylloceras* sp. (1);
Bed 184) *Protogrammoceras* sp. (2);
Bed 185) *Protogrammoceras* sp. (3), *Fieldingiceras* sp. (1), *Reynesocoeloceras* sp. (1), *R. simulans* (3);
Bed 186) *Protogrammoceras* sp. (5), *Fieldingiceras* sp. (3);
Bed 187) *Fieldingiceras* sp. (3), *Protogrammoceras* sp. (45), *Reynesocoeloceras* sp. (3), *L. (Becheiceras) bechei* (3), *Phricodoceras* sp. *aff. P. taylori* (1), *Phylloceras* sp. (3);
Bed 188) *Protogrammoceras* sp. (7), *P. dilectum* (7), *Phylloceras* sp. (1), *Audaxlytoceras* sp. (1);
Bed 190) *L. (Becheiceras) bechei* (1);
Bed 191) *Protogrammoceras dilectum* (1), *Audaxlytoceras* sp. (1), *Phylloceras* sp. (1);
Bed 195) *Protogrammoceras dilectum* (5);
Bed 199) *Fieldingiceras* sp. (1);
Bed 216) *Fuciniceras* sp. (19), *F. costicillatum* (3), *Fieldingiceras fieldingii* (3), *Juraphyllites* sp. (6), *Phylloceras* sp. (5), *Reynesocoeloceras* sp. (3).

Westernmost Bugarone Quarry Section (Mt Nerone)

This section was sampled along the southern slopes of Mt Nerone (about 1000 m elevation), near the westernmost Bugarone Quarry (sheet 116, IV SW, 1: 25000 map) (fig. 1). By contrast to the sections described above, this one was deposited on a structural high. The whole of the Corniola Fm. is only 12 m thick: its lower part is represented by nine carixian beds, with 5 fossiliferous levels, which yielded 116 ammonites, fragments included (fig. 5), (Pl. 7, figs 2, 4, 5, 7, 9; Pl. 8, fig. 3). Textures range from light-brown fine intrasparites, to grey-brown biointrasparites and biomicrites, to pinkish-grey micrites.

Fossiliferous levels

Bed 12) *Tropidoceras mediterraneum* (2), *T. demonense* (3), *T. erythraeum* (2), *T. zitteli* (2), *T. calliplocum* (2), *Protogrammoceras* sp. (2), *Metaderoceras gemmellaroi* (3), *Phylloceras* sp. (3), *Juraphyllites libertus* (4), *Partschiceras striatocostatum* (1), *Liparoceras (Becheiceras)* sp. (1);
Bed 13) *Metaderoceras gemmellaroi* (2), *Dubariceras cf. dubari* (1), *Juraphyllites libertus* (3), *Galaticeras aegoceroide* (2), *T. zitteli* (3), *T. demonense* (2), *T. calliplocum* (2), *L. (Becheiceras)* sp. (1);
Bed 14) *Protogrammoceras dilectum* (2), *L. (Becheiceras) bechei* (1);
Bed 18) *Protogrammoceras dilectum* (3) *Coeloceras* sp. (2);
Bed 21) *Fuciniceras costicillatum* (3), *Fuciniceras* sp. (3), *Reynesocoeloceras* sp. (1).

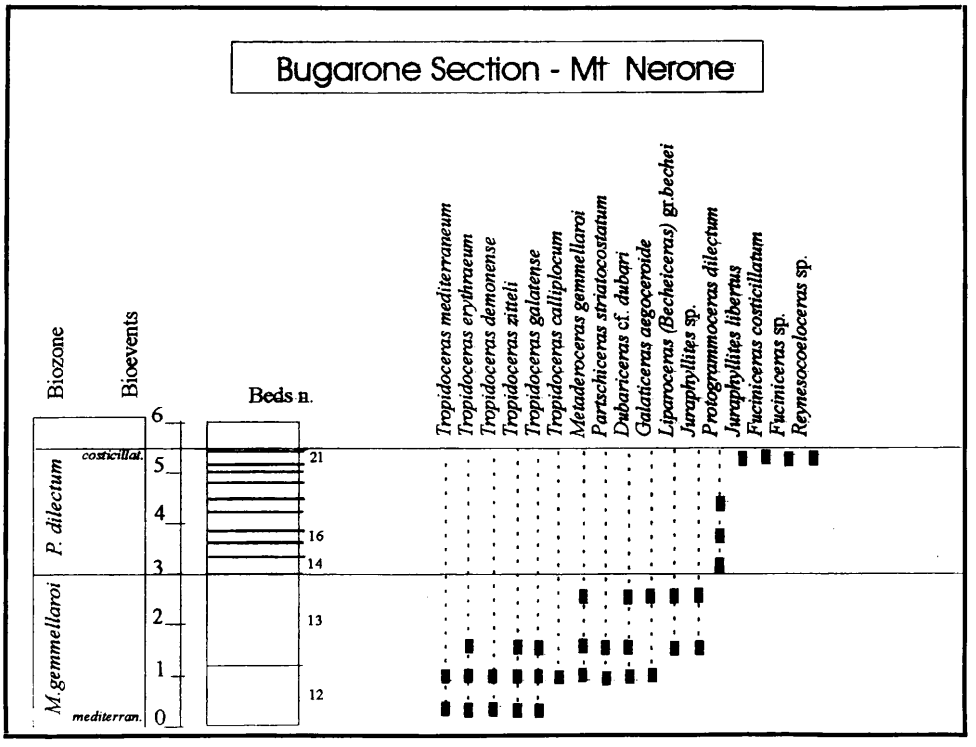

Fig. 5 - Westernmost Bugarone Quarry section (Mt Nerone), middle and upper Carixian, *M. gemmellaroi* and *P. dilectum* zones.

Pallareto Quarry section (Mt Acuto)

The Pallareto Quarry section is found along the western slopes of Mt Acuto (about 1150 m elevation), along the Chiaserna - Mt Catria road (fig. 1). We sampled a 3 m thick, thin-bedded cherty limestone interval. This interval has only one horizon, (richly) fossiliferous, which corresponds to a marly interbed (Venturi 1978). This yielded silicified ammonite moulds (about 300), with representatives of the following species (fig. 6), (Pls 11-13):

Phylloceras sp. (5), *Juraphyllites nardii* (4), *Galaticeras catriense* (250), *Galaticeras* sp. (2), *Aegolytoceras varicosum* (15), *Radstockiceras* sp. *aff. R. numismale* (3), *Paramicroderoceras?* sp. (1), *"Epideroceras" ancyrense* (5), *"Epideroceras" latinodosum* (3), *Coeloderoceras* sp. (1), *Gemmellaroceras* sp. (1), *Phricodoceras* sp. *aff. P. taylori* (3), *Catriceras catriense* (6), *"Catriceras"* sp. (2).

BIOSTRATIGRAPHICAL RESULTS

Preface

In undertaking a biostratigraphic subdivision of our successions, it became apparent that existing schemes (like those of Dean, Donovan & Howarth, 1961; Geczy, 1976; Braga *et alii*, 1982) could not be applied without changes. We therefore had to introduce some

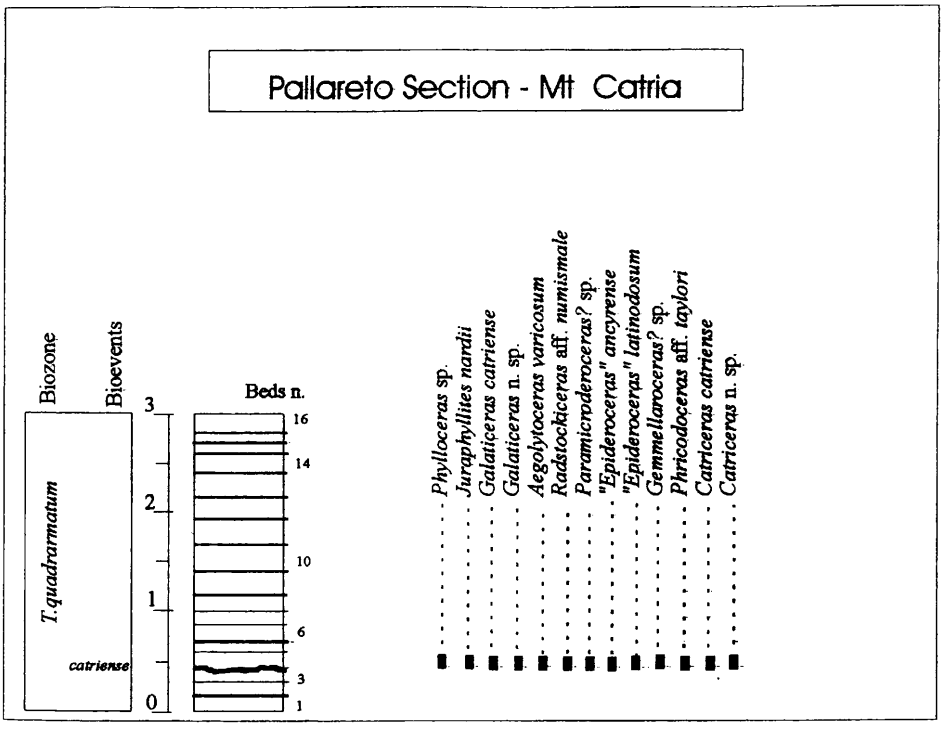

Fig. 6 - Pallareto Quarry (Mt Acuto), lower Carixian, *T. quadrarmatum* Oppel zone.

Bosso Valley

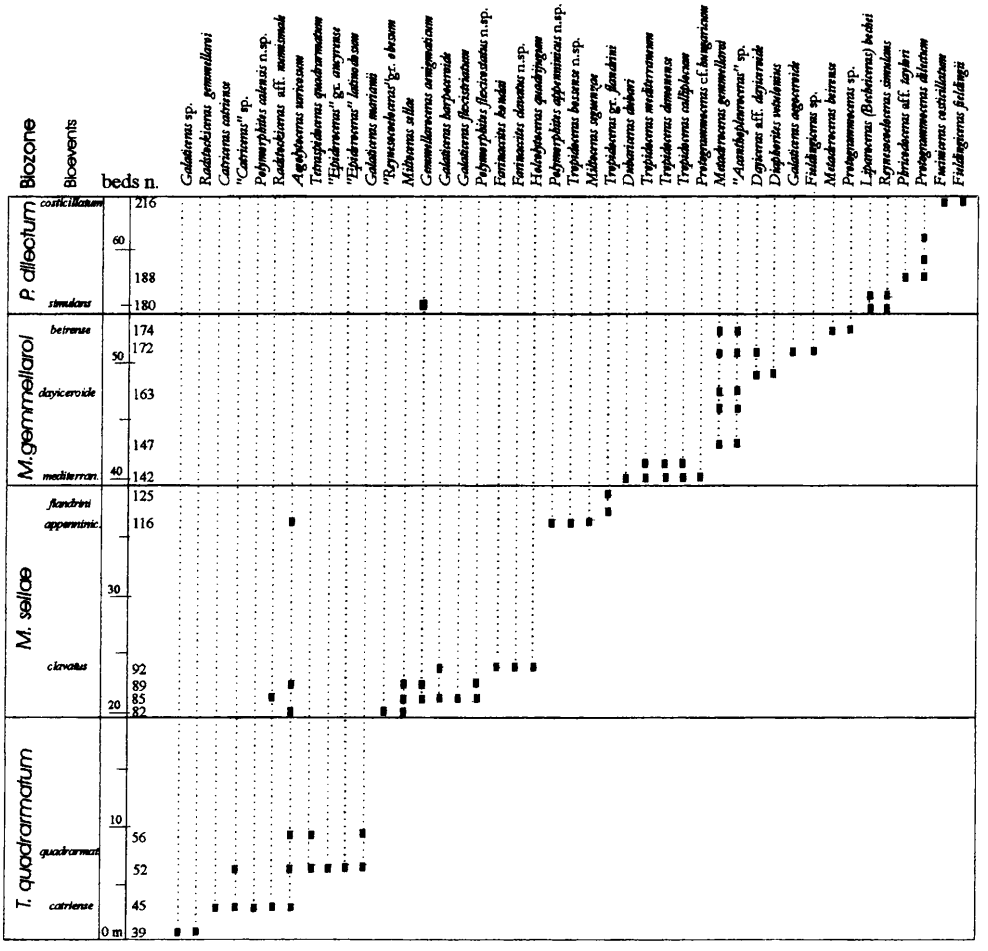

Fig. 7 - Species range chart of the Bosso Valley Carixian (Stirpeto and Bosso River sections)

modifications in the form of new markers whenever needed. We chose to make use of Oppel zones (according with the First Edition of the International Stratigraphic Guide, 1976: 57-58, even though this type of assemblage zone is dismissed in the II Edition of the International Stratigraphic Guide, 1994: 93) wherever the first appearance of the marker did not coincide with the faunal turnover that characterized a biozone boundary. Bioevents were recognized within individual biozones.

The Bosso River Valley yielded the most useful Carixian assemblages for biostratigraphy.

The two sections (Bosso River and Stirpeto) have been correlated to produce the species range chart shown in fig. 7. Our data indicate that some modifications must be made to the schemes by Geczy (1976) and Braga *et alii* (1982).

Our proposal includes the following points:

- to subdivide the lower Carixian into the *Tetraspidoceras quadrarmatum* Oppel zone (below) and the *Miltoceras sellae* taxon range zone (above) in place of the *Uptonia jamesoni* zone;
- to use *Metaderoceras gemmellaroi* as an Oppel zone for the middle Carixian in place of *Tragophylloceras ibex*;
- to use *Protogrammoceras dilectum* as a marker (*sensu* Braga *et alii*, 1982) for the youngest Carixian taxon range zone, in place of *Prodactylioceras davoei*.

Tetraspidoceras quadrarmatum Oppel zone
(Bosso River section, beds 39 to 81; thickness 19 m)

This is an Oppel zone, characterized by the co-occurrence of several typical lower Carixian taxa. We have elected to choose *T. quadrarmatum* as the index because of its easily recognizable shell, with a characteristic double row of spines on primary ribs, and well documented stratigraphic range through the Mediterranean and Boreal Palaeoprovinces.

The lower boundary of this Oppel zone is marked by the appearance of an assemblage comprising *Galaticeras* sp. and *Radstockiceras gemmellaroi* (Pompecki). A more diverse assemblage is found just above (see fig. 7).

Tetraspidoceras quadrarmatum appears later in our reference section. The upper boundary of the unit is placed at the first appearance of monospinate representatives of *Miltoceras* Wiedenmayer.

The oldest Carixian level (bed 39) bears *Galaticeras* sp. (Pl. 4, fig. 6) and *Radstockiceras gemmellaroi.*

Catriceras catriense (Pl. 4, fig. 3), *"Catriceras"* sp. (Pl. 4, fig. 7; Pl. 10, figs 1, 2), *Radstockiceras* sp. *aff. R. numismale* (Pl. 4, fig. 1), *Aegolytoceras varicosum* (Pl. 1, figs 3, 4; Pl. 10, figs 16-18), *Partschiceras striatocostatum* (Pl. 1, fig. 8) and *Polymorphites calensis* n. sp. (Pl. 3, figs 13, 14, 17, 18; Pl. 9, figs 1-3) occur in bed 45.

Beds 52-56 yield forms with two rows of spines, like *Tetraspidoceras quadrarmatum* (Pl. 2, fig. 1; Pl. 4, fig. 2) and "Epideroceras" gr. ancyrense (Pl. 3, fig. 2). They are associated to *"Epideroceras" latinodosum* (Pl. 3, fig. 1; Pl. 10, figs 4-6), *Galaticeras marianii* (Pl. 1, fig. 6; Pl. 4, fig. 5) and *Aegolytoceras varicosum.* This assemblage closely resembles that of Mt Acuto (Venturi, 1978) and is therefore of clear early Carixian age.

Two bioevents (*Catriceras catriense* and *Tetraspidoceras quadrarmatum*) are recognizable in this Oppel zone.

- Observations - *T. quadrarmatum* was used by Geczy (1976) in Hungary as a marker of the lowest horizon of the *U. jamesoni* zone.

Dommergues, Mouterde & Phelps (1984), though with only sparse data from the Tethyan region, had envisaged the genera *Tetraspidoceras* and *Apoderoceras*, namely *A. (Miltoceras) sellae*, as key forms for correlation between NW Europe and the Tethys. In fact *T. quadrarmatum* is a well known species in NW Europe, and its occurrence is documented in several basal Carixian localities by Dommergues & Meister (1992).

Meister & Sciau (1988) report the same species in the Causses basin (Southern France),

associated to Phricodoceras taylori, both species being typical of the *U. jamesoni* zone, *P. taylori* subzone.

Also *Radstockiceras* and *Polymorphites* are well known genera in NW Europe: Wiedenmayer (1977), Dommergues & Mouterde (1978), Schlatter (1980, 1991), Dommergues (1982, 1987), Mouterde, Dommergues & Rocha (1983), Meister (1986), Dommergues & Meister (1992) provide detailed information on these genera, which they hold as typical of the *U. jamesoni* zone.

"Epideroceras" ancyrense and *"Epideroceras" latinodosum*, are found by Bremer (1965) in the *E. raricostatum* and *P. taylori* subzones of Turkey. These forms have been reviewed and figured by Cope (1991) and Alkaya & Meister (1995).

The genus *Galaticeras* has a rather limited areal distribution, being typical of Italy, the Austrian Alps (Rosemberg, 1909) and Switzerland (Wiedenmayer, 1977). In our section it appears from the earliest levels of the *T. quadrarmatum* zone.

Catriceras catriense characterizes the base of the *T. quadrarmatum* zone. Due to its stratigraphic distribution, and to its very different suture line (Pl. 11, figs 4, 6, 9) this species cannot, in our opinion, be put in relation to Tropidoceras stahli (Dommergues, 1987).

Aegolytoceras varicosum, which in our sections is common in the *T. quadrarmatum* and *M. sellae* zones, is also found in Turkey (Cope, 1991, Pl. 1, fig. 9, identified as *Audaxlytoceras audax*; and Alkaya & Meister 1995, Pl. 4, fig. 3).

Miltoceras sellae taxon range zone

(Bosso River section; beds 82 to 125; thickness 20 m)

This biozone is characterized by monospinate forms. We have found *Gemmellaroceras* sp. and the earliest monospinate forms of *Miltoceras* sp. and *"Reynesocoeloceras"* gr. *obesum* (Pl. 4, figs 4, 8) in bed 82.

There is a very rich fauna of *Miltoceras sellae* (Pl. 6, figs 1, 3, 5-7) in bed 85; these forms are associated to *Galaticeras harpoceroide* (Pl. 1, fig. 1), *G. flexistriatum, Gemmellaroceras aenigmaticum, Polymorphites flexicostatus* n. sp. (Pl. 3, figs 7, 8, 15, 16; Pl. 9, figs 4, 5), *Radstockiceras* sp. *aff. R. numismale* and *Aegolytoceras varicosum*.

Some forms of Polymorphitidae, *Farinaccites clavatus* n. gen. n. sp. (Pl. 5, figs 1, 4; Pl. 9, figs 9-12), *F. kondai* (Pl. 6, fig. 8), associated with *Holcolytoceras quadrijugum* (Pl. 1, fig. 5) and *Aegolytoceras varicosum*, appear in beds 90-92. *Polymorphites appenninicus* n. sp. (Pl. 3, figs 3-6, 9, 10; Pl. 9, figs 6-8), *Miltoceras seguenzae* (Pl. 6, fig. 2), *Tropidoceras bossense* n. sp. (Pl. 5, figs 2, 3; Pl. 9, figs 13-18) and *Aegolytoceras varicosum* have been found in bed 116.

Tropidoceras gr. *flandrini* (Pl. 6, fig. 4) and the earliest representatives of *Metaderoceras* sp. are present in bed 125 (uppermost bed of the *M. sellae* taxon range zone).

Three bioevents (*Farinaccites clavatus, Polymorphites appenninicus* and *Tropidoceras* gr. *flandrini*) are recognizable in this taxon range zone.

- Observations - The main events characterizing the taxon range zone are the disappearance of forms with two rows of spines (*Tetraspidoceras quadrarmatum* and *"Epideroceras"* gr. *ancyrense*), and the appearance of forms with one row of spines, like *M. sellae*.

The genus *Miltoceras* (according to Hillebrandt, 1981) was created by Wiedenmayer (1977) as a subgenus of *Apoderoceras* Buckman (1921) to group also *Aegoceras sellae* and *A. seguenzae*, two species first described by Gemmellaro (1884).

This genus has been reported from the Subbetic Cordillera of Spain (Braga *et alii*, 1982 quote *M. sellae* from the lower Carixian); from North America and Canada (Smith *et alii*, 1988; Smith & Tipper, 1996); these authors report *Miltoceras* from the *Pseudoskirroceras imlay* zone, corresponding to the *U. jamesoni* zone.

From South America Riccardi (1984) and Hillebrandt (1987) report the genus from their *Apoderoceras* and *Eoderoceras* zone, corresponding to the *U. jamesoni* zone.

The genus *Gemmellaroceras*, with its species *G. aenigmaticum*, is used in Spain by Braga *et alii* (1982) as a marker of the lower Carixian. *Polymorphites* is well documented in NW Europe.

From the Tethys it is reported by Braga *et alii* (1982) from the *G. aenigmaticum* zone of Spain, and by Geczy (1976) in the *U. jamesoni* zone of Hungary.

Farinaccites n. gen. occurs in Hungary with the species *F. kondai*, which comes from the upper part of the *U. jamesoni* subzone (Geczy 1976).

At the top of the *M. sellae* zone we recovered specimens of *Tropidoceras* gr. *flandrini*.

In NW Europe the species occurs at the base of the *T. ibex* zone (Dommergues, Mouterde & Phelps, 1984) and at the top of the lower Carixian with the subspecies *T. flandrini densicosta* (Turin, Mouterde & Dommergues, 1985; Meister, 1986).

In Turkey, Alkaya & Meister (1995) report *T. flandrini* and *T. flandrini* cf. *obtusum* from the *U. jamesoni* subzone.

***Metaderoceras gemmellaroi* Oppel zone**
(Stirpeto section, beds 141 to 179; thickness 14, 5 m)

Bed 141 is characterized by the appearance of *Dubariceras dubari*. A differentiated fauna of *Tropidoceras*, represented by *T. demonense, T. mediterraneum* (Pl. 7, fig. 8), *T. calliplocum*, was collected from bed 142. The same bed also yields the earliest representatives of *Protogrammoceras*, mainly bisulcate forms of the *P. hungaricum* group (Pl. 7, fig. 1). *Metaderoceras gemmellaroi* (Pl. 8, fig. 10; Pl. 10, figs 10-14) and *"Acanthopleuroceras"* sp. occur in bed 147. Beds 162 and 163 contain *Dayiceras* sp. *aff. D. dayiceroide* (Pl. 7, fig. 3; Pl. 10, figs 7, 8) which appears with numerous specimens. *Diaphorites vetulonius* is found in bed 165.

Galaticeras aegoceroide, along with numerous small *Protogrammoceras* sp., occurs in bed 172. Bed 174 yielded *Metaderoceras beirense* (Pl. 8, figs 6, 9), *Protogrammoceras* sp, and *"Acanthopleuroceras"* sp. (Pl. 7, fig. 6).

Three bioevents (*Tropidoceras mediterraneum*, *Dayiceras* sp. *aff. D. dayiceroide* and *Metaderoceras beirense*) are recognizable in this Oppel zone.

- Observations - *Metaderoceras gemmellaroi* is a well known species in the Umbria-Marche Apennines and throughout the Mediterranean Tethys.

Ferretti (1972, 1975, 1991) and Cecca *et alii* (1990) place *M. gemmellaroi* and *M.* gr. *evolutum* from the Mt Nerone - Mt Catria area into the middle Carixian, *T. ibex* zone.

Cantaluppi & Montanari (1968, 1971) found some species of *Metaderoceras*, different from *M. gemmellaroi* and *M. evolutum*, in the middle Carixian of the Pre - Alps (*Crucilobiceras submuticum*, and *M.* gr. *muticum*).

Dubar & Mouterde (1978) report the group *M. evolutum, M. gemmellaroi, M. atlantis, M. venarense, M. beirense* from the *T. ibex* zone of Morocco.

Colera *et alii* (1978) describe several species of *Metaderoceras* from the upper *T. ibex* zone of the Iberian Cordillera (Spain).

Braga *et alii* (1982) and Braga & Rivas (1985) report abundant *Metaderoceras* from the middle Carixian of the Subbetic Cordillera (Spain).

Dommergues, Mouterde & Phelps (1984), with reference to NW Europe, place *M.* gr. *muticum* into the *P. brevispina* subzone (*U. jamesoni* zone), and *M. venarense* with *M. beirense* into the *A. valdani* subzone (*T. ibex* zone); these Authors also claim that *Metaderoceras* is not present from the lower Carixian of the Mediterranean Province; the greater part of tethyan *Metaderoceras* (*M. gemmellaroi, M. evolutum*) appear in the middle Carixian.

The lowest fossiliferous level in the *M. gemmellaroi* Oppel zone is the first appearance of *T. mediterraneum* (along with *T. demonense, T. calliplocum* and *T. zitteli*). These forms mark the beginning of the middle Carixian (*T. ibex* zone) also in NW Europe, where *T. masseanum* is held as coeval to *T. mediterraneum* (Dommergues, Mouterde & Phelps, 1984).

The same beds with *T. mediterraneum* also contain the earliest *Protogrammoceras*, which include some bisulcate forms belonging to *P. hungaricum* and they are utilized by Geczy (1976) as markers of the upper *U. jamesoni* zone in the Bakony Mts (Hungary).

The occurrence of *Dayiceras* sp. *aff. D. dayiceroide* can be correlated to the occurrence of several congeneric species in Portugal; these species are subzone (*D. renzi*) and horizon (*D. dayiceroide, D. renzi, D. polymorphoides, D. splendens, D. amaltheiforme/nanum*) markers of the lower *T. ibex* zone (Mouterde, Dommergues & Rocha, 1983).

Rakus (1972) describes *D. baltzeri* as co-occurring with *T. flandrini* in the Carixian of Tunisia.

Rare specimens of *M. beirense* come from the upper part of the *M. gemmellaroi* zone.

Mouterde, Dommergues & Rocha (1983) utilize this species in Portugal as a marker of the second subzone of the middle Carixian (*T. ibex* zone).

***Protogrammoceras dilectum* taxon range zone** (*sensu* Braga *et alii* 1982)
(Stirpeto section, beds 180 to 216; thickness 10, 5 m)

Reynesocoeloceras sp., *R. simulans* (Pl. 8, fig. 7), *L. (Becheiceras) bechei* (Pl. 8, figs 5, 8), *Gemmellaroceras aenigmaticum, Fieldingiceras* sp. are found in beds 180 - 185.

Protogrammoceras dilectum (Pl. 8, fig. 4), *L. (Becheiceras) bechei, Phricodoceras* sp. *aff. P. taylori* (Pl. 8, fig. 2), and *Audaxlytoceras* sp. (Pl. 10, fig. 15) appear in beds 187 - 199.

Fuciniceras sp. and *F. costicillatum* (Pl. 8, fig. 1), co-occur with *Fieldingiceras fieldingii* in bed 216.

Two bioevents (*Reynesocoeloceras simulans* and *Fuciniceras costicillatum*) are recognizable in this biozone.

- Observations - We found a close correspondence of our biozone to that proposed by Braga *et alii* (1982) for the upper Carixian of the Mediterranean Tethys.

Ferretti (1972, 1975) holds the levels bearing *P. dilectum* as belonging to the upper Carixian in the Mt Nerone area.

In a later work, Ferretti (1991) puts his *Fuciniceras dilectum* horizons (lower and upper) into the middle Carixian (*T. ibex* zone). As already documented by Dommergues *et alii* (1983), Ferretti's (1991) specimens might not belong to *Protogrammoceras dilectum*, and be instead similar to species we found in our sections starting from the *M. gemmellaroi* zone.

Cantaluppi & Montanari (1968, 1971), in the western Pre-Alps, attribute several species to the upper Carixian or, more in general, to the Carixian-Domerian transition. These are: *Prodactylioceras* sp., *Fuciniceras detractum*, *F. normanianum*, *F. boscense*, *F. (Eofuciniceras)* gr. *dubari*, *P. (Eoprotogrammoceras)* gr. *carixiense*, *P. (Protogrammoceras)* gr. *exiguum*, *Reynesocoeloceras simulans*, *Prodactylioceras* gr. *colubriforme*.

Du Dresnay (1963) reports *P. dilectum* and *F. costicillatum* from the *P. davoei* zone of Morocco.

Geczy (1976) quotes *P. dilectum* in the *P. davoei* zone of the Bakony Mts (Hungary); he also proposes two alternative markers (either *P. (Aveyroniceras) italicum* or *F. costicillatum)* to *P. davoei*.

Braga & Rivas (1980, 1985) and Braga *et alii* (1982) place an association with *Radstockiceras* sp., *Reynesocoeloceras indunense, R. colubriforme, Liparoceras* gr. *bechei, Protogrammoceras carixiense, P. wiedenmayeri, P. dilectum, Fuciniceras giemmense* into the *P. dilectum* zone of Spain.

Dommergues *et alii* (1983), in a paper dealing with correlation between Tethyan (Italy and Hungary) and Subboreal (France and Portugal) faunas, place the Tethyan Carixian/Domerian boundary as corresponding to the boundary between the *Protogrammoceras costicillatum* and the *Fuciniceras portisi/lavinianum* horizons.

Dommergues (1986) delves deep into the subfamily Reynesocoeloceratinae, whose species replace the latest ones of *Metaderoceras* of the middle Carixian.

Meister (1986) reports *F. costicillatum* as ranging from the *P. davoei* to the *A. stokesi* zones in southern France (Subboreal Province).

L. (Becheiceras) bechei is found in the upper Carixian of Spain (Braga & Rivas, 1980) and Hungary (Geczy, 1976), and is also reported from the *P. davoei* zone of NW Europe by Schlatter (1980, 1991) and Meister (1986), and from North America and Canada (*A. whiteavesi* to *F. kunae* zones) (Smith *et alii*, 1989; Smith & Tipper, 1996).

SYSTEMATIC DESCRIPTIONS

The standard dimensions are given in millimetres and as percentages of the diameter. The following abbreviations have been used: D = diameter, Ud = umbilical diameter, Ww = Whorl width, Wh = Whorl height, K = number of ribs per half whorl. The measures in bold are referred to the holotypes. For a descriptive terminology of suture lines see Wiedmann & Kullman (1980) and Venturi (1985). The figured specimens are temporarily stored in the Faraoni collection (Via Sparapani 11c Ancona).

Classis Cephalopoda Leach, 1817
Order Ammonoidea Zittel, 1884
Suborder Ammonitina Hyatt, 1889
Superfamily Eoderocerataceae Spath, 1929
Family Polymorphitidae Haug, 1897
Subfamily Polymorphitinae Haug, 1897

Genus ***Polymorphites*** Haug, 1897
Type species: ***Ammonites polymorphus*** Quenstedt, 1845.

In Arkell's (1957) opinion, the genus groups small species with subquadrate, to subrectangular, to subelliptical whorl section, and weak to strong, dense to sparse ribbing. The ventral area may bear proverse ribs creating a chevron; small tubercles may be present on ventrolateral margin; the suture line is simple in young and complex in adult specimens. The species generally have domed ventral area, and rib angles are arranged accordingly. In our opinion, the diagnosis could be amended to accommodate our new species from the Apennines. *P. calensis* and *P. flexicostatus* have in fact a rounded venter and faint ribbing; on the other hand, *P. appenninicus* is closer to typical *Polymorphites*. Dommergues & Mouterde (1978) suggest that *P. evolutus* and *P. bronni* be microconchs of *U. regnardi* and *U. jamesoni* respectively. Dommergues (1987) considers the species of the *P. polymorphus* group to be microconchs of *Parinodiceras* Trueman, 1918.

Geographic distribution: America, Europe, North Africa, East Turkey.

Polymorphites calensis n. sp.
(Pl. 3, figs 13, 14, 17, 18; Pl. 9, figs 1-3)

1980 *Polymorphites* sp. nov. (?), Schlatter, p. 94, Pl. 7, fig. 7, a, b., beil. 16, fig. E.

Name derivation: after the original latin name (*Cale*) of Cagli village (PS).
Holotype: Po 17 a; Pl. 3, figs 17, 18; Pl. 9, figs 1, 2.
Paratypes: Po 17, Po 18.
Type locality: Bosso River near Secchiano di Cagli.
Type level: Bosso River section; Bed 45, *T. quadrarmatum* Oppel zone.
Depository: Faraoni Collection.
Material: 2 complete specimens and 2 fragments.

Specimen	D	Ud	Ww	Wh	K
Po 17a	**26**	**12(0, 46)**	**7, 6(0, 29)**	**8(0, 31)**	**14**
Po 17	19	8, 6(0, 45)	6, 3(0, 33)	6, 7(0, 35)	12

Description - Small platycones, relatively evolute; whorls overlap by 1/6. Whorl section subquadrate; ventral area domed to rounded. Sides subconvex, with rounded umbilical wall; shallow umbilicus. Ribs simple, sharp, regularly spaced from the inner whorls, radial to slightly proverse, originating at the umbilical wall and becoming stronger at mid-flank. On ventral-lateral margin, ribs form a node-spine, then become proverse and fade out on venter, forming a faint obtuse angle (chevron) at connection to those running from the opposite side.

Simple suture line with E asymmetrically shifted on the left side; the two L's are therefore unequal, as well as the ES saddles of both sides; E lobe is a long as L.

Discussion: The Portuguese specimens (Mouterde, Dommergues & Rocha, 1983) of *Polymorphites* sp. *aff. P. costatus* have a more markedly dome-shaped venter. Ribbing is strong on ventral area, and the "chevron" is more acute. *P. lineatus* has stronger and denser ribs on venter. *P. muellensis* has stronger ribs and narrower venter. *P. acanthobronni* is more

evolute, with narrower venter and stronger siphon. *P.* gr. *polymorphus* figured by Dommergues (1987, Pl. 6) have finer and denser ribs and have no ventrolateral spines; the specimen of *P. polymorphus* figured by Schlatter (1980 Pl. 7, fig. 2) has a different ventral area. *P. echioceratoides* (Geczy, 1976, Pl. 13, fig. 1) has wider whorl. *P. interruptus* has coarser ribs and strong chevrons on domed venter.

Polymorphites flexicostatus n. sp.
(Pl. 3, figs 7, 8, 15, 16; Pl. 9, figs 4, 5)

Name derivation: after its flexuous and fine ribbing.
Holotype: Po 37; Pl. 3, figs 15, 16; Pl. 9, figs 4, 5.
Paratype: Po 38.
Type locality: Bosso River, near Secchiano di Cagli.
Type level: Bosso River section; Bed 85. It is also presents in bed 88, *M. sellae* taxon range zone.
Depository: Faraoni Collection.
Material: 2 complete specimens and 4 fragments.

Specimen	D	Ud	Ww	Wh	K
Po 37	**19. 3**	**8(0, 41)**	**6, 8(0, 35)**	**7(0, 38)**	**15**
Po 38	14	6(0, 43)		5(0, 36)	14

Description: small, medium-involute; whorls slightly overlapping. Section width and height almost equal. Flexuous ribs, sigmoidal, slightly projecting, becoming coarser at lateral spines, and then almost disappearing on rounded venter. Sides convex. Suture has asymmetrical E, as long as L; U2 and U3 very small. ES saddle wider than LS1, with A shifted towards L.

Discussion: *P. flexicostatus* differs from *P. calensis* n. sp. in that it grows faster and has flexuous ribs, and from *P. appenninicus* n. sp. for non flat morphology and rounded venter with faint ribs (*P. appenninicus* has sharper, ribbed venter). It differs from *P. lineatus* and *P. bronni* for its virtually unribbed, rounded venter. *P. echioceratoides* is also unribbed but has wider whorl section; moreover its suture has E lobe much longer than L (in *P. flexicostatus*, E is as long as L).

Polymorphites appenninicus n. sp.
(Pl. 3, figs 3-6, 9, 10; Pl. 9, figs 6-8)

Name derivation: after the Apennines mountain range of Italy.
Holotype: Po18; Pl. 3, figs 5, 6; Pl. 9, figs 6-8.
Paratypes: Po 19, Po 20, Po 21, Po 22, Po 23, Po 25, Po 39.
Type locality: Bosso River, near Secchiano di Cagli.
Type level: Bosso River section; Bed 116, *M. sellae* taxon range zone.
Depository: Faraoni Collection.
Material: 15 complete specimens and about 30 fragments.

Specimen	D	Ud	Ww	Wh	K
Po 18	**12**	**5, 2(0, 43)**	**2, 6(0, 22)**	**3, 7(0, 33)**	**22**
Po 19	11. 3	4, 7(0, 41)		3, 6(0, 32)	24
Po 23	14	6, 2(0, 44)	3(0, 21)	4, 5(0, 32)	22
Po 20	11. 6	5(0, 43)	2, 6(0, 22)	4(0, 34)	22
Po 22	13. 3	6(0, 45)	3(0, 22)	4, 5(0, 34)	24
Po 25	9. 3	3, 8(0, 41)		3, 7(0, 40)	23
Po 21	11	4, 4(0, 40)		4, 2(0, 38)	23
Po 39	12. 8	5(0, 39)		4, 2(0, 33)	23

Small (maximum diameter 15 mm), medium-evolute; whorls overlap by 1/8 and grow rapidly in height. Whorl section is more high than it is wide, with subacute venter. Convex sides gradually merge into ventral area. Umbilical wall rounded. Shallow umbilicus. Ribs fine, dense, flexuous, slightly biconcave, tending to project on ventral area; ribs tend to be born twinned at umbilical margin, with no tubercles. Suture simple, with E in symmetrical position, equal or slightly longer than trifid L; U2 and U3 small. ES as wide as LS1.

Discussion: the species differs from *P. calensis* and *P. flexicostatus* in that it has no lateral-ventral spines; it has acute domed venter, flexuous proverse ribs, and differing suture. It differs from *P.* gr. *polymorphus* in having flatter whorl (Dommergues, 1987; Pl. 6, figs 7, 8, 13, 14). *P. lineatus* has a different style of ornamentation with fine, dense ribs.

Subfamily uncertain

Genus ***Farinaccites*** n. gen.
Type species ***F. clavatus*** n. sp.

Name derivation: The genus is dedicated to Prof. Anna Farinacci, of the University "La Sapienza", Roma.

Description: Medium-size platycone, high-spired evolute with sides flat to slightly convex and nearly tabulate venter. Ribs depart from the umbilical margin, rursiradiate to straight radial, to slightly proverse. Elaborate suture line, with trifid L and U3 converging into U2 (Pl. 9, fig. 9).

Two species occur at the Bosso River section: *Farinaccites clavatus* n. sp., which we elect as type species, and *F. kondai*.

Discussion: Geczy (1976) ascribed his species to *Uptonia* without considering that its "tubercules très aigus, en forme d'épine" became flat and bent forward. Also, the smooth ventral area is unknown in *Uptonia* (that has ribbed venter).

Stratigraphic distribution: upper *M. sellae* taxon range zone, and upper *U. jamesoni* zone in Hungary.

Geographic distribution: Italy and Hungary.

Farinaccites clavatus n. sp.
(Pl. 5, figs 1, 4; Pl. 9, figs 9-12)

Name derivation: from the latin language clavatus, for the straight ornamentation of this species with clavi

Holotype: Fa 1; Pl. 5, fig. 1.
Paratypes: Fa 2, Fa 4.
Type locality: Bosso River, near Secchiano di Cagli.
Type level: Bed 92, *M. sellae* taxon range zone.
Depository: Faraoni Collection.
Material: 3 complete specimens and 4 fragments.

Specimen	D	Ud	Ww	Wh	K
Fa 1	**116**	**69(0, 59)**	**11(0, 094)**	**29(0, 25)**	**42**
Fa 2	93	53(0, 57)	10(0, 107)	21(0, 22)	36
Fa 4	75	45(0, 60)	11(0, 14)	18(0, 24)	34

Description: medium size platicone, evolute (about Ud/D 0. 6), with hardly overlapping coils, slow growing. Whorl section more high than wide, subrectangular; nearly tabulate venter, slightly convex sides that merge smoothly into the umbilical margin, where ribs become rursiradiate. Nearly flat umbilicus. Single ribs tall and regularly spaced, as wide as inter rib spaces. Ribs are rursiradiate at early growth stages, then become radial to slightly proverse; they terminate at ventral margin with flat, sharp clavi, gently sloping into sides and proverse. Elaborate suture, with trifid L and rotated U3, blocking the U2.

Farinaccites kondai (Geczy, 1976)
(Pl. 6, fig. 8)

1976 *Uptonia konday* n. sp., Geczy, p 66, Pl. 13, figs 4, 6; Pl. 14, fig. 1 a-c.

Specimen	D	Ud	Ww	Wh	K
Fa 3	107	63(0, 59)	14(0, 13)	23(0, 21)	27

Description: medium-size evolute shell, with coils hardly overlapping, slowly growing in height, whorl section subrectangular, with slightly rounded ventral area; convex sides gradually merge into umbilical margin; shallow umbilicus. Strong radial ribs, with ample inter-rib spaces, ending with ventro-lateral proverse clavi, similarly to *Farinaccites clavatus*.

Discussion - It differs from *Farinaccites clavatus* in having stronger and less dense ribbing, more convex sides, and wider whorl section.

Level: Bosso River, bed 92 *M. sellae* taxon range zone. The species is also known in the Bakony Mts (Hungary) from the upper *U. jamesoni* zone.

Subfamily Tropidoceratinae

Genus ***Tropidoceras*** Hyatt, 1867
Type species ***Ammonites masseanus*** d'Orbigny, 1844.

Diagnosis - More or less flat and involute shells, with whorl section more high than wide, with rounded umbilical margin and subacute ventral area; this latter bears a tall keel.

Flexuous primary and secondary ribs, with low relief, fading towards venter (see type species). Suture with E shorter than L, which is generally bifid, narrow stemmed, enlarging toward the bottom. Sutural lobe more or less evident, with sloping umbilical lobes.

- Observations -: according to Braga & Rivas (1985) *T. erythraeum* is the oldest *Tropidoceras* (a derivative of *Gemmellaroceras*). Then *T. flandrini-T. demonense* (a macro-microconch couple) would follow, succeeded by *T. mediterraneum-T. calliplocum* (macro-microconch) and then by *T. zitteli*. According to Dommergues (1987), three species groups would be recognizable within the genus, possibly corresponding to subgenera: *T flandrini-T. obtusum, T. masseanum-T. demonense,* and *T. stahli-T. catriense*. In proposing various hypotheses about the origin of these groups, he is uncertain as whether the *masseanum-demonense* group would have arisen from Acanthopleuroceratinae (polyphyletic hypothesis), or from the *T. flandrini-T. obtusum* group. The Author states *T. catriense* would be derived from *T. stahli*, due to its stratigraphic position within the *A. valdani* subzone (middle *T. ibex* zone); he also believes this evolution would have involved loss of secondary ribs (his fig. 51). However, while Dommergues (1987) admits the origin of *Tropidoceras* is still unclear, he speculates the *T. flandrini-T. obtusum* groups might have stemmed from Eoderoceratacеae (due to the double row of tiny spines on the sides).

Our data from the Apennines indicate that the *T. flandrini* group appears early, and the oldest *Tropidoceras* are those of the *C. catriense* group. This early appearance is further supported by the faunal assemblage of the Pallareto Quarry (Mt Acuto) (Venturi, 1978), that also includes bispinate Eoderoceratacеae (*Microderoceras*) and *Radstockiceras* gr. *numismale*. The Bosso association confirms, in our opinion, the validity of *Catriceras* at least at the subgeneric level, since it appears to be unrelated to *Tropidoceras* and *Acanthopleuroceras* on both morphologic and stratigraphic grounds; *Catriceras* occurs in the basal Carixian.

Stratigraphic distribution: according to Arkell, 1957 the genus appears in the *U. jamesoni* zone. According to Schlatter (1980), it would appear in the upper part of the *U. jamesoni* zone. This datum is acknowledged by Dommergues (1987) who, following a detailed review, states the group disappears in the *A. valdani* subzone.

Geographic distribution: the species of the genus occur in America and Canada, Europe, North Africa, east Turkey and Indonesia.

Tropidoceras bossense n. sp.
(Pl. 5, figs 2, 3; Pl. 9, figs 13-18)

Name derivation: after the Bosso River where type specimens were collected.

Holotype: Tr 73; Pl. 5, fig. 2; Pl. 9, figs 16-18.

Paratypes: Tr 100, Tr 101.

Type locality: Bosso River, near Secchiano di Cagli.

Type level: Bosso River, bed 116, *M. sellae* taxon range zone. It also occurs in Stirpeto section, bed 126, *M. sellae* taxon range zone.

Depository: Faraoni Collection.

Material: 3 complete specimens and 4 fragments.

Specimen	D	Ud	Ww	Wh	K
Tr 73	**45**	**19(0, 42)**		**15(0, 33)**	**12**
Tr 100	43	18(0, 42)		15(0, 35)	12
Tr 101	25	10(0, 40)		9(0, 36)	10

Description: medium involute, small, high, flat section with subacute venter, low-relief, distant rectiradiate ribs, fading at external third of side (10-12 every half whorl). Suture with E much shorter than L, bifid, asymmetrical; U2 and U3 little developed and only slightly sloping.

Discussion: This species apparently belongs to the *T. masseanum-T. demonense* group (which also includes *T. mediterraneum*) of Dommergues (1987); this might be given the status of subgenus *T. (Tropidoceras)*, grouping those forms with closer affinities to the type species of *Tropidoceras*. As far as we know, this is the oldest species of the group. It differs from *T. demonense* in being more involute, with weaker ribs, and having much smaller E lobe; unlike other species of Tropidoceras (*T. masseanum, T. mediterraneum*) this one has no secondary ribs.

CONCLUSIONS

This paper confirms the importance of the Umbria-Marche Apennines regarding the Lower Jurassic ammonites. Our data add to the available knowledge of the Mediterranean Carixian.

The actual biostratigraphic range of some forms described by many older great Italian paleontologists (*e. g.* G. G. Gemmellaro, A. Fucini, M. Canavari and G. Meneghini) has been documented, thus rendering their papers usable in biostratigraphic terms.

The occurrence of Boreal genera like *Tetraspidoceras* and *Polymorphites* adds new data about the faunal provincialism issue, and might allow new correlations.

We stress the affinity between certain Mediterranean taxa (*Miltoceras, Gemmellaroceras*) to North American assemblages.

The new genus *Farinaccites* and the new species of *Polymorphites* and *Tropidoceras* may help understand the taxonomy of these forms also in the Boreal domain.

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Plate 1

Fig. 1 - *Galaticeras harpoceroide* (Gemmellaro 1884), Ga 21, Bosso River, bed 85, *M. sellae* taxon range zone.

Fig. 2 - *Juraphyllites diopsis* (Gemmellaro 1884), Ju 7, Stirpeto, bed 174, *M. gemmellaroi* Oppel zone.

Fig. 3 - *Aegolytoceras varicosum* Venturi 1978, Ae 21, Bosso River, bed 45, *T. quadrarmatum* Oppel zone.

Fig. 4 - *Aegolytoceras varicosum* Venturi 1978, Ae 12, Bosso River, bed 52, *T. quadrarmatum* Oppel zone.

Fig. 5 - *Holcolytoceras quadrijugum* (Rosemberg 1909), Ho 20, Bosso River, bed 92, *M. sellae* taxon range zone. Artificial mould.

Fig. 6 - *Galaticeras marianii* (Gemmellaro 1884), Ga 32, Bosso River, bed 51, *T. quadrarmatum* Oppel zone.

Fig. 7 - *Juraphyllites libertus* (Gemmellaro 1884), Ju 181, Stirpeto, bed 141, *M. gemmellaroi* Oppel zone.

Fig. 8 - *Partschiceras striatocostatum* (Meneghini 1853), Pr 31, Bosso River, bed 45, *T. quadrarmatum* Oppel zone.

All figures are natural size.

Plate 2

Fig. 1 - *Tetraspidoceras quadrarmatum* (Dumortier 1869), Te 29, Bosso River, bed 52, *T. quadrarmatum* Oppel zone. Natural size.

Plate 3

Fig. 1 - *"Epideroceras" latinodosum* Bremer 1965, Ep. 11, Bosso River, bed 52, *T. quadrarmatum* Oppel zone.

Fig. 2 - *"Epideroceras"* gr. *ancyrense* Bremer 1965, Ep 12, Bosso River, bed 52, *T. quadrarmatum* Oppel zone. Artificial mould.

Figs 3, 4 - *Polymorphites appenninicus* n. sp., Po 19, Bosso River, bed 116, *M. sellae* taxon range zone, 4) x 2.
Figs 5, 6 - *Polymorphites appenninicus* n. sp., Po 18, Bosso River, bed 116, *M. sellae* taxon range zone, 6) x 2, Holotype.
Figs 7, 8 - *Polymorphites flexicostatus* n. sp., Po 38, Bosso River, bed 85, *M. sellae* taxon range zone, 8) x 2.
Figs 9, 10 - *Polymorphites appenninicus* n. sp., Po 23, Bosso River, bed 116, *M. sellae* taxon range zone, 10) x 2.
Figs 11, 12 - *Polymorphites* sp., Po 39, Bosso River, bed 116, *M. sellae* taxon range zone, 12) x 2.
Figs 13, 14 - *Polymorphites calensis* n. sp., Po 17, Bosso River, bed 45, *T. quadrarmatum* Oppel zone, 14) x 2.
Figs 15, 16 - *Polymorphites flexicostatus* n. sp., Po 37, Bosso River, bed 85, *M. sellae* taxon range zone, 16) Holotype.
Figs 17, 18 - *Polymorphites calensis* n. sp., Po 17a, Bosso River, bed 45, *T. quadrarmatum* Oppel zone, 18) x 2, Holotype.

All figures, unless specified, are natural size.

Plate 4

Fig. 1 - *Radstockiceras* sp. aff. R. *numismale* (Oppel 1853), Rd 30, Bosso River, bed 45, *T. quadrarmatum* Oppel zone.
Fig. 2 - *Tetraspidoceras quadrarmatum* (Dumortier 1869), Te 30, Bosso River, bed 45, *T. quadrarmatum* Oppel zone.
Fig. 3 - *Catriceras catriense* Venturi 1978, Ca 8, Bosso River, bed 52, *T. quadrarmatum* Oppel zone.
Fig. 4 - *"Reynesocoeloceras"* gr. *obesum* (Fucini 1905), Re 35, Bosso River, bed 82, *M. sellae* taxon range zone.
Fig. 5 - *Galaticeras marianii* (Gemmellaro1884), Ga 5, Bosso River, bed 55, *T. quadrarmatum* Oppel zone.
Fig. 6 - *Galaticeras* sp., Ga 6, Bosso River, bed 39, *T. quadrarmatum* Oppel zone.
Fig. 7 - *"Catriceras"* sp., Ca 9, Bosso River, bed 45, *T. quadrarmatum* Oppel zone.
Fig. 8 - *"Reynesocoeloceras"* gr. *obesum* (Fucini 1905), Re 36, Bosso River, bed 82, *M. sellae* taxon range zone.

All figures are natural size.

Plate 5

Fig. 1 - *Farinaccites clavatus* n. gen. n. sp., Fa 1, Bosso River, bed 92, *M. sellae* taxon range zone, Holotype.
Fig. 2 - *Tropidoceras bossense* n. sp., Tr 73, Bosso River, bed 116, *M. sellae* taxon range zone, Holotype.
Fig. 3 - *Tropidoceras bossense* n. sp., Tr 100, Stirpeto, bed 126, *M. sellae* taxon range zone.
Fig. 4 - *Farinaccites clavatus* n. gen. n. sp., Fa 2, Bosso River, bed 92, *M. sellae* taxon range zone.

All figures are natural size.

Plate 6

Fig. 1 - *Miltoceras sellae* (Gemmellaro 1884), Mi 34, Bosso River, bed 88, *M. sellae* taxon range zone.
Fig. 2 - *Miltoceras seguenzae* (Gemmellaro 1884), Mi 231, x 2, Bosso River, bed 116, *M. sellae* taxon range zone.
Fig. 3 - *Miltoceras sellae* (Gemmellaro 1884), Mi 232, Stirpeto, bed 107, *M. sellae* taxon range zone.
Fig. 4 - *Tropidoceras* gr. *flandrini* (Dumortier 1869), Tr 119, Bosso River, bed 125, *M. sellae* taxon range zone.
Fig. 5 - *Miltoceras sellae* (Gemmellaro 1884), Mi 233, Bosso River, bed 88, *M. sellae* taxon range zone.
Fig. 6 - *Miltoceras sellae* (Gemmellaro 1884), Mi 152, Stirpeto, bed 107, *M. sellae* taxon range zone.
Fig. 7 - *Miltoceras sellae* (Gemmellaro 1884), Mi 33, Bosso River, bed 88, *M. sellae* taxon range zone.
Fig. 8 - *Farinaccites kondai* (Geczy 1976), Fa 3, Bosso River, bed 92, *M. sellae* taxon range zone.

All figures, unless specified, are natural size.

Plate 7

Fig. 1 - *Protogrammoceras hungaricum* Geczy 1976, Pr 201, Stirpeto, bed 142, *M. gemmellaroi* Oppel zone.
Fig. 2 - *Tropidoceras demonense* (Gemmellaro 1884), Tr 165, Bugarone quarry, bed 12, *M. gemmellaroi* Oppel zone.
Fig. 3 - *Dayiceras* sp. aff. *D. dayiceroide* (Mouterde 1951), Da 166, Stirpeto, bed 168, *M. gemmellaroi* Oppel zone.
Fig. 4 - *Tropidoceras calliplocum* (Gemmellaro 1884), Tr 116, Bugarone Quarry, bed 12, *M. gemmellaroi* Oppel zone.
Fig. 5 - *Tropidoceras mediterraneum* (Gemmellaro 1884), Tr 167, Bugarone Quarry, bed 12, *M. gemmellaroi* Oppel zone.
Fig. 6 - *"Acanthopleuroceras"* sp., Ac 119, Stirpeto, bed 174, *M. gemmellaroi* Oppel zone.
Fig. 7 - *Tropidoceras erythraeum* (Gemmellaro 1884), Tr 113, Bugarone Quarry, bed 12, *M. gemmellaroi* Oppel zone.
Fig. 8 - *Tropidoceras mediterraneum* (Gemmellaro 1884), Tr 120, Stirpeto, bed 142, *M. gemmellaroi* Oppel zone.
Fig. 9 - *Tropidoceras zitteli* (Fucini 1889), Tr 164, Bugarone Quarry, bed 13, *M. gemmellaroi* Oppel zone.

All figures are natural size.

Plate 8

Fig. 1 - *Fuciniceras costicillatum* (Fucini 1902), Fu 145, Stirpeto, bed 216, *P. dilectum* taxon range zone.
Fig. 2 - *Phricodoceras* sp. aff. *P. taylori* (Sowerby 1826), Ph 121, x 2, Stirpeto, bed 187, *P. dilectum* taxon range zone.
Fig. 3 - *L. (Becheiceras)* sp., Be 124, Bugarone Quarry 13, *M. gemmellaroi* Oppel zone.

Fig. 4 - Protogrammoceras dilectum (Fucini 1900), Pr. 203, Stirpeto, bed 195, *P. dilectum* taxon range zone.
Fig. 5 - *L. (Becheiceras) bechei* (Sowerby 1821), Be 223, Stirpeto, bed 187, *P. dilectum* taxon range zone.
Fig. 6 - *Metaderoceras beirense* Mouterde 1970, Me 32, Stirpeto 174, *M. gemmellaroi* Oppel zone.
Fig. 7 - *Reynesocoeloceras simulans* (Fucini 1905), Re 125, Stirpeto, bed 183, *P. dilectum* taxon range zone.
Fig. 8 - *L. (Becheiceras) bechei* (Sowerby 1821), Be 9, Stirpeto, bed 187, *P. dilectum* taxon range zone.
Fig. 9 - *Metaderoceras beirense* Mouterde 1970, Me 88, Stirpeto, bed 174, *M. gemmellaroi* Oppel zone.
Fig. 10 - *Metaderoceras gemmellaroi* (Levi 1896), Me 151, Stirpeto 175, *M. gemmellaroi* Oppel zone.

All figures, unless specified, are natural size.

Plate 9

Figs 1, 2 - *Polymorphites calensis* n. sp., Po17a, Holotype. Bosso River, bed 45, *T. quadrarmatum* Oppel zone. 1) Suture line x 4; 2) whorl section x 1, 5.
Fig. 3 - *Polymorphites calensis* n. sp., Po 17, Bosso River, bed 45, *T. quadrarmatum* Oppel zone. Suture line x 4.
Figs 4, 5 - *Polymorphites flexicostatus* n. sp., Po 37, Holotype. Bosso River, bed 85 *M. sellae* taxon range zone. 4) Suture line x 4; 5) whorl section x 1, 5.
Figs 6, 7, 8 - *Polymorphites appenninicus* n. sp., Po 18 Holotype. Bosso River, bed 116 *M. sellae* taxon range zone. 6) Suture line x 4; 7) whorl section x 3; 8) lateral view x 3.
Figs 9, 10, 11 - *Farinaccites clavatus* n. gen. n. sp., Fa 5. Bosso River, bed 90, *M. sellae* taxon range zone. 9) Suture line x 4; 10) whorl section; 11) lateral view.
Fig. 12 - *Farinaccites clavatus* n. gen. n. sp., 1) Fa 6, Bosso River, bed 92, *M. sellae* taxon range zone. Lateral view.
Fig. 13 - *Tropidoceras bossense* n. sp., Tr 180, Bosso River, bed 116, *M. sellae* taxon range zone. Suture line x 4.
Fig. 14 - *Tropidoceras bossense* n. sp., Tr 100, Bosso River, bed 116, *M. sellae* taxon range zone. Suture line x 4.
Fig. 15 - *Tropidoceras bossense* n. sp., Tr 101, Bosso River, bed 116, *M. sellae* taxon range zone. Suture line x 4.
Figs 16, 17, 18 - *Tropidoceras bossense* n. sp., Tr 73, Holotype. Bosso River, bed 116, *M. sellae* taxon range zone. 16) Two contiguous suture lines x 4; 17) Lateral view; 18) whorl section.

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Plate 10

Figs 1, 2 - *"Catriceras"* sp., Ca 9, Bosso River, bed 45, *T. quadrarmatum* Oppel zone. 1) Suture line x 4; 2) Whorl section.
Fig. 3 - *Catriceras* cf. *catriense* Venturi 1978, Ca 10, Bosso River, bed 52, *T. quadrarmatum* Oppel zone. Suture line x 4.

Figs 4, 5, 6 - *"Epideroceras" latinodosum* Bremer 1965, Ep 11, Bosso River, bed 52, *T. quadrarmatum* Oppel zone. 4) Suture line x 4; 5) Whorl section; 6) lateral view.

Figs 7, 8 - *Dayiceras* sp. aff. *D. dayiceroide* (Mouterde, 1951), Da 167, Stirpeto, bed 166, *M. gemmellaroi* Oppel zone. 7) Suture line x 4; 8) Whorl section.

Fig. 9 - *Metaderoceras* sp., Me 115, Bosso River, bed 126, *M. gemmellaroi* Oppel zone. Suture line x 4.

Figs 10, 11, 12 - *Metaderoceras gemmellaroi* (Levi 1896), Me 182, Stirpeto, bed 162, *M. gemmellaroi* Oppel zone. 10) Suture line x 4; 11) Whorl section; 12) lateral view.

Fig. 13, 14 - *Metaderoceras gemmellaroi* (Levi 1896), Me 11, Stirpeto, bed 175, *M. gemmellaroi* Oppel zone. 13) Suture line x 4; 14) Whorl section.

Fig. 15 - *Audaxlytoceras* sp., Au 174, Stirpeto, bed 188, *P. dilectum* taxon range zone. Suture line x 4.

Fig. 16, 17, 18 - *Aegolytoceras varicosum* Venturi 1978, Ae 12, Bosso River, bed 52, *T. quadrarmatum* Oppel zone. 16) suture line x 4; 17) Whorl section; 18) lateral view.

All figures, unless specified, are natural size.

Plate 11

Figs 1, 2 - *Catriceras catriense* Venturi 1978, Ca 301, Pallareto Quarry, *T. quadrarmatum* Oppel zone. 1) Lateral view; 2) whorl section.

Figs 3, 4 - *Catriceras catriense* Venturi 1978, Ca 302, Pallareto Quarry, *T. quadrarmatum* Oppel zone. 3) Lateral view; 4) Suture line x 4.

Figs 5, 6, 7 - *Catriceras catriense* Venturi 1978, Ca 303, Pallareto Quarry, *T. quadrarmatum* Oppel zone. 5) Lateral view; 6) Suture line x 4; 7) Whorl section.

Figs 8, 9, 10 - *Catriceras catriense* Venturi 1978, Ca 304, Pallareto Quarry, *T. quadrarmatum* Oppel zone. 8) Lateral view; 9) Suture line x 4; 10) Whorl section.

Figs 11, 12 - *Catriceras catriense* Venturi 1978, Ca 305 Holotype, Pallareto Quarry, *T. quadrarmatum* Oppel zone. 11) Ventral view; 12) Lateral view.

All figures, unless specified, are natural size.

Plate 12

Fig. 1 - *"Epideroceras" ancyrense* Bremer 1965, Ep 401, Pallareto Quarry, *T. quadrarmatum* Oppel zone. Suture line x 4.

Fig. 2 - *"Epideroceras" ancyrense* Bremer 1965, Ep 402, Pallareto Quarry, *T. quadrarmatum* Oppel zone. Suture line x 4.

Fig. 3 - *Coeloderoceras* sp., Co 111, Pallareto Quarry, *T. quadrarmatum* Oppel zone. Suture line x 4.

Fig. 4 - *"Epideroceras" latinodosum* Bremer 1965, Ep 403, Pallareto Quarry, *T. quadrarmatum* Oppel zone. Suture line x 4.

Plate 13

Figs 1, 5 - *"Epideroceras" latinodosum* Bremer 1965, Ep 405, Pallareto Quarry, *T. quadrarmatum* Oppel zone. 1) Lateral view; 5) Whorl section.

Figs 2, 9 - *Radstockiceras* sp. aff. R. numismale (Oppel 1853), Ra 13 Pallareto Quarry, *T. quadrarmatum* Oppel zone. 2) Lateral view; 9) Whorl section.

Figs 3, 4 - *Phricodoceras* sp. aff. *P. taylori* (Sowerby 1826), Ph 77, Pallareto Quarry, *T. quadrarmatum* Oppel zone. 3) Lateral view; 4) Whorl section.

Figs 6, 7, 8 - *"Epideroceras" latinodosum* Bremer 1965, Ep 406, Pallareto Quarry, *T. quadrarmatum* Oppel zone. 6) Suture line x 4; 7) Lateral view; 8) Whorl section.

All figures, unless specified, are natural size.

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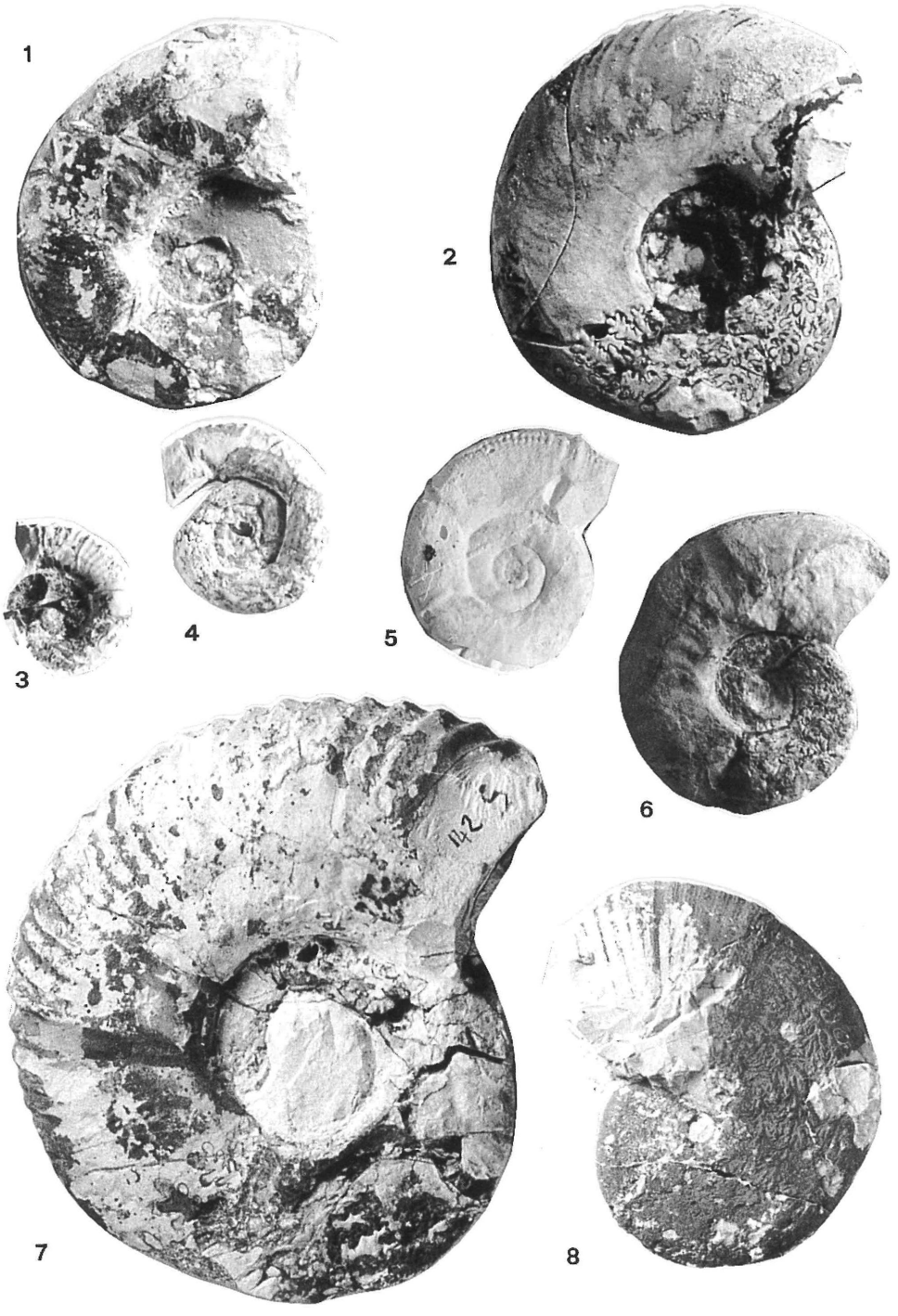

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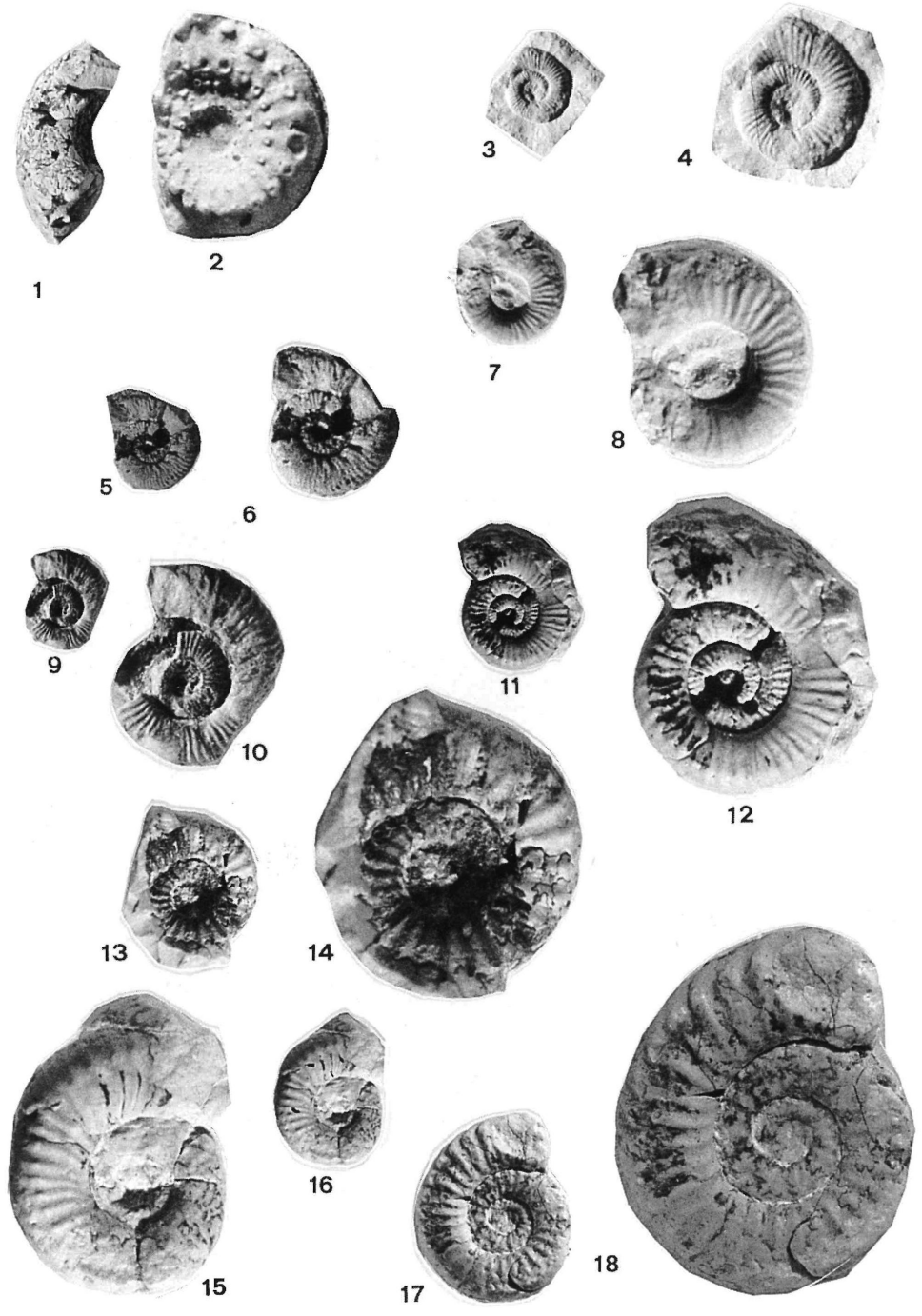

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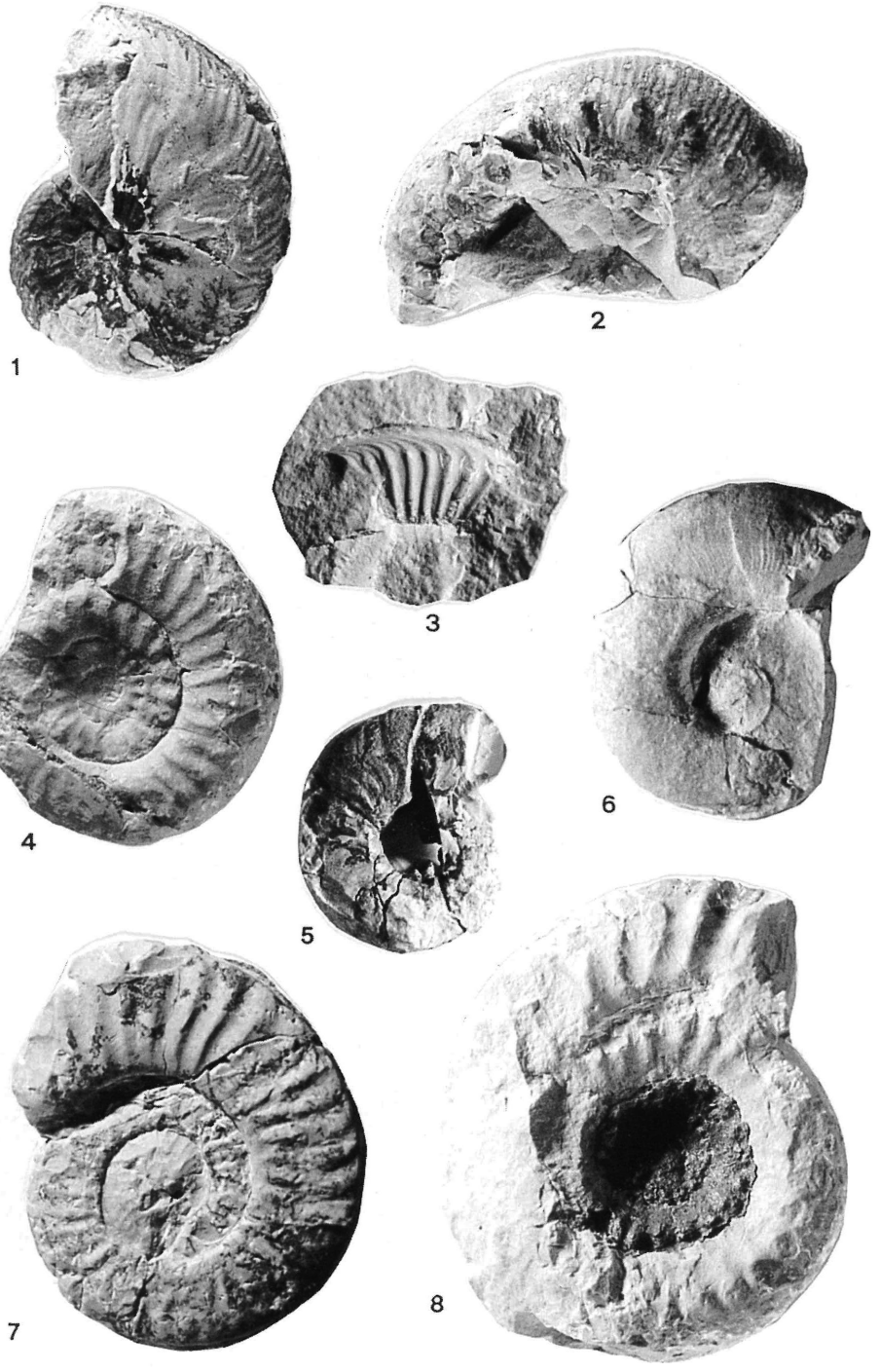

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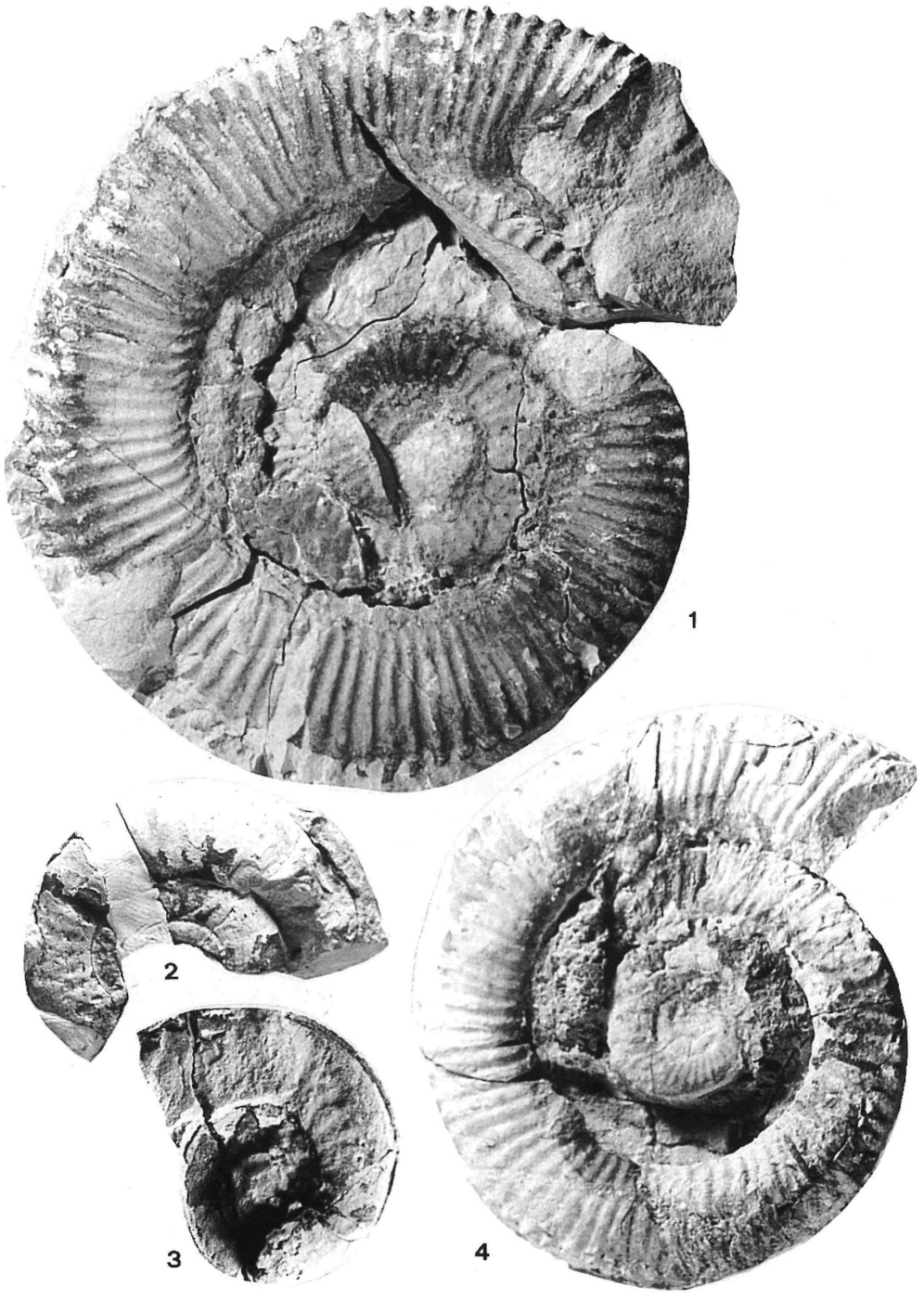

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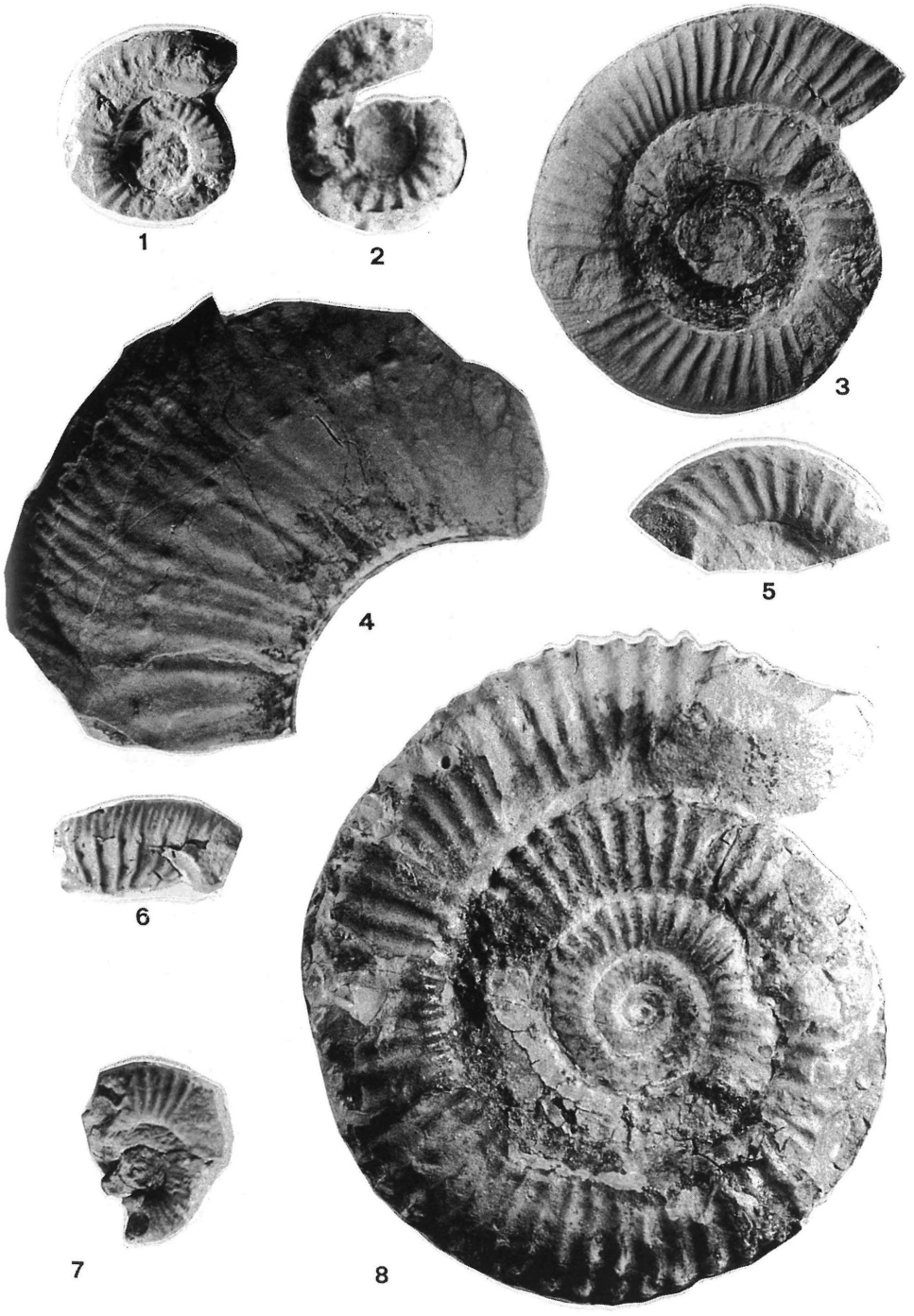

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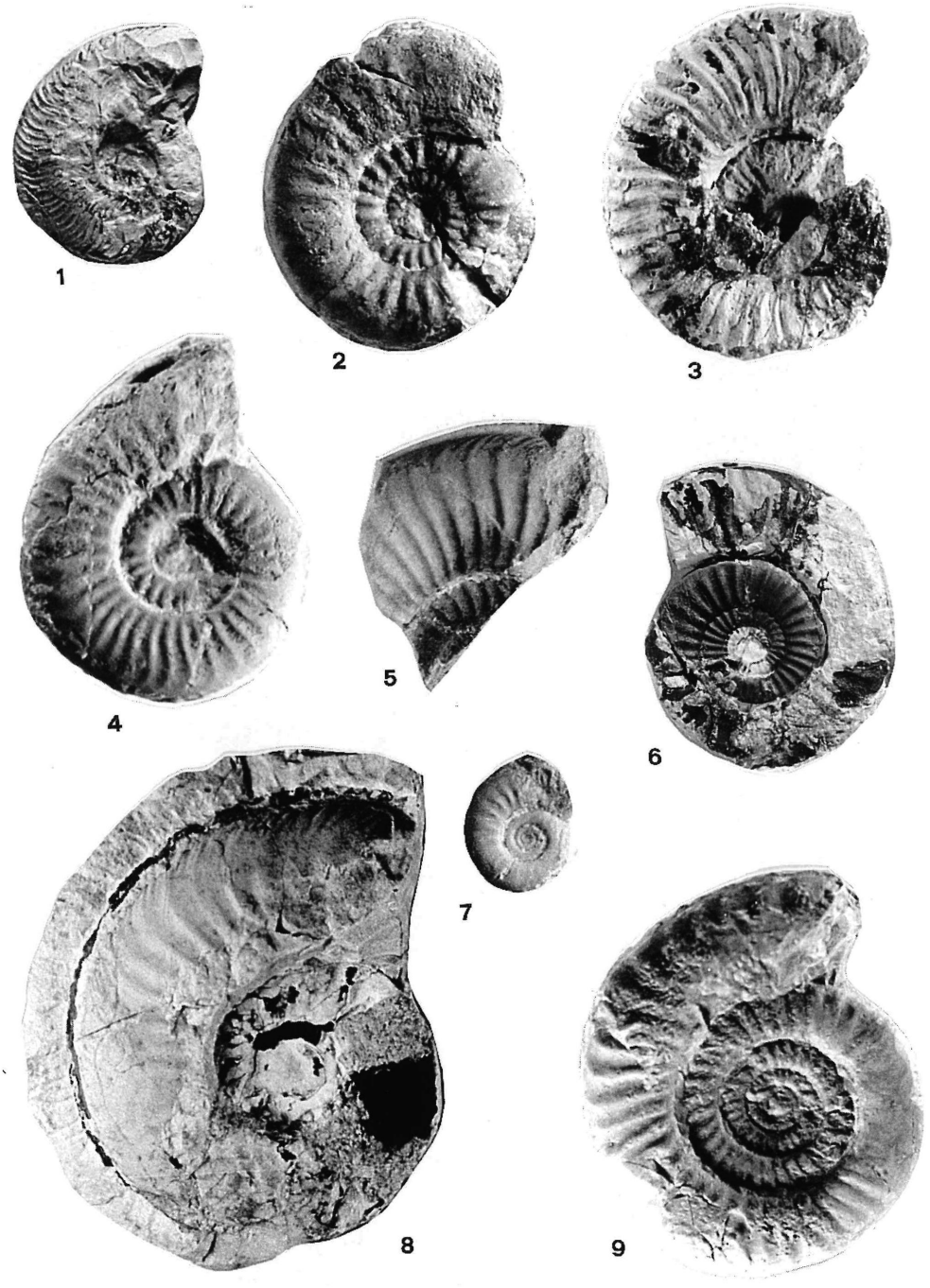

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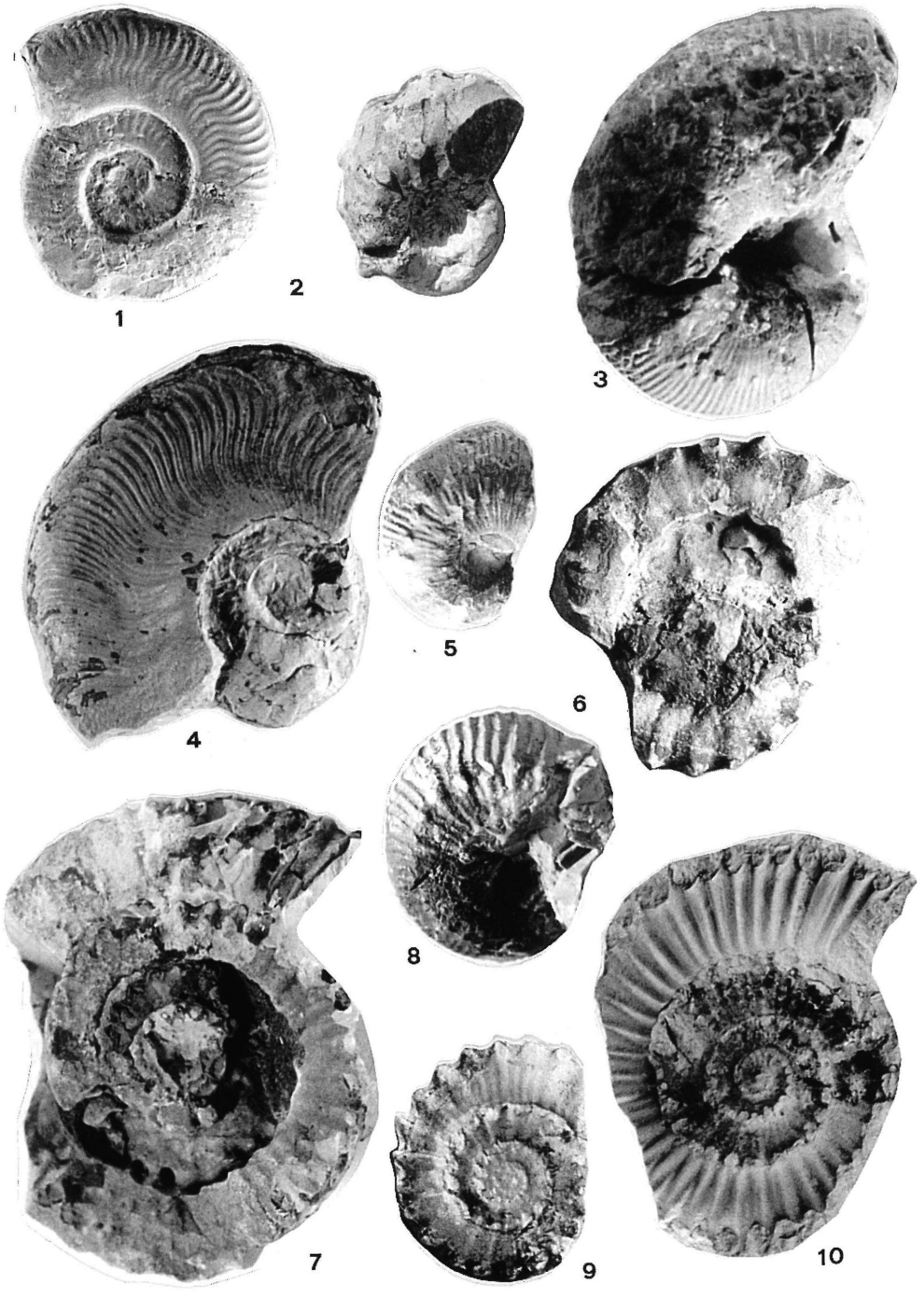

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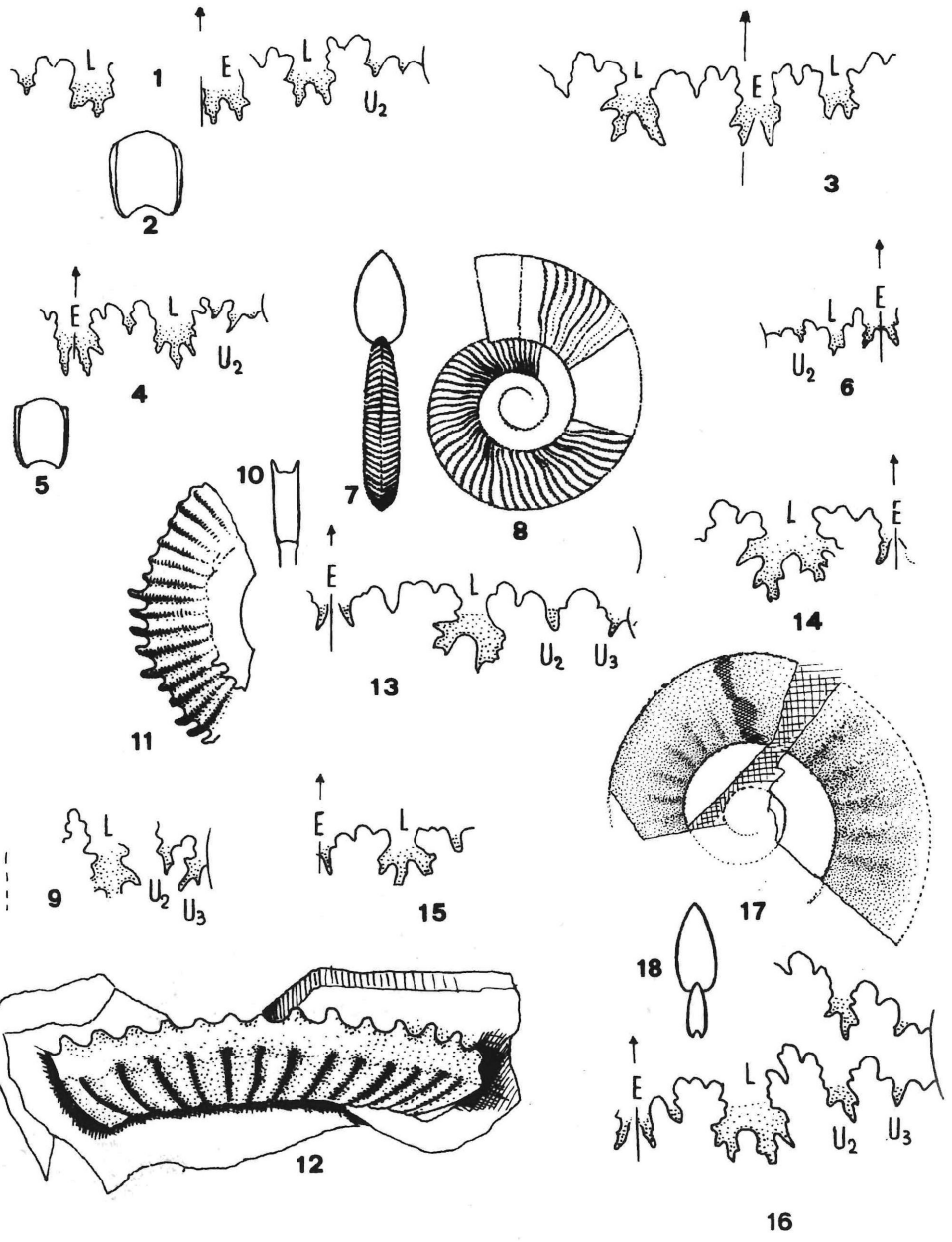

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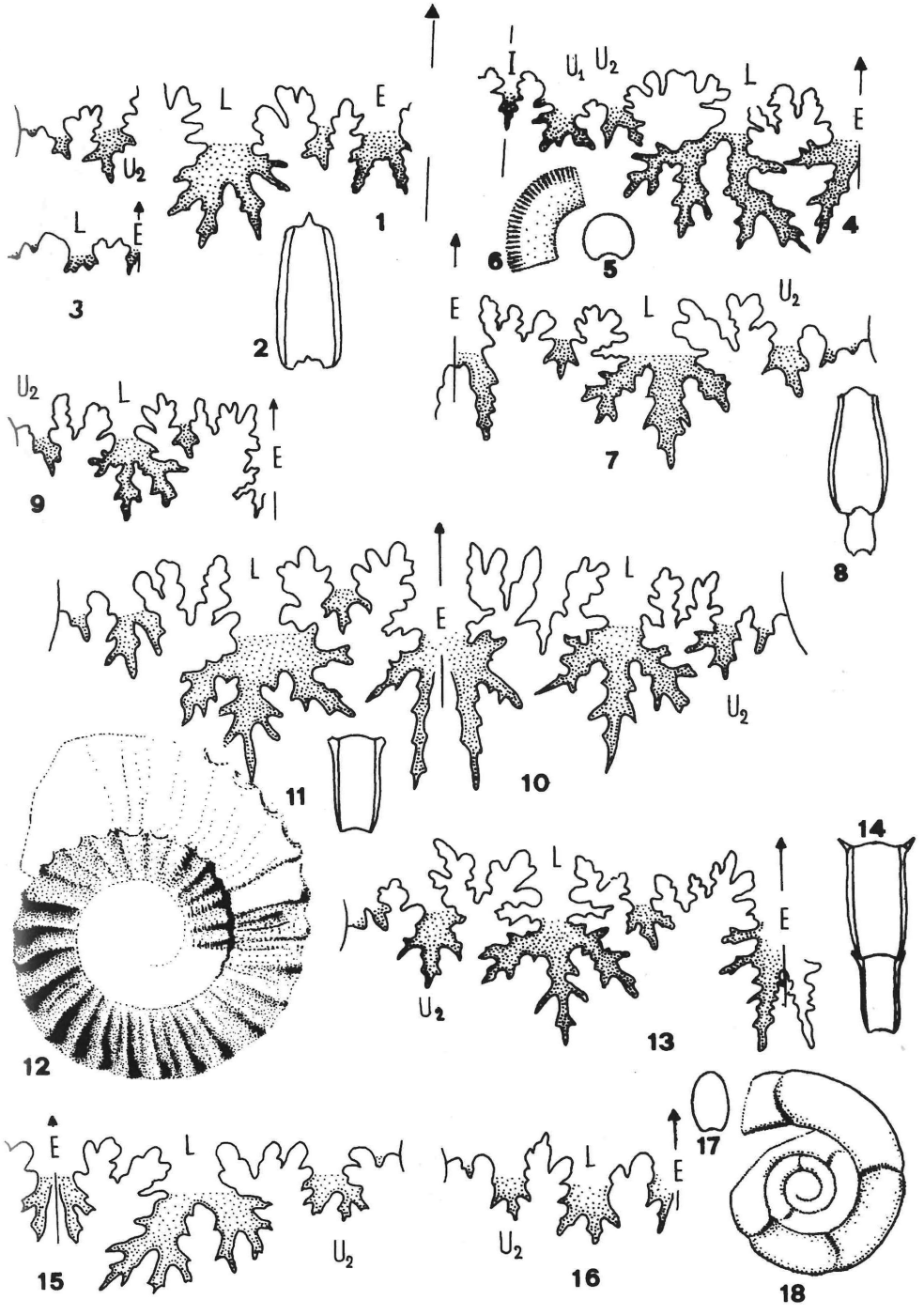
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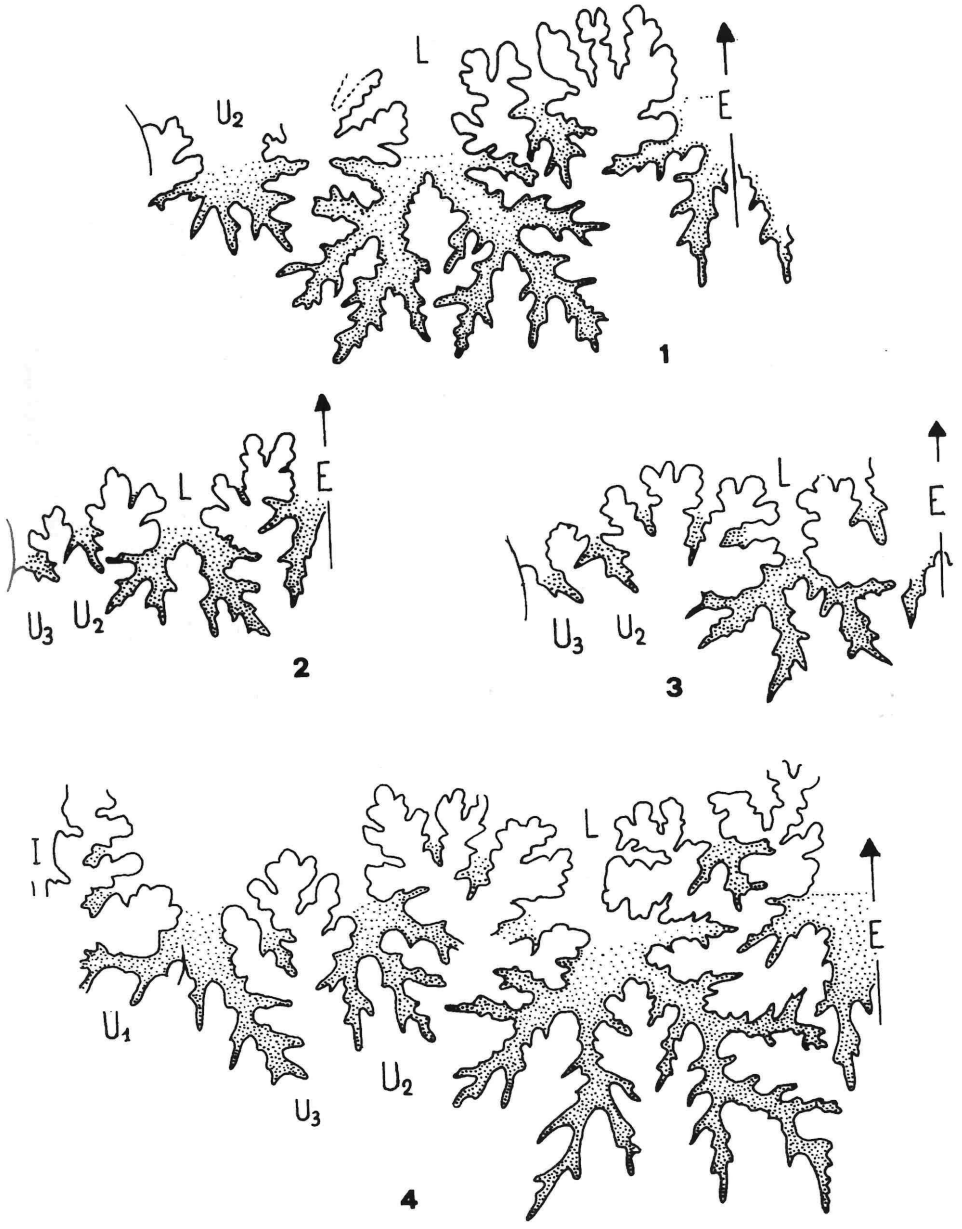

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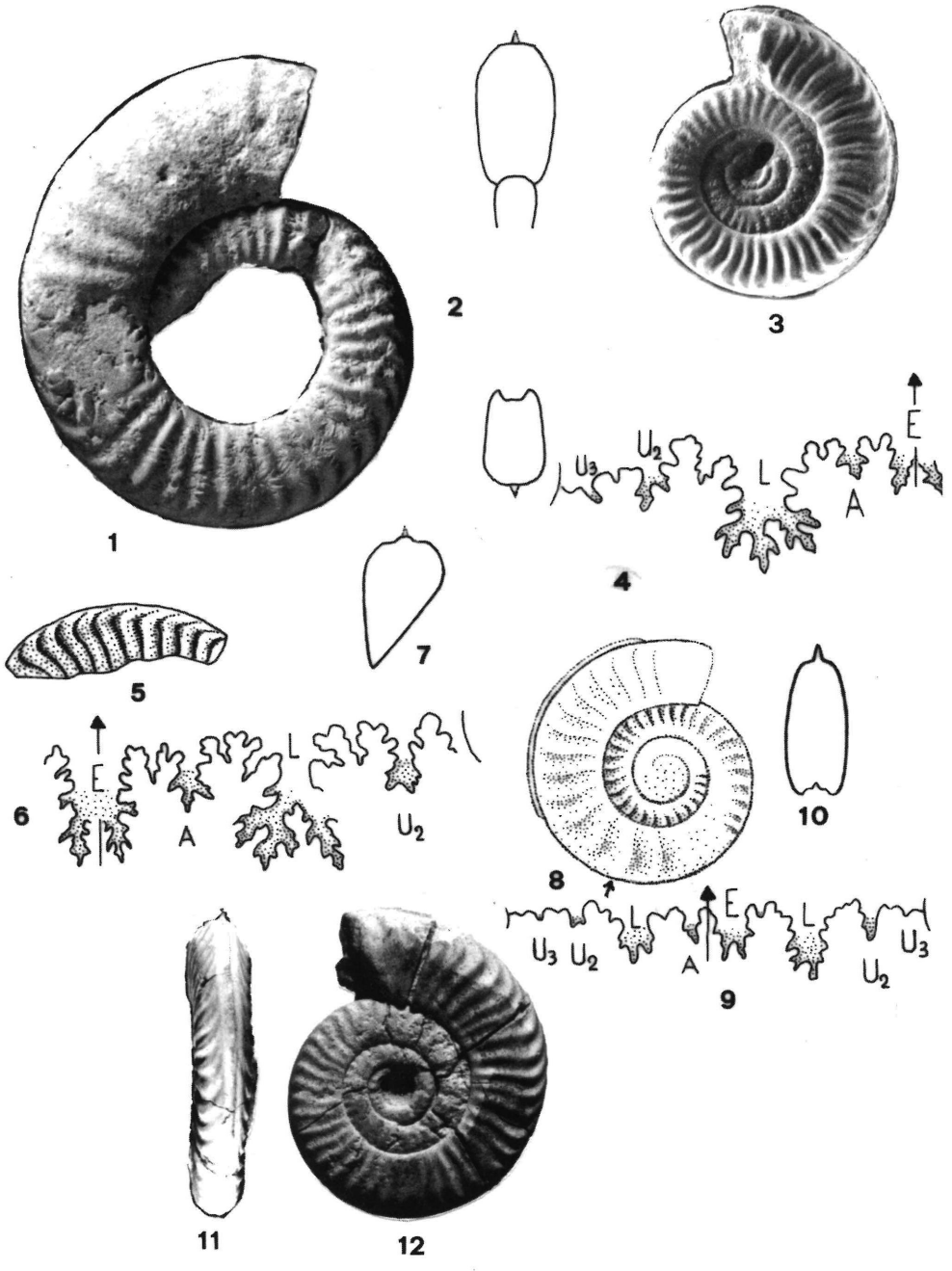

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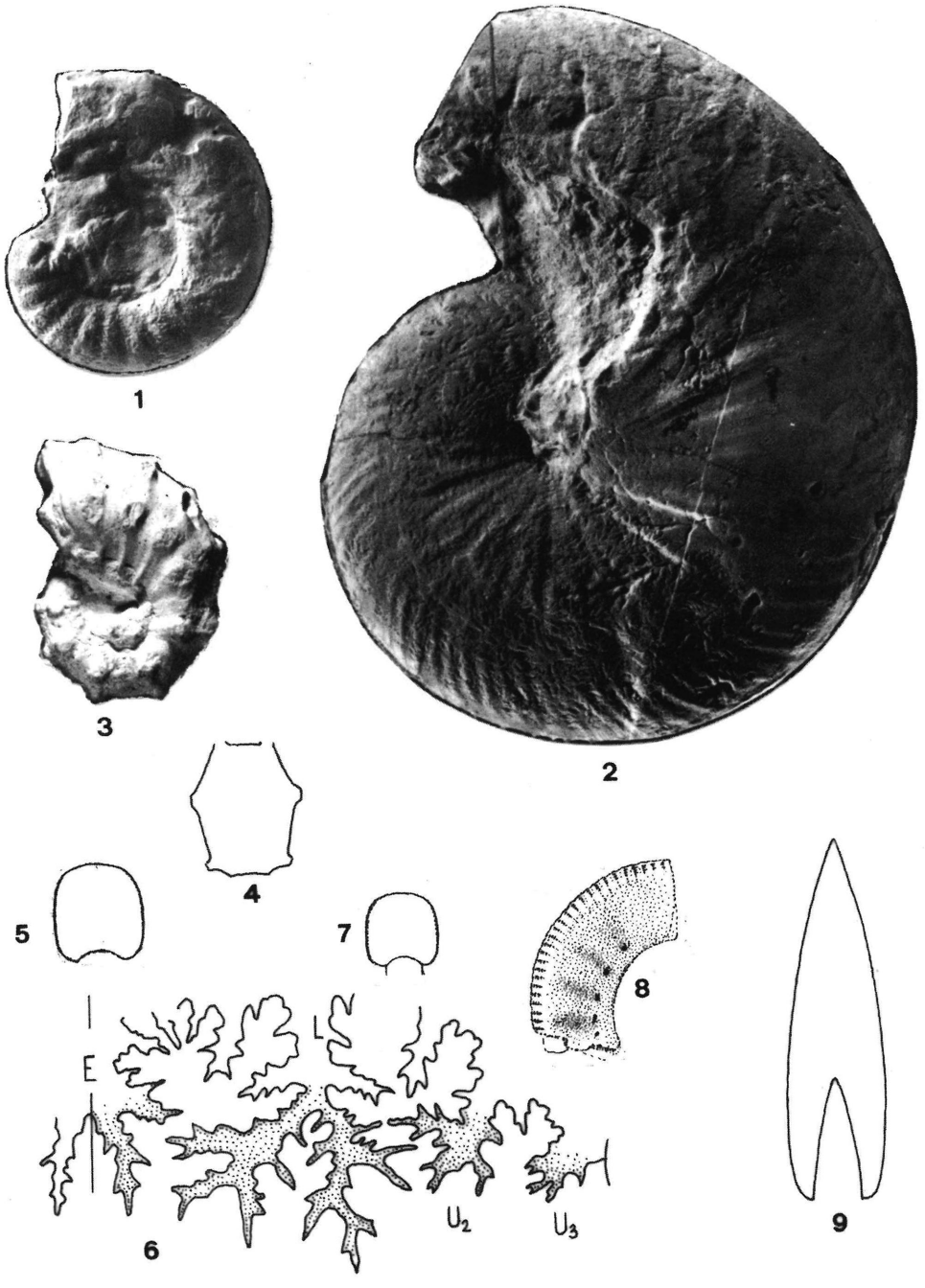

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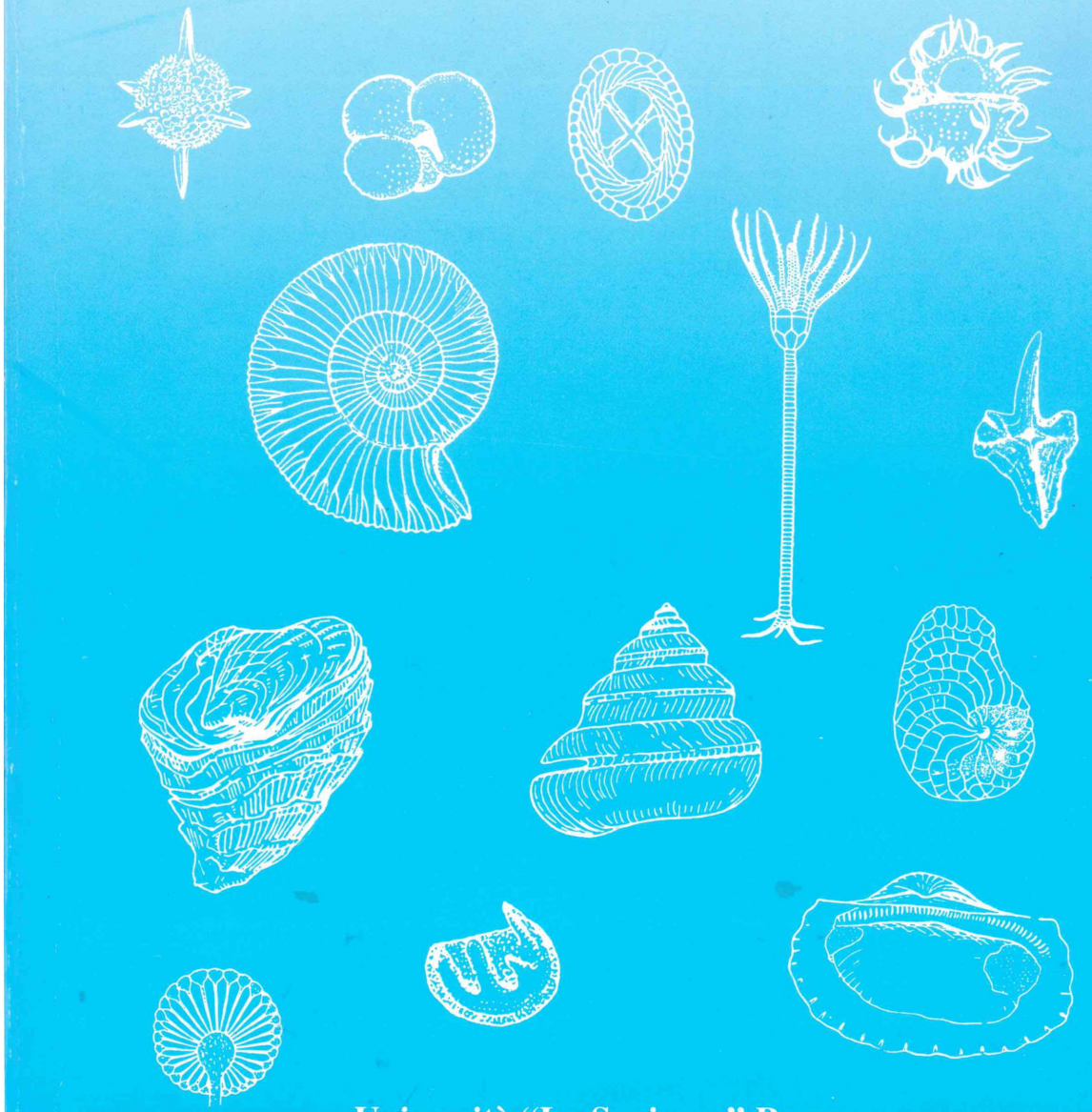

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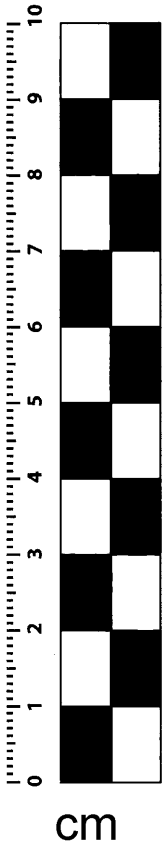
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