

Bollettino

della

**Società Paleontologica
Italiana**

Pubblicato sotto gli auspici
del Consiglio Nazionale delle Ricerche

Volume 42, n. 3, 2003

MUCCHI - MODENA

<i>Bollettino della Società Paleontologica Italiana</i>	42 (3), 2003	ISSN 0375-7633	241-265	3 pls.	Modena, Dicembre 2003
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Bryozoa from the Oligocene succession of Jabal Hafit, Al Ain, United Arab Emirates and Arabian Peninsula

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KEY WORDS – Bryozoa, Systematics, New Taxa, Oligocene, Tethys, Emirates, Arabian Peninsula.

ABSTRACT – The stratigraphy of the Paleogene sequences of Jabal Hafit (Al Ain region, U.A.E.-Arabian Peninsula) is described and analyzed in detail. The Asmari Formation (Oligocene), mostly consisting of shallow water fossiliferous limestones, can be divided in three members. The lower part with maroon brown silty marls (Zakher Mb.) early-middle Oligocene, while the upper (Mutaredh and Muwaiji Mbs), mainly of algal bioclastic limestones, is entirely of middle Oligocene age. In nearly the whole sequences, fragments of nummulitids, pelecypods, gastropods, echinoids and bryozoans are common. This paper deals particularly with the bryozoans, which are not frequent but very interesting. Fiftyfour species (15 Cyclostomatida and 39 Cheilostomatida), have been recognized; some left in open nomenclature, fours being new species: *Steginoporella arabica*, *Adeonellopsis omanensis*, *Beisselina robusta* and *Batopora stellata*.

The Indo-Pacific character of this bryozoan fauna is emphasized, especially regarding the Tethyan distribution of its content, and the interruption of the supposed eastward bryozoan migration in the Lower Miocene due to the Arabian plate motion. The paleoecology of area, typical of shallow marine water and with warm-temperate or subtropical temperatures, is inferred also in the basis of zoarial form.

RIASSUNTO – [I Briozoi della successione oligocenica di Jabal Hafit, Al Ain, United Arab Emirates e Penisola araba] – Viene dapprima descritta e analizzata in dettaglio la stratigrafia delle sequenze paleogeniche di Jabal Hafit (Al Ain region, U.A.E.-Oman Peninsula). La Formazione Asmari (Oligocene), costituita quasi interamente di calcari fossiliferi di mare poco profondo, può essere suddivisa in tre membri. La parte inferiore, composta di marne silteose grigio-marrone (Membro di Zakher) appartiene all'Oligocene inferiore-medio p.p., mentre la parte superiore (Membri di Mutaredh e Muwaiji), perlopiù di calcari bioclastici algali è interamente di età medio oligocenica. Quasi in tutte le sequenze si trovano comunemente nummulitidi e microforaminiferi, frammenti di bivalvi, gasteropodi, echinoidi e briozoi. Per quanto riguarda il contenuto in briozoi, in realtà non molto frequenti, ma significativi, sono state riscontrate 54 specie (15 Cyclostomatida e 39 Cheilostomatida), alcune in nomenclatura aperta, 4 nuove: *Steginoporella arabica*, *Adeonellopsis omanensis*, *Beisselina robusta* e *Batopora stellata*. È ipotizzato inoltre un legame con le faune a briozoi paleogeniche della Tetide occidentale e una loro migrazione verso i bacini orientali, interrottasi nel Miocene inferiore per lo spostamento della placca arabica. La paleoecologia di quest'area, tipicamente di mare non molto profondo e con temperatura temperato-calda o subtropicale, viene desunta anche dai parametri di base delle forme zoariali.

LOCATION OF THE STUDY AREA

Al Ain City is situated in the east of the Emirate of Abu Dhabi (United Arab Emirates), near the border with the Sultanate of Oman. Geologically, Al Ain City is located at the west margin of the Northern Oman Mountains and was involved in the later stages of the mountain building processes.

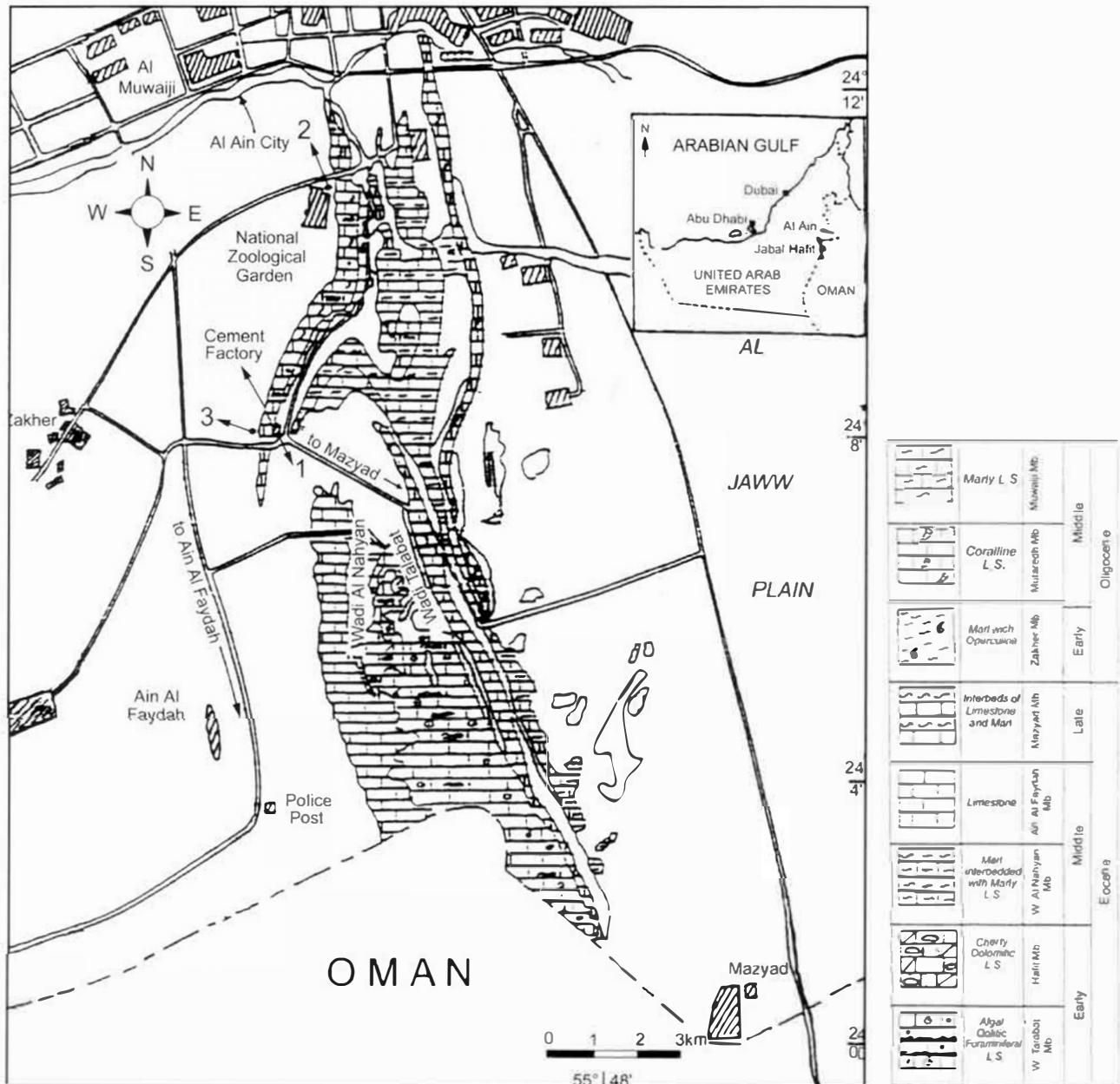
Jabal Hafit (study area) is located to the south east of Al Ain City (lat. 24°02' to 24°13' N and long. 55°44' to 55°49' E). It is bounded to the north by Al Ain City, to the east by the Al Jaww plain, to the south east by the Mazyad suburb, to the south by Oman and to the west by Al Ain Al Faydah and Zakher suburbs (Text-fig.1).

The geomorphology of Jabal Hafit is determined by its asymmetric anticlinal structure. Its length is about 29 km, the width is about 5 km, and it reaches an elevation of about 1160 m above sea level. The mountain has a whaleback form (composite asymmetric anticline) with beds dipping down to the east and to the west in the two limbs (strike ridges). The

eastern limb dips about 70° to the east (East Cuesta) whereas the western limb dips about 29° to the west (West Cuesta).

STRATIGRAPHY

The stratigraphy of the Paleogene succession in the Al Ain region, U.A.E., has been attempted by several workers: Gibb (1979), Terratest (1973), and Holderbank (1975). They carried out surveys as part of a feasibility study for establishing the Al Ain Cement Factory. Their works were submitted as internal reports to the concerned Departments of the U.A.E. Hunting (1979), studied the geology of Al Ain region and established a geologic map of Jabal Hafit. This investigation resulted in the first lithostratigraphic and chronostratigraphic subdivision of the Paleogene strata (Tab. 1). The Hunting report recognized eleven mappable and coded time rock units. Cherif & El Deeb (1984) had studied the Paleogene sequence of Jabal Hafit. They formally introduced three formations subdivided into mem-



Text-fig. 1 - Geological map of Jabal Hafit area (modified after Hunting,1979) showing the location of the Oligocene successions (Zakher : 1, Mutaredh : 2, Muwaiji : 3 Members).

bers partly similar to the lithostratigraphic units established by Hunting (1979). However, they assigned some of Hunting's units to their new lithostratigraphic units and proposed some changes to their respective ages on the basis of micropaleontologic data. In the neighbouring areas, such as in Qatar, the Paleogene sequence was subdivided by Cavellier (1970) from base to top into the Umm Er Radhuma Formation (Paleocene to lower Eocene), Rus Formation (lower Eocene) and Dammam Formation (lower to middle Eocene) (Tab. 1).

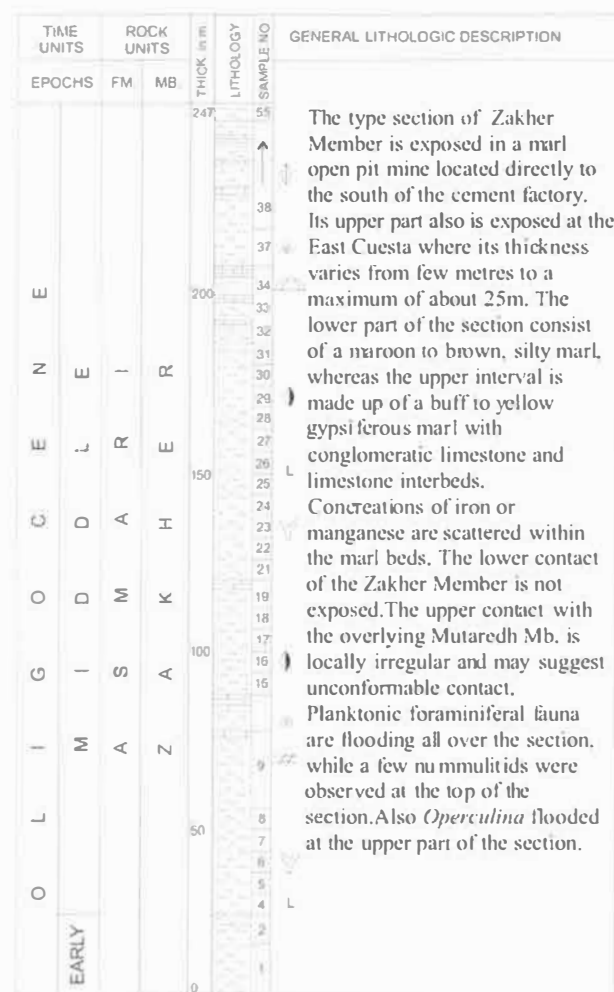
Detailed field study carried out by Hamdan &

Bahr (1992) on the Paleogene Sequence of Jabal Hafit allowed the recognition and delineation of three formal formations and eight formal members (Tab. 2). In their study, the gross lithologic characters, thicknesses, stratigraphic contacts and ages based on index planktonic foraminifera and large forams (Nummulites) are defined and recorded for each rock unit. These formal rock units arranged from top to base are as follows: Asmari Formation (Oligocene), divisible into three members which in descending order are: Muwaiji Member, Mutaredh Member, Zakher Member; Dammam Formation (middle -

ing Dammam Formation is not exposed because of scree or alluvial cover. The upper contact is also not exposed because of alluvial cover. At the West Cuesta, where present in its full thickness (the studied section), the Asmari Formation is subdivided into three formal members, which are from base to top, the Zakher, Mutaredh and Muwajji Members.

ZAKHER MEMBER (Early Oligocene - Middle Oligocene)

The name is derived from the Zakher suburb which is located to the northwest of Jabal Hafit. The type section is exposed in a marl pit mine located directly to the south of the Cement Factory (lat. 24° 08' 20" N, long. 55° 44' 10" E). The thickness of the Zakher Member at the type section is 247m (Text-fig. 2). The lower part consists of a maroon to brown, silty marl, whereas the upper interval is made up of a buff to yellow gypsiferous marl with conglomeratic



Section (1) : Cement Factory marl open pit mine : Zakher Member (CF)

Coordinates : Lat. 24° 8' 20" N, Long. 55° 44' 10" E

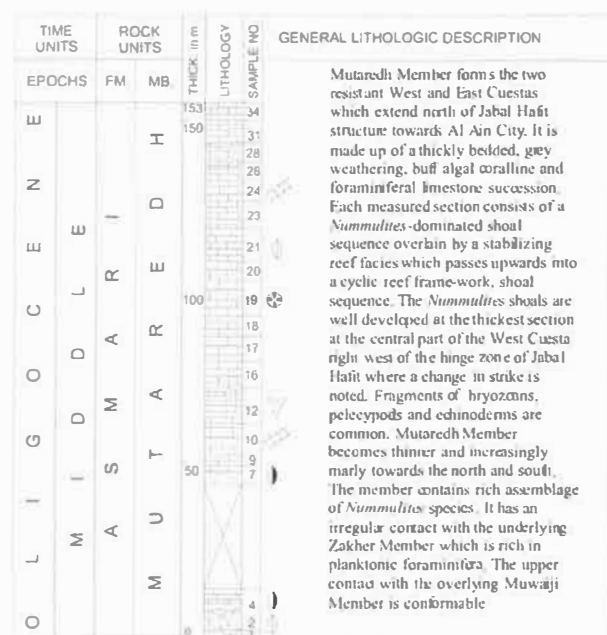
Text-fig. 2 - General description of the Zakher Member of the Asmari Fm. in the western limb of Jabal Hafit.

limestone and limestone interbeds. The lower contact of the Zakher member with the underlying Mazyad Member is not exposed. The upper contact with the overlying Mutaredh Member is locally irregular and may suggest an unconformable contact. On the basis of the fossil occurrences and their related zones, the Zakher Member is assigned an early to middle Oligocene age (Anan *et al.*, 1992).

MUTAREDH MEMBER (middle Middle Oligocene)

The Mutaredh Member is a new member named after the Mutaredh suburb of Al Ain city which is located to the north of the West Cuesta, east of Al Ain Zoological Garden along the road to the Zakher Suburb (lat. 24° 11' N, long. 55° 44' 55" to 55° 45' 14" E). It forms the two resistant West and East Cuestas which extend north of Jabal Hafit Structure towards Al Ain city. The surface extent of the member to the south ends abruptly south to the Cement Factory at the West Cuesta. At the type section (Text-fig. 3), the Mutaredh Member attains a thickness of about 153 m. It is made up of a thickly bedded, grey - weathering buff algal, coralline and foraminiferal limestone succession. Fragments of nummulitids, bryozoans, pelecypods, gastropods and echinoderms are common.

The Mutaredh Member becomes thinner and increasingly marly towards the north and south. It has an irregular contact with the underlying Zakher Member which may suggest an unconformity, while



Section (2) : Al - Ain Zoological Garden : Mutaredh Member (O₁) (Asman Formation)

Coordinates : Lat. 24° 11' N, Long. 55° 44' 55" to 55° 45' 14" E

Text-fig. 3 - General description of the Mutaredh Member of the Asmari Fm., in the western limb of J. Hafit.

the upper contact with the overlying Muwajji Member is conformable.

The rich assemblage of nummulitids and planktonic foraminifera assigns the member to middle Middle Oligocene.

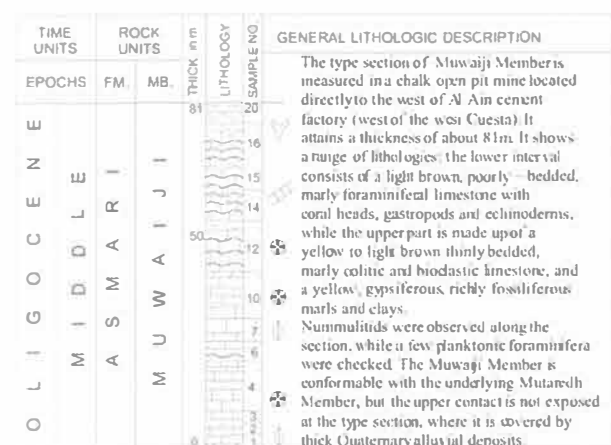
MUWAIJI MEMBER (late Middle Oligocene)

The Muwajji Member is a new member taking its name from the Muwajji suburb which is located to the northwest of the West Cuesta. The type section (Text-fig. 4) is measured in a chalk open pit mine located directly to the west of the Al Ain Cement Factory (west of the west Cuesta) (lat. 24° 08' 30" N, long. 55° 43' 55" E). At the type section, the member attains a thickness of about 81 m. It shows a range of lithologies. The lower interval consists of a light-brown, poorly-bedded, marly foraminiferal limestone with coral heads, gastropods and echinoderms. The upper part is made up of a yellow to light brown, thinly-bedded, marly oolitic and bioclastic limestone and yellow, gypsiferous, richly fossiliferous marls and clays. The Muwajji Member is conformable with the underlying Mutaredh. The upper contact is not exposed at the type section, where it is covered by thick Quaternary alluvial deposits. On the basis of nummulitids, the Muwajji Member is assigned to the late Middle Oligocene.

PALEONTOLOGY

SOME OBSERVATION ON RESIDUE SAMPLES

As can be seen in the stratigraphy section, three sequences have been examined for the study of bryozoan faunas, all belonging to Asmari Formation. They are respectively CF (= Tle₂ in Tab. 1) of Zakher

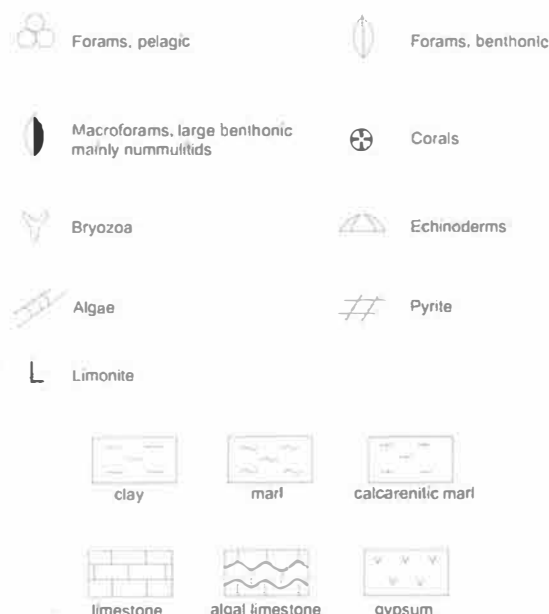


Section (3): Cement Factory chalk open pit mine Muwajji Member (O₂) (Asmari Formation)

Coordinates: Lat. 24° 8' 30" N; Long. 55° 43' 55" E

Text-fig. 4 - General description of the Muwajji Member of the Asmari Fm., in the western limb of Jabal Hafit.

LEGENDA



Text-fig. 5 - Symbols of fossils and lithotypes referring to Text-figs 2-4.

Mb. (lower to middle Oligocene p.p.), O₁ (=TIO₁) of Mutaredh Mb. (middle Oligocene p.p.) and O₂ (=TIO₂) of Muwajji Mb. (late Oligocene).

The location of the several samples is only indicative and it refers to the sampled horizons.

CF samples 1-55

From the CF sequence have been derived 55 washed residues, most of them poor in bryozoan content and not well preserved. Only 34 samples from the upper part of the section are relatively rich in bryozoans (see Tab. 3).

Samples 1-2-3: barren;

Sample 4: Orbituliporid oxidized fragments;

Sample 5: barren

Sample 6: macroforams, fairly abundant bryozoans (*Cellaria reussi*, *Dittosaria prima*, *Margaretta cereoides* and *Reteporella tuberculata* are recognized);

Sample 7: the only organic content belongs to some poorly preserved specimens of the genus *Batopora*. They can be attributed to a new species (see Systematics chapter);

Sample 8: microforams and oxidized rare bryozoans. Problematic Cyclostomatida and Cheilostomatida; the only certainly recognized species are *Cellaria reussi* and *Stenosipora simplex*;

Sample 9: completely barren;

Sample 10: in this residue there is only one (!) fairly well preserved colony of *Stenosipora simplex*;

Sample 11: in this very interesting residue there are only 12 specimens of the same *Batopora* species found in sample 6. It is important that they represent all growth stages of colony, from the ancestrular one to neanastic and ephebastic forms;

Sample 12: only four specimens of bryozoan remains (*Disporella grignonensis* and *Tychinella schreibersi*). They are completely altered into pyrite; and in the residue many small pyrite crystals are present;

LIST OF THE SPECIES OCCURRING IN U.A.E. SAMPLES CF/O/O, AND THEIR ZOARIAL GROWTH FORMS (Basic morphotypes and specific forms). FE: Flexible forms; RE: Rigid forms; EN Encrusting; OF: Other forms (Lunuliform; Conescharrelliniform)		
CYCLOSTOMATIDA		
<i>Crista haueri</i> REUSS	FE	(Cellariform)
<i>Crista haueri</i> REUSS	FE	(Cellariform)
<i>Crista</i> spp.	FE	(Cellariform)
<i>Disporella grignonensis</i> MILNE-EDWARDS	EN	(Lichenoporeiform)
<i>Disporella</i> sp.	EN	(Lichenoporeiform)
<i>Exidmonea atlantica</i> DAY, MONG, POUYET	RE	(Vinculariform)
<i>Exidmonea concava</i> (REUSS)	RE	(Vinculariform)
<i>Exidmonea</i> sp.	RE	(Vinculariform)
<i>Filicrista</i> sp.	FE	(Cellariform)
<i>Filisparsa fallax</i> CANU & BASSLER	RE	(Vinculariform)
<i>Filisparsa</i> sp.	RE	(Vinculariform)
<i>Hornera</i> sp.	RE	(Vinculariform)
<i>Mecynocera proboscidea</i> (MILNE-EDWARDS)	RE	(Vinculariform)
<i>Mecynocera</i> sp.	RE	(Vinculariform)
CHEILOSTOMATIDA		
<i>Adeonellopsis omanensis</i> n.sp.	RE	(Adeoniform)
<i>Adeonellopsis cf. coccinophora</i> (REUSS)	RE	(Adeoniform)
<i>Adeonellopsis cf. porina</i> (ROEMER)	RE	(Adeoniform)
<i>Alderina subulmaria</i> (REUSS)	EN	(Membraniporeiform)
<i>Arthropoma sparsigera</i> (REUSS)	EN	(Membraniporeiform)
<i>Batopora stellata</i> sp.n.	OF	(Conescharrelliniform)
<i>Biflustra</i> sp.	RE	(Vinculariform)
<i>Beisselina robusta</i> sp.n.	RE	(Vinculariform)
<i>Culpeusia</i> sp.	RE	(Vinculariform)
<i>Cellaria reussi</i> d'ORBIGNY	FE	(Cellariform)
<i>Chelipora</i> sp.	EN	(Cellariform)
<i>Crassimarginatella cf. macrostoma</i> (REUSS)	RE	(Vinculariform)
<i>Cribrella haueri</i> (REUSS)	RE	(Vinculariform)
<i>Cribrella radiata</i> (MOLL)	EN	(Membraniporeiform)
<i>Dactylopora cf. septentrionalis</i> (WATERS)	FE	(Catenicellariform)
<i>Dittosaria prima</i> (REUSS)	FE	(Cellariform)
<i>Escharoides coccinea</i> (ABILDGAARD)	EN	(Membraniporeiform)
<i>Fedora indentata</i> (REUSS)	OF	(Lunuliform)
<i>Glymnapora cf. duplicata</i> (REUSS)	EN	(Membraniporeiform)
<i>Klomia</i> sp.	FE	(Cellariform)
<i>Margaretta cereoides</i> (MILNE-EDWARDS)	FE	(Cellariform)
<i>Margaretta</i> sp.	FE	(Cellariform)
<i>Membraniporida</i> sp.	EN	(Membraniporeiform)
<i>Meniscopora cf. syringopora</i> (REUSS)	RE	(Adeoniform)
<i>Microporella</i> sp.	EN	(Membraniporeiform)
<i>Nellia tenella</i> (LAMARCK)	FE	(Cellariform)
<i>Poricellaria complicata</i> REUSS	FE	(Cellariform)
<i>Porina cf. coronata</i> (REUSS)	RE	(Vinculariform)
<i>Reteporella tuberculata</i> (REUSS)	RE	(Reteporeiform)
<i>Reteporella</i> spp.	RE	(Reteporeiform)
<i>Scrupocellaria maritima</i> BIZZARINI & BRAGA	FE	(Cellariform)
<i>Scrupocellaria</i> spp.	FE	(Cellariform)
<i>Semiocheta subhyformis</i> (d'ARCHIAUC)	RE	(Vinculariform)
<i>Spariporina elegans</i> REUSS	RE	(Reteporeiform)
<i>Stenoporella arabica</i> sp.n.	RE	(Echeliform)
<i>Stenosipora reussi</i> (STOLICZKA)	OF	(Lunuliform)
<i>Stenosipora simplex</i> KOSCHINSKY	OF	(Lunuliform)
<i>Tychinella schreibersi</i> (REUSS)	RE	(Vinculariform)
<i>Vincularia subsymmetrica</i> (CANU)	FE	(Cellariform)

Tab. 3 - List of the species occurring in U.A.E. CF, O, and O₂ sequences and their zoarial growth forms (basic morphotypes and specific forms); FE: flexible erect forms, RE: rigid erect forms, EN: encrusting forms, O: other forms (Lunuliform and Conescharrelliniform).

- Sample 13: this residue is also very poor and contains pyrite crystals. There are fragments of badly preserved bryozoans and forams. Only one specimen of *Vincularia subsymmetrica*, curiously well preserved;
- Sample 14: Planktonic forams prevailing; bryozoan specimens fairly abundant, but only with 3 species: *Batopora* sp.n. (see nos 6 and 11), *Cellaria reussi*, and *Vincularia subsymmetrica*. Particularly, the specimens of *Batopora* are in a very large amount with all stage of growth. Unfortunately many are incrustated, so obscuring some important characters of this new species;
- Sample 15: benthic forams, and very rare bryozoans. There are sequent two fragments of *Stenosipora reussi* and *Stenosipora simplex* type where the zooecia may or may not have the char-

acteristic avicularium (see Systematics chapter and Pl. 3, figs 11-12);

Sample 16: virtually barren; only unrecognizable fragments;

Sample 17: echinoid fragments, oxidized bivalves and problematic bryozoan remains;

Samples 18-19-20: barren

Sample 21: very rare bryozoans (*Disporella grignonensis* and *Vincularia subsymmetrica*); the cyclostomatous completely oxidized;

Samples 22-23: barren;

Sample 24: Very rare unrecognizable fragments of bryozoans;

Sample 25: all fragments of residue completely oxidized; very rare *Nellia tenella* and *Vincularia subsymmetrica* occur;

Samples 26-27-28: no bryozoans; only benthic forams;

Sample 29: very rare bryozoan fragments and rare oxidized benthic forams. Among the bryozoan there is one interesting ovicelled *Crista haueri* and a specimen of *Poricellaria complicata*;

Sample 30: echinoids fragments, problematic bryozoan remains;

Sample 31: with this sample there is a very sudden change of bryozoan occurrence, especially of delicate cyclostomatous, mostly belonging to *Crista haueri* and *Exidmonea atlantica* species. There are also two interesting cheilostomata, which can be attributed respectively to new species of *Adeonellopsis* and *Beisselina* (see Systematics chapter);

Sample 32: barren

Sample 33: very rare bryozoans, among which *Nellia tenella* and *Microporella* sp.

Sample 34: planktonic forams and some colonies of small bryozoans badly preserved. Among them only *Nellia tenella* and *Crista haueri*, the latter sometimes not easily recognizable;

Sample 35: two specimens in poor condition, hardly determinable;

Sample 36: macroforams present (mostly *Operculina* sp.), many small bryozoan fragments of *Crista haueri* and *Nellia tenella*;

Sample 37: no bryozoans, planktonic forams only;

Sample 38: benthic and, subordinate, planktonic forams. Among the bryozoans *Nellia tenella* prevails. Small fragments of *Adeonellopsis cf. porina* present;

Sample 39A: Also in this sample the genus *Operculina* is prevalent. The bryozoans are fairly abundant, especially with specimens of *Mecynocera proboscidea*. There also occur again the same two new species, belonging to genera *Adeonellopsis* and *Beisselina*, seen in sample 31. Rare *Nellia tenella* and problematic cyclostomatous specimens;

Sample 39B: the content is the same of sample 39A but with quite rare specimens,

Samples 40-41-42-43: no bryozoans, planktonic forams (40-41) and planktonic/benthic forams (42-43) present;

Sample 44: unimportant fossil remains (*Operculina*), and small fragments of *Nellia tenella*;

Sample 45: No bryozoans; planktonic forams;

Sample 46: rare *Operculina* and planktonic forams. Some badly preserved cyclostomatous (*Filisparsa fallax*, *Exidmonea atlantica* and *Mecynocera proboscidea*). As in many previous samples the presence of *Nellia tenella* is fairly high;

Sample 47: this sample is relatively the richest of bryozoan remains, together with rare nummulitids and planktonic forams. Among the bryozoans is emphasized the occurrence of many fragments of *Exidmonea atlantica*, *Reteporella tuberculata* is also frequent. For the occurrence of other cyclostomatous and cheilostomatous see Tab. 3;

Sample 48: no bryozoans; very rich in planktonic forams;

Sample 49: Nummulitids and benthic forams present. As in the other samples from the top of this sequence the residue is characterized by a typical oligospecificity with a great number of one or two species. There are 70 fragments of *Vincularia subsymmetrica*, most of them well preserved. The other relatively frequent, with 12 specimens, is *Margaretta cereoides*;

Sample 50: benthic forams; *Vincularia subsymmetrica* is vanished (?), while *Margaretta cereoides* is still present;

Samples 51-52 and 54: henthic forams; the bryozoan content in these samples is quite similar (see Tab. 3). Noteworthy is the reappearance of the new species belonging to genus *Adenellopsis* seen for the first time in sample 51. Here is it quite abundant (20 specimens) and well preserved, with clear specific character for a good description:

Sample 53: barren;

Sample 55: Nummulitids and benthic forams; some rare small and poorly preserved fragments of bryozoans.

O₁ and O₂ sequences

In the sequence O₁ (Mutaredh Mb.) and O₂ (Muwajji Mb.) both belonging to the upper part of Asmari Formation (lower-middle Oligocene) many samples (35 and 20 respectively) were collected, but most are totally barren or without bryozoan remains. Nevertheless some of them are quite differentiated in species content and number of specimens (see in Tab. 4 especially the numbers 3-4 and 13 for O₁ and 11, 17 and 19 for O₂).

O₁ Sequence

Sample 1: limestone fragments; nummulitids and rare badly preserved bryozoans. Particularly interesting is the occurrence, also in this sequence, of the n. sp. of *Adenellopsis* previously seen in the upper section of CF samples;

Sample 2: limestone fragments, rare planktonic forams, very rare bryozoans;

Sample 3: limestone fragments, rare nummulitids and benthic forams; the abundance of *Exidmonea atlantica* is significant;

Sample 4: limestone fragments, rare nummulitids and benthic forams. In this residue the bryozoans are relatively abundant in specimens and quite rich in species. The discovery of a single specimen probably belonging to *Kilonisa* is interesting.

Sample 5: limestone fragments, rare organic remains (sponge spicules) and rare but interesting bryozoans, among them *Ditaxiporina* cf. *septentrionalis*.

Samples 7-8A: these two samples have a poor content not only in bryozoans but also in benthic forams;

Sample 13: This residue is characterized by very abundant fragments of small articulated colonies belonging to *Nellia tenella* and *Cellaria reussi*; another species, rare and curiously well preserved is *Poricellaria complicata*;

Sample 14: This residue, the poorest of the whole sequence, is nearly barren. There are only some henthic forams and four bryozoan specimens, belonging to four different problematic taxa. It is noteworthy that samples 18-34 contain only limestone fragments, sometimes oxidized, and with regard to other fossils are totally barren.

O₂ Sequence

Sample 2: It is almost a barren sample. We have only a small and badly preserved fragment of *Vincularia subsymmetrica*;

Sample 7: Some benthic forams, fish teeth and small echinoids. Rare bryozoans; the presence of three specimens of well enough preserved *Poricellaria complicata* is notable;

Sample 11: Oxidized residue, benthic forams (miliolids), and abundant (50 specimens) *Vincularia subsymmetrica* is prevalent. *Poricellaria complicata* (two specimens) is still present;

Sample 13: Virtually barren; very rare small fragments of *Vincularia subsymmetrica* and other very rare and not well preserved specimens of *Nellia tenella* and *Reteporella* sp.;

Sample 16: the content is similar to the previous samples; a specimen of *Poricellaria complicata* is very well preserved and has been so utilized to illustrate it (Pl. 2, figs. 8-10);

Sample 17: bivalve fragments and macroforams. The content is quite diverse and, although most specimens are badly preserved, they were generically determined. Remarkably abundant are some encrusting bryozoans probably belonging to *Microporella*. They nevertheless need detailed systematical studies. Another problematic specimen is figured in Pl. 2, figs. 3-4. It is an encrusting fragment doubtfully assigned to *Gigantopora* cf. *duplicata*: The shape of the aperture and the position of large ascopore are very similar to that of Reuss's species, which however seems to have usually a vincularian growth form;

Sample 18: practically barren sample; all fossils, the "phantom" bryozoans as well are completely oxidized;

Sample 19: many macroforams. The numerous specimens are not really well preserved, but comparisons with the same species present in previous samples allow us to recognize *Margaretta ceroides* (30 specimens), *Vincularia subsymmetrica* (10), and *Nellia tenella* (20). There are four specimens belonging to the genus *Steginoporella*, that are ascribed to a new species (see Systematics chapter);

Sample 20: practically barren; very rare bryozoan fragments.

SYSTEMATICS

In this section all discovered species are reported (see Tab. 3, with growth forms, Tabs. 4 and 5, which give occurrence of bryozoans in the sampled sequences, all names in alphabetic order for easily consulting), and the synonymic names and the stratigraphic distribution are briefly listed. Also the descriptions of the four new species are restricted to basic remarks. They will be the topic of a separate subsequent paper.

This list partly follows the classification of R.S. BASSLER (in R.C. MOORE, 1953: Treatise of Invertebrate Paleontology, Part G, Bryozoa), but it needs also to consider the most important papers recently published and the continuous Progress reports on above Treatise (Revised), Coordinator D.P. Gordon, with P.L. Cook, E. Hakansson & P.D. Taylor.

Order CYCLOSTOMATIDA Busk, 1852

Family CRISIIDAE Johnston, 1838

Genus *Crisia* Lamouroux, 1812

Crisia elongata Milne-Edwards, 1838

Crisia haueri Reuss, 1848

Crisia hoernesii Reuss, 1848

Crisia spp.

Genus *Filicrisia* d'Orbigny, 1853

Filicrisia sp.

Family TUBULIPORIDAE Johnston, 1838

Genus *Exidmonea* David, Mongereau & Pouyet, 1972

Exidmonea atlantica David, Mongereau & Pouyet, 1972

Exidmonea concava (Reuss, 1869)

Exidmonea sp.

Family ONCOSOECIIDAE Canu, 1918

Genus *Filisarsa* d'Orbigny, 1852

Filisarsa fallax Canu and Bassler, 1920

Filisarsa sp.

Family ENTALOPHORIDAE Reuss, 1863

Genus *Mecynoecia* Canu, 1918

Mecynoecia proboscidea (Milne-Edwards, 1838)

Mecynoecia sp.

Family HORNERIDAE Gregory, 1899

Genus *Hornera* Lamouroux, 1821

Hornera sp.

Family LICHENOPORIDAE Smitt, 1866

CYCLOSTOMATIDA	1	2	3	4	5	7	8A	13	14	Tot	2	7	11	13	16	17	18	19	20	Tot
<i>Crista elongata</i> M.Edw.	1	3		3			1	1		9										
<i>Crista haueri</i> REUSS																				
<i>Crista hoernesii</i> R.							1			1										
<i>Crista</i> spp.	1	2					2			5										
<i>Disporella grignonensis</i> M.EDW.																				
<i>Disporella</i> sp.				2						2										
<i>Egidmonea atlantica</i> DAV, MONG, POU.	1		90	20						111										
<i>Egidmonea concava</i> (R.)				1						1										
<i>Egidmonea</i> sp.					3				1	4										
<i>Filicrista</i> sp.				10						10										
<i>Filisparsa fallax</i> C.BASSLER							2			2										
<i>Filisparsa</i> sp.				30						30			1							1
<i>Hornera</i> sp.				1						1										
<i>Mecynoechia proboscidea</i> M.EDW.			7	2					1	10										
<i>Mecynoechia</i> sp.				2						2										
CHEILOSTOMATIDA																				
<i>Adeonellopsis omanensis</i> n.sp.	3			9						12					3					3
<i>Adeonellopsis</i> cf. <i>coscinophora</i> (R.)																				
<i>Adeonellopsis</i> cf. <i>porina</i> ROEMER																				
<i>Alderina subtilimargo</i> (R.)																				
<i>Arthropoma sparsipora</i> (R.)															1					1
<i>Batopora stellata</i> sp.n.																				
<i>Beisslinia robusta</i> sp.n.																	2			2
<i>Biflustra</i> sp.				1						1		2					2			4
<i>Calpensia</i> sp.																		1		1
<i>Cellaria reussi</i> d'ORB.	4	1	3	1				50	1	60										
<i>Celleporaria</i> sp.																		4		4
<i>Crassimarginatella</i> cf. <i>macrostoma</i> (R.)																				
<i>Cribrilaria haueri</i> (R.)				1						1										
<i>Cribrilaria radiata</i> (MOLL)															1					1
<i>Ditaxiporina</i> cf. <i>septentrionalis</i> (WATERS)					9	1	1	1		12										
<i>Dittosaria prima</i> (R.)																				
<i>Escharoides coccinea</i> (ABILDG.)															1					1
<i>Fedora bidentata</i> (R.)																				
<i>Gigantopora</i> cf. <i>duplicata</i> (R.)															1					1
<i>Kylonia</i> sp.				1						1										
<i>Margaretta cereoides</i> (M.EDW.)				2				2		4			4					30		34
<i>Margaretta</i> sp.								1		1										
<i>Membraniporida</i> sp.																				
<i>Meniscopora</i> cf. <i>syringopora</i> (R.)																				
<i>Microporella</i> sp.															10				1	11
<i>Nellia tenella</i> (LAMARCK)		1		1	10	10	15	20	1	58		6	7	1	6		1	20	1	42
<i>Poricellaria complicata</i> R.								1	1	2		3	2		2				1	8
<i>Porina</i> cf. <i>coronata</i> (R.)																1				1
<i>Reteporella tuberculata</i> (R.)													3			6		3		12
<i>Reteporella</i> spp.				1				6		7				1	2	1		1		5
<i>Scrupocellaria marastiana</i> B.&BR.																				
<i>Scrupocellaria</i> spp.			1	3	1	6	4			15										
<i>Semieschara subpyriformis</i> (d'ARCH.)				1						1										
<i>Sparsiporina elegans</i> R.				1		1		1		3			1							1
<i>Steginoporella arabica</i> sp.n.				2						2								4		4
<i>Stenosipora reussi</i> (STOLICZKA)																				
<i>Stenosipora simplex</i> KOSCHINSKY																				
<i>Tychinella schreibersi</i> (R.)																				
<i>Vincularia subsymmetrica</i> (CANU)			3					3		6	1			50	7	1		10	1	70
Number of specimens	10	7	104	95	23	18	26	87	4	374	1	9	68	9	11	25	1	74	4	203

Tab. 5 - Occurrence of U.A.E. Bryozoa in O₁ and O₂ samples (Middle Oligocene-Later Oligocene).

Genus *Disporella* Gray, 1848
Disporella grignonensis (Milne-Edwards, 1838)
Disporella sp.

Order CHEILOSTOMATIDA Busk, 1852
 Family MEMBRANIPORIDAE Busk, 1854
 Genus *Biflustra* d'Orbigny, 1852
Biflustra sp.

Family VINCULARIIDAE Busk, 1852
 Genus *Vincularia* Defrance, 1829
Vincularia subsymmetrica (Canu, 1907)

Family CALLIOPORIDAE Norman, 1903
 Genus *Alderina* Norman, 1903
Alderina subtilimargo (Reuss, 1864)

Genus *Crassimarginatella* Canu, 1900
Crassimarginatella cf. macrostoma (Reuss, 1848)

Genus *Membraniporida* Canu & Bassler, 1917
Membraniporida sp.

Family QUADRICELLARIIDAE Gordon, 1984
 Genus *Nellia* Busk, 1852
Nellia tenella (Lamarck, 1816)

Family CANDIDAE d'Orbigny, 1851
 Genus *Scrupocellaria* Van Beneden, 1845
Scrupocellaria marosticana Bizzarini & Braga, 2001
Scrupocellaria spp.

Family CALPENSIIIDAE Canu & Bassler, 1923
 Genus *Calpensia* Jullien, 1888
Calpensia sp.

Family PORICELLARIIDAE Harmer, 1926
 Genus *Poricellaria* d'Orbigny, 1852
Poricellaria complicata (Reuss, 1869)

Family ONYCHOCELLIDAE Jullien, 1881
 Genus *Semieschara* d'Orbigny, 1852
Semieschara subpyriformis (D'Archiac, 1846)

Family MICROPORIDAE Hincks, 1883
 Genus *Microporella* Hincks, 1877
Microporella sp.

Family STEGINOPORELLIDAE Hincks, 1884
 Genus *Steginoporella* Smitt, 1873
Steginoporella arabica sp.n.

Family CELLARIIDAE Fleming, 1828
 Genus *Cellaria* Ellis-Solander, 1786
Cellaria reussi (d'Orbigny, 1851)

Family SKILONIIDAE Sandberg, 1963
 Genus *Kylonisa* Keij, 1972
Kylonisa sp.

Family CRIBRILINIDAE Hincks, 1879
 Genus *Cribrilaria* Canu & Bassler, 1929
Cribrilaria haueri (Reuss, 1848)
Cribrilaria radiata (Moll, 1803)

Family PASYTHEIIDAE Davis, 1934
 Genus *Dittosaria* Busk, 1866
Dittosaria prima (Reuss, 1866)

Family CATENICELLIDAE Busk, 1852
 Genus *Ditaxiporina* Stach, 1935
Ditaxiporina cf. septentrionalis (Waters, 1891)

Family ADEONIDAE Busk, 1884
 Genus *Adeonellopsis* McGillivray, 1886
Adeonellopsis omanensis sp.n.
Adeonellopsis cf. coccinophora (Reuss, 1848)
Adeonellopsis cf. porina (Roemer, 1863)

Family ROMANCHEINIDAE Jullien, 1888
 Genus *Escharoides* Edwards, 1836
Escharoides coccinea (Abildgaard, 1806)

Family TETRAPLARIIDAE Harmer, 1952
 Genus *Tychinella* Zagorsek & Kazmer, 2001
Tychinella schreibersi (Reuss, 1848)

Family BEISELINIDAE Gordon, 2001
 Genus *Beisselina* Canu, 1913
Beisselina robusta sp.n.

Family PORINIDAE d'Orbigny, 1852
Porina cf. coronata (Reuss, 1869)

Family GIGANTOPORIDAE Bassler, 1935
 Genus *Gigantopora* Ridley, 1881
Gigantopora cf. duplicata (Reuss, 1848)

Family MARGARETTIDAE Harmer, 1917
 Genus *Margaretta* Gray, 1843
Margaretta cereoides (Ellis-Solander, 1786)
Margaretta sp.

Family LACERNIDAE Jullien, 1888
 Genus *Arthropoma* Levinsen, 1909
Arthropoma sparsipora (Reuss, 1869)

Family ASCOSIIDAE Jullien, 1883
 Genus *Fedora* Jullien, 1882
Fedora bidentata (Reuss, 1869)

Genus *Stenosipora* Canu & Bassler, 1927
Stenosipora reussi (Stoliczka, 1862)
Stenosipora simplex (Koschinsky, 1885)

Family LEPRALIELLIDAE Vigneaux, 1949
 Genus *Celleporaria* Lamouroux, 1821
Celleporaria sp.

Family PHIDOLOPORIDAE Gabb & Horn, 1862
 Genus *Reteporella* Busk, 1884
Reteporella tuberculata (Reuss, 1869)
Reteporella spp.

Genus *Sparsiporina* d'Orbigny, 1852
Sparsiporina elegans (Reuss, 1848)

Family BATOPORIDAE Neviani, 1900
 Genus *Batopora* Reuss, 1867
Batopora stellata sp.n.

CYCLOSTOMATIDA

CRISIA ELONGATA Milne-Edwards, 1838

- 1838 *Crisia elongata* MILNE-EDWARDS, p. 203, pl. 7, fig. 2.
 1848 *Crisia Edwardsii* REUSS, p. 53, pl. 7, fig. 30.
 1980 *Crisia elongata* Milne-Edwards - ANTOLINI, BRAGA & FINOTTI, p. 35, fig. 17.
 2001 *Crisia elongata* Milne-Edwards - ZAGORSEK & KAZMER, p. 23, pl. 1, figs 4-5.

Description – Colony articulated and biserial. Width of the colony approximately equal to the distance between two lateral apertures. Apertures circular with very salient peristome. Dorsal wall porous.

Occurrence – Eocene-Present.
 Samples: CF 15,49/O₁ 1,2,4,8A,13.

CRISIA HAUERII Reuss, 1848
Pl. 1, fig. 2

- 1848 *Crisia haueri* REUSS, p. 54, pl. 7, figs 22-24.
 2001 *Crisia haueri* Reuss - ZAGORSEK & KAZMER, p. 23, pl. 1, fig. 2.

Description – Colony articulated, narrow and biserial, with slightly developed peristome. The zoecial wall smooth and slightly porous. The high distance between the two lateral apertures is characteristic of this species.

Occurrence – Upper Eocene-Miocene.
 Samples: CF 29,31,34,36,52.

CRISIA HOERNESI Reuss, 1848
Pl. 1, fig 1

- 1848 *Crisia Hoernesii* REUSS, p. 54, pl. 7, fig. 21, pl. 11, fig. 28.
1975 *Crisia hoernesii* Reuss - BRAGA, p. 143, pl. 1, fig. 1.
1988 *Crisia hoernesii* Reuss - BRAGA & BARBIN, p. 505.
2001 *Crisia hoernesii* ZAGORSEK & KAZMER, p. 23, pl. 1, fig. 3.

Description – Colony articulated and biserial. As in *elongata* the width of the colony is about the same with the distance of the two lateral apertures, but the zooecial tubes are not visible on the surface, and the zoarium is nonporous. Aperture circular with non salient peristome.

Occurrence – Eocene-Present.
Samples: CF 55/O₁ 8A.

CRISIA spp.

Remarks – In sample sequences CF and O₁ some poorly preserved specimens, belonging to the genus *Crisia*, are present (see Tabs. 4-5).

FILICRISIA sp.

Remarks – In O₁ sequence (sample 4) there are many fragments of articulated bryozoans with slender long internodes and prominent apertures. They certainly belong to family Crisiidae, being however more similar to *Filicrisia* than to other *Crisia* found in the studied residues. The specimens will be object of subsequent research. No gonozooecium present.

EXIDMONEA ATLANTICA
David, Mongereau & Pouyet, 1972
Pl. 1, figs 3-4

- 1969 *Exidmonea atlantica* Auct. - MONGEREAU, p. 216, pl. 16, fig. 1, pl. 17, fig. 1.
1988 *Exidmonea atlantica* Auct. - BRAGA & BARBIN, p. 506, pl. 1, fig. 1.
1992 *Exidmonea atlantica* David, Mongereau & Pouyet - TAYLOR & VOIGT, p. 123.
2001 *Exidmonea atlantica* David, Mongereau & Pouyet - ZAGORSEK & KAZMER, p. 24, pl. 1, figs 8-9.

Description – Colony erect, bifurcated, and normally in many specimens there are 3 to 5 zooecia in each fascicular row, with the fascicles which open alternately on both side of the zoarium. Aperture quadrangular and dorsal side of the colony smooth.

Occurrence – Eocene- Present.
Samples: CF 31, 34, 40, 47/O₁ 1, 3, 4.

EXIDMONEA CONCAVA (Reuss, 1869)

- 1869 *Idmonea concava* REUSS, p. 282, pl. 35, figs 3-4.
1988 *Exidmonea concava* (Reuss) - BRAGA & BARBIN, p. 506, pl. 1, figs 3-4, 7.

Remarks – The dorsal surface is typical for Reuss's *concava* species, with flat or sometimes convex profile; 3 or 5 fascicles externally evident.

Occurrence – Upper Eocene-Oligocene.
Samples: CF 34, 39A, 47/O₁ 4.

EXIDMONEA sp.

Remarks – In samples O₁ 5 and 14 there are some specimens, poorly preserved, that cannot be ascribed either to *atlantica* or to *concava* species.

FILISPARSA FALLAX Canu & Bassler, 1920

- 1920 *Filisparsa fallax* CANU & BASSLER, p. 693, pl. 142, figs 1-11.
1963 *Filisparsa fallax* Canu & Bassler - BRAGA, p. 49, pl. 5, fig. 8.

Remarks – These rare specimens are very similar to the cyclostome colonies collected by Braga (1963) in the Lower Oligocene of Montecchio di Costozza (Mt. Berici) and then attributed to the Canu and Bassler species.

Occurrence – Eocene-Oligocene.
Samples CF 46/ O₁ 8A.

FILISPARSA sp.

Remarks – The several specimens present in sample O₁ 4 are reminiscent of the zoarial shape of the genus *Onconsoecia* in having long peristomes that open only in the frontal surface. They nevertheless have cylindrical and narrow branches and many zooecial apertures, with small diameter. Lacking the typical *Onconsoecia*'s ovicell it is better to ascribe these specimens only to genus *Filisparsa*.

MECYNOCIA PROBOSCIDEA (Milne-Edwards, 1838)

- 1838 *Pustulopora proboscidea* MILNE-EDWARDS, p. 219, pl. 12, fig. 2.
1920 *Mecynocia proboscidea* (Milne-Edwards) - CANU & BASSLER, p. 726, pl. 108, figs 1-15.
1988 *Mecynocia proboscidea* (Milne-Edwards) - BRAGA & BARBIN, p. 509, pl. 2, fig. 5.
2001 *Mecynocia proboscidea* (Milne-Edwards) - ZAGORSEK & KAZMER, p. 26, pl. 2, figs 7-8.

Description – Colony erect, cylindrical, with zooecial tubes that open around the zoarium. They are very long, with circular aperture and prominent peristome.

Occurrence – Eocene-Present.
Samples: CF 39A, 39B, 46/O₁ 3, 4, 14.

MECYNOCIA sp.

Remarks – In the same previous samples there are some poorly preserved specimens that, for their zoar-

ial shape, could possibly be included in the wide variability of *proboscidea*, but this is doubtful as they have very narrow unusual peristomes.

HORNERA sp.

Remarks – Only very poor fragments in samples CF 31 and O₁ 4. For the hornerid distinctive shape of the dorsal surface (*sulci*) they nevertheless could be ascribed to this genus.

DISPORELLA GRIGNONENSIS (Milne-Edwards, 1838) Pl. 1, fig. 5

- 1838 Tubulipore de Grignon MILNE-EDWARDS, p. 333, pl. 13, figs 2-2D.
1980 *Lichenopora grignonensis* (Milne-Edwards) - ANTOLINI, BRAGA & FINOTTI, p.44, figs 25-26.
1988 *Lichenopora grignonensis* (Milne-Edwards) - BRAGA & BARBIN, p. 514, pl. 4, fig. 1.
2001 *Disporella grignonensis* (Milne-Edwards) - ZAGORSEK & KAZMER, p. 29, pl. 3, fig. 10.

Description – Colony encrusting and discoidal with lower surface flat. Fascicle not much salient, uniserial and short. One or two rows of polygonal or rectangular *cancelli*. Gonozooecium not observed. This species, commonly ascribed to *Lichenopora*, now belongs to the genus *Disporella* (Gordon & Taylor, 1997).

Occurrence – Upper-middle Eocene.

Samples: CF 12 (pyritized specimen), CF 21 (oxidized).

DISPORELLA sp.

Remarks – Two small fragments, very poorly preserved, that could belong to the genus *Disporella*.

CHEILOSTOMATIDA

BIFLUSTRA sp.

Remarks – Rare fragments of specimens, attributable to the family Membraniporidae. Despite the poor preservation, these fragments may be ascribed to

the genus *Biflustra* based on the shape of zooecia arranged in longitudinal rows and the position of the opesia.

Samples: O₁ 4 and O₂ 7 and 8.

VINCULARIA SUBSYMMETRICA (Canu, 1907) Pl. 1, fig. 8

- 1907 *Heterocella subsymmetrica* CANU, p. 16, pl. 2, figs 1-3.
1961 *Heterocella subsymmetrica* Canu - LABRACHERIE, p. 12, pl. 2, fig. 6.
1988 *Vincularia subsymmetrica* (Canu) - BRAGA & BARBIN, p. 514, pl. 4, fig. 7.

Description – Articulated zoaria, zooecia subrectangular, large and separated by a narrow furrow. D zooecia (divergent) not clearly discernible by C zooecia (convergent). Large opesia, slightly smaller than those of C.

Remarks – This characteristic and unmistakable species is one of the more common and well represented in all series, especially in the samples from the upper part of CF sequence.

Occurrence – Middle-Upper Eocene.

Samples: see Tabs 3 and 4.

ALDERINA SUBTILIMARGO (Reuss, 1864)

- 1864 *Membranipora subtilimargo* REUSS, p. 630, pl. 9, fig. 5.
1974 *Alderina subtilimargo* (Reuss) - DAVID & POUYET, p. 106, pl. 2, fig. 4.
1988 *Alderina subtilimargo* (Reuss) - BRAGA & BARBIN, p. 516, pl. 5, fig. 5.
2001 *Alderina subtilimargo* (Reuss) - ZAGORSEK & KAZMER, p. 31, pl. 4, fig. 4.

Remarks – Only one encrusting fragment of a zoarium. Zooecia oval, irregularly arranged in quincunx. Opesia large, with very small gymnocyst. No ovicelled zooecia in the specimen.

Occurrence – Eocene-Miocene.

Sample: CF 52.

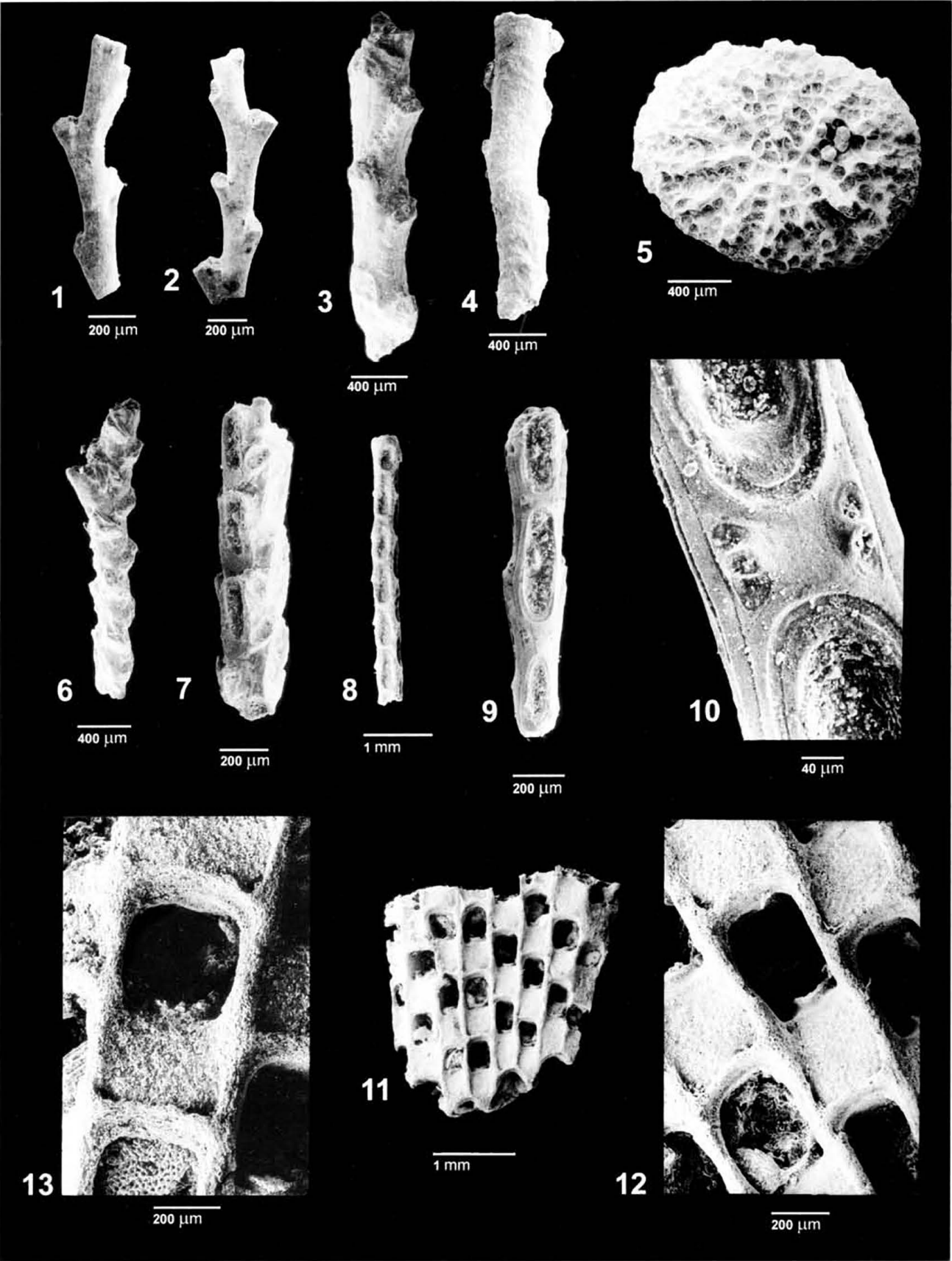
EXPLANATION OF PLATE 1

- Fig. 1 - *Crisia hoernesii* (Reuss): CF 31;
Fig. 2 - *Crisia haueri* (Reuss): CF 31;
Figs 3-4 - *Exidmonea atlantica* (David, Mongereau & Pouyet): O₁ 3;
Fig. 5 - *Disporella grignonensis* (Milne-Edwards): CF 12;
Figs 6-7 - *Scrupocellaria marosticana* Bizzarini & Braga: CF 51;
Fig. 8 - *Vincularia subsymmetrica* (Canu): CF 49;
Figs 9-10 - *Nellia tenella* (Lamarch): CF 36;
Figs 11-13 - *Steginoporella arabica* sp.n.: O₂ 19 (*Holotypus*).

CF: Zakher Mb. (Asmari Fm.): Lower Oligocene - Middle Oligocene.

O₁ Mutaredh Mb. (Asmari Fm.): middle Middle Oligocene.

O₂ Muwajji Mb. (Asmari Fm.): Middle Oligocene-Late Oligocene.



CRASSIMARGINATELLA cf. MACROSTOMA (Reuss, 1848)

- 1848 *Cellaria macrostoma* REUSS, p. 64, pl. 8, figs 5-6.
 1974 *Crassimarginatella macrostoma* (Reuss) - DAVID & POUVET, p. 107, pl. 3, figs 3-4.
 1988 *Crassimarginatella macrostoma* (Reuss) - BRAGA & BARBIN, p. 516, pl. 4, fig. 8.
 2001 *Crassimarginatella macrostoma* (Reuss) - ZAGORSEK & KAZMER, p. 32, pl. 4, figs 7,8.

Remarks - Two small fragments, very poorly preserved. The oval, slightly elongated opesia, and the presence of a reduced gymnocyst are characters that can do questionably attribute these specimens to Reuss' species.

Occurrence - Eocene - Miocene (*C. macrostoma*).
 Sample: CF 49.

MEMBRANIPORIDRA sp.

Remarks - Zoarium encrusting; zooecia elongate, distinct, oval, with a proximal small gymnocyst; mural rim very thin; opesia elliptical. A distal triangular impression is present, perhaps belonging to an avicularian structure.
 Samples: CF 33,54.

NELLIA TENELLA Lamarck, 1816
 Pl. 1, figs 9,10

- 1852 *Nellia oculata* BUSK, p. 18, pl. 64, fig. 6, pl. 65, fig. 4.
 1907 *Farcinia tenella* (Lamarck) - CANU, p.76, pl. 2, figs 26-27.
 1963 *Nellia tenella* Lamarck - BRAGA, p. 27.
 1966 *Nellia tenella* Lamarck - CHEETHAM, p. 48, fig. 28.

Description - Zoarium erect, very thin, articulated and rectangular or fairly rounded in transverse section. Zooecia in four rows, off set by a distance of half zooecium and separated by a thin furrow. Narrow subtriangular opesia, with two small distal avicularian pores. Gymnocyst smooth, occupying one third of the entire zooecium.

Remarks - This species, with the other articulated colonies (*Cellaria reussi* and *Vincularia subsymmetrica*), is one of the most common in all examined sequences.

Occurrence - Middle Eocene-Present.
 Samples: see Tabs 4 and 5.

SCRUPOCELLARIA MAROSTICANA
 Bizzarini & Braga, 2001
 Pl. 1, figs 6-7

- 1891 *Scrupocellaria elliptica* Reuss - WATERS, p. 6, pl. 1, figs 9-10.
 1999 *Scrupocellaria watersi* BIZZARINI & BRAGA, p. 114, figs 8a,b.
 2001 *Scrupocellaria marosticana* BIZZARINI & BRAGA, p. 445, fig. 1

Description - Very slender zoarium. Ventral sur-

face with an elliptical opesia. Avicularia below the opesia and very clear trace of spines on the external distal margin of the zooecium. Characteristic triangular transverse avicularia on dorsal surface. Ovicell hyperstomial.

Occurrence - Upper Eocene.
 Sample: CF 51.

SCRUPOCELLARIA spp.

Remarks - In the sample sequence O₁ there are many small fragments of the genus *Scrupocellaria*; nevertheless, owing to poor preservation of most zoaria, it is very difficult to decide to which species they can be assigned.
 Samples: O₁ 3, 4, 5, 7, 8A.

CALPENSIA sp.

Remarks - Only one specimen, very poorly preserved, encrusting a limestone fragment. The semilunar opesia, with two opesiules situated below it and the porous cryptocystal area, allow us to ascribe it to the genus *Calpensia*.
 Sample: O₂ 19.

PORICELLARIA COMPLICATA (Reuss, 1869)
 Pl. 2, figs 8-9

- 1869 *Diplodidymia complicata* REUSS, p. 468, pl. 3, figs 6-9.
 1973 *Poricellaria complicata* (Reuss) - LAGAN & COOK, p. 492, pl. 1, figs 7-8.
 1975 *Poricellaria complicata* (Reuss) - BRAGA, p. 146, pl. 2, figs 9-10.
 2001 *Poricellaria complicata* (Reuss) - ZAGORSEK & KAZMER, p. 38, pl. 4, fig. 5.

Description - Zoarium erect, articulated, with four zooecia arranged in longitudinal rows, suboval and laterally divergent. Cryptocysts well developed, with distal semilunar opesia. Avicularia round, placed proximally between the zooecia.

Occurrence - Upper Eocene-Upper Oligocene.
 Samples: CF 29, 30B/O₁ 13, 14/O₂ 7, 11, 16, 20.

SEMIESCHARA SUBPYRIFORMIS (D'Archiac, 1846)

- 1848 *Eschara excavata* REUSS, p. 72, pl. 8, fig. 36.
 1980 *Onychocella subpyriformis* (D'Archiac) - ANTOLINI, BRAGA & FINOTTI, p. 46, figs 29-30.
 1999 *Semieschारा subpyriformis* (D'Archiac) - BIZZARINI & BRAGA, p. 113.

Remarks - Only one fragment of encrusting zoarium, not well preserved. Nevertheless the hexagonal shape of the zooecia, with large, semilunar opesia, and the onychocellarian avicularia are character that suffice to classify this western tethyan species, which

is very common, for example, in the Paleogene of Veneto region.

Occurrence – Upper Eocene-Lower Oligocene.
Sample: O₁ 4.

MICROPORELLA sp.

Remarks and description – In O₂ sequence (samples 17, 20) there are many poorly preserved specimens, with features masked by granular incrustations, that may belong to the family Microporellidae. The zoarium is encrusting, unilamellar, with hexagonal zooecia, distinctly separated by a marked furrow. The aperture is semicircular, placed at the distal extremity of the zooecium. The frontal wall is convex and finely perforated. One long beaked avicularium, placed to the right or left corner of the aperture, is present or sometimes lacking. Not ovicelled zooecia observed. We assign these specimens to *Microporella*, but they need a supplementary future study.
Samples: O₂ 17, 20.

STEGINOPORELLA ARABICA sp.n.
Pl. 1, figs 11-13

Description – The zoarium is erect, flat or cylindrical. The number of rows of zooecia is high (18 in one specimen). They are long and strictly rectangular, separated by a thick mural rim. The opesia are large, quadrangular and the opesiular indentations are not much evident, arranged on each side of a small lip. The cryptocyst is well developed, thinly porous. In the few observed specimens the presence of A and B zooecia is not clear.

Remarks – This species has affinities with *Steginoporella rectangularia* (Canu & Bassler, 1920, p.263, pl. 40, fig. 1), from the Jacksonian (Late Eocene) of South Carolina. Similarities of the two species include shape of the zooecia with rectilinear margins, and the externally invisible opesiula which are lateral incisions of the opesia. In our specimens also the opesia are large and less arcuate or rectangular than in *S. rectangularia*. *S. rectangularia*, according to David and Pouyet (1979) is synonymic with *Steginoporella jacksonica* (Canu & Bassler, 1920).

Derivatio nominis – From Arabia, geographic area of occurrence.

Holotype – Pl. 1, figs. 11-13, Muwaiji Mb. (Asma'ri Fm., Middle Oligocene-Late Oligocene, sequence O₂, sample No. 19).

Paratypes – Remaining material (see Tab. 5). Material deposited in the City Museum of Natural History-Rovereto (TN, Italy), inv. typi No. 1352.
Samples: O₁ 4/O₂ 19.

CELLARIA REUSSI (d'Orbigny, 1851)
Pl. 2, fig. 1

- 1869 *Salicornaria reussi* d'Orbigny - REUSS, p. 261, pl. 29, fig. 5.
1988 *Cellaria reussi* (d'Orbigny) - BRAGA & BARBIN, p. 519, pl. 6, fig. 7.
2001 *Cellaria reussi* (d'Orbigny) - ZAGORSEK & KAZMER, p. 42, pl. 9, fig. 5.

Description – Zoarium erect, articulated, with circular segments in transverse section. Zooecia subrhomboidal in shape, with rows offset by a distance of half zooecium. Cryptocyst large and smooth. Orifice, when evident, semilunar. No avicularia.

Occurrence – Upper Eocene-Present.
Samples: CF 6, 8, 14/ O₁ 1, 2, 3, 4.

KYLONISA sp.
Pl. 2, fig. 11

Description – A single, very interesting fragment (O₁ 4) of a presumably articulated zoarium, attributable to the family Skyloniidae. The internode is club-shaped, with four zooecia in vertical rows and five (incomplete in number) in superimposed zooecia. The boundary between the zooecia is fairly indistinct. Its dimensions seem to increase distally, with the apertures vertically elliptical, surrounded by a thick rim. This specimen most probably belongs to the genus *Kylonisa* Keij, 1972, and is very similar to *Kylonisa nagappai* Keij, 1972, from Middle Eocene deposits of India. The specimen has a very similar zoarium to that of above species; it differs in having indistinct boundaries of zooecia and in the form of the aperture. Probably it is a new species, but the scarcity of material obliges us to use an open nomenclature, hoping to have in future more material.

CRIBRILARIA HAUERI (Reuss, 1848)

- 1848 *Cellaria haueri* REUSS, p. 63, pl. 8, fig. 9.
1848 *Eschara crenatimargo* REUSS, p. 72, pl. 8, fig. 38.
1988 *Cribrilaria haueri* (Reuss) - BRAGA & BARBIN, p. 521, pl. 7, fig. 1.
2001 *Puellina* (*Cribrilaria*) *haueri* (Reuss) - ZAGORSEK & KAZMER, p. 42, pl. 11, figs 1-2.

Remarks – Only one very poorly preserved fragment. The shape of the zooecia, with the frontal wall typically segmented by close costae, and the semicircular aperture, provided with small spines is enough, we think, to attribute this fragment to Reuss' species.

Occurrence – Upper Eocene-Lower Oligocene.
Sample : O₁ 4.

CRIBRILARIA RADIATA (Moll, 1803)

- 1920 *Puellina radiata* Moll - CANU & BASSLER, p. 294, pl. 41, figs 14-18.
1972 *Cribrilaria radiata* (Moll) - DAVID, MONGEREAU & POUYET, p. 30, pl. 9, fig. 3.

1988 *Cribrilaria radiata* (Moll) - BRAGA & BARBIN, p. 521.

2001 *Puellina* (*Cribrilaria*) *radiata* (Moll) - ZAGORSEK & KAZMER, p. 42, pl. 11, fig. 3.

Remarks – As for the previous species, there is only one specimen that, actually, is very similar to *baueri*. It differs above all by the presence of the peculiar interzoecial avicularium.

Occurrence – Eocene-Present.

Sample.: O₂ 4.

DITTOSARIA PRIMA (Reuss, 1866)

Pl. 2, fig. 2

1866 *Lepralia* (*Gemellaria*) *prima* REUSS, p. 170, pl. 7, figs 6-7.

1920 *Gemellaria prima* Reuss - CANU & BASSLER, p. 200, pl. 31, figs 22-24.

1966 *Dittosaria prima* (Reuss) - BRAGA, p. 233, pl. 30, figs 8-9.

Remarks – Only four specimens in sample 6 of CF sequence. They are not well preserved but are easily recognizable as Reuss' species.

Occurrence – Middle-Upper Oligocene.

DITAXIPORINA cf. SEPTENTRIONALIS (Waters, 1891)

Pl. 2, fig. 14

Description – Many specimens, unfortunately not well preserved, have been found in sample 5 of O₁ sequence. The uni- or biglobular articulated zoaria are very similar in shape and in the general characters to Waters species. The nearby orbicular aperture and the presence of the avicularium in the upper corner of the aperture are especially significant structures for identifying this species. It differs only in the non-porous frontal wall, which could possibly be a result of the poor preservation. Nevertheless we note that some figures in Waters (1891) also show zoaria with a non-porous surface.

Occurrence – Upper Eocene (*Ditaxiporina septentrionalis*).

Samples: O₁ 5, 7, 8A, 13.

ADEONELLOPSIS OMANENSIS sp.n.

Pl. 2, figs 5-7

Description – The zoarium is erect, adeoniform or eschariform, with 6 or more vertical zoecial rows. The zooecia are ellipsoidal, with thick mural rim. No areolar pores. The spiramen can be oval or closely round, perforated by 3-5 pores, sometimes large. The aperture is circular or semilunar. Problematic small triangular avicularia placed distally, and normally in the right corner of the aperture. No ovicelled zooecia observed. These specimens are very abundant, especially in CF sequence.

Remarks – This species is quite different to all known species. Its characteristic is the near equidimension of the spiramen and aperture, in addition with the apparent lack of areolar pores, present in almost all known species. On the whole a comparison can be made with *Adeonellopsis porina* (Roemer, 1863), which nevertheless has both evident areolar pores and subapertural avicularium. The shape of the zooecia in our specimens is reminiscent of *Adeonellopsis punctata* Canu, 1907 (p.149, pl.6, fig. 2) from the Eocene of the Paris basin, but the description does not tally with the poor figure of the "unique échantillon".

Derivatio nominis – From Oman in Arabian Peninsula.

Holotype – Pl. 2, figs 5 and 7, Zakher Mb. (Asmari Fm.), Lower Oligocene - Middle Oligocene p.p., sequence CF, sample No. 31.

Paratypes – Remaining material (see Tabs 4 and 5). Material deposited on the City Museum of Natural History-Rovereto (TN, Italy), inv. typi No.1353. Samples: see Tabs 4 and 5.

ADEONELLOPSIS cf. COSCINOPHORA (Reuss, 1848)

Pl. 3, fig. 5

1848 *Eschara coscinophora* REUSS, p. 67, pl. 8, fig. 20.

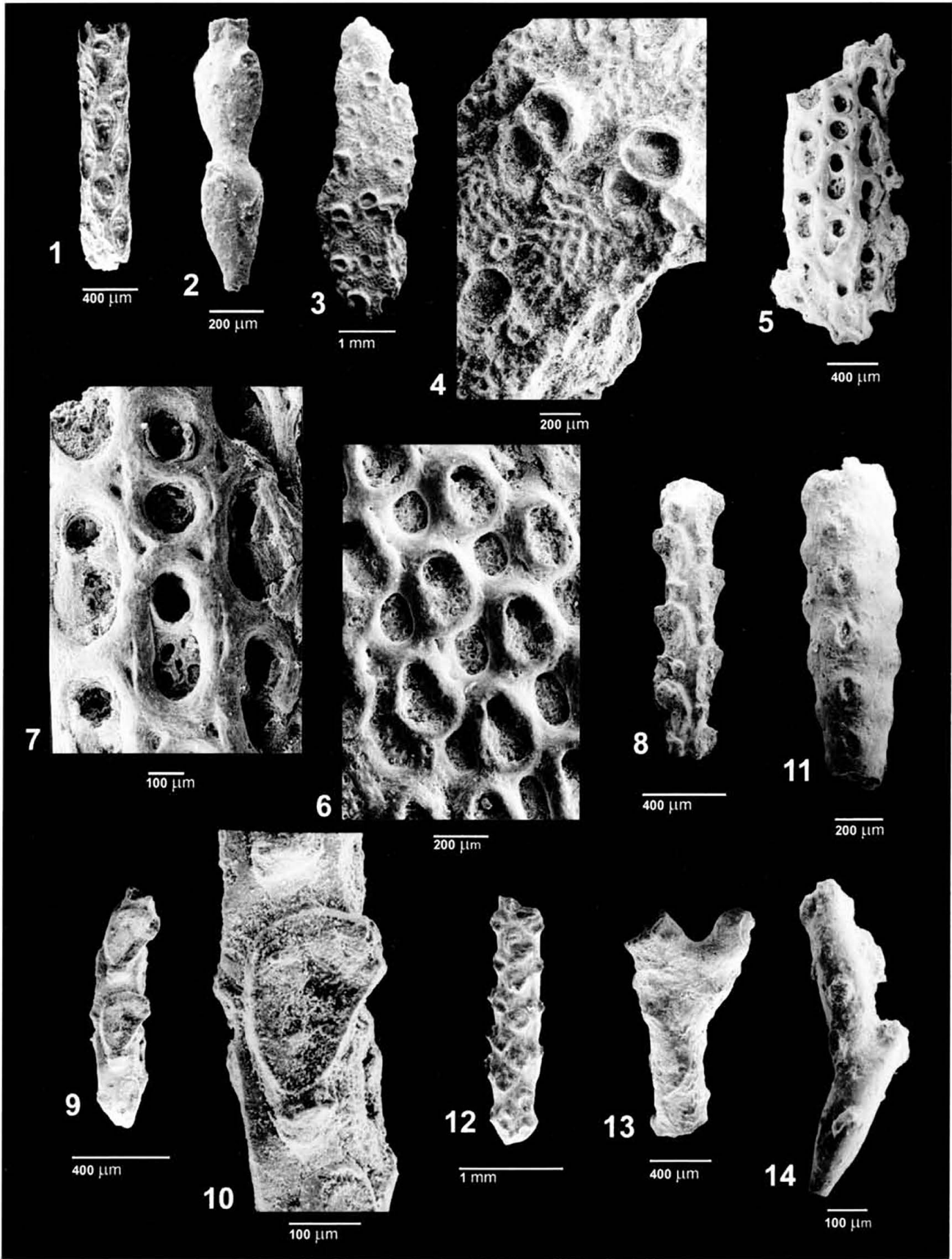
EXPLANATION OF PLATE 2

- Fig. 1 - *Cellaria reussi* (d'Orbigny): CF 6;
- Fig. 2 - *Dittosaria prima* (Reuss): CF 6;
- Figs 3-4 - *Gigantopora* cf. *duplicata* (Reuss): O₂ 17;
- Figs 5-7 - *Adeonellopsis omanensis* sp.n. (*Holotypus*: figs 5 and 7): CF 31;
- Figs 8-10 - *Poricellaria complicata* (Reuss): O₂ 16;
- Fig. 11 - *Kylonisa* sp.: O₁ 4;
- Figs 12-13 - *Reteporella tuberculata* (Reuss): O₁ 4;
- Fig. 14 - *Ditaxiporina* cf. *septentrionalis* (Waters): O₁ 5.

CF: Zakher Mb. (Asmari Fm.) : Lower Oligocene - Middle Oligocene.

O₁ Mutaredh Mb. (Asmari Fm.): middle Middle Oligocene.

O₂ Muwaiji Mb. (Asmari Fm.) : Middle Oligocene-Late Oligocene.



1974 *Adeonellopsis coscinophora* (Reuss) - DAVID & POUYET, p. 201, pl. 8, fig. 3

Remarks – Two very poorly preserved specimens in CF sequence. This doubtful determination with Reuss' species is supported by the shape of the spiramen and especially by the presence of the avicularia placed proximally and just below the aperture

Occurrence – Eocene-Miocene (*A. coscinophora*).
Sample: CF 52, 54.

ADEONELLOPSIS cf. PORINA (Roemer, 1863)

- 1863 *Vincularia porina* ROEMER, p. 204, pl. 35, fig. 2.
1975 *Adeonellopsis porina* (Roemer) - BRAGA, p. 147, pl. 3, figs. 2-3
1988 *Adeonellopsis (Lobopora) porina* (Roemer) - BRAGA & BARBIN, p. 527, pl. 10, fig. 3.
2001 *Adeonellopsis porina* (Roemer) - ZAGORSEK, p. 534, pl. 9, fig. 2.

Remarks – As for the above examined material, the specimens are also poorly preserved. The small spiramen and the position and direction of the subapertural avicularia (different from that of *coscinophora*) in the 3 fragments of zoaria are typical characters of Roemer's species. Nevertheless, for the above-said reason we prefer to put it in doubtful classification.

Occurrence – Upper Eocene-Upper Oligocene (*A. porina*).
Sample: CF 38.

ESCHAROIDES COCCINEA (Abildgaard, 1806)

- 1866 *Eschara grotriani* REUSS, p. 187, pl. 6, fig. 1.
1869 *Lepralia pteropora* REUSS, p. 257, pl. 30, fig. 4.
1968 *Escharoides coccineus* (Abildgaard) - CHEETHAM, p. 61, pl. 16, fig. 4.
1988 *Escharoides coccineus* (Abildgaard) - BRAGA & BARBIN, p. 524, pl. 8, fig. 5.
2001 *Escharoides coccinea* (Abildgaard) - ZAGORSEK & KAZMER, p. 52, pl. 17, figs 5-6.

Remarks – Only one specimen of an encrusting zoarium. Nevertheless the shape of zooecia with non-porous frontal wall and the marked areolar pores, together with presence of two divergent avicularia next to the short, peristome characterize this specimen as belonging to Abildgaard's species. About the

use of *coccinea* instead of *coccineus* introduced by Cheetham (1968), see the note of Zagorsek and Kazmer (2001, p. 53).

Occurrence – Upper Eocene-Present.
Sample: O₂ 17.

TYCHINELLA SCHREIBERSI (Reuss, 1848) Pl. 3, fig. 10

- 1848 *Cellaria schreibersi* REUSS, p. 63, pl. 8, fig. 8.
1963 *Tetraptaria schreibersi* (Reuss) - BRAGA, p. 39.
2001 *Tychinella schreibersi* (Reuss) - ZAGORSEK & KAZMER, p. 63, pl. 18, figs 3-4.

Description – Zoarium characterized by two laterally elongated zooecia, placed side by side with one median. Frontal wall markedly porous. Aperture terminal, oval, with two small avicularia near and below it.

Occurrence – Upper Eocene-Lower Oligocene.
Samples: CF 1.

BEISSELINA ROBUSTA sp.n. Pl. 3, figs 1-4

Description – Zoarium bilamellar eschariform or adeoniform, with a solid and vigorous look. Zooecia indistinct, with the peristomes irregularly placed and slightly elevated or imbedded. Ascopores large and placed so proximally that it is midway between the aperture and that of the next-proximal zooecium, sometimes not well identifiable. Some problematic slits (avicularia?) present laterally to aperture. For the zoarial and zooecial characters we believe that these specimens may belong to genus *Beisselina* instead of genus *Porina*. Among quite a lot of *Beisselina* species in the literature, it is most similar to the species *Beisselina midwayanica* Canu & Bassler, 1920 (Eocene of Georgia, USA). The material nevertheless will be object of further paleontological studies.

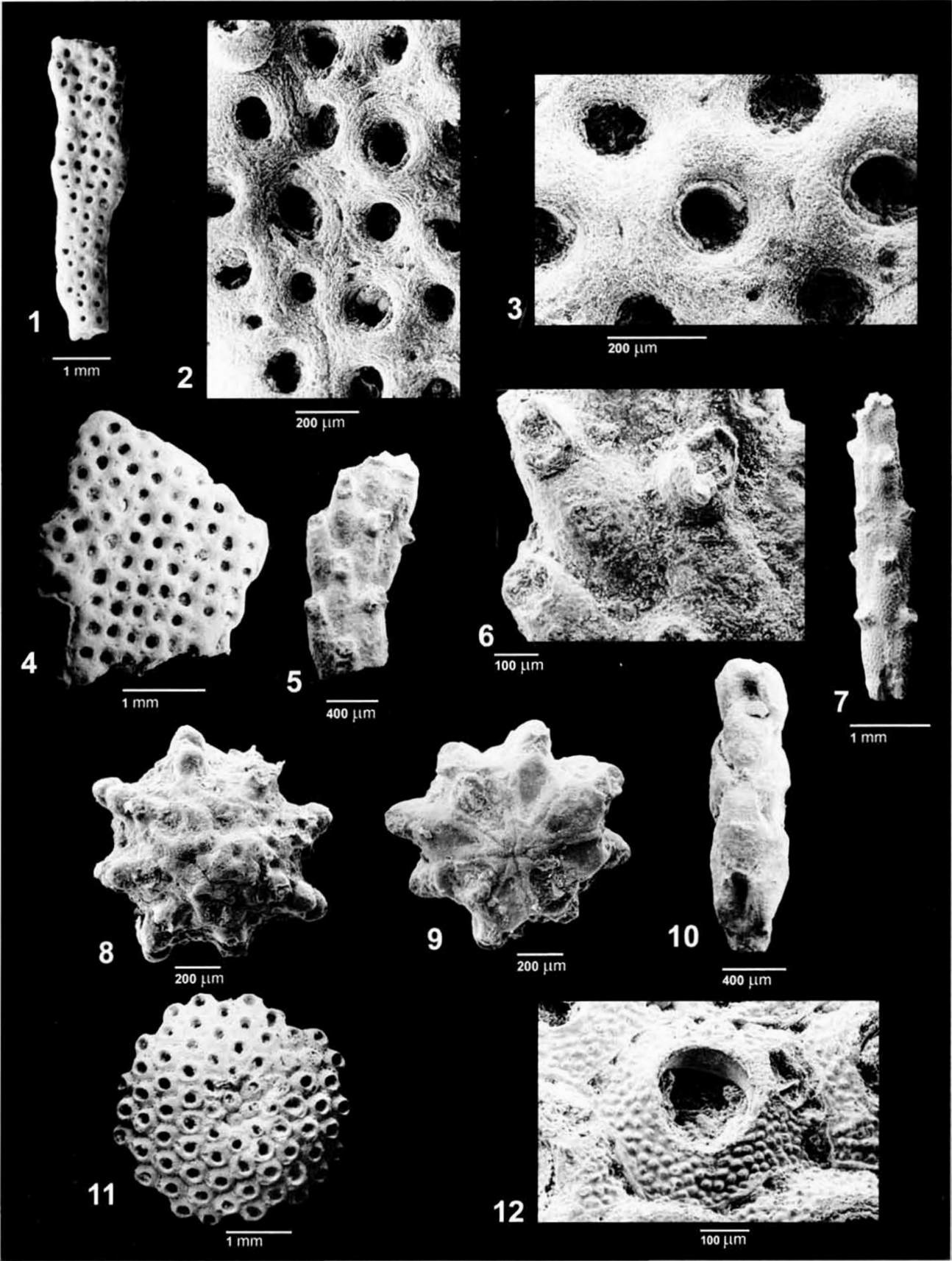
Derivatio nominis – For the well calcified and thick zoarium we suggest for this species the name *robusta* (latin for robust).

Holotype – Pl. 3, fig. 1, Zakher Mb. (Asmari Fm.), Lower Oligocene-Middle Oligocene p.p., sequence CF, sample No. 31.

EXPLANATION OF PLATE 3

- Figs 1-4 - *Beisselina robusta* sp.n. (*holotypus* fig. 1): CF 31;
Figs 5-6 - *Adeonellopsis cf. coscinophora* (Reuss): CF 52;
Fig. 7 - *Margaretta cereoides* (Ellis-Solander): CF 49;
Figs 8-9 - *Batopora stellata* sp.n. (*holotypus*): CF 11;
Fig. 10 - *Tychinella schreibersi* (Reuss): CF 12;
Figs 11-12 - *Stenosipora simplex* (Koschinsky): CF 15.

CF: Zakher Mb. (Asmari Fm.) : Lower Oligocene - Middle Oligocene.



Paratypes – Remaining material (see Tabs 4 and 5). Material deposited in the City Museum of Natural History-Rovereto (TN, Italy), inv. typi No. 1354. Samples: CF 9, 31, 39A, 47 /O₂ 19.

PORINA cf. CORONATA (Reuss, 1848)

Remarks – A few poorly preserved specimens. Zoaria vinculariiform with numerous zooecia, not well discernible. Apertures circular, and peristome with the characteristic small punctiform avicularia around it. The lack of the proximal avicularium and the absence or lack of evidence of ascoporan pore prevent precise determination.

Occurrence – Upper Eocene-Lower Oligocene (*P. coronata*).
Samples: CF 39B /O₂ 17.

GIGANTOPORA cf. DUPLICATA (Reuss, 1848)
Pl. 2, figs 3-4

1848 *Cellaria duplicata* REUSS, p. 62, pl. 7, fig. 34.
1963 *Gigantopora duplicata* (Reuss) - BRAGA, p. 31, pl. 4, fig. 1.
1988 *Gigantopora duplicata* (Reuss) - BRAGA & BARBIN, p. 522, pl. 7, fig. 8.

Description – Zoarium encrusting, with about 3 entire zooecia. Zooecia oblong with strongly porous frontal wall. Aperture large, semicircular, with an evident peristomial spiramen very close to the aperture. One small avicularium lies proximally to the aperture or in the body of the zooecium.

Remarks – Unfortunately we have only one fragment of this interesting specimen. The features are typical of the genus *Gigantopora*, but there are some substantial differences from Reuss' species; one of it is, for example, that an encrusting example of *G. duplicata* is previously unknown.

Occurrence – Upper Eocene-Lower Oligocene (*G. duplicata*).
Sample : O₂ 17.

MARGARETTA CEREOIDES (Ellis - Solander, 1786)
Pl. 3, fig. 7

1874 *Cellaria cereoides* Ellis - Solander - REUSS, p. 146, pl. 11, figs 11-15, pl. 12, fig. 12.
1975 *Margaretta cereoides* (Ellis - Solander) - BRAGA, p. 147, pl. 2, figs 15-16.
1988 *Margaretta cereoides* (Ellis - Solander) - BRAGA & BARBIN, p. 525, pl. 10, fig. 5.
2001 *Margaretta cereoides* (Ellis - Solander) - ZAGORSEK & KAZMER, p. 65, pl. 26, figs 5-7.

Description – Zoarium erect, articulated, semicircular in cross-section, and normally with four zooecia back to back arranged and hardly discernible. They are elongated, with strongly porous, little inflated

frontal wall. Aperture round, with short and narrow peristome. Median ascopore small and not much evident among the frontal porosity. No avicularia.

Occurrence – Upper Eocene-Present.
Samples: CF 6, 47, 49, 50, 54/O₁ 4, 13/O₂ 11, 19.

MARGARETTA sp.

Remarks – In the sequence O₁ (sample 13) there is one specimen, which is rather poorly preserved, with the zoarial form typical of *Margaretta*. Nevertheless it is very slender and with the peristomes much prominent. Perhaps it may be a new species, but the scarcity of material suggests a general determination.

ARTHROPOMA SPARSIPORA (Reuss, 1869)

1869 *Lepralia sparsipora* REUSS, p. 263, pl. 30, fig. 1.
1988 *Hippoporina sparsipora* (Reuss) - BRAGA & BARBIN, p. 524, pl. 8, fig. 1.
2001 *Arthropoma sparsipora* (Reuss) - ZAGORSEK & KAZMER, p. 66, pl. 22, figs 4-6.

Description – One small and poorly preserved encrusting fragment, but with the typical characters of Reuss' species. Zooecia oval and frontal that seems smooth, but to high magnification is perforated by small pores. Aperture semilunar with small sinus. The distinctive ovicell of this species is not present in this specimen.

Occurrence – Upper Eocene.
Sample: O₂ 17.

FEDORA BIDENTATA (Reuss, 1869)

1869 *Cupularia bidentata* REUSS, p. 277, pl. 29, figs 1-2.
1980 *Fedora bidentata* (Reuss) - ANTOLINI, BRAGA & FINOTTI, p. 62, figs 70-71.
1988 *Fedora bidentata* (Reuss) - BRAGA & BARBIN, p. 528, pl. 9, fig. 2.

Remarks – Only one very poor fragment has been found in CF sequence (Sample 54). The shape of the zooecia and the presence of the characteristic avicularia, nevertheless is enough to confirm this specific attribution.

Occurrence – Upper Eocene.

STENOSIPORA REUSSI (Stoliczka, 1862)

1862 *Stichoporina reussi* STOLICZKA, p. 93, pl. 3, fig. 6.
1980 *Stenosipora reussi* (Stoliczka) - ANTOLINI, BRAGA & FINOTTI, p. 62, fig. 6.

Description – Zoarium unilamellar, free living. Hexagonal zooecia regularly arranged. Aperture elliptical, with two condyles. Avicularium usually not present.

Occurrence – Upper Eocene-Lower Oligocene.
Samples: CF 8, 15.

STENOSIPORA SIMPLEX (Koschinsky, 1885)
Pl. 3, figs 11-12

Description – Only one well preserved specimen very similar to the previous species. Zoarium with free living growth form. Zooecia hexagonal, with granular frontal wall. Aperture elliptical with two condyles and one large lateral avicularium near the aperture.

Occurrence – Middle Eocene-Lower Oligocene.
Sample: CF 10.

Remarks – Regarding these two species of *Stenosipora*, as pointed out by Braga (1988, p.529), the basic difference between the two above described species is that in *simplex* there is an avicularium lateral to the aperture, while in *reussi* it is lacking or very rare. In the specimen figured on Pl. 3, fig. 11, it is clearly visible that in a sector of the colony many zooecia are devoid of avicularia. Perhaps this corroborates Braga's opinion (1980, p. 62) who put the two species in synonymy, as made before by Canu (1918).

CELLEPORARIA sp.

Remarks – In the series O₂ sample 19 there are some globular zoaria, sometimes partially broken and poorly preserved that may belong to genus *Celleporaria*.

RETEPORELLA TUBERCULATA (Reuss, 1869)
Pl. 2, figs 12-13

1869 *Retepora tuberculata* REUSS, p. 267, pl. 31, figs 9-10.
1963 *Retepora tuberculata* Reuss - BRAGA, p. 36, pl. 4, fig. 5.
1988 *Sertella tuberculata* (Reuss) - BRAGA & BARBIN, p. 526, pl. 9, fig. 6

Remarks and description – Most specimens are poorly preserved. Nevertheless the specific characters of Reuss' species are sufficiently evident. Zoarium ramose, reteporiform. Zooecia closely arranged in alternate rows and indiscernible. Aperture subcircular, with peristome fairly salient. Dorsal surface with *vibices* not evident.

Occurrence – Upper Eocene.
Samples: CF 6,47,49.

RETEPORELLA spp.

Remarks – In the sequences O₁ and O₂ there are some fragments of specimens clearly belonging to the genus *Reteporella*, and perhaps to different species. The very poor preservation does not allow us to make a more detailed determination.
Samples: O₁ 4,13/ O₂ 13, 16, 17, 19.

SPARSIPORINA ELEGANS (Reuss, 1848)

1848 *Retepora elegans* REUSS, p. 48, pl. 6, fig. 38.
1891 *Retepora elegans* Reuss - WATERS, p. 30, pl. 4, figs 9-10.
1975 *Sparsiporina elegans* (Reuss) - BRAGA, p. 147, pl. 2, fig. 7.
1988 *Sparsiporina elegans* (Reuss) - BRAGA & BARBIN, p. 526, pl. 9, fig. 8.

Remarks – Several slender fragments of zoaria, mostly not well preserved. Nevertheless the specific determination is possible and based on the characteristic dorsal surface where there are well defined roundish zooecia obliquely arranged and directed outward alternatively to right and left side.

Occurrence – Upper Eocene-Lower Oligocene.
Samples : CF 47, 49/O₁ 4, 7, 8/ O₂ 11.

BATOPORA STELLATA sp.n.
Pl. 3, figs 8-9

Description – Zoarium semiglobular or conical, more or less high, or also cupuliform. The surface of the colony has a fine rugosity. The number of the zooecia in the adult stage is more than 60, and some juvenile specimens are very small and with very few zooecia. In the adapical area is closely evident the ancestroecium characterized by a quadrangular border. Close to it is present the kenozoecial pit only just protruding, from which presumably came out the rootlet apparatus. The zooecia have indefinite borders, rhombo-ovoidal with terminal ellipsoidal suborbicular apertures. In both sides of the aperture there are two pores, perhaps avicularian. Frequently in the same specimen there are numerous ovicelled zooecia, with a characteristic infrapertural hemispheric ovicell. The colony "basis" (antapical zone) is flat and here there are evident the dorsal walls of the last grown zooecia, which give to surface a characteristic star shape.

Remarks – Nearly all *Batopora* species have been reviewed by Cook and Lagaaij (1976), some also with detailed comparisons, descriptions and figures: the two species not figured are *Batopora ernii* Darteville, 1948 and *Batopora excentrica* Ceretti & Poluzzi, 1973. On the latter we observe that Cook and Lagaaij quote in the References the Ceretti and Poluzzi paper, but they report only *Batopora multiradiata* Reuss. We think important to note that of our new proposed species there are 49 specimens, some well preserved, from young zoaria, small with few zooecia to that of late astogenetic stage or gerontastic, with about 60 zooecia, doing so more valid comparisons with the other known species. The differences are: 1) they do not reach great dimensions as *B. multiradiata* or *B. grandis* Cook & Lagaaij, 1976; 2) the lack of a prominent "pit", surrounded by evident kenozoecia as in the above two species and also as *B. scrobiculata*

Koschinsky, 1885; 3) the presence of two pores, lateral to the aperture, probably avicularian, but no clear avicularia as in *B. clithradata* (Gregory, 1893). In several zoaria of our species, in the adapical area, we can observe a characteristic ancestroecial quadrangular structure, never reported in other known species. The eccentric position of the apical "pit" is in common with *B. excentrica*, which nevertheless the authors have not examined closely having only one poor preserved specimen of it. *B. rosula* always has different shape and dimensions (Pizzaferrri & Braga, 2000), as does the genotype *B. stolickzkai* Reuss which, according to Waters (1919, p. 84) could be a young stage of *B. multiradiata*. Even if the figures in the Darteville paper seem rather imprecise, *B. ernii* is also completely different. Not comparisons can be made with *B. murrayi* Cook and *B. asterizans* Cook & Lagaaij. About *B. ernii*, the occurrence of this bryozoan in the Cenozoic of northern Iran (Mazanderan district) is very interesting. The age is doubtful ("probable Miocene" as reported by Darteville, 1948). Unfortunately the Stage is not defined precisely. About the uncertain age we can note that in the coastal area of the Caspian sea the Miocene sediments consist of gypsiferous clays and litoral conglomerates, superimposed on Paleogene finely stratified marls and nummulitic and algal limestones (ENI: Enciclopedia del Petrolio, 1969: item Iran, p. 81), the latter more suitable rocks for this kind of organisms. The hypothesis that the origin of the genus *Batopora*, as other Orbituliform took place in the western Tethys, joined with the exact knowledge of *B. ernii* age could establish that also the eastward migration of this bryozoan species occurred before the arabian plate closure. Darteville himself emphasized this occurrence. He wrote in 1948: "La presence d'une Bryozoaire de ce genre dans le Bassin néo-tertiaire arolo-caspien n'avait pas encore été signalée à notre connaissance". (See also the sketch map 1, in Cook & Lagaaij, 1973, p. 369).

This interesting species, with another Paleogene tethyan *Batopora*, will be examined closely by Braga and Pizzaferrri (work in progress).

Derivatio nominis – This name is suggested by the characteristic cone basis that shows a star shape, or "stella" (latin).

Holotype – Pl. 3, figs 8-9, Zakher Mb., (Asmari Fm.), Lower Oligocene-Middle Oligocene p.p., sequence CF, sample No. 11.

Paratypes – Remaining material (see Tab. 4). Material deposited in the City Museum of Natural History – Rovereto (TN, Italy), inv. typi No. 1355. Samples: CF 7, 11, 14.

CONCLUSIONS

BIOSTRATIGRAPHIC OBSERVATIONS

As noted in the chapter on Stratigraphy, three distinct sequences, belonging to the Paleogene Asmari Formation, have been sampled. Only the samples with bryozoan content has been investigated. The oldest series (CF=Te-) correspond to the Zakher Mb. (Lower to Middle Oligocene) and the other two superimposed segments are respectively the O₁ (=Tl O₁) of the Mutaredh Mb. (Middle Oligocene p.p.) and O₂ (=Tl O₂) of the Muwaiji Mb. (late Middle Oligocene). The detailed biostratigraphy and lithologies have been pointed out by several previous studies (see References-Stratigraphy). The Bryozoa were not previously studied as far as we know.

The sampling of the sections was made in the northern part of Jabal Hafit area by one of us (S.B.). Bryozoans occur with other faunal content (see chapter on Some observations....p. 245) such as benthic or planktonic forams, macroforams (most part nummulitids), and with unidentified skeletal fragments or clastic compound.

Actually the bryozoans are fairly rare and often poorly preserved. The total amount of the found specie is 54 (14 Cyclostomatida and 40 Cheilostomatida), of which 16 have been determined only to genus, four are new species. In some samples the occurrence of specimens is very rare, often with only 1 or 2 fragments of zoaria. On the contrary, the presence of some species is very abundant or exclusive in some residues. For example, in sample 14 of CF sequence there are 48 specimens of *Cellaria reussi*, and in samples 49 and 51 of the same section *Vincularia subsymmetrica* is present respectively with 70 and 40 specimens. Strong variation in distribution and abundance is also seen in sequences O1 and O2. In O1, sample 3, there are 90 fragments of *Exidmonea atlantica*, and in O2, sample 19, *Margaretta cereoides* is prevalent. Other less evident frequencies are also in some samples, as may be seen in Tabs 4 and 5.

Interesting consideration can be made on comparisons and distribution pattern among this fauna and that of the classical western tethyan Paleogene outcrops with bryozoan marls as, for example, that of NE Veneto, Austria, Hungary and Rumenia regions (see Vavra, 1977; Braga, Kazmer & Zagorsek, 1996; Zagorsek & Kazmer, 2001).

Actually, almost all species are everywhere in the above mentioned areas. Particularly we refer to the more abundant species as, for example, *Vincularia subsymmetrica*, *Margaretta cereoides* and *Poricellaria complicata*. We emphasize also that this area in the UAE was connected with the Mediterranean region before the closure of Tethys and the connection was abruptly terminated in Burdigalian time due to tectonic development in the Arabian Peninsula.

Even if the *Kylonisa* sp., which represents a genus

as typical for the western Europe Paleogene, is unfortunately rare in the studied sediments, we note that species of the same taxon have been found in the Middle Eocene of India (see p. 255) so its geographic range in the Middle Eocene extends in the east beyond the UAE.

SOME OBSERVATIONS ABOUT PALEOECOLOGY

As one can see in tables 4 and 5, the bryozoans occurring in the sampled sections are fairly rare. Only in some samples and just for a few species they are well represented. However some observations on their paleoecological importance can be drawn. This can be done both from environmental factors of species still living and by table analysis of growth forms (Tab. 3) and Tab. 6 of more significant samples of CF and O₁, O₂ sequences. The deductions can also be corroborated by the occurrence of forams (benthic and planktonic), nummulitids and sedimentological characters (see section on Some observations..... p. 245).

The sediments of CF samples, which represent the lower part of the Oligocene and, especially, samples

31-50, have specimens belonging to basic flexible erect and rigid erect zoarial growth forms, while the encrusting forms are insignificant (Tab. 6). According to McKinney and Jackson (1989), the number of species of erect rigid forms increases with depth, contrarily to encrusting colonies.

The species still living (*Exidmonea atlantica*, *Mecynoecia proboscidea*, *Margaretta cereoides*) prefer a moderate deep water between 20-80 metres (Canu & Bassler, 1929; Gautier, 1962; Moissette, 1988; Hayward & McKinney, 2002). Even if these colonies can be present also in deeper environment, this possibility can be excluded for the concurrent occurrence in several samples of nummulitids, which just live in the photic zone, and for the high ratio benthic/planktonic forams.

In conclusion, we think that the environmental situation was an open marine basin, neritic depth of up to 100 m and considering the whole area, it could have been subject to repeated fluctuations of the depth or of temporary emersion by the presence in some samples of oxidized or not well preserved specimens. Perhaps in some cases, these fluctuations gave rise to isolated small basins with anoxic nature of the water, some samples being characterized by the presence of completely pyritized species (sample 12 of CF sequence: *Tychinella schreibersi* and *Disporella grignonensis*). The cause of the continuous changes of the environmental situation of this area could be the tectonic instability during entire Paleogene time, and during the initial stages of the tethyan closure that occurred in the Burdigalian stage of the Lower Miocene, (Roegl, 1998; Dercourt *et al.*, 2000), due to movement of Arabian plate. To complete the remarks on paleoenvironmental condition with data on temperature we note that two species, i.e. *Mecynoecia proboscidea* and *Cellaria reussi*, are still living in tropical or warm temperate seas. Furthermore, the Arabian Bryozoa share several taxa, of the well-known Paleogene Assemblage of the "Marne a Briozoi Unit", widespread in the Venetian Region, like *Adeonellopsis*, *Dittosaria*, *Margaretta*, and *Scrupocellaria*, regarded of warm-temperate environment (Braga, 1963; 1975; Antolini, Braga & Finotti, 1980; Braga & Barbin, 1988).

This is also corroborated by the presence of the above-named genera in the tropical area of the Indo-Pacific oceans (Lagaaij & Cook, 1973; Braga, 1987).

ACKNOWLEDGEMENTS

We should like to thank Ileana Monica Crihan (Ploiesti University- Rumania) who gave us some suggestions for the general lines of the paper. Heartly thanks to Ken McKinney who carefully reviewed and greatly improved the final manuscript. Completion of the text and the preparation of tables, plates and figures was made possible by the support of Emanuela Danieleto, Stefano Castelli and Nicola Michelin (Department of Geology, Padua University). SEM micrographs were made in the C.U.G.A.S. laboratory (Padua University). Useful advice, especially about *Batopora* sp.n. was given by Claudio Pizzaferrri (Parma).

Samples	No. Specimens	FE	RE	EN	OF
CF Sum	675	64	26	1	0
CF 14	86	59	0	0	41
CF 31	78	64	36	0	0
CF 36	45	100	0	0	0
CF 39A	41	10	90	0	0
CF 47	55	31	67	2	0
CF 49	88	94	6	0	0
CF 51	90	77	22	1	0
O ₁ Sum	373	49	50	1	0
O ₁ 3	104	7	93	0	0
O ₁ 4	114	18	80	2	0
O ₁ 13	87	90	9	1	0
O ₂ Sum	203	77	14	9	0
O ₂ 11	68	93	7	0	0
O ₂ 19	74	81	15	4	0

Tab. 6 - Growth form percentage in more significant samples of CF and O₁, O₂ sequences. Each sample of about 500 g was washed over a set of sieves with progressively diminishing mesh size. All the specimens of bryozoans have been picked and counted from the wide sieve; nevertheless also the minute fractions have been observed. See Tab. 3 for specific forms.

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(manuscript received May 9, 2003
accepted November 18, 2003)

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