KÖLNER FORUM
FÜR GEOLOGIE UND PALÄONTOLOGIE

19/2011

11th Symposium on Fossil Cnidaria and Porifera
Liège, August 19–29, 2011

Abstracts

Markus ARETZ, Sandrine DELCULÉE, Julien DENAYER
& Edouard POTY (Eds.)

Institut für Geologie und Mineralogie der Universität zu Köln

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Cover: Domal stromatoporoid-*Frechastraea* association, including *F. pentagona* that has first been thickly encrusted by auloporids, the latter covered by irregular laminar stromatoporoids where sparitic cavities correspond to (small?) decayed sponges. Upper Member of the Aisemont Fm (Upper Frasnian –late *rhenana* conodont biozone), Lambermont section, southern Belgium. (Fig. 8 of DENAYER, J. & POTY, E. (2010): Facies and palaeoecology of the upper member of the Aisemont Formation (Late Frasnian, southern Belgium): an unusual episode within the Late Frasnian crisis. - Geologica Belgica, **13** (3): 197-212.)

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Contents

Preface

We cordially welcome you, some hundred participants from 25 countries around the globe to the 11th Symposium on Fossil Cnidaria and Porifera in Liège, 19-29. August 2011!

The symposium in Liège is the 11th symposium of the **International Association for the Study of Fossil Cnidaria and Porifera** and for the second time the association holds its symposium in a French-speaking country. The symposium takes up the roots laid by the first symposium at Novosibirsk in 1971 and followed by nine very successful symposia. Many of us attended already the last symposia at Graz 2003 (HUBMANN & PILLER 2007) and St. Petersburg 2007 (KOSSOVAYA & SOMERVILLE 2010), but we see also the constant entry of new young scientists in our field. This and the high quality of the scientific contributions presented during this symposium are encouraging signs for the future of our association. Even in times when palaeontological research, including our favourite groups Cnidaria and Porifera, faces some problems in being recognized and getting funding, the community remains very active and besides more traditional aspects of our work and research the constant input of new ideas, themes and techniques confirms the vivacity of our scientific community.

Thus the symposium at Liège provides young scientists and established colleagues the opportunity to experience state of the art results on fossil Cnidaria and Porifera during the 5 day indoor-meeting at the Institute of Zoology. These days a flanked by field trips to the Devonian and Carboniferous strata in Belgium and neighbouring Northern France (ARETZ & POTY 2011).

During this years symposium we would also like to remember in a special session those colleagues who passed away in the last decades, but have deeply influenced our science and association. This session is due to an initative from several members of the association. The organising committee would like to take up this initative and propose that in the future IASFCP awards at every symposium a medal to one association member who has made outstanding contributions to our field of research.

We would also like to use this opportunity to acknowledge the support and help of the University of Liège, the Fond national de Recherche scientifique, Carmeuse S.A., the Ville de Liège, the field trip leaders, and last but not least the members and students of the "Department de Géologie" helping on and behind the scenes.

We hope that the 11th Symposium on Fossil Cnidaria and Porifera becomes a successful and enjoyable meeting providing you with new insights, ideas and friends. We wish you pleasant days!

Markus Aretz, Sandrine Delculée, Julien Denayer, Luc Hance, Yves Quinif & Edouard Poty

Liège, August 2011

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Early Ordovician stromatoporoid *Pulchrilamina spinosa* from South China: Significance and implications for reef development

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The *Pulchrilamina* (monospecific *P. spinosa*) was first established for large, massive, densely grown, dome-shaped to laminar, skeletal frame-builders which occurred in the Early Ordovician (early Floian) reefs of Texas and southern Oklahoma (TOOMEY & HAM 1967). Another occurrence was subsequently reported from South China (ZHU et al. 1993). Here, we report on the (1) morphological characteristics, (2) reef-building role, (3) distribution in South China, and (4) significance and implications for reef development of the Early Ordovician (late Tremadocian–early Floian) *Pulchrilamina* from the Fenhsiang and Hunghuayuan formations of the Three Gorges area, South China.

Characteristics of *Pulchrilamina*

The studied *Pulchrilamina* is characterized by very thin, sheet-like forms (0.05–0.4 mm in height) with commonly ragged margins or comparatively thick sheet-like to low domal forms (<4 mm in height). The upper- and under-sides of laminae are generally uneven and highly irregular, with the upper surfaces showing randomly arranged spines (ca. 0.03 mm in diameter and 0.5–0.8 mm in length). The microstructure is completely recrystallized to sparry mosaic calcite.

Pulchrilamina only occurs in reef environments. Interestingly, the first appearance of *Pulchrilamina* and the initiation of reef development are concurrent in the studied section. *Pulchrilamina* occurs in both lithistid sponge–microbial and lithistid sponge–bryozoan reefs of the Fenhsiang and Hunghuayuan formations, occupying less than 5% of the reef volume as subsidiary reef-builders. However, it plays an important role in reef development as an encruster on the surfaces of the main reef-builders. The laminae of *Pulchrilamina* (<0.4 mm thick) and microbialites with *Girvanella* (<1 mm thick) repeatedly accumulated together to produce remarkable bindstone. In addition, aggregations of *Girvanella* are repeatedly intercalated with the *Pulchrilamina*. These encrustations are inferred to have been produced by repeated biotic interaction through a pause in *Pulchrilamina* growth followed by the predominant growth of microbes and then by the subsequent recovery of *Pulchrilamina* over microbialites in the succession.

The distribution of *Pulchrilamina* from the Three Gorges area and other areas of South China (Dongzhi of Anhui Province and Tongzi of Guizhou Province) is summarized as follows. *Pulchrilamina* first developed in the Fenhsiang Formation (late Tremadocian) of the Three Gorges area in a mid-shelf setting, and continued to develop in the overlying Hunghuayuan Formation (late Tremadocian–early Floian). *Pulchrilamina* then began to flourish in the Hunghuayuan Formation of the Tongzi area in a nearshore setting, and in the Hunghuayuan Formation of the Dongzhi area in an offshore setting, although it still acted as a reef dweller or accessory builder in this area. Thus, *Pulchrilamina* expanded its habitat from the mid-shelf to nearshore and offshore settings during the Early Ordovician.

Significance of *Pulchrilamina* and implications for reef development

The systematic position of *Pulchrilamina* has been variously discussed in terms of microbial structures, algae, and coelenterates (TOOMEY & HAM 1967; ZHU et al. 1993). *Pulchrilamina* is now tentatively assigned to the stromatoporoids (STEARN et al. 1999). Both Chinese and North American examples commonly possess spines and recrystallized skeletal structures. However, the very thin, sheet-like forms and encrusting roles of Chinese examples are in contrast to the North American equivalents, which were the main frame-builder. *Pulchrilamina* from South China (late Tremadocian–early Floian) appeared earlier than in North America (early Floian). This time gap may explain the contrasting reef-building abilities of *Pulchrilamina* in the two regions. In any case, *Pulchrilamina* may be a phylogenetically initial stage of stromatoporoids.

Therefore, the relevant skeletal-reef builder provides significant information on the origin and subsequent development of stromatoporoid-dominated reefs that first attained an acme in the Middle–Late Ordovician.

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Early Ordovician reefs in the Three Gorges area of Hubei Province, South China: deciphering the early development of skeletal-dominated reefs

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The Ordovician saw the Great Ordovician Biodiversification Event (GOBE), which brought about a marked increase in the biodiversity of marine organisms. Reef-building sponges and bryozoans flourished and were widespread during the transition from microbe- to metazoan-dominated reefs. The oldest known bryozoan reefs in the Three Gorges area of Hubei Province, South China, are especially remarkable because they represent the earliest establishment of skeletal-dominated reefs (ADACHI et al. 2011). Here we document the early evolution of skeletal-dominated reefs, based on the various reef types and their temporal distributions, in the Fenhsiang (late Tremadocian) and Hunghuayuan (late Tremadocian–early Floian) formations at the Chenjiahe section in the Three Gorges area.

Five types of reefs are identified based on the main reef-building organisms and their roles in reef development: 1. lithistid sponge–stromatolite reef, 2. lithistid sponge–microbial reef, 3. microbial–receptaculitid–lithistid sponge reef, 4. lithistid sponge–bryozoan reef, and 5. bryozoan–pelmatozoan reef. Although type 1 and 2 reefs commonly contain lithistid sponges, microbialites (e.g., stromatolites) are the main encrusters and frame-builders. In contrast, skeletal organisms are much more abundant than microbialites in type 3–5 reefs. Bryozoans encrusted the surfaces of lithistid sponges in type 4 reefs and the surfaces of pelmatozoans in type 5 reefs, and grew to produce reefs with rigid skeletal frameworks. Such reefs in the studied section are well developed in the lower part of the Fenhsiang and Hunghuayuan formations. The type 1 reefs are developed only in the lower part of the Fenhsiang Formation. The type 2 reefs are the most common type within the studied section, and receptaculitids show an increase in abundance within the Hunghuayuan Formation over time. Similarly, the type 3 reefs, which are dominated by receptaculitids and lithistid sponges, are remarkably well developed in the upper part of the Hunghuayuan Formation. The type 4 reefs occur in several reef horizons. Interestingly, the initial reef development in this section is marked by the first appearance of type 4 reefs, and the bryozoans are most strongly developed in the lower part of the Fenhsiang Formation. In contrast with the decline in stromatolites within the Hunghuayuan Formation, skeletal reef-builders (e.g., receptaculitids and lithistid sponges) became dominant and increased in abundance.

Although these patterns and processes of reef development may have been controlled by changes in the local environments (mainly changes in sea level), the overall changes in the distribution of each reef type reflect the global transition from microbe- to skeletal-dominated reefs. These trends can be further clarified by comparing with reefs in the Chenjiahe section with those in other sections within South China. In the late Tremadocian, a variety of reef types had already developed at the Chenjiahe section in a mid-shelf setting. In contrast, at this time only stromatolite reefs had developed at Dongzhi (Anhui Province) in an offshore setting, and at Tongzi (Guizhou Province) in a nearshore setting (LIU et al. 2010). In both of these latter sections, the type 1 and type 2 reefs started to develop in the late Tremadocian–early Floian (ADACHI et al. 2009; LIU et al. 2010). Thus, varied skeletal reef-builders developed earlier in the present study area than elsewhere and established the first skeletal-dominated (e.g., type 4) reefs in the late Tremadocian. The skeletal reef-builders then expanded their habitat into offshore and nearshore settings.

Skeletal-dominated reefs characterized by the type 4 reefs are limited to the Three Gorges area and adjacent areas (ZHU et al. 2006). Elsewhere (worldwide), no skeletal-dominated reefs had developed by the Middle–Late Ordovician (e.g., WEBBY 2002), with the exception of Early Ordovician (early Floian) stromatoporoid reefs in North America (TOOMEY & HAM 1967). The Early Ordovician reefs were commonly characterized by stromatolite and thrombolite reefs as well as type 1 and 2 reefs. These reefal features and distributions, as observed at the Chenjiahe section, provide important information on the factors that brought about the establishment and subsequent development of skeletal-dominated reefs, and on the nature of palaeoenvironmental triggers of the GOBE.

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A general classification for habitats of colonial rugose corals: the Mississippian (Carboniferous) of Western Europe as example

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Corals are major constituents in many marine benthic communities in the past. Classifying their habitats is thus a common task in many Phanerozoic time slices. Very different concepts for doing this result from the incorporation and weighting of taxonomic, palaeobiological and sedimentological information and factors.

For the Carboniferous, the roots have been laid by HILL (1938-1941) who differentiated three mayor associations termed "*Cyathaxonia* fauna", "caninid-clisiophyllid fauna" and "reef-coral fauna" for the Early Carboniferous corals of Scotland. She defined very broad categories, which could be widely applied. The colonial corals were all grouped in the third association. Later VUILLEMIN (1990) and SOMERVILLE & RODRÍGUEZ (2007) refined the classification of HILL in using taxonomic and stratigraphic data for creating subclasses for specific time slices. These classifications have been proven useful in their specific spatial and temporal context, but comparisons with other regions or coral communities of different ages is severely hampered.

As response to these difficulties a classification for habitats of colonial rugose corals with has a focus on field observations with limited data from carbonate (micro)facies analyses has recently been proposed (ARETZ 2010). The most important data are coral abundance and distribution, colony sizes, distances between colonies, taphonomy of coralla, further macrofauna, lithofacies, and sedimentary structures.

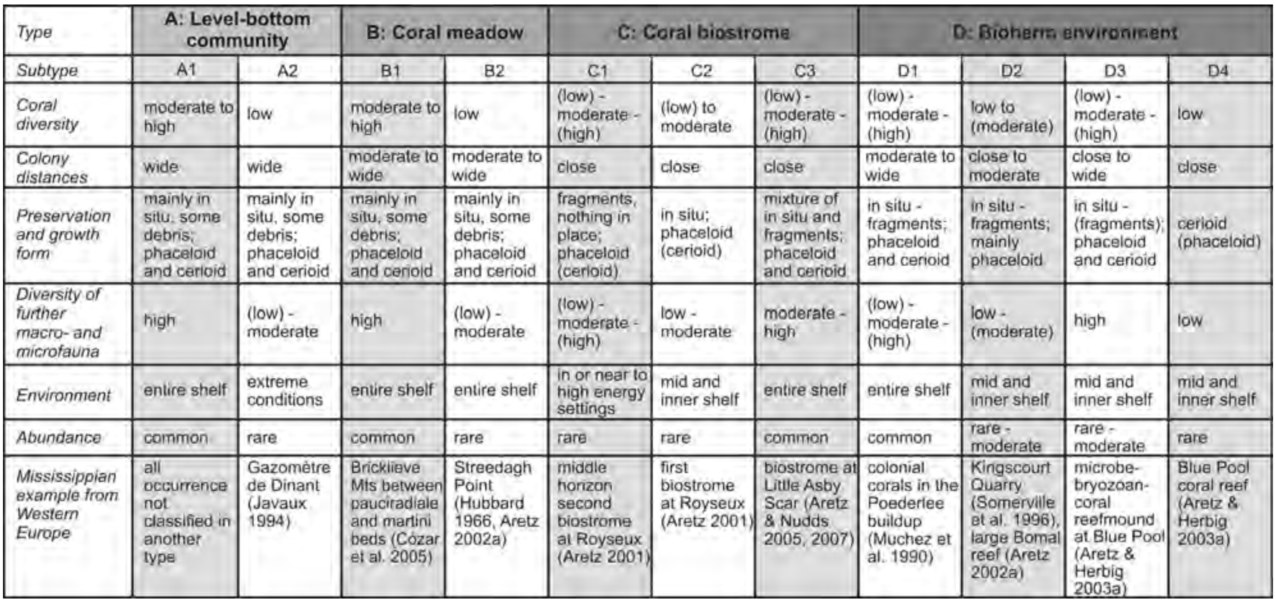
The classification has been elaborated based on work on the Mississippian colonial corals from Western Europe (ARETZ 2010). Four basic habitat types are be differentiated and those are further subdivided into subtypes (Fig. 1). Type A: **Level-bottom communities** have large colony distances as characteristic and they represent the most basic community type; based on coral diversity a polyspecific subtype (A1) and a monospecific subtype (A2) are differentiated. Type B: **Coral meadows** form when the distances between the individual specimens decrease. This can result in a homogenous coral distribution (subtype B1) or in the development of patches (subtype B2). Type C: **Coral biostromes** represent a spectrum between hydrodynamically controlled biostromes (nothing in place, subtype C1) and biologically constructed and controlled biostromes (subtype C2). The bulk of the biostromes represent mixtures of those two subtypes (subtype C3). Type D: **Bioherm environments** were largely inhabited by colonial rugose corals during the Mississippian. They lived as dwellers (subtype D1), formed capping beds (subtype D2), supported framework building along with other organisms (subtype D3), and formed coral framework (subtype D4). The latter subtype (coral framework) is probably the most uncommon subtypes in Mississippian times.

However the classification is not limited to the Mississippian strata in Western Europe. It has been successfully applied to occurrences of Mississippian colonial rugose corals in Northern Africa, China and Australia. The classification was also successfully tested for solitary rugose corals and tabulate corals in Mississippian strata (ARETZ 2010).

Based on the Mississippian data attempts have been made to extent the temporal aspect and the biological focus of the classification. Field work in the Devonian strata of Western Europe shows that all corals habitats can be recognized and all coral occurrences can be classified. Not surprisingly is the difference in abundance of subtypes. The same is true for Devonian stromatoporids.

Then based on literature data the classification has been applied to different Phanerozoic environments and organisms. It became obvious that the classification can also be applied to scleractinian corals and archaeocyaths; some types and subtypes may also be valid for groups like bryozoans.

Finally, taxonomical data allow to refine the classification for more restricted use in short stratigraphical intervals and palaeogeographical units.



Type	A: Level-bottom community		B: Coral meadow		C: Coral biostrome			D: Bioherm environment			
Subtype	A1	A2	B1	B2	C1	C2	C3	D1	D2	D3	D4
Coral diversity	moderate to high	low	moderate to high	low	(low) - moderate - (high)	(low) to moderate	(low) - moderate - (high)	(low) - moderate - (high)	low to (moderate)	(low) - moderate - (high)	low
Colony distances	wide	wide	moderate to wide	moderate to wide	close	close	close	moderate to wide	close to moderate	close to wide	close
Preservation and growth form	mainly in situ, some debris; phaceloid and cerioid	mainly in situ, some debris; phaceloid and cerioid	mainly in situ, some debris; phaceloid and cerioid	mainly in situ, some debris; phaceloid and cerioid	fragments, nothing in place; phaceloid (cerioid)	in situ; phaceloid (cerioid)	mixture of in situ and fragments; phaceloid and cerioid	in situ - fragments; phaceloid and cerioid	in situ - fragments; mainly phaceloid	in situ - (fragments); phaceloid and cerioid	cerioid (phaceloid)
Diversity of further macro- and microfauna	high	(low) - moderate	high	(low) - moderate	(low) - moderate - (high)	low - moderate	moderate - high	(low) - moderate - (high)	low - (moderate)	high	low
Environment	entire shelf	extreme conditions	entire shelf	entire shelf	in or near to high energy settings	mid and inner shelf	entire shelf	entire shelf	mid and inner shelf	mid and inner shelf	mid and inner shelf
Abundance	common	rare	common	rare	rare	rare	common	common	rare - moderate	rare - moderate	rare
Mississippian example from Western Europe	all occurrence not classified in another type	Gazomètre de Dinant (Javaux 1994)	Bricklieve Mts between pauciradiale and martini beds (Cózar et al. 2005)	Streedagh Point (Hubbard 1966, Aretz 2002a)	middle horizon second biostrome at Royseux (Aretz 2001)	first biostrome at Royseux (Aretz 2001)	biostrome at Little Asby Scar (Aretz & Nudds 2005, 2007)	colonial corals in the Poederlee buildup (Muchez et al. 1990)	Kingscourt Quarry (Somerville et al. 1996), large Bomal reef (Aretz 2002a)	microbe-bryozoan-coral reefmound at Blue Pool (Aretz & Herbig 2003a)	Blue Pool coral reef (Aretz & Herbig 2003a)

Fig. 1: Overview on the main characteristics of the types and subtypes. Coral diversity: low (1-3 taxa), moderate (4-7 taxa), high (>7 taxa); Colony distances: close (touching or centimetre scale), moderate (decimetre scale), wide (metre scale); Diversity of other fauna: low (none or few other fauna), moderate (low diverse faunas), high (diverse faunas); Abundance: rare (0-~20% of all exposures), moderate (~20%-~40% of all exposures), common (>~40% of all exposures) (modified from ARETZ 2010).

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Palaeobiogeographical analysis for the late Viséan corals in the Variscan Realm of Western Europe and Northern Africa

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The proximity of palaeobiogeographical units can be evaluated and correlated with the spatial distribution of benthic faunas. A case study is herein been presented for the late Viséan rugose corals of the European and African Variscan Realm.

The dataset on the species level comprises the well-studied coral faunas from both sides of the Rhenohercynian Basin in Belgium and SW Spain. Additionally the low diverse coral fauna of Nova Scotia (POTY 2002) has been added. In the southern Variscan domain of Europe late Viséan coral faunas are less well documented and described. For the purpose of this study published and unpublished data from the Montagne Noire, the Pyrenees and the Betic Cordillera were used. In Northern Africa late Viséan coral faunas are widely known, but currently the quality of taxonomic information is very heterogeneous (see discussion in ARETZ 2010a). For the purpose of this study all available data have been compiled for the Moroccan Meseta and neighbouring palaeogeographical units and the Sahara Platform in Morocco and Algeria.

All these regions have been grouped into the Western European coral province by SANDO (1990). Although representing a single palaeobiogeographical province, the distribution patterns of specific taxa within this province are very heterogeneous, e.g. *Siphonodendron junceum* and colonial axophyllids. This can only partly be explained by their adaptation to specific environments (ARETZ 2010b) or the local lack of reliable data.

For this case study seven spatial units have been differentiated: Sahara Platform (Basins south of the South Meseta Fault), Meseta (representing the mobile Variscan Morocco), Ossa Morena, Nova Scotia, Belgium, Southern France (Montagne Noire and Pyrenees) and Betics (Malaguides and Baleares). The single units comprise very different environments and their sizes partly homogenise the lack of data.

Several statistical analyses show that three distinctive clusters existed in the Western European coral province sensu SANDO (1990). These are (1) Belgium, Nova Scotia, Ossa Morena and Moroccan Meseta, (2) Sahara platform, and (3) southern France and SE Spain (Fig. 1).

The most isolated cluster is that of the southern European Variscan. A significant palaeobiogeographical barrier has to be proposed for the time slice and that should correspond to the central zones of the Variscan Orogen separating a northern and southern realm. It can further be concluded that two regions, which are geographical proximal in present days, were clearly separated in Variscan times, the Eastern Moroccan Meseta and the Malagides. The coral faunas of the Western and Eastern Moroccan Meseta are part of the 'Rhenohercynian cluster' and thus good indicators for the potential continuation of the European Variscan Zones into North Africa and the plate configuration at that time. The coral faunas of the Sahara Platform are much closer to the 'Rhenohercynian cluster' than to the southern European Variscides. This can be explained by minor faunistic and environmental differences between the stable cratonic basins south of the South Meseta Fault and the mobile zones of the Moroccan and European Variscides. However, the information of inter- and interspecific variabilities of the coral taxa in this region are badly known, and the number of endemic species (SEMENOFF-TIAN-CHANSKY 1974) may be currently overestimated.

The data on corals are also supported from the data obtained for other benthic and pelagic macrofauna (brachiopods, ammonoids). The distribution of the calcareous algae *Eovelibitella* (VACHARD et al. 2006) is a good example for the overlap with the Southern Variscan coral cluster, and thus shows that the coral clusters indicate more than environmental control or insufficant data.

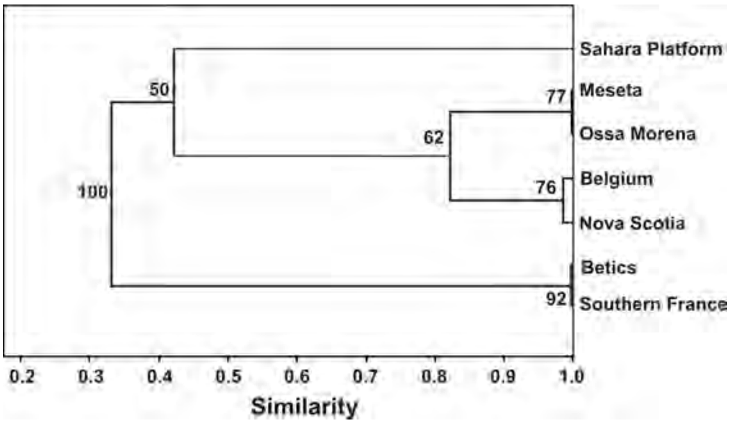

Fig. 1: Cluster Analysis (Raup-Crick Coefficent; node supports at 1000 bootstrap replicates) for the Western European coral province of Sando (1990). Seven spatial units of late Viséan coral faunas have been differentiated in Western Europe and Northern Africa.

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Study of Carboniferous Corals in the Ozbak-kuh Mountains (East of Central Iran)

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During Upper Visean-Gzhelian times, marine sedimentation was restricted to the East of Central Iran. Carbonates of the Ozbak Kuh Mountains are rather unique for the Carboniferous of Iran, which is commonly represented by sandy-shaly facies. In order to study Carboniferous corals, the Zeludu section in the Ozbak Kuh Mountains was selected. The Carboniferous strata in this section are 360 meters thick and are Late Visean to Late Gzhelian in age.

After field studies and sampling, 100 specimens of corals were selected and studied.

In the studied section, 19 species and 1 subspecies belong to 10 genera of rugose and tabulae corals. These include the following species: *Heritschioides pseudosolitarius*, *Heritschioides vepres*, *Heritschioides* cf. *vepres*, *Paraheritschiodes antoni antoni*, *Orygmophyllum* sp., *Durhamina* sp., *Fomichevella hoeli*, *Fomichevella holtedahli*, *Fomichevella nevadensis*, *Fomichevella orientalis,* *Fomichevella stuckenbergi,* *Petalaxis* sp., *Michelinia* sp., *Minatoa bulla*, *Multithecopora* sp. 1, *Multithecopora* sp. 2, *Pseudozaphrentoides winsensi*, *Pseudozaphrentoides* aff. *melendezi* and *Pseudozaphrentoides* sp.

In this study, we reviewed the ages of the species *Heritschioides vepres*, *H. pseudosolitarius*, *H.* cf. *vepres*, *Paraheritschiodes antoni antoni* and *Pseudozaphrentoides winsensi*. Three genera (including *Orygmophyllum*, *Petalaxis* and *Durhamina*) and six species (*Fomichevella hoeli*, *F. holtedahli*, *F. nevadensis*, *F. orientalis*, *F. stuckenbergi* and *Pseudozaphrentoides* aff. *melendezi,*) are reported for the first time from Iran.

The coral abundance in the studied section is heterogeneous. Three limestone members contain coral faunas.

Member 1 is composed of a one meter thick chertified micritic limestone and contains a coral fauna of low abundance: *Heritschioides*, *Paraheritschioides*, *Durhamina*, *Multithecopora* and *Orygmophyllum*. It is late Serpokhovian in age.

Member 2 comprises a 5 meter thick package of micritic limestone. Its coral fauna consists of *Fomichevella*, *Minatoa*, *Michelinia*, *Multithecopora* and *Petalaxis*. It is early Bashkirian in age.

Member 3 is 35 m thick. It comprises medium-bedded limestones containg abundant solitary corals. There are two 20 cm thick coral beds, which merely consist of *Pseudozaphrentoides* in growth position. Indeed, these beds represent high abundant, but low diverse coral faunas.

Based on ecological evidences, corallite arrangements and dissepiments thicknesses, three paleoecological zones in respect to zonations along a shallow carbonate ramp can be differentiated in the Zeludu section.

Zone 1 consists of fasciculate dendroid and solitary corals, belonging to a quiet and low energy lagoon. This zone is found in the late Serpokhovian. It should be mentioned that in this zone, paleoecological factors such as endemism and extinction phases are considered uniquely especially for the Durhaminidae fauna.

Zone 2 consists of diversified colony builder and predominantly path-like ones, resembling cerioid and asteroid corals. The mentioned coral assemblage indicates highly agitated water in a shallow setting, and is Early Bashkirian in age.

Zone 3 consists of large and thick dissepiments corals froming a biostrome. It indicates high energy shallow water environment and open marine towards a barrier. This zone is Gzhelian in age.

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Cyrtophyllid corals of Mongolia

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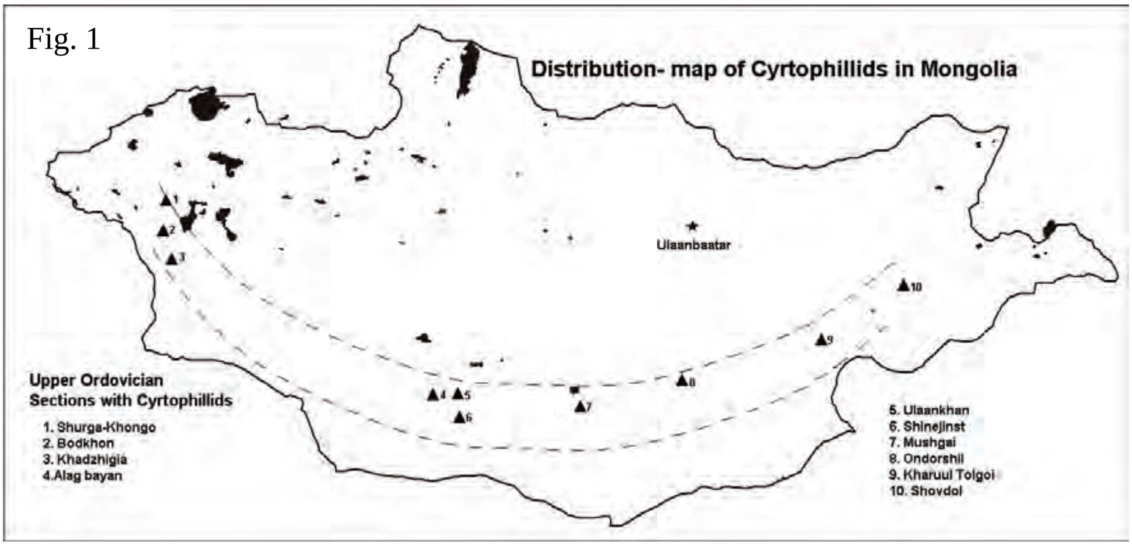
Cyrtophyllids are colonial coral that inhabited warm, shallow seas during the Middle-Late Ordovician. Lindström (1882) first described these corals from Siberia. Since then, they have been discovered in the Urals, Taimyr, Gorny Altai, and Northeastern regions of Russia, Arctic islands of Canada, New Jersey state (USA), and Greenland. Mongolian cyrtophillid corals have been found in Ordovician sections of the Khovd, Govi-Altai, and Mandal-Ovoo Terrains in the Central Asian Orogenic Belt (Fig. 1).

Fig. 1



Cyrtophillid corals share a number of characters with three subclasses of Anthozoa: Tabulata, Heliolitoidea, and Rugosa. As a consequence, their systematic position within the Anthozoa and even systematics among cyrtophillids remains controversial. The reasons why these controversies persist are that 1) these corals are typically found in remote areas and thus sample sizes are often limited, 2) they typically have short geologic ranges and therefore have limited geographic distributions, and 3) they occur in specific depositional environments and are not found in upper Ordovician carbonates. Therefore, research on cyrtophillids corals has been limited and typically they have not been the focus of individual studies. Instead they are often studied as a component of much larger multidisciplinary studies. Based on new specimens from Mongolia, we are proposing the following new systematic scheme for cyrtophillid corals.

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A new columellate genus of Middle Devonian deep-water Rugosa from Morocco

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Small solitary rugose corals of the so-called *Cyathaxonia* fauna with an axial structure were for long time regarded as typical for the Carboniferous–Permian coral communities. HILL (1956) classified them as three families of Cyathaxonioidea (suborder Streptelasmatina): Cyathaxoniidae, Lophophyllidiidae and Timorphyllidae. Later, HILL (1981) accepted five families in two suborders for such taxa: Metriophyllina (Cyathaxoniidae, Metriophyllidae) and Plerophyllina (Lophophyllidae, Timorphyllidae, Verbeekiellidae). At present, further approaches towards a phylogenetical taxonomy support the independent arise of these columellate structures already in ten Carboniferous–Permian families (Cyathaxoniinae MILNE-EDWARDS & HAIME 1850, Rylstoniinae YÜ et al. 1983, Lophophyllidae GRABAU 1928, Variaxoninae FEDOROWSKI 2010, Lophophyllidiidae MOORE & JEFFORDS 1945, Timorphyllidae SOSHKINA in SOSHKINA et al. 1941, Verbeekiellidae SCHOUPPÉ & STACUL 1955, Wannerophyllidae FEDOROWSKI 1986, Lophotichiidae WEYER 1972 and Asserculiniinae FEDOROWSKI 1986).

Radical changes in the stratigraphic aspect started with RÓŻKOWSKA (1969) who recorded *Cyathaxonia* MICHELIN 1847 and its subgenus *Cyathocarinia* SOSHKINA 1928 already in the Famennian of Poland. The next surprising discovery was *Columnaxon* SCRUTTON 1971 from the Ludlowian of Venezuela and several Devonian columellate taxa *Famaxonia* WEYER 1971 (Late Famennian, Germany), *Yishanophyllum* WU & LIAO 1988 (Late Famennian, Guangxi province of China), nov. gen. pro *Cyathaxonia*? *hercynica* ROEMER 1855 (WEYER & ZAGORA 1990, Middle Givetian, Germany), nov. gen. nov. sp. I (WEYER et al. 2003, Late Frasnian, Germany) and *Cheilaxonia* WEYER 2004 (Early Famennian, Germany).

Actual systematics classified these pre-Carboniferous columellate genera into two subfamilies (Protozaphrentinae IVANOVSKIY 1959, Columnaxoninae WEYER 1980) and as incertae sedis, probably all within the suborder Cyathaxoniina SPASSKIY 1977. Surely, this taxonomic classification does not reflect real phylogenetic relationships and should be continuously developed according to urgently needed worldwide future studies of these "forgotten" rare corals in Silurian and Devonian times.

Devonian Rugosa of the *Cyathaxonia* facies (ahermatypic, of dysphotic/aphotic and psychrospheric environments) are extremely poorly known in the Givetian (especially in its upper part after the Taghanic Event), in the complete Frasnian, and in the basal Famennian (time span of seven conodont zones, from Lower *Palmatolepis triangularis* to Uppermost *Palmatolepis crepida*). Perhaps; they are sometimes really rare (e.g. immediately after the global Upper Kellwasser Event), but mainly they remained uncollected and unstudied. This explains the high number of Frasnian "silent taxa" (WRZOŁEK 2002, including many "Lazarus taxa" and isolated "Elvis taxa").

Here we propose an unexpected new pleonophorous genus of the suborder Cyathaxoniina Spasskiy 1977 based on only four specimens of tiny corals from the Middle Eifelian (upper *Costapolygnathus costatus* Zone) of the famous mud mound area at the Hamar Laghdad Ridge (Anti-Atlas, Morocco). It is classified as a member of the surely still polyphyletic Columnaxoninae WEYER 1980 (Cyathaxoniidae MILNE-EDWARDS & HAIME 1850). Outstanding characters are the complex axial structure (prominent median lamella in the cardinal-counter plane, and radial lamellae nearly equal to the number of major septa), rather long contracline minor septa connected with a strongly biform tabularium, and an adult circle of one to two rows of simple dissepiments.

A possible diaphragmatophorous ancestor of this new taxon seems to be another still undescribed Middle Eifelian to Middle Givetian new genus from Germany, France, and Morocco, with a morphology very similar to the Carboniferous–Permian *Lophophyllidium* (*Lophbillidium*) FEDOROWSKI 1986. It had already been published as *Cyathaxonia hercynica* ROEMER 1855 from the German Harz Mountains, and we are now preparing the necessary revision (using new topotypic collections suitable for the choice of a neotype).

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Distribution of Palaeogene Corals on the Arabian Shelf

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The distribution of the coral faunas during the Palaeogene in the Middle East depends on the development of the Arabian shelf. During the Eocene/Oligocene and middle Miocene global and regional mechanisms like tectonic movements and eustatic sea-level changes controlled dimension and facies distribution on the platform. This triggering mechanisms influenced the coral growth during the different time-slices.

The transgression started during the late Palaeocene and an epicontinental sea persisted continuously up to the late Eocene. Later, due to a fairly generalized regression of the Eastern Arabian Peninsula, the Oligocene and the Miocene seas were much more limited in extent. At the end of the early Miocene littoral sedimentation only occurred in several small inlets, bordering the present-day coast.

The collision of Africa (Arabia) and Eurasia led to the rise of the alpinotype mountain ranges. This caused a transection of the Tethys in the Middle East region and influenced the paleogeography, marine circulation and climate. The formation of the Oman Mountains restricted the shelf development. The coral distribution ended with the end of the existance of the Arabian platform in the middle Miocene.

Study areas are in North Oman (Sumeini/Hafit), Central Oman (Seeb/Sur) and South Oman (Duqm/Dhofar). Different types of bioconstructions can be found in the following formations in SE Arabia:

Sirab Formation: (large isolated dendroid coral colonies) This formation comsists of calcareous and marly deposits varying in thickness considerably as deposition took place on the slopes and the lower edges of the shelf. The formation is dated as Thanetian to Cusian age and marks the beginning of the Palaeogene coral development on the Arabian Peninsula.

Jafnayn Formation: (coral banks) This formation is dated as Late Paleocene to Early Eocene. The upper part, representing a shallow shelf environment, consists of carbonate horizons with alveolinid foraminifera, coralline algal nodules or corals (*Astrocoenia, Siderastrea, Pachygyra, Dendrophyllia, Polytremacis*).

Aydim Formation: (coral banks) The calcarenitic deposits are characterized by a rich macrofauna (molluscs, echinids and corals). The corals are abundant in the basal part (e.g. *Astrocoenia, Dendracis, Montastraea, Porites, Stylophora*). The Aydim formation contains a rich benthic foraminifera microfauna, and the nummulitids indicate a Barthonian to Priabonian age.

Mam/Al-Jaww Formation: (coral patch reefs) The limestones with marly and sandy intercalations contain patch reefs of Oligocene (Rupelian) age with *Actinacis, Alveopora, Astreopora, Diploria* and an abundant macrofauna of echinoids, gastropods and bivalves.

Warak Formation: (coral banks, thickets and patch reefs) This formation forms a small cliff composed of alternating beds of pure white chalky to bioclastic limestone with coral biostromes and bioherms up to 5m thick and debris flow deposits. The fauna contains corals of different size and growth form, (*Acropora, Goniopora, Hydnophora, Stylophora, Tarbellastrea*), molluscs and echinoids. The foraminiferal assemblages dominated by peneroplids are good evidence for Burdigalian to early Langhian age.

Based on coral distribution patterns a biostratigraphic subdivision into four time slices is possible. Among them, the Palaeocene and Eocene are especially interesting, because of the general increase in diversity after the K/T boundary (Bernecker & Weidlich 2005) and the faunal changes during the Palaeocene-Eocene, a time of global warming.

Preliminary results from the taxonomic studies of the Palaeocene/Eocene coral fauna point to close palaeobiogeographic affinities to the Mediterranean region. The Oligocene/Miocene fauna shows a mixture of Indopacific and Mediterranean elements.

The East/West tropical seaway of the Tethys was still open during the Palaeogene and the major oceanic realms (Atlantic and Indopacific) had been connected.

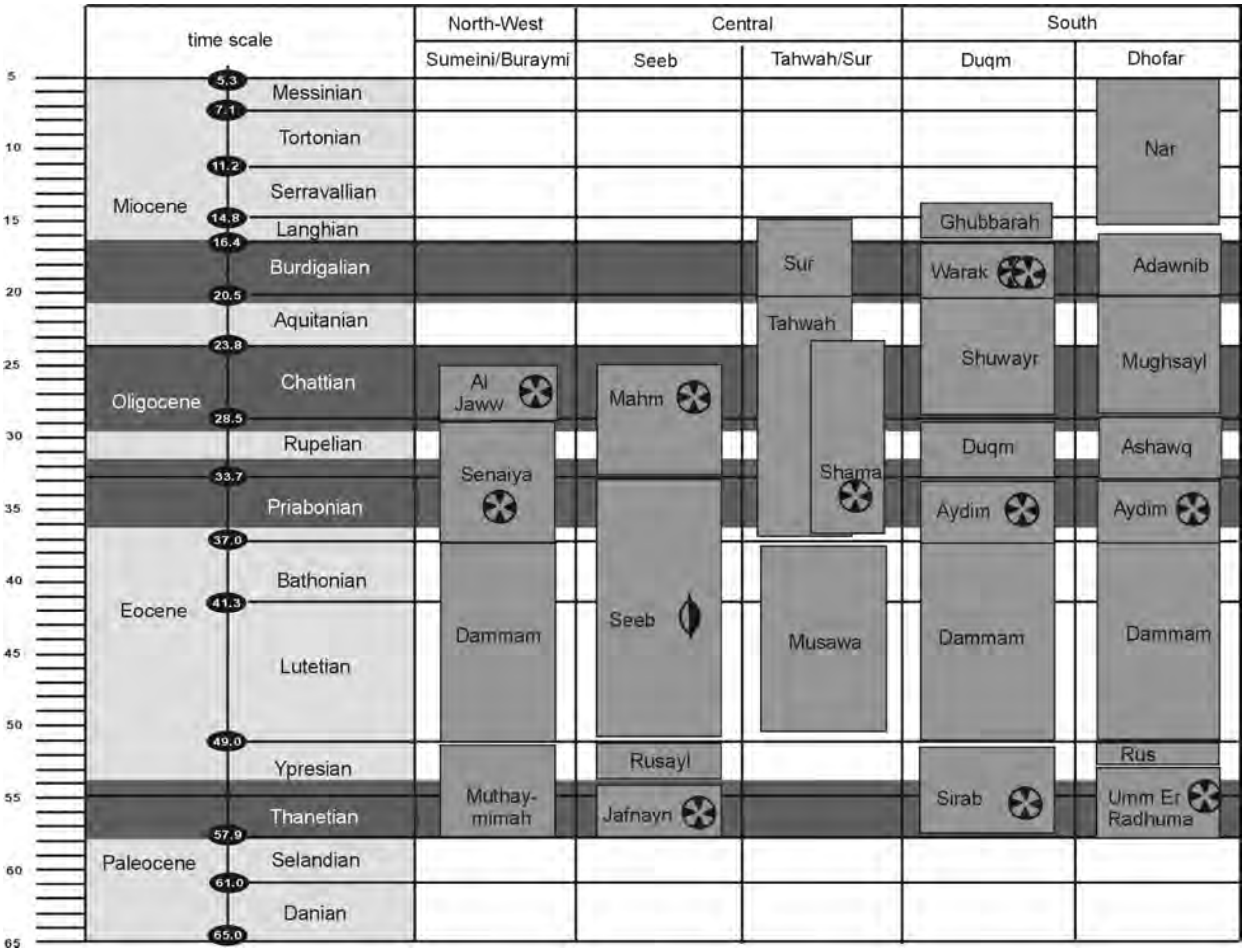

Fig. 1 : Palaeocene to Miocene coral distribution related to formations and time slices in Oman.

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Limnomedusoid fossils from the Upper Devonian in the Vesdre Nappe, Belgium

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A lens of thinly stratified micaceous siltstone in an abandoned quarry of upper Devonian sandstone was found by Mr W. Kampschuur in 1969 to contain hundreds and hundreds of circular inprints with a pronounced rim, identified here as limnomedusoids.

The fossils and their sedimentary environments are shortly described and discussed.

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Coral assemblages of Cenozoic mixed carbonate-siliciclastic settings: sediment-resistant corals and their constructional and depositional facies

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In many regions of modern oceans coral reefs, traditionally associated with well-lit, oligotrophic, shallow waters and high-energy conditions, develop also in areas where terrigenous sediments are an important component of the sedimentary environment. Despite, in fact, relatively high turbidity conditions, restricted light penetration, presence of often mobile terrigenous sediment substrates, active coral growth is well developed (Woolfe & Larcombe 1999; Perry 2005) and many coral bioconstructions in the past are actually associated with marly and mixed carbonate-siliciclastic sediments (Sanders & Baron-Szabo 2005). Their reconstruction, however, largely refers to uniformitarian assumptions based on present-day classic clear-water reef models, and there are a limited number of studies and limited data, especially for the Cenozoic, concerning their detailed structure and composition, depositional patterns and relationship with main controlling factors such as light penetration, turbidity, sedimentary input, hydrodynamic energy, nutrient supply.

Two main case studies are investigated in detail and correspond to delta and fan delta systems respectively of the Upper Eocene of the Jaca Basin (southern Pyrenees, Spain) (Morsilli et al., submitted) and of the Oligocene of the Tertiary Piedmont Basin (northwestern Italy). In these areas extensive fieldwork with detailed coral facies mapping has been performed together with biofacies and microfacies analyses. A non-conventional approach based on microtaphofacies analysis has been also applied in order to unravel the depositional history of these coral assemblages which are often dominated by coral rubble deposits. Even *in situ* bioconstructions result largely affected by taphonomic processes such as encrustation and bioerosion.

Results, compared with other fieldwork and literature data, reveal the occurrence of distinctive coral assemblages and facies characterizing mixed carbonate-siliciclastic settings during Eocene to Miocene time in the Mediterranean region. These can be distinguished on the base of their taxonomic composition, growth forms, taphonomic signatures and associated sediments, and include both coral growth fabrics (such as platestone, domestone and pillarstone) and rubble deposits (floatstone and rudstone).

Constructional features highlight that these assemblages represent an alternative product of the carbonate factory with respect to "clear-water" reefs. Large part of bioconstructions can be defined as cluster reefs (*sensu* Riding 2002), are usually characterized by a low topographic relief and rare coral interlocking. Taphonomic alteration and especially bioerosion is high, also concurring to determine fragmentation of corals and definitely the formation of rubble.

The examined contexts are consistent with generally mesophotic, low-energy conditions, with occasional higher energy episodes responsible of sediment resuspension and consequent turbidity, or connected to coarse sediment run-off and successive sediment accumulation. Among others, corals able to face sediment accumulation, to tolerate periods of sediment veneer, to cope with turbidity/reduced water transparency, include poritids like *Porites* and *Goniopora*, *Actinacis*, typical branching corals such as *Stylophora* and the phaceloid *Caulastrea*, platy agariicids like *Cyathoseris*, and faviids such as *Antiguastrea*, *Tarbellastraea*, *Favia*, *Colpophyllia*, *Diploria*. The genus *Acropora*, displaying mostly a branching growth form, is also common, especially during the Oligocene, suggesting a capacity to grow within low-energy and turbid waters.

Taphonomic processes and signatures (abrasion, fragmentation, bioerosion, encrustation), whose effect is basically related to surface residence time of corals, appear to be a promising tool for better understanding the response of corals to the influence of sedimentary input resulting in water turbidity and/or sediment accumulation.

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Morphological phylogenetics of faviid and mussid corals

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Molecular analyses are transforming our understanding of the evolution of scleractinian corals, and challenge long-held notions concerning their systematics (Budd et al. 2010; Fukami et al. 2008; Kitahara et al. 2010). Analyses of mitochondrial and nuclear markers (e.g., *cytB*, *COI*, ß-tubulin) have found that as many as 14 of 24 traditional extant families are not monophyletic (Fukami et al. 2008; Kitahara et al. 2010), and that many cosmopolitan, ecologically dominant reef-building genera (e.g., *Montastraea*, *Favia*) are also polyphyletic. In addition, they have discovered two new, exclusively Caribbean molecular clades (clades XII, XXI of Fukami et al. (2008)), contradicting traditional notions that Caribbean and Indo-Pacific corals are closely related.

Many of the discrepancies between traditional classification and molecular phylogenies can be attributed to the morphologic characters on which traditional classification is based. Macromorphology has been emphasized in traditional classification, and the full range of variation in micromorphology and microstructure has not been considered. Because knowledge of skeletal growth is limited, many characters are not homologous, and homoplasy is rampant. As a result, morphological phylogenetics has not contributed significantly to scleractinian systematics to date. Nevertheless, such analyses are critical to including fossils in phylogenies, which facilitates studies of diversification, trait evolution, and biogeography.

We performed phylogenetic analyses of morphological, and combined morphological and mitochondrial datasets, using a new dataset of 22 macromorphological, 13 micro-morphological, and 13 microstructural characters for 32 extant taxa in clades XIX, XX, and XX of Fukami et al. (2008). The results (Fig. 1) show: (1) homoplasy is more prevalent in the morphological dataset, (2) a mix of congruence (e.g., the *Manicina areolata*–*Favia fragum* clade and the *Mussismilia hispida*–*Favia fragum* clade are well-supported in both datasets) and conflict (e.g., both clade XIX and the *Scolymia cubensis*–*Mycetophyllia ailiciae* clades are paraphyletic in the morphological topology) between morphological and mitochondrial trees, (3) support in the morphological dataset is higher at shallower nodes, where support and resolution are lacking in the mitochondrial dataset, and (4) the reverse is true for support at deep nodes. The combined analysis is thus largely consistent with the mitochondrial topology, with lower level resolution driven by morphological characters.

We used ILD tests to assess signal homogeneity, comparing morphological partitions simultaneously and in pairwise combinations. We also quantified differences in the phylogenetic signal of characters as measured on the maximum likelihood mitochondrial tree of Fukami et al. (2008). All four ILD tests were consistent with significant differences in signal between partitions ($p \leq 0.02$). Macromorphological characters possess significantly less phylogenetic signal than the other partitions as measured by Lambda (Pagel 1999). Micromorphological characters possess significantly more phylogenetic signal than the other partitions as measured by the *K* statistic (Blomberg et al. 2003). Thus, differences in phylogenetic signal exist between the morphological partitions.

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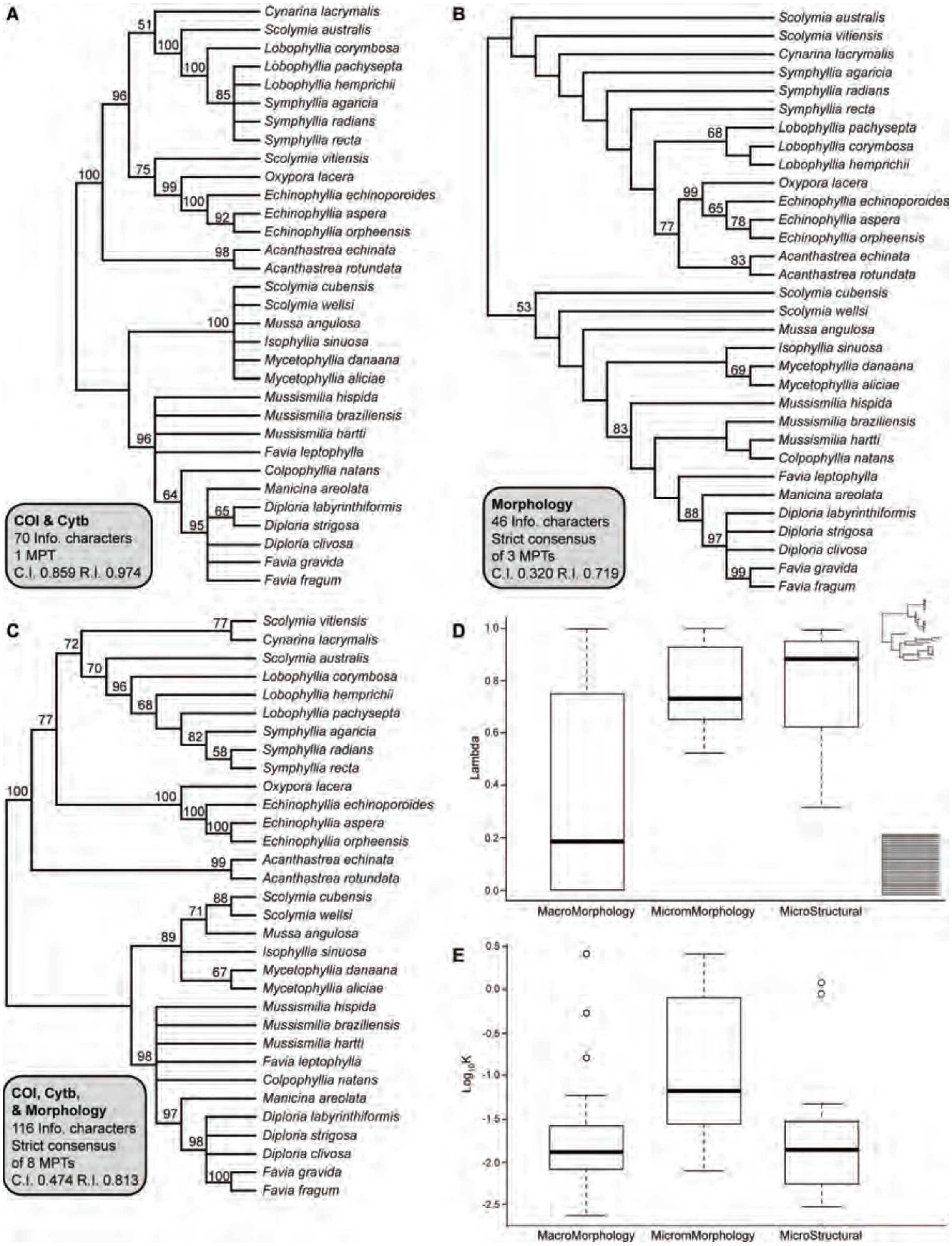

Fig. 1: (A-C) Results of preliminary phylogenetic analyses focused on clades XIX, XX, and XXI of FUKAMI et al., (2008). A) Single MPT from mitochondrial dataset. B) Strict consensus of 3 MPTs from morphological dataset. C) Strict consensus of 8 MPTs from the combined data analysis. (D–E) Boxplots of the level of phylogenetic signal present in different partitions of the morphological dataset, assessed using the topology and branch lengths from the mitochondrial tree. D) Lambda (PAGEL 1999), with tree topologies under Lambda=1.0 and 0.0 indicated at right. E) Log_{10} *K* [(BLOMBERG et al. 2003). Median values indicated by thick line; boxes include middle second and third quartiles of the data; whiskers extend to 1.5x the interquartile range of the data (~ 2 st. dev.).

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The Tournaisian rugose corals of Tournai: revision of a classical fauna

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The "Calcaire de Tournai" is mainly Ivorian (upper Tournaisian) and developed in the western part of the Hainaut sedimentation area. This part of the Namur-Dinant Basin was marked by an important subsidence that led to the deposition of about 500 m of argillaceous limestone of monotonous facies (Hennebert & Doremus, 1997).

The "Calcaire de Tournai" has been divided into (1) the Tournai Formation, mainly constisting of wackestones in which bioclasts result of a nearly *in situ* accumulation and dissociation of the organisms, and (2) the Antoing Formation, mainly composed of mudstones, characterised by numerous ichnofossils (*Zoophycos*).

The sedimentological study agrees with the more recent interpretations of the depositional environment. The part of the Tournai Formation which has been studied in this work (upper part of the Providence Member and the Pont-à-Rieu and Vaulx Members) corresponds to an open shelf environment, situated below the storm wave base, his uppermost part (Vaulx Member) shows a weak deepening trend preceding the deeper and restricted environments of the Antoing Formation (Calonne lower Member and lower part of the Calonne upper Member).

The "corallian fauna of Tournai", mainly benthic, is rich and very diversified. It includes many tabulate and rugose corals which were primarily studied during the 19th century by Michelin, De Koninck and Milne-Edwards & Haime, and at the beginning of the 20th century by Salée, Carruthers and Lecompte. Since then these corals were almost not studied, so that currently and in spite of the abundance of specimens, they remain still very badly known.

Moreover, huge collections were collected during decades without exact locations and stratigraphic positions, so that their distribution in the lithosratigraphic units of Tournai is not known.

It was thus useful to re-examine the systematic on the basis of the modern classification and to define the stratigraphic distribution of the rugose corals present in the Tournai area and to specify their paleoecology. With this intention, numerous specimens were collected in the accessible parts of two still active quarries in the Tournai area and their stratigraphic position specified. Specimens coming from old collections were also studied for comparison and to supplement materials collected in the quarries.

The systematic revision of the rugose corals allows to confirm the presence of nine species previously recorded in the area (*Amplexus coralloides*, *Cyathaxonia cornu*, *Proheterelasma omaliusi*, *Zaphrentites delanouei*, *Sychnoelasma konincki*, *Caninia cornucopiae*, *Siphonophyllia cylindrica*, *Caninophyllum patulum* and *Eostrotion tortuosum)*. Three other species were recorded for the first time (*Saleelasma* cf. *delepini*, *Pentaphyllum* sp. and *Aulokoninckophyllum* sp.) and three are new: *Hapsiphyllum* nov. sp. 1, *Caninia* nov. sp. 1 and *Siphonophyllia* nov. sp. 1.

Lophophyllum konincki, the type species of the genus *Lophophyllum*, defined by Milne-Edwards & Haime (1850) from 6 specimens from the Upper Tournaisian of Tournai, was revised based on the new collected material. It corresponds to a young stage and is a junior synonym of *Caninia cornucopiae*. The latter showing a very large morphological variability (Poty, 2007).

The small rugose corals without dissepiments formerly grouped in "*Zaphrentis*" (*Proheterelasma, Zaphrentites, Hapsiphyllum* and *Sychnoelasma*) are abundant in Tournai, they show very similar characters in the juvenile stages and thus generic and specific distinctions are usually difficult to establish. The great variability of *Caninia cornucopiae* and the similarity of the young stages in the small "*Zaphrentis*" could be a response to a deep and stable environment with low selective pressure.

The distribution of the recorded species was established for the first time in the area. The Tournai Formation is rich in rugose corals unlike the Antoing Formation which is almost devoid of them, except for its base. Foraminifers and conodonts are very uncommon. The biostratigraphic correlations, based on the rugose corals biozones defined by POTY et al (2006), allow to attribute the Providence Member (Tournai Formation) to the RC3α subzone and thus, to correlate it with the Yvoir Formation of the Condroz sedimentation area. The Pont-à-Rieu and Vaulx Members correspond to the RC3β subzone, and thus are equivalent to the Ourthe Formation. The paucity of rugose corals in the Antoing Formation does not allow any correlation.

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The nature of changes of natural environment in Late Carboniferous and Early Permian on western Spitsbergen.

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In my paper I would like to present the nature of changes of natural environments in the Late Carboniferous and Early Permian of western Spitsbergen.

The rugose corals (several dozen of specimens) collected on Kruseryggen (Hornsund area) and Polakkfjellet (Wedel Jarlsberg Land) hills and in Linnédalen (Grønfjorden area) valley (Fig. 1) are the base for my conclusions. Regarding rugose corals morphological specificity and their appearance in different places, the heterogeneity biostratinomic process and ecological conditions are possible to analyze. The mentioned areas present broad sedimentary environments and allow a nearly complete taphonomic analysis including almost all processes that happened during organism transfer from biosphere to lithosphere. Furthermore considering the fact, that the polyps occupy the highest part of skeletons only, these animals are very useful for reconstructing processes that occurred in their life time. According to Rodríguez (2004), the skeletons of those organisms might have been subjected to the influence of biotic and abiotic environmental factors shortly after their creation, changing original structures of the skeletons just before the death of the polyps. Consequently to the analysis of collected material the answer to the problem which changes have to be considered as ecological and which as biostratinomic becomes possible. Due to the small number of studies of the taphonomy of rugose corals in general (Fedorowski 2003, Rodríguez 2004), the results of my research could provide essential contribution to the understanding of the condition of fossil material.

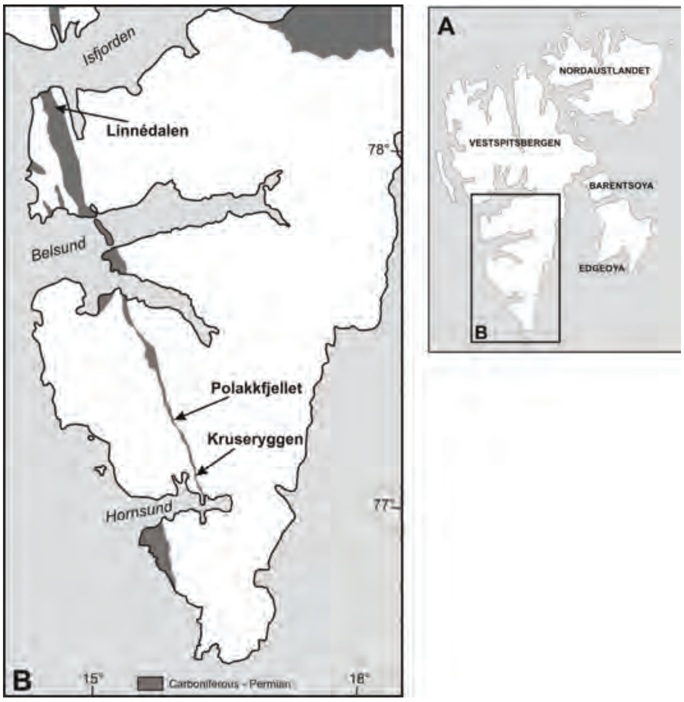

Fig. 1: A - Map of Spitsbergen. B - Sketch map of part of Spitsbergen showing outcrops of Carboniferous and Permian rocks after Harland (1997).

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Stratigraphic distribution of massive rugose corals at the base of the Late Frasnian in Belgium

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Among the massive rugose corals, the genus *Frechastraea* Scrutton 1968 succeeds to the genus *Hexagonaria* Gürich 1896 at the base of the Late Frasnian in Belgium. Indeed, *H. davidsoni* (Milne-Edwards & Haime 1851) and *H. mae* Tsien 1978 are very abundant in the first metres of the Neuville Formation from the Philippeville Massif lying in the southwest central part of the Dinant Synclinorium. The last representatives of these two species are associated with small colonies of *Frechastraea phillipsastraeiformis* (Moenke 1954) along the railway section of Neuville and with small colonies of *Scruttonia bowerbanki* (Milne-Edwards & Haime 1851) close to the Petit-Mont quarry at Vodelée. The overlying nodular limestones of the Neuville Formation which serve as basement for the red marble bioherms of the Petit-Mont Member, contain mostly specimens that have been assigned to *Phillipsastrea pentagona carinata* (Scrutton 1968) by Coen-Aubert (1974a) and to *F. carinata* by Coen-Aubert (1994, 2000) and Boulvain et al. (1999). This material is now considered as a new species provisionally named *Frechastraea* n. sp. A which is mainly characterized by septa typically carinate and restricted to the dissepimentarium. Moreover, the first occurrence of *Frechastraea* n. sp. A corresponds to the entry of the conodont *Ancyrognathus triangularis* indicating the Early *Palmatolepis rhenana* Zone at the base of the Late Frasnian. The new taxon also occurs in the lower part of the reefal lens of Les Bulants quarry, close to the railway section of Neuville, where it is associated with *Phillipsastrea conili* Tsien 1978 and *Frechastraea* cf. *borealis* McLean 1994. The latter species differs from *Frechastraea* n.sp. A by the lack of carinae and by a less well delimited astreoid wall. *F. micrastraea* (Penecke 1904) is found in the upper part of the Les Bulants lens and at its top is noted the entry of *Ancyrognathus asymmetricus* characteristic of the Late *Palmatolepis rhenana* Zone. In the much thicker bioherm of the Petit-Mont quarry, *Frechastraea* n. sp. A and *F.* cf. *borealis* are observed in the lower red limestone with stromatactis whereas *F. micrastraea* and *Phillipsastrea ananas* (Goldfuss 1826) are present in the upper part of the lens together with *Ancyrognathus asymmetricus*. This locality was described among others by Coen et al. (1977) who considered that *Frechastraea* n. sp. A on the one hand as well as *F. micrastraea* and *Phillipsastrea ananas* on the other hand are typical of the first two faunas of massive rugose corals occurring in the Late Frasnian of Belgium.

It is interesting to mention that *Frechastraea* n. sp. A is widespread at the base of the Late Frasnian in the Dinant and Namur Synclinoria. To the north of the Philippeville Massif, it is abundant at the base of the Neuville Formation in the Barbençon and Gourdinne quarries, in different outcrops of Laneffe and along the disused railway section of Gerpinnes. It is accompanied by a few specimens of *Frechastraea phillipsastraeiformis* and rarely by *F. limitata* (Milne-Edwards & Haime 1851). Moreover, *Hexagonaria davidsoni* is still present at Barbençon, about one metre before the first *Frechastraea*.

Gerpinnes belongs in fact to the north side of the Dinant Synclinorium and to the east, in the Meuse valley, the Neuville Formation passes laterally into the Aisemont Formation. This lithostratigraphic unit is represented by two levels of more or less argillaceous limestones separated by shales. In this area, massive rugose corals are rather rare in the lower limestone layers. However, *Frechastraea* n. sp. A has been collected at Bauche and Lustin, in the sections described among others by Coen-Aubert & Coen (1975). In the latter locality, one colony of *Hexagonaria davidsoni* has been found at the very base of the Aisemont Formation, in contact with the underlying Lustin Formation.

As discussed already by Coen-Aubert (1974a, b) and Coen et al. (1977), *Frechastraea* n. sp. A is frequent in the Vesdre Massif, between Les Surdents lying to the east of Verviers and Colonster lying to the south of Liège, in the first level of the Aisemont Formation which is more or less coralliferous. At Embourg, to the north of Colonster, where the thickness of these limestones reaches nearly 16 m, *Frechastraea* n. sp. A is associated with *F. limitata* and *F. micrastraea*. To the north of the Vesdre Massif, in the Streupas outlier, this biostromal level is 19 m thick and contains *F. micrastraea* and *Phillipsastrea ananas* in its upper part.

Frechastraea n. sp. A is also well known at the base of the Aisemont Formation, in the Namur Synclinorium, at Huccorgne on its north side and in different localities from its south side such as Presles, Strud and Huy or even Landelies in the outlier of La Tombe. In La Mallieue quarry at Engis located at the eastern end from the south side of the Namur Synclinorium and described by COEN-AUBERT & LACROIX (1979) and POTY & CHEVALIER (2007), the first limestone level of the Aisemont Formation is again thicker and very rich in massive rugose corals. In the main part of this biostrome, there are numerous colonies of *Frechastraea* n. sp. A accompanied by a few specimens of *F. limitata* and even *F. phillipsastraeiformis* at the base. However, in the last 2.5 m of this reefal level, the fauna is different with the occurrence of *F.* cf. *borealis* and *F. micrastraea*.

In conclusion, it appears that *Frechastraea* n.sp. A is a remarkable marker for the base of the Late Frasnian in various areas of Belgium. This study confirms also the well known diachronism of the bases of the Neuville and Aisemont Formations from the south to north, in the direction of the transgression. This diachronism emphasized recently by POTY & CHEVALIER (2007) is based on the distribution of the conodonts and the massive rugose corals. It culminates in the more northern sections such as Embourg, Streupas and Engis where the first limestone level of the Aisemont Formation is more developed and typically coralliferous. Therefore, the species *F. micrastraea* and *Phillipsastrea ananas* appear in the upper part of this biostrome, above *Frechastraea* n. sp. A, just as it is the case in the upper part from the much thicker lenses of red marble belonging to the Petit-Mont Member in the Philippeville Massif

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From shallow water to deep mound - sedimentology and stromatoporoids paleoecology from the Frasnian (Upper Devonian) of Belgium

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Stromatoporoid faunas from the Frasnian of southern Belgium are abundant in the carbonate platform and mound environments present in this area.

Comparable facies were observed in the carbonate platform and in the mounds (Fig. 1). Although the mounds and platform are independent, similar stromatoporoids are observed in similar facies in each, indicating a strong paleo-environmental control. From the more distal to the more proximal, facies are: (1) outer platform or off-mound (shales, crinoidal packstones); (2) outer intermediate platform or deep mound (muddy facies with crinoids and reef-builders); (3) inner intermediate platform or shallow mound (muddy facies with algae) and (4) inner restricted platform or mound (laminites, mudstones, paleosols).

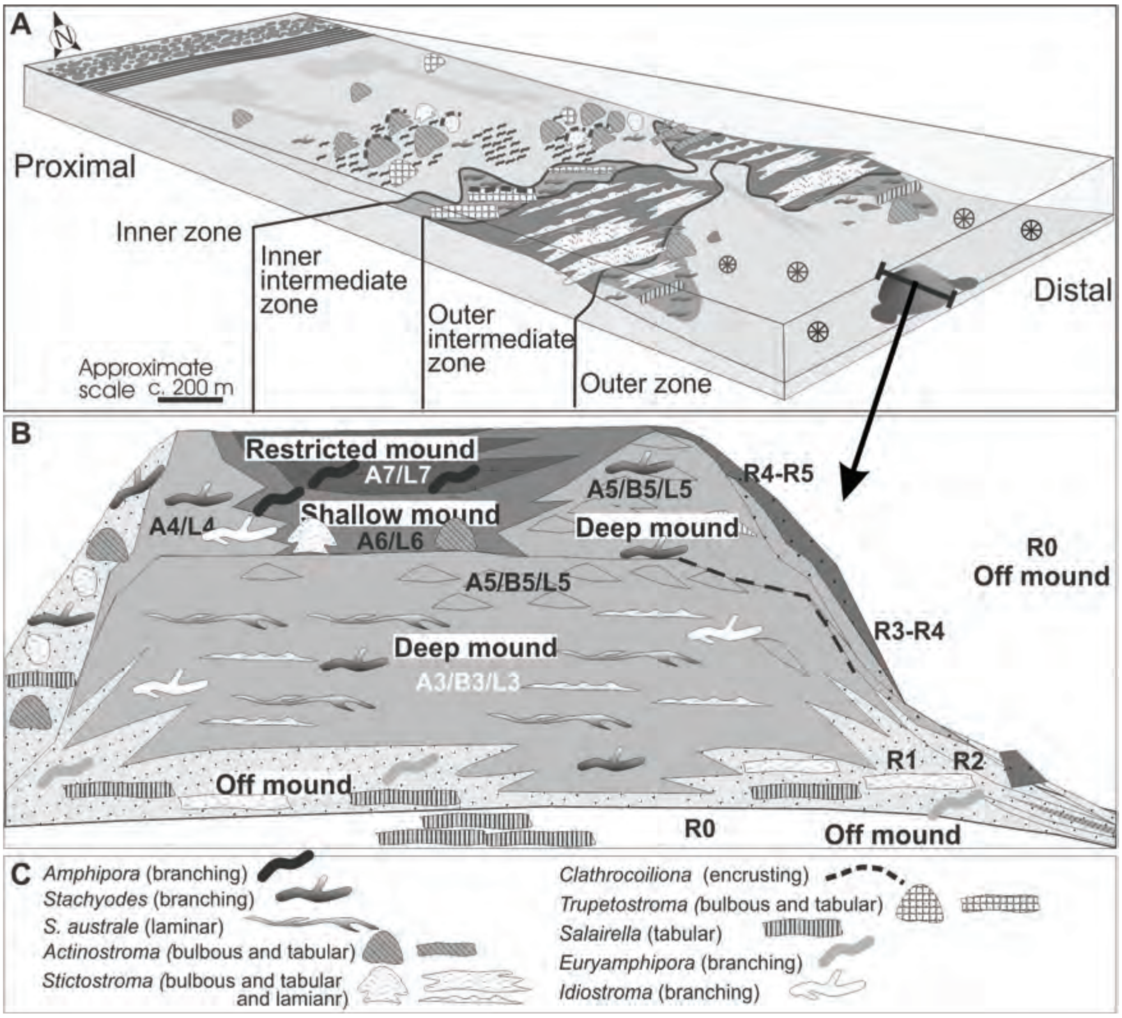
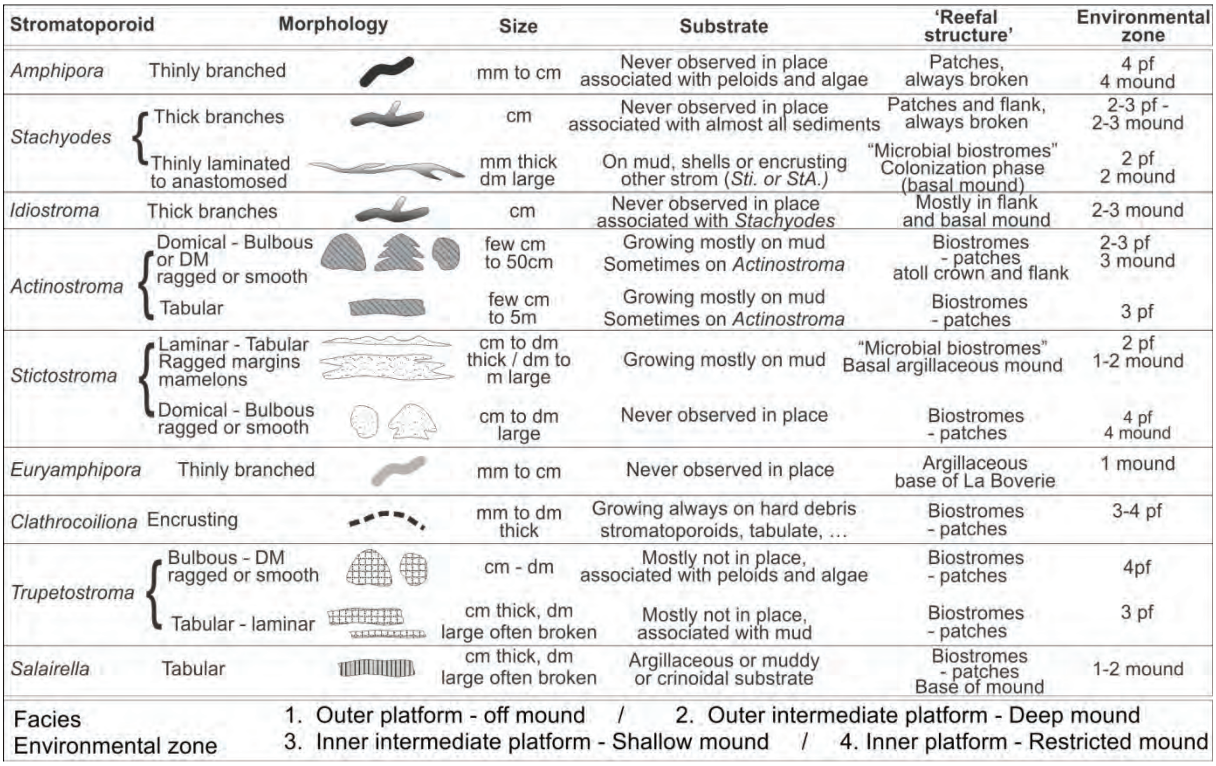


Fig. 1: Facies model for the whole Frasnian platform (A) and for the carbonate mound (B); with facies distribution and main settings and corresponding stromatoporoid distribution (growth shape and type of stromatoporoid).

Stromatoporoids dominate the large skeletal organisms, with principal occurrence in biostromes and mound deposits. Stromatoporoid genera include: *Actinostroma*, *Amphipora*, *Euryamphipora*, *Atelodictyon, Clathrocoilona, Idiostroma*, *Salairella, Stachyodes, Stictostroma, Stromatopora* and *Trupetostroma*.

Low profile stromatoporoids (dominated by *Stictostroma* and *Salairella*) are often observed at the beginning of sequences, as stabilizers and in outer to outer-intermediate platform facies and in off-mound and deep mound facies (so they likely led to expansion of the carbonate factory). High domical stromatoporoids (dominated by *Actinostroma*, *Atelodictyon* and *Trupetostroma*) occur in inner-intermediate and restricted platform facies, in association with branching stromatoporoids. The branching stromatoporoids are the most ubiquitous shapes.

Stromatoporoid growth forms seem to be related mostly to environmental parameters but there is also some taxonomic control (Fig. 2 and DA SILVA et al. 2011 a and b).



Stromatoporoid	Morphology	Size	Substrate	'Reefal structure'	Environmental zone
Amphipora	Thinly branched	mm to cm	Never observed in place associated with peloids and algae	Patches, always broken	4 pf 4 mound
Stachyodes	Thick branches	cm	Never observed in place associated with almost all sediments	Patches and flank, always broken	2-3 pf - 2-3 mound
	Thinly laminated to anastomosed	mm thick dm large	On mud, shells or encrusting other strom (*Sti. or StA.)*	"Microbial biostromes" Colonization phase (basal mound)	2 pf 2 mound
Idiostroma	Thick branches	cm	Never observed in place associated with *Stachyodes*	Mostly in flank and basal mound	2-3 mound
Actinostroma	Domical - Bulbous or DM ragged or smooth	few cm to 50cm	Growing mostly on mud Sometimes on *Actinostroma*	Biostromes - patches atoll crown and flank	2-3 pf 3 mound
	Tabular	few cm to 5m	Growing mostly on mud Sometimes on *Actinostroma*	Biostromes - patches	3 pf
Stictostroma	Laminar - Tabular Ragged margins mamelons	cm to dm thick / dm to m large	Growing mostly on mud	"Microbial biostromes" Basal argillaceous mound	2 pf 1-2 mound
	Domical - Bulbous ragged or smooth	cm to dm large	Never observed in place	Biostromes - patches	4 pf 4 mound
Euryamphipora	Thinly branched	mm to cm	Never observed in place	Argillaceous base of La Boverie	1 mound
Clathrocoiliona	Encrusting	mm to dm thick	Growing always on hard debris stromatoporoids, tabulate, …	Biostromes - patches	3-4 pf
Trupetostroma	Bulbous - DM ragged or smooth	cm - dm	Mostly not in place, associated with peloids and algae	Biostromes - patches	4pf
	Tabular - laminar	cm thick, dm large often broken	Mostly not in place, associated with mud	Biostromes - patches	3 pf
Salairella	Tabular	cm thick, dm large often broken	Argillaceous or muddy or crinoidal substrate	Biostromes - patches Base of mound	1-2 mound

Facies
Environmental zone
1. Outer platform - off mound / 2. Outer intermediate platform - Deep mound
3. Inner intermediate platform - Shallow mound / 4. Inner platform - Restricted mound

Fig. 2: Description of the main stromatoporoid morphologies and their distribution on the platform in relation to the substrate, biostrome and environment. ***Sti.* = *Stictostroma*, *StA.* = *Stachyodes australe*** **and pf = platform.**

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Long-expected! - First record of demosponge-type spicules in a Devonian stromatoporoid (Frasnian, Belgium)

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The stromatoporoid are hypercalcified sponges which were major reef-builders during the Palaeozoic. Since they were discovered by Goldfuss in 1826 and controversy has surrounded their taxonomic position (foraminifers, spongies, madreporans, bryozoans, hydrozoans, algae and cyanobacteria; Stearn 2010). Since the 1980s, they are considered as Porifera, in the classes Calcarea and Demospongia (Vacelet 1985; Reitner 1991) and spicules were found in some Mesozoic specimens (Wood 1987; Wood & Reitner 1986). Although, the major division of the Porifera by zoologists is largely based on the spicule types and the fact that all the early and middle Palaeozoic specimens found until now are aspiculate, and lead some authors to consider that their taxonomic position cannot be validly classified (Reitner 1991; Reitner et al. 2002).

Here, for the first time, are presented some evidence of demosponge-type spicules in a Devonian stromatoporoid. The specimen is a broken stromatoporoid piece of 2.5 x 2 cm size, surrounded by dolomitic and sparitic cement and which is part of a stromatoporoid rudstone. This rudstone is from La Boverie quarry, from the middle part of the Arche carbonate mound which belongs to the middle Frasnian (see Da Silva et al. 2011).

The stromatoporoid skeleton is cassiculate with locally dominant coenosteles or coenostromes and with a melanospheric microstructure. The spicules are of two size ranges (Fig. 1), the large ones are ranging between 500 to 2000 μm long and the small ones are 50 to 100 μm long. They have a simple structure, styles (monoaxons), are circular and no axial canal is present, due to diagenetic processes (Fig. 1). Observed shapes are straight or slightly curved styles or strongyles. The spicules are organized as followed: they are commonly enclosed in the skeleton and are intramural. They are relatively closely packed and arranged as a perpendicular network (Fig. 1) or plumos following the main skeleton.

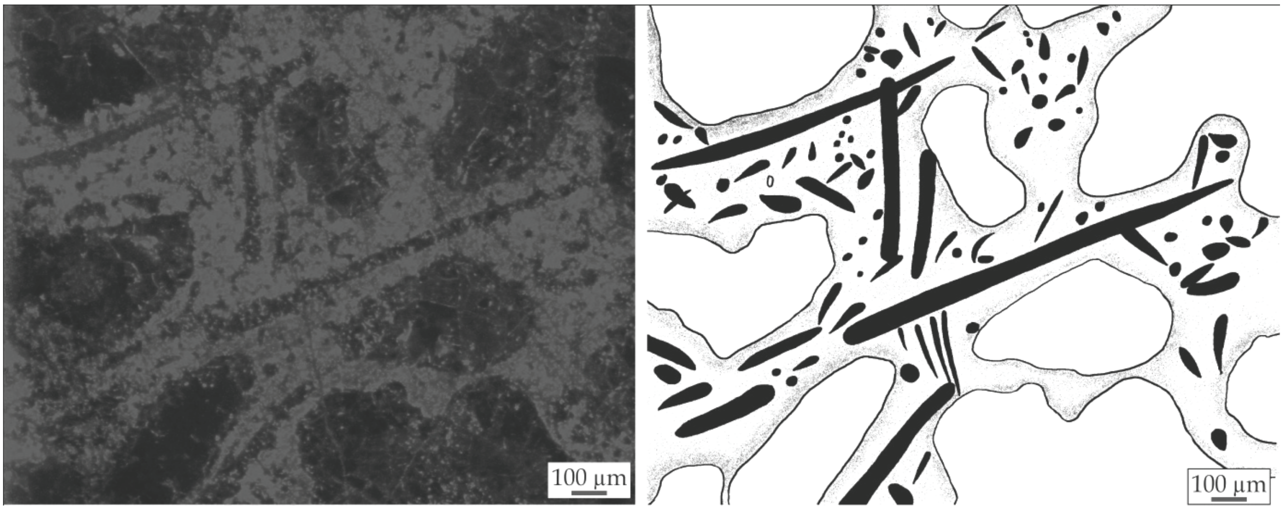

Fig. 1: CL and SEM pictures, organization of the spicules and shape. Left: Large spicules organized as a perpendicular network in CL, with numerous small spicules. Right: Schematic sketch.

The arrangement and type of spicule is relatively close to the observations made in the Upper Carboniferous haplosclerid demosponge *"Newelia" mira* (Wood et al. 1989) (*Spongonewellia* sensus Özdikmen 2009) and Lower Cretaceous *Euzkadiella erenoensis* (Reitner 1987) but the size of the spicules in the Devonian specimen is ten times bigger (Fig. 2).

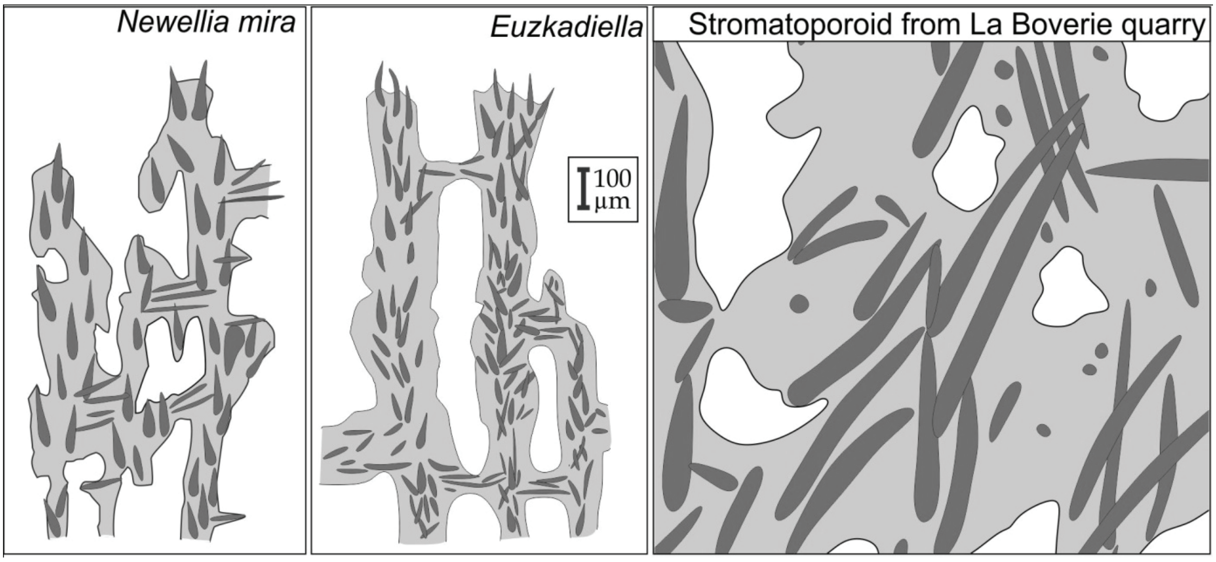

Fig. 2: Comparison of *Newellia mira* (Wood et al. 1989) and *Euzkadiella erenoensis* (Reitner 1987) with the stromatoporoid presented in this paper from La Boverie quarry. The type of spicules and their arrangement is relatively similar but their size is strongly different with spicules 10 times bigger in our specimen.

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Mississippian Lithostrotionidae from Zonguldak and Bartin (NW Turkey)

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The Mississippian of the Istanbul Zone (Northwestern Turkey) is represented by variegated shallow-water limestones and dolostones containing rugose corals, brachiopods and tabulate corals. Several lithostrotionids corals were been frist described by Charles (1933) in his regional study of Zonguldak and Bartın. He figured three *Siphonodendron* species: *Lithostrotion martini*, *Lithostrotion* aff. *irregulare* and *Lophophyllum fraiponti*. Charles's collection and newly collected material from Charles's localities around Bartın and Zonguldak are re-described. Six sections, Süzek, Topluca, Gökgöl, Kokaksu, Ulutam and Kişla, have been sampled in the Bartın and Zonguldak areas. The middle and late Viséan are particularly fossiliferous. The coral associations indicate the Rugose Coral Biozones RC5 to RC8 of Poty et al. (2006), thus a Livian to Warnantian age (middle-late Viséan, Lower Carboniferous). Among the rugose corals, a rich and diversified assemblage of Lithostrotionidae has been collected. The oldest association includes *Siphonodendron ondulosum* (wrongly described as "*Lophophyllum fraiponti*" by Charles 1933), *S. martini* and *Lithostrotion araneum* together with *Dorlodotia briarti*, *D*. sp., cerioid *Dorlodotia*, *Palaeosmilia murchisoni* and *Clisiophyllum* sp. The Late Viséan association is more diversified and composed of *S. martini*, *S. irregulare*, *S. pauciradiale*, *S. asiaticum*, *S. scaleberense*, *S.* sp., *Lithostrotion araneum*, *L. vorticale* and *L.* sp. 1. The variety described by Yabe & Hayasaka (1915) "*S. irregulare* var. *asiatica*" and old literature equivalent taxa are considered as a fully distinct species and renamed *S. asiaticum*. It corresponds to an intermediate form between *S. irregulare* and *S. junceum*, both in size and characters. A new form, temporarly named *Siphonodendron* sp. 1, is probably another species characterized by its very high number of septa versus diameter ratio. This new *Siphonodendron* is typical of the RC7β biozone of Poty et al. (2006).

S. ondulosum adapted to high-energy facies purchases a sub-cerioid trend by the packing of their corallites (Poty 1993; Javaux 1994). The latter has evolved in cerioid colonies by neoteny and given rise to *Lithostrotion araneum*. However, only "closely packed sub-cerioid colonies" were known from the Livian in Western Europe. Livian colonies of S. ondulosum from Zonguldak and Bartın show a clear cerioid trend with edge-to-edge polygonal corallites as the premise features of *Lithostrotion* genus, occurring in the upper part of the Livian.

The major part of the assemblage belongs to classical European taxa but the occurrence of species with Asian affinity, as *S. asiaticum* or with Russian affinity, as *Nemistium* sp., shows that Northwestern Turkey was at the crossing path of several palaeobiogeographic zone during Mississippian times.

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The Upper Viséan rugose corals in the microbial-sponge-bryozoan-coral bioherm in Kongul Yayla (Taurides, S. Turkey)

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The Anatolide-Tauride Block (Ozgül 1984) is an assemblage of 6 tectono-stratigraphic units elongated E-W. In its centre the Geyik Dağı unit is considered to be autochthonous. All other units are allochtonous; these are the Bozkır, Bolkar Dağı and Aladağ units in the north, and the Antalya and Alanya units in the south. In the Hadim area, only the Aladağ and Bolkar Dağı units contain Mississippian sedimentary rocks (Ozgül 1997). In the latter unit, the Viséan succession consists of shallow-water limestones intercalated into shales. Özgül (1997) attributed a Viséan-Serpukhovian age to the limestones (Zindancık Member) and concluded that they are intercalated in contemporaneous shales. Turan (2000) considers that all the limestone lenses of the Kongul Formation are allochthonous blocks ("Zindancik metaolistromu", Devonian to Permian in age) included into a thick flysch sequence of supposed Triassic age.

The bioherm of Kongul Yayla (located between Hadim and Taşkent) shows four main lithological units reflecting distinct growth stages from the base to the top:

(1) the basal bioclastic beds made of coarse bioclastic rudstones overlaid by a bafflestone with *Siphonodendron pauciradiale* containing numerous multithecoporid tabulate coral.

(2) the core facies formed of microbial floatstones and wackestones poor in macrofauna at its base but the diversity increases upward: lithisid sponges, fistuliporid bryozoan, pelmatozoans, brachiopods, foraminifers and corals. The solitary rugose are: *Axophyllum* aff. *pseudokirsopianum*, *A.* aff. *kirsopianum*, *Caninophyllum* aff. *archiaci*, *Palaeosmilia murchisoni* and *P.* aff. *multiseptata*. The colonial rugose corals are all of fasciculate growth form: *Siphonodendron pauciradiale*, *S. irregulare* and *Espiell*a sp. In the upper part of the bioherm, microbial communities, michelinid tabulate corals and small solitary undissepimented corals (*Amplexocarinia* aff. *cravenensis* and *Rotiphyllum densum*) form microbial boundstones.

(3) the crest in the uppermost part of the bioherm is a coral-chaetetid capping bed formed by large (1 m-scaled) colonies of *Listhostrotion maccoyanum* and *Chaetetes* sp. Despite of their exceptional size, the colonies seems to have fought against sediment fouling and burial (or microbial coating?), because many of them show disrupting growth on the topmost surface of the colonies and rejuvenescence features.

(4) the bioclastic facies containing reworked material from the bioherm in lateral and overlying positions to it. The entire bioherm is topped by siltstones with thin bioclastic horizons, often slumped. The fauna is the same than in the reef but reworked (?) and coated by microbial micritic laminae. These rudstones are covered by shales and siltsones containing bioclasts and solitary rugose corals related to *Sochkineophyllum* sp.

Preliminary biostratigraphic dating is based on rugose corals. The occurrence of *Siphonodendron pauciradiale* at the base and of *Lithostrotion maccoyanum* at the top of the bioherm, and without younger fauna, indicate a Warnantian age (Asbian, RC7β biozone of Poty et al. 2006). The bioclastic rudstones and the shale above the bioherm are also Viséan in age, because the solitary rugose coral (*Sochkineophyllum* sp.) has been collected near the contact with the reef.

The Kongul Yayla reef shares many similarities with contemporaneous reefs in Europe and North Africa, especially to the Cracoean reefs from northern England by the incorporation of sponges and corals into a microbial framework (Aretz & Herbig 2003). The rugose coral assemblage (*Siphonodendron, Lithostrotion, Palaeosmilia, Axophyllum*) is very similar to those described from England (Aretz & Herbig 2003), Southern Spain (Cozar et al. 2003) and Northern Africa (Aretz & Herbig 2008) witnessing the affinities of this part of the Palaeotethys with the Western European Realm. Facies and the coral fauna argue for an European affinity of the Anatolian terrane.

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Origin and evolution of *Dorlodotia* (Rugosa)

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Dorlodotia is a fasciculate coral common in the Viséan of Belgium,France, England, Donetz, South China and Japan. More than 30 species have been reported, mainly from Asia, but were often misidentified and/or misnamed (*Thysanophyllum*, *Thysanophylloides*, *Pseudodorlodotia*, *Kwangsiphyllum*, *Lithostrotionella*, etc., see POTY 2007). *Dorlodotia briarti* SALÉE (1920), the type species, shows the typical characters of the genus (reviewed by POTY 1975 1981, 2007) and exposes the high variability of the species, concerning the length of the septa, the development of the dissepiments, the thickening of the skeletal elements and the shape of the columella. Unfortunately, Salée's lectotype and unpublished material from the type locality of *D. briarti* are thought to be unusual and non representative by having well developed minor septa. Although, less than 5% of the thousand colonies of *D. briarti* checked for this study show well developed minor septa!

Dorlodotia appears in Western Europe during the Uppermost Tournaisian "Avins event" (RC4β1 rugose coral biozone of POTY et al. 2006). It does not originate from *Siphonodendron*, *Axophyllum* nor *Lonsdaleia* as stated by different authors, but probably evolved from a solitary caninoid coral which have budded and developed a weak columella from a long counter septum (POTY 2007). For example, *Caninia cornucopiae* from Tournai (Late Tournaisian) shows such a columella, associated with short or not developed minor septa and rare lonsdaleoid dissepiments that remind the *Dorlodotia briarti* corallite. *Corphalia*, was first described by POTY (1975) form the Belgian Early Viséan as protocorallite of *Dorlodotia* that does not bud. Since the paper of POTY, *Corphalia* sp. (very close to small *Caninia* with long counter septum) was found in the Latest Tournaisian and thus could seriously be considered as the original taxa giving birth to *Dorlodotia*.

Several Chinese *Dorlodotia* differ from species of the *D. briarti* group by the absence of a columella and the various development of lonsdaleoid dissepiments. These two features also remind the Asian genus *Kwangsiphyllum*. Both could have evolved from another caninoid solitary coral (small *Siphonophyllia*? or *Caninia*?) and gave birth to a lateral branch of the *Dorlodotia* genus, in which the acolumellate *D. pseudovermiculare* could also be placed.

North American "*Dorlodotia*" are different from European and Asian ones in many important characters: (1) moderately to well developed minor septa, (2) very long major septa except if they are interrupted by lonsdaleoid dissepiment, (3) lonsdaleoid dissepiments absent or very irregularly developed, (4) discontinuous weak columella (SANDO & BAMBER 1985), (5) inner row of dissepiments not thickened. Because of these differences, North American "*Dorlodotia*" are clearly separated from European and Asian *Dorlodotia* and should thus be excluded from the genus (contrarily to FEDOROWSKI & BAMBER 2007). They probably are homeomorphic to the latter, the same way North American "*Siphonodendron*" are homeomorphic to European and Asian ones (Poty 2010).

Sub-cerioid and cerioid trends have been figured within fasciculate *Dorlodotia* in Europe and Asia, but there are very sparse data establishing links between *Dorlodotia* and cerioid *Dorlodotia*-related taxa. Recent discoveries in Northwest Turkey (DENAYER, in press) have brought new precisions to the evolution of *Dorlodotia*. A new species, *D. euxinensis* (DENAYER, in press) is thought to evolve from *D. briarti* as the result of an increase in size and complexity (hypermorphosis process). During the Middle Viséan this "giant" *Dorlodotia* gave rise to a cerioid form described in a new genus, *Ceriodotia* (DENAYER, in press). *Ceriodotia bartinensis* evolved from *D. euxinensis* with a delay in the separation of the daughter corallite from its parent (neotenic process) and thus to the appearance of the cerioid trend. *Ceriodotia bartinensis* then evolved into *C. petalaxoides* (DENAYER, in press) by a decrease in size and complexity leading to the loss of mature stages in the new species in comparison with its ancestor (progenetic process).

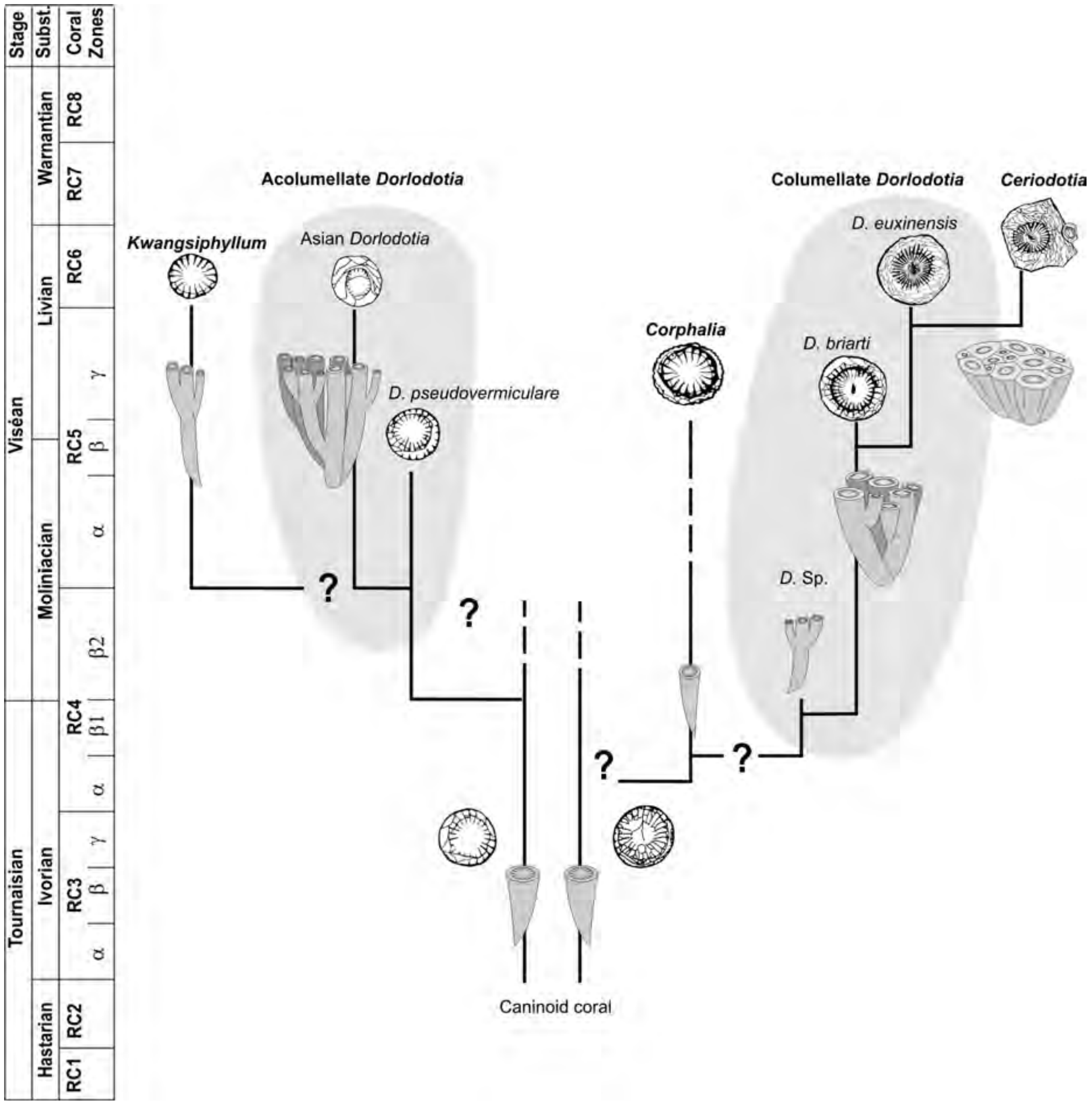

Fig. 1: stratigraphic distribution and proposed phyletic lineage for *Dorlodotia* and related genera. Tournaisian small solitary corals (*Corphalia* ?, *Caninia* ?) are tought to gave rise to fasciculate genera by budding during the Latest Tournaisian. One group gave rise to acolumellate *Dorlodotia* (*D. pseudovermiculare* and Asian species) and questionalbly to *Kwangsiphyllum*. Another group seems to evolved in columellate *Dorlodotia* (*D. briarti* and close species). The latter purchased a cerioid trend during the Middle Viséan (Livian), giving rise to *Ceriodotia*. Coral zones and substages after Poty et al. (2006).

The lineage *Dorlodotia*/*Ceriodotia* shows an evolution comparable to the lineage *Siphonodendron*/*Lithostrotion* and *Lonsdaleia*/*Actinocyathus* in which fasciculate forms give rise to cerioid ones. Easton (1973) compared the cerioid genus *Petalaxis* to *Dorlodotia*. However, *Dorlodotia* is not thought to be the direct ancestor of *Petalaxis*, but part of Viséan "*Acrocyathus*", being considered as *Ceriodotia* could constitute the root of Upper Carboniferous cerioid taxa.

In comparison with the phyletic lineage cited above, the next "step" of the evolution of *Dorlodotia* should be the loss of the outer wall and the increase of integration of the corallites as stated by Poty (2010). Until now, neither astreoid nor aphroid forms have been identified as "*Dorlodotia*-like" but it constitute an interesting topic for future research!

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Extreme constructional forms of Carboniferous Rugosa from the Akiyoshi Terrance in Japan: Palaeoecological implications of remarkable morphological combinations

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Morphologically and asexually specific colonial Rugosa were recovered from the Early to Middle Carboniferous (Serpukhovian to late Bashkirian) of the Akiyoshi Terrane of southwest Japan. Individual corallites are small (ca. 1.7 mm in diameter) and occur as uniserial fasciculate and phaceloid growth forms with a deep calice. However, they contain most of the constituents essential to the Rugosa, including walls, major and minor septa, tabulae, and columella. In addition, each component occurs in a rather remarkable manner, even given the structural constraints of being rugose corals. That is, the walls are extremely dilated with the fibrous lining facing inward, occupying up to half of the corallite interior and thereby prohibiting the formation of dissepiments; major and minor septa occur alternately, although they are occasionally densely packed within corallites; tabulae are sparse and near-horizontal; and the columella is represented by the axial elongation of the cardinal septum (Fig. 1). Parricidal increase is solely by dichotomous branching (division). In bipartite increase, parent corallites always provide their descendants with dividing walls on a cardinal-counter plane (bilateral plane) by an axial connection of the cardinal septa and the (opposite) counter septa. For structural reasons, offset corallites make the best use of parental skeletons, in a stable manner (Ezaki 2004). The remarkable integration of all these components culminates in somewhat unbalanced, rather than simple, corallite characteristics, thereby justifying the establishment of a new genus.

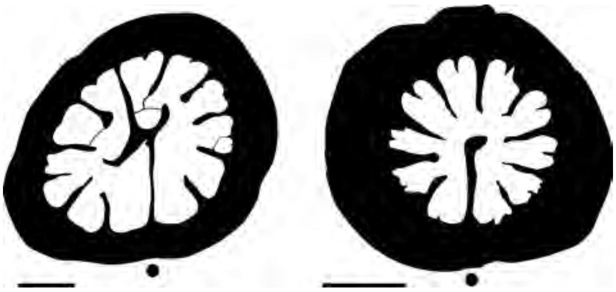

Fig. 1: Transverse sections through the new genus. The cardinal septum is indicated by a black dot. Scale = 0.5 mm.

It is remarkable that similar corals have been reported from the initial stages of both rugosan (e.g., Late Ordovician *Modesta prima* Tcherepnina 1962) and scleractinian diversification (e.g., Triassic *Zardinophyllum zardini* Montanaro-Gallitelli 1975 and *Pachydendron microthallos* Cuif 1975), when spatial competition for attachment remained limited. Similarly, the construction of the Akiyoshi organic reef complex occurred earlier in Panthallassa than elsewhere, following the Late Devonian extinction event (e.g., Ota 1968; Nagai 1985; Ezaki et al. 2007). These mutually similar corals are commonly characterized by morphologies that include thick walls, distinct septa, and simple columellas. However, the present Carboniferous genus is phylogenetically unrelated to the Ordovician *Modesta*, because the former shows a diffuso-trabecular, septal fine structure that is characteristic of the Carboniferous and Permian Rugosa (Kato 1963). Such constructional similarity may have resulted from convergence. The Akiyoshi Terrane is famous for the occurrence of endemic rugose corals represented by pseudopavonids (Kato & Minato 1975). It is probable that the relevant Carboniferous genus represented a dead-end, as well as an ephemeral extinct experiment of a rugosan clade rather than a progenitor taxon. Analogous corals of different ages and taxa, although unique in construction, may represent the limits of the morphological availability of coral constituents and their combinations, and would only have flourished within temporally vacant niches during times of weak biotic interrelationships during the Phanerozoic.

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Professor Maria Różkowska (15 Aug. 1899—20 July, 1979)

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Maria Różkowska was born in August 15, 1899 in the village of Gorzewo, Great Poland (Wielkopolska), into the family of the school teacher Józef Dembiński. Thus, her first research was published under the name Maria Dembińska. Being born in Wielkopolska, she was a German citizen of Polish nationality. The western part of Poland was then occupied by Germany. Thus, she attended High School where German was the obligatory lecturing language and so spoke perfect native German, but additionally, she also spoke fluent English and French. She learned Russian when almost 50 years old in order to read Russian coral literature with a full understanding of it.

In 1919 Maria Dembińska attended the newly founded Poznań University from which she received her MSc. and PhD degrees in 1923 and 1926 respectively; both in the Natural Sciences and both under the supervision of a malacologist, Professor Wilhelm Friedberg. This was the reason why she studied fossil gastropods and "worms" at the beginning of her scientific career. In 1923 she married Kazimierz Różkowski and gave birth to two daughters (Helena 1925; Jadwiga 1931) and a son (Andrzej 1928).

Her interest to corals only surfaced in 1929, as a result of her visit to the famous British coral specialist Stanley Smith. Already in 1932 she published a monograph titled, "The Miocene corals from Poland" (in Polish with German summary) and was ready for the *veniam legendi* examination based on that monograph. Unfortunately, something unknown happened and she suddenly left the University. Science was always one of the two priorities in her life, parallel to, but equal with her family. Thus, the decision was very painful, as she mentioned several times, but always without discussing the reasons.

Her absence from scientific studies was 13 years long, including the Second World War years and her banishment, with her children, from their home town to eastern Poland. As were many other Poles she was forced by the Germans to leave her home and to move to the unknown in the East. Her husband, a war-time officer, was imprisoned in the so-called "Oflag" (Officer's Camp) until 1945, when he returned home seriously ill. They were reunited in the summer that year, but he never fully recovered. Despite this and various other duties connected with her children, Maria Różkowska came back to the University in 1945 and published her first paper after the war, "The Silurian rugose corals from Podolia" in 1946. That paper was the result of her studies on Podolian Silurian strata and corals, conducted by her privately at the time that she left the University before the war.

The years 1953-1969 provide the time of the most fruitful scientific activity of Professor Maria Różkowska. Her well known papers on the phillipsastraeid group of corals (1953, 1956, 1957); her study on blastogeny, documenting the taxonomic and phylogenetic value of that type of study (1960); and her fundamental opus on Famennian corals (1969) are seminal. She was active literally until the end of her life. Her last papers (1979, 1980), were written or dictated in the hospital and in bed at home, and were published after her death.

She did not to travel internationally. However, she was visited by many colleagues from European countries and in addition, from Australia, Japan, China, the former U.S.S.R., and the United States. Many of these visitors, just like her, are dead, but some among us will fondly remember their visits during this session. Literally, everyone who met her had a true affection for her as a person. In addition, all respected her science. Her personality made her a much-loved professor and mentor.

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An unusual occurrence of Bashkirian (Upper Carboniferous) rugose corals from the Sverdrup Basin, Arctic Canada

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Abstract – The oldest known Carboniferous rugose coral fauna in the Canadian Arctic Islands occurs on the northwestern margin of the Sverdrup Basin, in the Yelverton Inlet area of northern Ellesmere Island. It was collected from Bashkirian carbonates of the lower Nansen and Otto Fiord formations and includes representatives of the genera *Dibunophyllum* Thomson & Nicholson, *Diphyphyllum* Lonsdale, *Lonsdaleia* McCoy and *Palaeosmilia* Milne-Edwards & Haime. Such a generic assemblage is unknown elsewhere above the Serpukhovian, but is typical for coral faunas in the Upper Viséan of Europe, North Africa and China. In those areas, genera of this assemblage range into the upper Serpukhovian and individual genera may continue into the Lower Bashkirian. For example, *Dibunophyllum* is known from the Lower Bashkirian of southern China and the Donets Basin, and *Lonsdaleia* occurs in the Bashkirian of the Voronezh uplift (Ukraine). *Diphyphyllum* and *Palaeosmilia* are unknown above the Serpukhovian, except for Bashkirian specimens of those genera in the Yelverton Inlet fauna. Thus, the Yelverton Inlet fauna shows limited similarity to Serpukhovian faunas of several other basins but differs from the Bashkirian faunas of those basins. It is unique in its unusual taxonomic content, high stratigraphic position, and remote geographic location. Further investigation is required to determine its possible origin and paleogeographic significance.

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The Hettangian corals of the Isle of Skye (Scotland): an extreme ecosystem just after the Triassic-Jurassic boundary crisis

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The Triassic-Jurassic boundary (T-J boundary), estimated at ~200 million years ago, was a critical transition where profound biotic and environmental changes occurred. This transition is considered as one of the big five mass extinction events of the Phanerozoic. The causes remain controversial. Many authors report that the end of Triassic was marked by an important increase in pCO_2 which induced a global warming. The source of the CO_2 emission was probably the Central Atlantic Magmatic Province (CAMP), one of the largest igneous provinces of the world which was occasioned by the break-up of the Pangea. Other scenarios have been proposed to explain the mass extinction including meteoric impacts and a sea-level change.

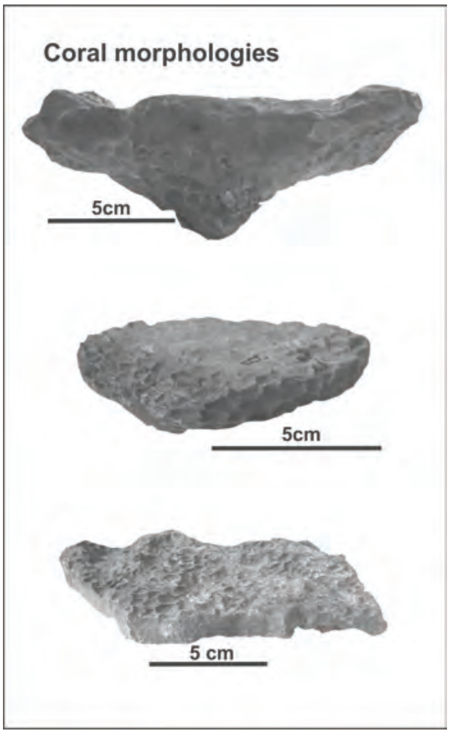
HAUTMANN (2004) has suggested that the important increase of the atmospheric CO_2 at the end of the Triassic caused a $CaCO_3$ undersaturation of the oceans which consequently induced a biocalcification crisis. Thus, the reef communities, and especially the corals suffered high extinction rates. Before the recovery of reef building during the Dogger (LATHUILIÈRE & MARCHAL 2009), the Lower Jurassic is characterized by a "reef gap". Thereby Hettangian outcrops showing genuine frameworks of colonial corals are very scarce and essentially concentrated in Western Europe (western Tethys).

This work focuses on the study of a Hettangian outcrop containing coral beds which is situated on the Isle of Skye (Ob Lusa locality, Highlands, Scotland). In comparison with their counterparts, these coral communities lived in a very high latitudinal area (around 40° N latitude). This area was situated in the eastern Inner Hebrides Basin. In a wider context, the Hebrides Basin was constituted during the Jurassic by a network of shallow seaways that connected the Tethys in the South to the Boreal ocean in the North (DORÉ 1992). In order to better understand the paleoenvironmental conditions of this north-western part of the Tethys during the Triassic-Jurassic reef crisis, it is especially important to make detailed observations in the field as well as analyses related to paleotemperatures, paleoecology and paleogeographic setting of the corals of the Isle of Skye.

At Ob Lusa, six distinct coral beds were found in the studied outcrop. The coral associations are monogenic, belonging to *Heterastraea*, a massive cerioid genus. The first bed exhibits relatively well developed colonies that constituted small bioconstructions, whereas the other beds display very small colonies completely drowned in the matrix. Thereby, the studied corals were sampled in this first coral bed. Their morphology and size can vary (Fig. 1) but the general growth fabric is dominated by platy colonies. This kind of growth fabric is defined as a platestone (INSALACO 1998). The more surprising characteristic of those specimens, and especially for the platy corals, is the growth pattern. Indeed, many samples do not show the classical growth polarity because they are bifacial; it means that the corallites grew toward both sides of the colonies (Fig. 2). The possibility that they were rolled has been rejected because the corals clearly form *in situ* bioconstruction.

The sedimentological study revealed that those corals lived in a shallow environment with fluctuating paleoenvironmental conditions (e.g., sea-level, currents and maybe climate). Moreover, the facies show that the area was influenced by a strong siliciclastic input. The corals developed during periods with a lower input but the quantity of quartz is nevertheless not insignificant. It is also important to notice that the general faunistic assemblage of the studied outcrop is low diversified and is mainly composed of allochthonous bioclasts. The paucity of other organisms (e.g., foraminifers, bivalves, sponges, etc.), which are more tolerant and normally abundant in reefal environments, is striking because corals are generally thought to have a lower environmental tolerance.

Additionally, geochemical analyses ($\delta^{18}0$, $\delta^{13}C$) were realized on oyster shells associated to the corals. The results indicate that the mean values of paleotemperatures were around 22°C and it represents optimal temperatures for zooxanthellate corals. However, considering the paleoenvironmental conditions and the paleoecological assemblage, the corals of the Isle of Skye are regarded as having belonged to an extreme ecosystem.



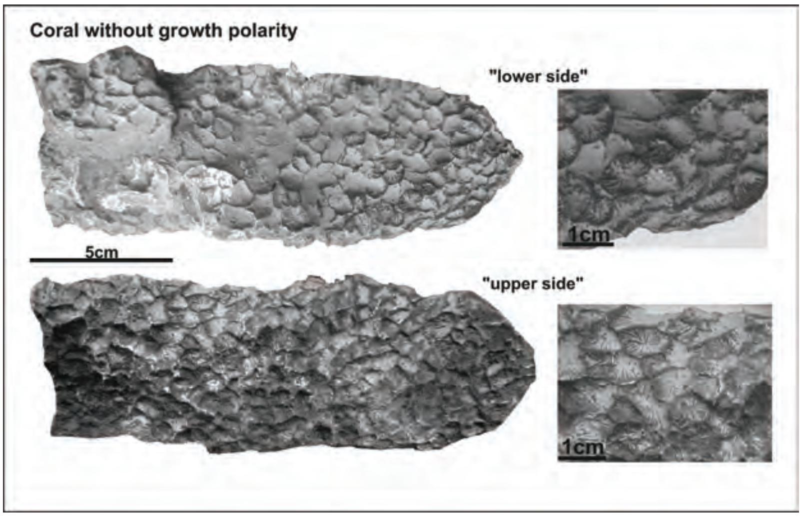


Fig. 2: Well developed corallites on both sides of the coral

Fig. 1: General morphologies of the studied corals

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Dorlodotia Salée 1920 (Rugosa) and related taxa in the Dinantian (Lower Carboniferous) of Russia and Ukraine

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Dorlodotia Salée 1920 is widely distributed in the Lower Carboniferous of Europe and Asia. The genus is distinguished by fasciculate growth habit, although can also show subcerioid trend, by minor septa poorly developed or absent, by axial structure typically represented by lath-like columella which may be vertically discontinuous or absent. Tabulae are conical in the presence of columella, flat or domed in its absence, dissepimentarium commonly dominated by first order transeptal dissepiments. Increase is lateral.

In the Donets Basin, records of *Dorlodotia* (Vasilyuk 1960; Vasilyuk & Zhizhina 1978; Ogar 2010) are from the Glubokaya (C_1Vb-C_1Vc, Moliniacian) and Donets (C_1Vf, Warnantian) formations, and include *D. fomischevi* Zhizhina 1978, *D. pseudovermiculare* McCoy 1849 in the sense of Ogar (2010), both possibly synonymous with *D. briarti* Salée 1920, and *Pseudodorlodotia subkakimii* Vassilyuk 1978. *Lonsdaleia sokolovi* Dobrolyubova 1958 from the Mikhailov horizon (Brigantian) of the Moscow Basin also belongs to this genus. *Dorlodotia* includes at least one upper Moliniacian (?)-Livian species, *Th. vermiculare* Degtjarev 1973, reported from the Zapadny Ural horizon of the western flank of the Central Urals by Degtyarev (1973) and one Serpukhovian species, *Thysanophyllum concavum* Gorsky 1951, reported from the Novaya Zemlya by Gorsky (1951).

Garwood (1912), Smith (1916) and Hill (1940) considered *Lonsdaleia praenuntia* Smith 1916 as the ancestor of *Dorlodotia pseudovermiculare* (both species enter near the base of the Visean), and Poty (1981) suggested that the genus *Dorlodotia* originated from the genus *Lonsdaleia* McCoy 1849; evolution in the lineage *L. praenuntia – Dorlodotia pseudovermiculare* went in the direction of disappearance of axial structure and simplification of tabularium. *Lonsdaleia praenuntia* is restricted to the very base of the Visean, whereas *Lonsdaleia* is an upper Warnantian-Serpukhovian genus. Studies of variability in *Dorlodotia* suggest that *Lonsdaleia praenuntia* is also a *Dorlodotia*. In *D. sokolovi,* intracolonial variability involves inner tabularium and axial structures, and some corallites show primitive dibunophylloid axial structures resembling those of "*Lonsdaleia*" *praenuntia*. The strong similarity between "*L*". *praenuntia* and *Dorlodotia sokolovi* was already emphasized by Dobrolyubova (1958).

The genus *Ceriodotia* established by Denayer (in press) for cerioid species from the Livian of Northwestern Turkey closely resembles *Dorlodotia* in corallite morphology and most probably originated from it. *Protolonsdaleia tenuis* Zhizhina 1978 from the Glubokaya Formation (C_1Vc, Moliniacian) of the Donets Basin and probably *Eolithostrotionella lissitzini* Zhizhina 1960 from the Donets Formation (C_1Vf, Warnantian) of the same area belong to *Ceriodotia*. To this genus may be also attributed upper Moliniacian (?)-Livian *Eolithostrotionella grechovkae* Degtjarev 1973 from the eastern flank of the South Urals and probably *Thysanophyllum druzhininae* Degtjarev 1973 from the western flank of the Central Urals, both reported from the Zapadny Ural horizon (Degtyarev 1973). Other species from the Dinantian of the Donets Basin and Urals attributed to *Protolonsdaleia* Lissitzin 1925 and *Eolithostrotionella* Zhizhina 1956 (Vasilyuk 1960; Zhizhina 1960; Degtyarev 1973; Vasilyuk & Zhizhina 1978) commonly show long minor septa and resemble *Acrocyathus* d'Orbigny 1849.

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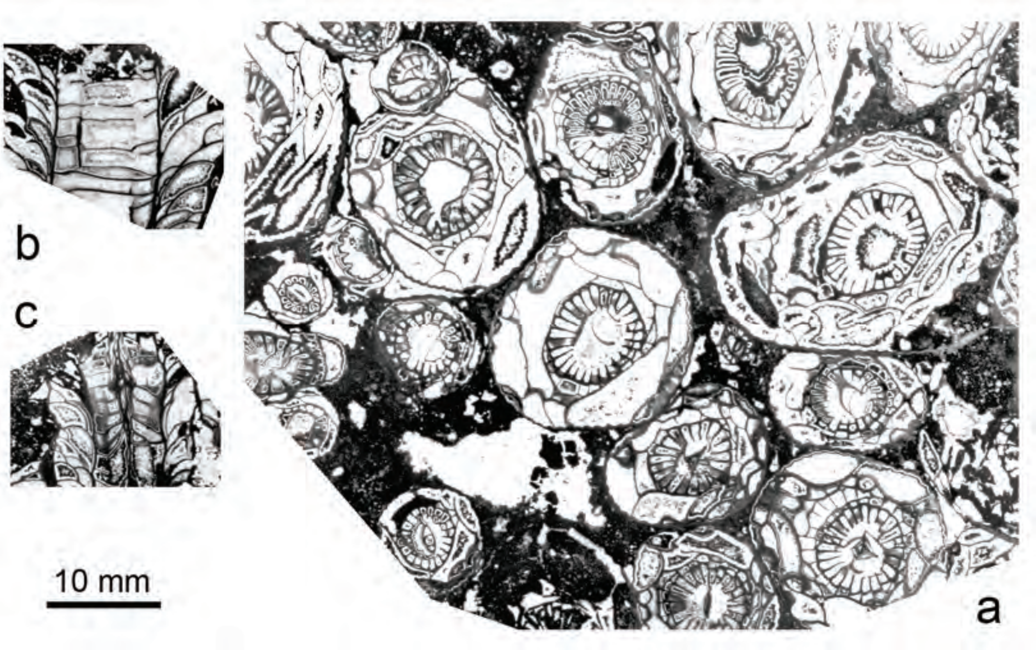

Fig. 1: *Dorlodotia sokolovi* (Dobrolyubova 1958): specimen PIN 705/161, holotype, showing strong variability in axial structures and tabularium; a – transverse section, b, c – longitudinal sections. Dinantian, Brigantian, Mikhailov horizon, north-western part of the Moscow Basin, 50-60 km N. of the town of Borovichi. x 1.5.

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Biform tabularia and periaxial cones in *Lonsdaleia* McCOY 1849 (Rugosa)

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The term *biform tabularium* was introduced by Weyer (1972) for different orientations, or *positions* in the sense of Sutherland (1965), of peripheral parts of tabulae in rugose corals situated on opposite sides of minor septa, those declined adaxially on one side of a given minor septum (*Position I*) and elevated on the other (*Position II*); biform tabularia are expressed in species with minor septa long enough to pentrate tabularium. First discovered in solitary rugosans, biform tabularia were also documented in few colonial genera (Bamber & Fedorowski 1998; Fedorowski et al. 2007), including in *Lonsdaleia* McCoy 1849 (Hecker 2010). At least five species from the Brigantian-Serpukhovian (Mississippian) of the Moscow Basin, *Lonsdaleia (Actinocyathus) floriformis* (Martin 1809), *L. (A.) crassiconus* (McCoy 1849), *L. (A.) subtilis* (Dobrolyubova 1958) (Fig. 1a-c), *L. (A.) gorskyi* (Dobrolyubova 1958) and *L. (A.)* sp. A, show two positions of periaxial tabellae.

The term *periaxial cones* was introduced by Bamber & Fedorowski (1998) for components of axial structure in *Cystolonsdaleia* Fomichev 1953. The axial structure in this genus is a discontinuous and variable axial column composed of a median lamella, septal and lateral lamellae, discontinuous series of axial tabellae, and periaxial cones. Periaxial cones represent combination of steeply elevated, vertically extended axial parts of tabulae with elongated axial tabellae (Fedorowski et al. 2007); they form irregular, incomplete conical structures partly enclosing other structural elements of axial column.

Lonsdaleia is distinguished by well-defined continuous axial column of dibunophylloid type comprising a median lamella, septal lamellae and typically regularly conical axial tabellae. Periaxial cones are locally developed in five *Lonsdaleia* species from the Brigantian-Serpukhovian of the Moscow Basin: *L. (Actinocyathus) subtilis* (Dobrolyubova 1958) (see Hecker 2010), *L. (A.) borealis* (Dobrolyubova 1958), *L. (A.) rossicus* (Stuckenberg 1904), *L. (A.) gorskyi* (Dobrolyubova 1958) and *Lonsdaleia (Lonsdaleia) duplicata* (Martin 1809) within the limits of their variability. Periaxial tabellae in *Lonsdaleia* typically extend from the dissepimentarium to the outer margin of the axial column and terminate adaxially against an axial tabella. Where periaxial cones are developed, periaxial tabellae of this type terminate against a periaxial cone. Periaxial tabellae forming periaxial cones are steeply elevated near the axial column and merge with elongated axial tabellae joining the median lamella. One can observe periaxial cones in the process of development, i.e. transition from the state when elevated periaxial tabellae terminate against elongated axial tabellae to the state when these structures merge to form a periaxial cone. Periaxial cones are better expressed in *Actinocyathus subtilis*, especially in the colonies form the northwestern part of the basin where the species reached the peak of its abundance and showed the highest variability in the Tarusa time (earliest Serpukhovian) (Fig. 2).

Bamber & Fedorowski (1998) consider biform tabularium and periaxial cones as one of the main characters distinguishing *Cystolondaleia* from similar cerioid taxa with complex axial structures and transeptal dissepiments, including *Lonsdaleia (Actinocyathus)* d'Orbigny 1849. It seems, however, that *Actinocyathus* differs from *Cystolondaleia* mainly by typically well-defined continuous axial column with regular axial tabellae and by absence of lateral lamellae. *Cystolondaleia* could have evolved from *Actinocyathus*, and evolution went in the direction of axial column becoming discontinuous and less regular, and lateral lamellae developing; biform tabularium and periaxial cones, occasionally developed in *Actinocyathus* within the limits of variability of some species, became characteristic structures in *Cystolondaleia*.

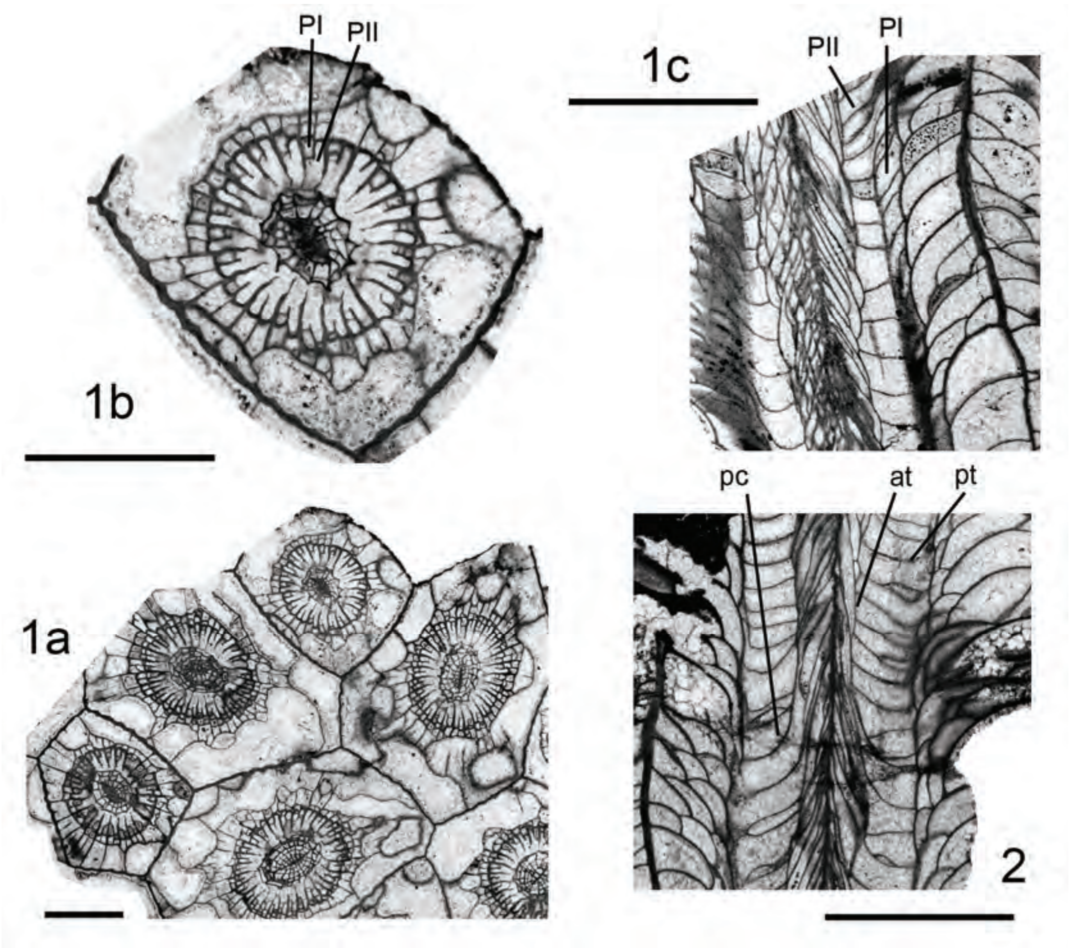

Fig. 1: *Lonsdaleia (Actinocyathus) subtilis* (Dobrolyubova 1958): specimen PIN 705/646; 1a – transverse section, x2; 1b – transverse section showing biform morphology of tabularium, x5; 1c - longitudinal section showing biform morphology of tabularium, x5; Lower Serpukhovian, Tarusa horizon, north-western part of the Moscow Basin, Retesha River 60 km northeast of the town of Boksitogorsk.
Fig. 2: *Lonsdaleia (Actinocyathus) subtilis* (Dobrolyubova 1958): specimen PIN 705/184; longitudinal section showing periaxial cone on left side of axial column, x5. Lower Serpukhovian, Tarusa horizon, north-western part of the Moscow Basin, Tutoka River 60 km northeast of the town of Boksitogorsk.
Abbreviations: PI, Position I of Sutherland (1965); PII, Position II of Sutherland (1965);
pa, periaxial tabella; at, axial tabella; pc, periaxial cone. Scale bar = 5 mm.

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Palaeodiversity and faunal dynamics of post-Frasnian Tabulates, Western Palaeotethys

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Introduction: Tabulate and rugose corals, and stromatoporids were the predominating framebuilders, bafflers and encrusters during the mid-Palaeozoic reef cycle. All were severely affected by the Frasnian-Famennian extinction event, but had a completely different post-Frasnian history. Palaeozoic stromatoporids never recovered sufficiently and got extinct at the Devonian-Carboniferous boundary. Rugose corals radiated again during the latest Devonian ("Strunian") and during the Mississippian. They flourished in carbonate platform settings and reinvaded the reef biotope, reaching almost their Devonian diversity (ARETZ 2010). Also tabulate corals recovered, but remained a mostly subordinate community element (SCRUTTON 1997).

Problems and Methods: Due to relative scarceness, missing biostratigraphic value and difficult taxonomic treatment, post-Frasnian tabulates are not sufficiently studied in the western Palaeotethys. We tried to evaluate diversity and faunal dynamics at species level based on exhaustive bibliographic survey. Data were cross-checked and supplemented with those from the Paleobiology Database (http://paeodb.org), to reduce uncertainties due to unrevised faunal data. Fossil lists of that database were used, if entries are on species level and ranges confined at least to regional stages in defined regions. Diversity was calculated for western European regional stages in standardised regions, using the normalised diversity metric proposed by COOPER (2004). Defined standard regions are Ireland, northern England, southern England, Belgium, Rhenish Slate Mountains, Holy Cross Mountains, Silesia-Cracow Upland, Saxothuringia, Southern Portugal, Catalonia, and the North African basins. Palaeogeographic relations were approached by cluster analysis based on the Dice similarity index using PAST software.

Palaeodiversity and disparity: No tabulate corals are recorded in the lower and middle Famennian of the western Palaeotethys except for a faunula from the lower Famennian of Moravia (HLADIL 1987). Not a single "Strunian" or Carboniferous species is recorded from pre-Famennian strata according to our knowledge. Thus, a completely new faunal cycle started in the "Strunian". It ended in the Kasimovian, comprising all together about 75 species from 33 genera and 14 families.

The diversity is relatively low in the "Strunian" but increases abruptly to reach an absolute maximum in the Molinacian. Then the diversity decline from the Viséan to the Kasmovian is interrupted by an expressed Brigantian peak. The low "Strunian" -Hastarian diversity reflects the slow recovery after the Frasnian-Famennian extinction. Declining diversity during the Viséan is due to steadily increasing extinction and decreasing origination rate, a trend only reversed during the Brigantian. The Mississippian diversity curve for western European rugose corals (ARETZ 2010) is similar to that of tabulates. Both correlate well with Mississippian sealevel variations. The Molinacian maximum is probably related with the Avins event, a widely recognized transgressive event, which introduced also many rugose taxa. Of special interest is the Brigantian peak, which introduced some Asiatic taxa to Poland, Belgium, the Betic Cordillera (own unpublished data) and Algeria (*Multithecopora, Sinopora, Verolites*). The quasi-extinction of tabulates at the end of the Viséan is related to the prograding Variscan orogeny, which caused emergence and widespread break-down of carbonate platforms. Moscovian and Kasimovian tabulates have been described from Cantabria and the Carnic Alps, but undescribed occurrences in the North African basins should increase Pennsylvanian diversity.

Syringoporidae, Michelinidae and, to a lesser degree, Favositidae are the most diverse and most abundantly occurring Carboniferous tabulate families in the western Palaeotethys (Fig. 1A). The normalised diversity curves of the Syringoporidae and the Michelinidae parallel the general trend of tabulates. Favositidae are not significantly changing. Like the Michelinidae, they are not recorded after the Brigantian. The pattern indicates that the recognized Favositidae (*Emmonsia*, *Squameofavosites*, *Sutherlandia*) are conservative taxa. The small colonies live predominanty in deeper-water and also in muddy environments and, obviously, are less controlled by facies changes or sealevel changes than the two other families, which prefer carbonate environments. The differing diversity curves of the families also indicate a declining disparity during the later Mississippian. Communicate fasiculate taxa (Multithecoporidae) gain predominance in the Pennsylvanian of the western Palaeotethys.

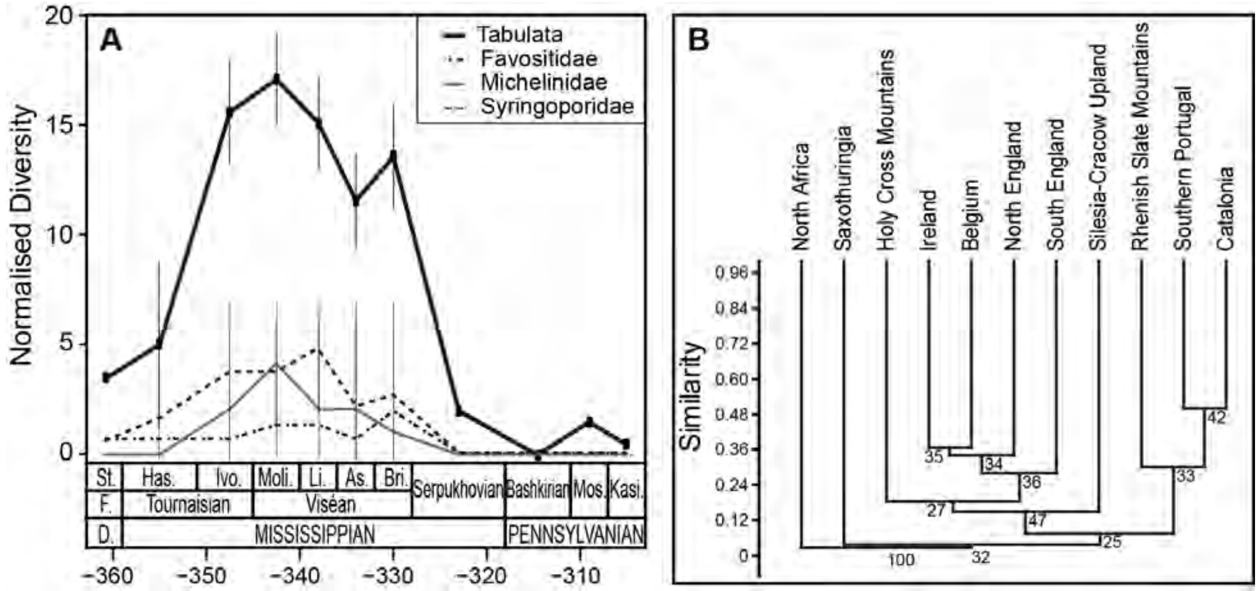

Fig. 1. (A) Normalised diversity of all tabulate corals, and of the three families Favositidae, Michelinidae and Syringoporidae; error bars represent the confidence interval at 95%; St: Strunian, Has: Hastarian, Ivo: Ivorian, Moli: Molinacian, Li: Livian, As: Asbian, Bri: Brigantian, Mos: Moscovian, Kasi: Kasimovian. (B) Cluster showing the faunal similarities between the considered geographic units; node supports at 1000 bootstrap replicates.

Palaeogeographic and facies relations: Major clusters indicate certain faunistic differences between the northwestern European carbonate platform (British Isles, Belgium) and a northeastern European carbonate realm (Poland), both situated on the southern Laurussian shelf (Fig. 1B). The northeastern European carbonate realm differs mostly by the existence of Roemeriidae, Multithecoporidae and Sinoporidae, by more diverse Syringoporidae and less diverse Michelinidae from the northwestern European platform. A second cluster embraces the Rhenohercynian Zone (Rhenish Slate Mts., Southern Portugal) and Catalonia. However, it is considered as facies group, characterized by mixed siliciclastic-carbonate deposits and pelagic carbonates. This is a typical *Cyathaxonia* facies with common Favositidae (*Sutherlandia* ssp.) and the Palaeacid *Smithinia humilis* (Hinde).

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Tabulate corals and stromatoporoids in the Mont d'Haurs and Fromelennes Formations (Late Givetian) at "Cul d'Houille" section (Flohimont, France)

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The "Cul d'Houille" section is located near Flohimont (France) on the western side of the Houille river in the southern part of the allochtonous Ardennes fold-and-thrust belt. The Mont d'Haurs and Fromelennes formations are observed in this section and have a measured thickness respectively of 87 and 148.5 meters. The boundary between the Mont d'Haurs and Fromelennes formations is characterised by the transition from reefal limestones to argillaceous limestones and siltstones. The successive Flohimont, Moulin-Boreux and Fort Hulobiet Members of the Fromelennes Formation are represented in the lithological column with some gaps due to badly outcropping conditions. The limits between the different members are imprecise due to sedimentary biases. The section was investigated previously for conodonts at the boundary between Mont d'Haurs and Fromelennes Formations (Bultynck 1974), for a comparison between stratigraphic sequences and the distribution of stromatoporoids (Cornet 1975) and for sedimentological and sequential analyses (Préat & Carliez 1994) only in the Moulin-Boreux Member and recently for lithology and faunal occurrence on the entire outcropping section (Hubert & Pinte 2009). In the Ardenne's sections, the Taghanic event is located in the lower part of the Fromelennes Formation (Flohimont Member). The authors interpret it as polyphased and consider it as one of the major events of the Devonian (Aboussalam & Becker 2001). A significant sea level change and a major global warming (Aboussalam 2003) are probably the main causes to explain this extinction.

Rock magnetism analyses have been recently conducted on the same samples used for sedimentological purposes (microfacies analyses). 13 microfacies were recognized and represent a standard sequence from open-marine to restricted conditions close to the emersion. The Mont d'Haurs Formation represents a global low regressive evolution to the Mont d'Haurs/Fromelennes formations. The first and last member (Flohimont and Fort Hulobiet Mb.) of the Fromelennes Formation correspond to transgressive episode. The intermediate member (Moulin Boreux Mb.) fluctuates from deepest to shallowest environment in several cycles. Magnetic susceptibility (MS) data were acquired on 600 samples. MS values range between -4.17 x 10^{-9} and 1.48 x 10^{-7} m^3/kg for the whole section. Several magnetic susceptibility evolutions (MSE) or magnetic sequences are recognised and are well correlated with the microfacies succession.

Reefal faunas are studied to estimate biodiversity and ecological trends. These are stromatoporoids and tabulate corals. Like in the Givet section, the Mont d'Haurs Formation shows a high diversity of stromatoporoids and tabulate corals (mainly dominated by lamellar, branching and massive forms). The passage to the Flohimont Mb. (Fromelennes Fm.) is marked by a decrease of the diversity during the transgressive episode (only some lamellar forms and branching like alveolitids and thamnoporids for tabulate corals and *Clathrocoilona* for stromatoporoids remain). The Moulin Boreux Mb. registered a low diversity. This member is also characterized by a large diversification in the upper part with the presence of large biostrome mainly composed by massive stromatoporoids. In contrast only opportunistic scoloporids were found during the post-Taghanic event for tabulate corals. The Fort Hulobiet Member is marked by a renewal of tabulate corals (alveolitids, auloporids).

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Pseudopercula in *Thamnopora orthostachys*; Plabutsch Formation (Eifelian), Graz Palaeozoic

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In the alpine orogenic belt Palaeozoic successions are distributed irregularly because they were incorporated as dismembered units into the Alpine nappe system. Two major regions separated by a prominent fault system can be distinguished, the Upper Austroalpine Variscan sequence and the Southern Alpine sequence. Both contain a different coral fauna, the Austroalpine Coral Fauna, and the Southalpine Coral Fauna.

The Graz Palaeozoic, part of the Upper Austroalpine Variscan sequence, represents a diversity hot spot of corals belonging to the 'Austroalpine Coral Fauna' (Hubmann 2002).

During the last decades of the 19th century several staff members of the Graz Institute for Geology collected fossils from various quarries (now all abandoned) in the vicinity of Graz. It was Karl Penecke (1858-1944) who taxonomically described them in his famous publication of 1894. Unfortunately the material – among them type material of 12 rugose species and 1 genus (*Thamnophyllum*), and 6 tabulate species – was lost during WWII. In some cases lectotypes were erected from specimens of the 'Penecke collection', but mostly the selection was not really successful because these specimens did not show (all) the species-distinguishing features.

During the last years re-collecting campaigns at prominent type localities (nearly all of them are totally expired) resulted in a considerable collection of coral specimens. Among them, very common are branches of thamnoporids which were named *Pachypora orthostachys* by Penecke (1894:607). Actually this tabulate belongs to *Thamnopora*, but we do not comply with Kropfitsch & Schouppé (1953) that the species "*orthostachys*" is a younger synonym of *Th. reticulata* (Blainville).

However, detailed studies of surfaces of *Thamnopora orthostachys* from two separate outcrops (Marmorbruch and Fuchsenloch) yielded in several specimens concentrically wrinkled structures at the bottom of some corallites. Concentric growth lines on these more or less horizontal, tabulae-like elements were obviously formed by centripetal growth from the walls to a central junction area. Septal spines are not affected since they are rather rare in *Th. orthostachys*. Structures like these which apparently sealed off individual corallites have been described by a number of authors since the mid 70ties of the 19th century as "pseudopercula".

Pseudopercula known especially from massive (e.g. *Favosites*, *Alveolites*) or simple to branching (e.g. *Crenulipora*) tabulate corals are calcareous membranes closing the apertures of certain corallites. The meaning of a polyp that bulkheads itself off the outside world by secreting a theca, was interpreted in various ways (see Nothdurft & Webb 2009 cum lit.).

Distribution of corallites sealed off in our ramose *Thamnopora orthostachys* specimens is neither extensive nor scattered over the coralla. Pseudopercula occur preferentially at the basal parts of branches.

The upper part of the Plabutsch Fm. is characterized by intercalations of red marls and marly limestones. All the specimens exhibiting pseudopercula were collected from these horizons, especially near to the limestone-marl interfaces. Intermittent (high) supply of clayey sediments (causing the marl-limestone intercalations) certainly stressed the corals. The formation of pseudopercula is therefore obviously a reaction of the thamnoporid colonies to protect their tissue in stressed zones. The sealing of portions of the colonies represents a strategy to preserve as much of the soft body as possible under stress conditions. Logically, polyps trapped under a close cover could not scavenge for food, but were able to communicate over the pore system.

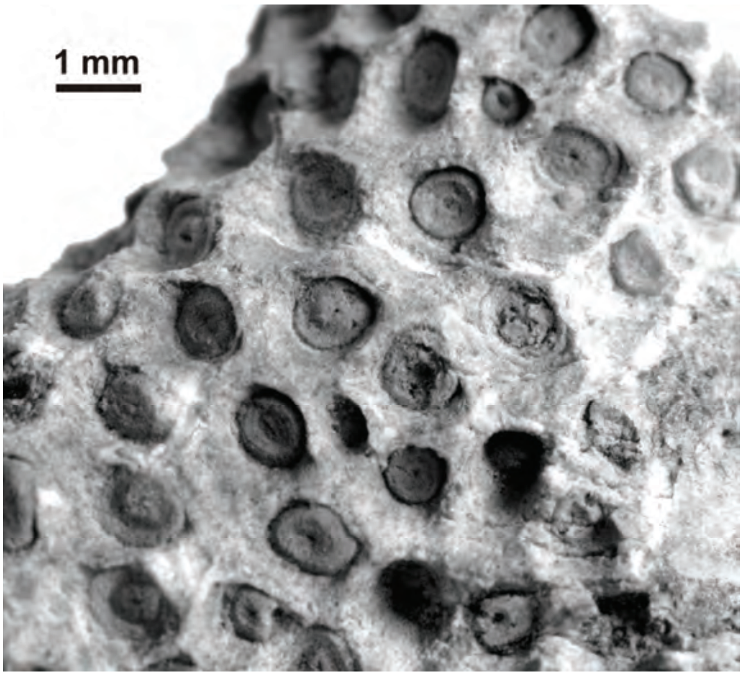

Fig. 1: Surface of *Thamnopora orthostachys* with corallites sealed off by pseudopercula; Marmorbruch, Plabutsch

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Initial growth-stages of a Givetian reef; Kollerkogel Formation, Graz Palaeozoic

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The Graz Palaeozoic (GP) extends over about 1250 km^2 and is isolated from other low metamorphic (from anchizonal to greenschist facies) Palaeozoic occurrences in the Alpine region.

The internal arrangement of the GP shows a subdivision into a basal, an intermediate and an upper nappe group based on lithological similarities, the tectonic position as well as the metamorphic superimposition of successions. This Mid-Cretaceous thrust complex is sealed by Late Cretaceous "Gosau" sediments.

The Upper Nappe System ("Rannach-Nappe"; upper Silurian to Upper Carboniferous) of the GP is characterised by upper Silurian volcanites and marly limestones, Lower to Middle Devonian volcaniclastic rocks, Lower to Middle Devonian siliciclastics and fossil-rich carbonates of near-shore environment followed by the pelagic sequences of late Givetian to Bashkirian age with shallow marine sediments at the top.

In some aspects the Rannach Nappe must be considered to be 'exotic' in its development when compared with other coeval alpine regions. Continuous sedimentation through the Tournaisian to Bashkirian time interval, as well as the lack of Variscan tectonic activities and the missing Permo-Mesozoic cover complicate the integration of the Rannach Facies with other Paleozoic remnants of the Eastern Alps. More likely similarities with the Hungarian Szendrö and Uppony Mountains and the Dinaridic Jadar Block Paleozoic are transparent.

During the Devonian the depositional environment within the Rannach Nappe of the GP changed from a peritidal setting (Pragian to Emsian) with predominant monotonous light grey late diagenetic dolostones, volcaniclastics and pure quartz sandstones, to subtidal (Eifelian) fossiliferous dark marly bioclastic limestones with coral-stromatoporoid-carpets). This phase is terminated by a repetition of tidal flat deposits obviously caused by an eustatic sea level fall. During the Givetian renewed transgression resulted in sequences with sharp (bio)facial contrasts between patch-reefs and monotonous mudstones (Kollerkogel Fm.). During the uppermost Givetian to lower Frasnian the sedimentation of shallow platform carbonates was replaced by micritic cephalopod limestones.

The mentioned Givetian transgression is obviously indicated by litho-facial changes from rauhwacke (cellular dolomite) to micritic limestones. Due to the lack of age-diagnostic fossils – the coral fauna points only to a Givetian age, and rare conodont findings refer only to *varcus* zone but do not permit further age restriction.

Especially the "Hasenstein" section at a steep slope of the Rannach Hill some 20 km north of Graz exhibits spatiotemporal ecological successions with certain community replacements. The latter comprise a basally developed 'reef pioneer settlement' dominated by densely packed stachyodes and auloporids in a black bituminous limestone matrix (*Stachyodes-Aulopora*-community). This well-bedded sequence passes into dark-grey fossil-rich limestones built up by thickets of small branching stromatoporoids (*Amphipora-Stachyodes*-community). This succession is followed by grey bioclastic limestones (*Thamnopora-Amphipora-Actinostroma*-community). A thin horizon (approximately 30–50 cm) with small colonies of the phaceloid rugosan *Thamnophyllum* and subordinate solitary *Mesophyllum* (*Thamnophyllum-Mesophyllum*-community) terminates the 'pioneer sequence', which is overlain by approx. 35 m thick, white and slightly dolomitized massive limestones. The latter contain accumulations of various reef-building organisms (stromatoporoids, rugose and tabulate corals).

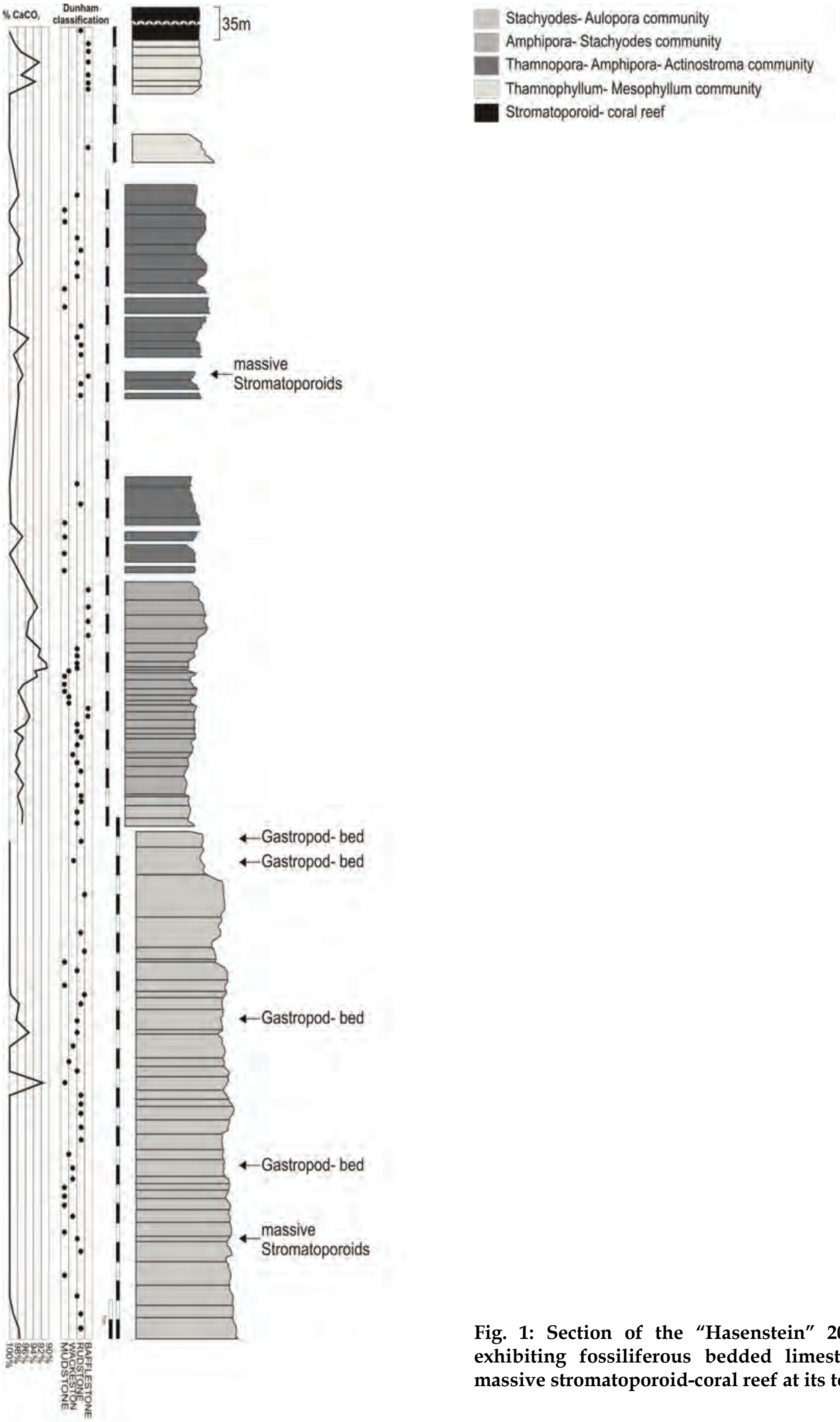

Fig. 1: Section of the "Hasenstein" 20 km north of Graz exhibiting fossiliferous bedded limestones passing into a massive stromatoporoid-coral reef at its top.

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Deep insight into deep-water corals: unique microstructure of micrabaciids

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The skeleton of scleractinian corals consists of two microstructural regions: (i) rapid accretion deposits ("centres of calcification", "early mineralization zone") and (ii) thickening deposits ("fibers", "stereome"). Traditionally, size and arrangement of "centers of calcification" were used as main diagnostic characters of the high-rank scleractinian taxa (Wells 1956). However, combined molecular and microstructural data revealed that equally valuable skeletal characters that supports molecular groupings are thickening deposits. For example, Acroporidae, the most speciose extant scleractinian family have thickening deposits formed as shingle-like units. Longer axes of fibers are aligned within individual bundles and are parallel to the skeletal surface whereas Pocilloporidae representatives have dome-shaped bundles of fibers perpendicular to the surface of the skeleton, showing a microtuberculate pattern on the surface. Thickening deposits in Flabellidae form thin scale-like bundles of fibers arranged quasi-parallel to the septal plane. All scleractinian taxa mentioned above are characterized by distinct types of thickening deposits (Fig. 1; see also Gautret et al. 2000; Stolarski 2003; Nothdurft & Webb 2007), and were recovered as monophyletic in molecular studies. Herein, based on skeletal analysis of the enigmatic group of deep-water micrabaciid corals, we provide further evidence supporting a role of thickening deposits in phylogenetic interpretations.

Micrabaciidae are solitary, azooxanthellate corals living today in the deepest parts of the ocean (up to 5000 m, Cairns 1989). They are known since the Early Cretaceous and attributed to five genera: *Letepsammia* Yabe & Eguchi 1932, *Leptopenus* Moseley 1881, *Stephanophyllia* Michelin 1841, *Rhombopsammia* Owens 1986 and *Micrabacia* Milne-Edwards 1849 (the latter known only from the fossil record). Modern and fossil species have porous, delicate skeleton and unique "bifurcation" of septa and costae. In contrast to other scleractinians, thickening deposits of micrabaciids, regardless of the geographic and bathymetric origin of samples, are composed of irregular meshwork of extremely thin (ca. 100-300 nm) and short (1-2 μm) fibres that are organized into small, chip-like bundles forming an irregular criss-cross pattern on the skeletal surface. Also, unlike other scleractinians, the growth layers in micrabaciid thickening skeleton are not well discernible.

The herein described microstructural pattern of thickening deposits is unique among corals and supports the monophyletic status of micrabaciids (Kitahara et al. 2010). In some geochemical proposals, formation of the fibrous part of the skeleton is considered to be analogous to inorganic precipitation of $CaCO_3$. In contrast to this interpretation, the consistent occurrence of distinct microstructural patterns of thickening deposits in different scleractinian clades (acroporids, pocilloporids, flabellids, micrabaciids), favours the organic matrix-mediated model of coral mineralization. According to it, these are macromolecules that form under a tight genetic control, and which are responsible for nucleation, spatial delineation and organization of basic microstructural units.

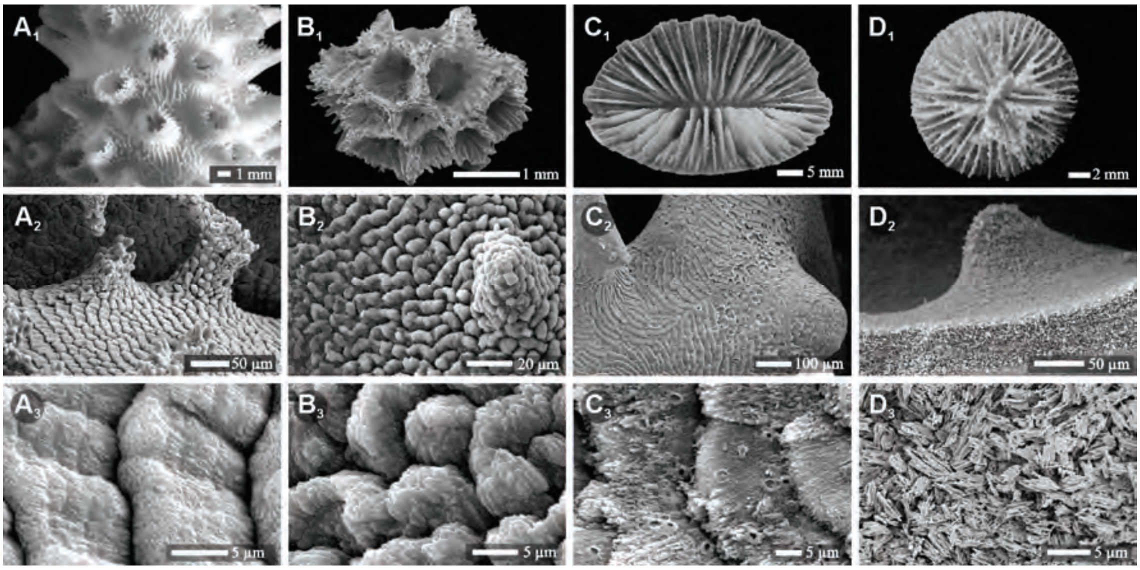

Fig. 1: Distinct types of thickening deposits in representatives of some monophyletic scleractinian families. A. Acroporidae (*Acropora cervicornis* (Lamarck 1816)): A_1 side view of the branch, A_2 SEM micrograph of septal surfaces showing shingle-like bundles of fibers (A_3 -enlargement); B. Pocilloporidae (*Pocillopora damicornis* (Linnaeus, 1758): B_1 fragment of the branch, B_2 SEM micrograph of a septal surface covered with microtuberculate texture (B_3 - enlargement); C. Flabellidae (*Flabellum chunii* Marenzeller 1904): C_1 Distal view of a coralum, C_2 septum covered with fibers arranged in thin scale-like units (C_3 - enlargement); D. Micrabaciidae (*Stephanophyllia complicata* Moseley 1876): D_1 Distal view of a coralum, D_2 SEM micrograph of thickening deposits composed of irregular meshwork of small fiber bundles, D_3 FESEM close-up on the bundles formed by extremely thin and short parallel fibers.

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Dorothy Hill, A.C., C.B.E.

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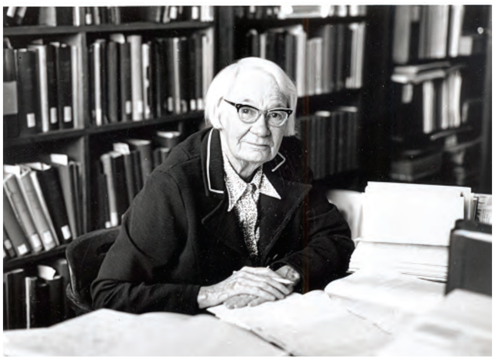

Dorothy HILL was born in Brisbane on 10 September 1907, educated at Brisbane Girls Grammar School and University of Queensland. She completed her PhD at Cambridge University in 1932, researching there until 1937 as a Fellow of Newnham College. In that year, she returned to the University of Queensland where she was to spend the rest of her career except for war service with the WRANS (1942-1945). Her brilliant career was marked by inspiring lecturing and teaching, outstanding palaeontological, stratigraphical and geological research, very skilled academic administration and leadership, and generous collaboration with government geological surveys, and with the petroleum, coal and mineral industries. She retired in 1973 but continued her research until a few years before her death on 23 April 1997.

This contribution focuses on her coral and archeocyathid research, and her contribution to our Association for the Study of Fossil Cnidaria and Porifera. Her coral studies started with the collection of a Carboniferous fauna from Mundubbera, 300 km northwest of Brisbane, when visiting a friend following her graduation. She began a detailed study of this fauna in Brisbane.

The award of a University of Queensland Foundation Travelling Scholarship in 1930, enabled her to undertake a PhD at University of Cambridge combining this work with a study of Carboniferous corals of Scotland. Her time in Cambridge greatly influenced her future career. Her supervisor G.L. ELLES, together with O.H.B. BULMAN, both graptolite workers, demonstrated how detailed morphological studies through well-controlled palaeontological sequences could provide refined stratigraphic results. Her coral work was greatly influenced by Stanley SMITH of Bristol University, the foremost coral specialist at the time, by fostering her interest in the skeletal structure of corals and the relationship of structural elements and soft tissue. W.D. LANG of the British Museum (Natural History) whose taxonomic expertise was outstanding inculcated in her the necessity for taxonomic rigor. H. Deighton THOMAS also of the BM(NH) introduced her to the value of extensive, well-preserved and curated collections. She also realized that good libraries were essential for quality scientific research. By the time she left the UK, she had published or had accepted for publication: a review of the terminology for describing the coral skeleton; her initial paper describing the microstructure of corals (Silurian cystimorphs); nine taxonomic papers on Silurian, Devonian, Carboniferous and Permian British and Australian faunas including her major monograph on the Carboniferous corals of Scotland.

Returning to Australia in 1937, she gained one of the new Council for Scientific and Industrial Research grants and embarked on a study of the coral-bearing Palaeozoic limestones of Australia. She found the literature, collections and academic standards in Australia wanting. She built a library of Palaeozoic coral literature second to none, established well-curated collections amassing over 10,000 thin-sections, and strove to improve academic standards all her life. She also found that much geological mapping was needed in Australia before the study of stratigraphy and facies could match the quality of such studies in UK and Europe. To this end she collaborated with the commonwealth and state geological surveys in their regional mapping programs.

She published 31 taxonomic papers on Australian Palaeozoic coral faunas aiming to provide the stratigraphic framework for unraveling Australia's geological history. In 1943, the first (*A re-interpretation of the Australian Palaeozoic record, based on a study of the rugose corals)* of eight papers detailing the stratigraphic sequences of the faunas was published. She also continued her work on coral microstructure and in 1943 published with W.H. BRYAN the seminal paper on skeletal growth of crystals forming the coral skeleton. This was progressed later using SEM techniques.

The quality of her work, her understanding of the structure of the coral skeleton and her knowledge of the world-wide stratigraphic distribution of Palaeozoic corals were soon recognized, prompting overseas workers to send her their collections for study. She published 15 taxonomic papers on material from other countries and several on regional stratigraphic and palaeobiogeographic distributions. The attention led R.C. MOORE, editor of the *Treatise of invertebrate paleontology*, to invite her to contribute to the Coelentrata volume. A co-contributor to the volume, John WELLS of Cornell University, visited Brisbane on study leave in 1954. He was a Mesozoic to Holocene scleractinian coral specialist, and the interaction of these two great minds coming from different backgrounds made a great advance in the understanding of coral palaeontology and enhanced the volume greatly when published in 1956. In 1981, Dorothy HILL produced a two volume supplement revising the Palaeozoic corals. The latter was not just a compilation of the world literature but represented the essence of her entire career.

With the discovery of archaeocyathid faunas in Antarctica, Dorothy began interpreting the structure of their skeletons using thin sections, as she had for corals. She published two small taxonomic papers and a major monograph on these Antarctic faunas, a review of the whole group in *Biological Reviews* in 1964, and a revision of the treatise Archaeocyatha volume in 1972.

On retirement, Dorothy HILL had completed three and a half volumes of the internationally acclaimed *Treatise of invertebrate paleontology*, more than any other contributor to that series.

Dorothy was deeply involved throughout her career with the scientific study of the Great Barrier Reef. By 1937, H.C. RICHARDS had drilled two holes through the reef and she became involved in the thorough analysis of the cores, publishing the results in 1942. As secretary of the Great Barrier Reef Committee she was very effective in seeking funds for the establishment of a research station on Heron Island. 1952 saw the completion of a small laboratory which was to evolve into an internationally renowned facility run today by the University of Queensland. She was involved in the establishment of the Australian Institute of Marine Sciences in Townsville. In 1970, she wrote a summary article on the research carried out on the Great Barrier Reef to that date, and later two articles detailing the history of the Great Barrier Reef Committee.

At the International Symposium on the Study of Fossil Corals held in Novosibirsk in 1971, Dorothy HILL was elected inaugural President of the International Association for the Study of Fossil Cnidaria and Porifera with its primary tasks of establishing a newsletter and organizing four-yearly symposia. She delivered an inspiring keynote address at the 1988 Brisbane Symposium outlining future avenues for fossil coral and sponge research. Dorothy was a respected mentor to many of our Association. R.K. JULL and I were her only PhD students to study Palaeozoic corals but most students who studied corals in Australia benefited from her lively discussion and constructive criticism, and access to her library and collections. For similar reasons, many overseas specialists visited Brisbane, some spending their study leave at the University. She carried on a prolific correspondence with specialists all around the world.

Throughout her career she received numerous civil, scientific and academic awards. Three honorific volumes were published by her students and colleagues. The Science, Engineering and Architecture Library of the University bears her name, as do postgraduate and postdoctoral scholarships offered by the University and the Australian Academy of Science, respectively. The University also established the Dorothy Hill Chair of Palaeontology and Stratigraphy in recognition of her outstanding achievements and her service to the University.

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Origin of the Great Barrier Reef

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The Great Barrier Reef (GBR) is by far the largest reef province of today's tropical seas and is World Heritage listed. It consists of more than 3,500 reefs scattered over a quarter of a million square kilometres off the east coast of Queensland, stretching 2,300 km from Lady Elliot Island in the south to Torres Strait in the north, and varying from 350 km wide off Rockhampton to 30 km wide off Cooktown. Less than ten percent of the province is actual coral reef. The reefs are very variable in size, shape and topography, and appear randomly distributed. Thus any explanation of the origin of the GBR must explain why such a great reef province is developed on the northeast coast of the Australian continent, what determines the reefs' morphology, and what controls their distribution. We are part of the way to understanding these and this contribution gives an historical perspective of our understanding of these to date.

Although probably sighted by early Portuguese, Spanish, Dutch and French navigators before 1770, it was Captain James Cook's description and charts of the reef in his journal of his voyage across the southern oceans that afforded the fascination with the GBR that followed. Cook saw it as a navigational hazard describing it as: 'a wall of Coral Rock rising all most perpendicular out of the unfathomable Ocean . . . the large waves of vast Ocean meeting with so sudden a resistance make a most terrible surf breaking mountains high'. With settlement of Australia in 1788, charting of the coastline became essential and this included the reefs of the GBR; many of these expeditions carried naturalists. The first geologists to visit the reef was J.B. Jukes onboard the *'Fly'* and in his two volume narrative of the voyage published in1847, provided the first interpretation of the structure of the GBR (Fig. 1).

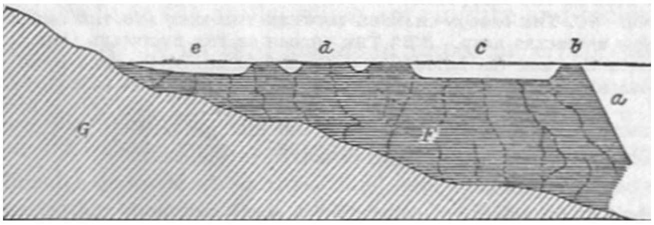

Fig. 1: Cross-section of GBR from Jukes (1847)

The assumption was that the GBR was very thick and old, formed by subsidence and thus supporting Charles Darwin's new theory on reef development. The only geological observations over the next 70 years were focused on the *coral reef problem*, W. Saville-Kent supporting Darwin and A. Agassiz taking the counter-view. T.W.E. David although deeply involved in the *coral reef problem* with the drilling of Funifuti Atoll did not contribute significantly to the geological understanding of the GBR.

Following the end of WW1, there was a surge in intetrest in the GBR, and H.C. Richards, professor of geology at the University of Queensland established the Great Barrier Reef Committee with the goal of encouraging scientific research on the GBR. Richard's aim was to understand the evolution of the reef, and to that end, planned to drill several holes across its northern, central and southern parts. By 1937, two wells were completed, one in the north on Michaelmas Cay off Cairns and the other at Heron Island in the south; results were published by Richards & Hill (1942). In 1957, a petroleum exploration well was drilled on Wreck Island to the north of Heron Island. The three wells had similar stratigraphies with 100 – 150m of reefal material overlying a thinner sequence of foraminiferal carbonates and silicastics, and in turn a much thicker sequence of marine and terresrial shelf sediments. Foraminiferal studies of the cores suggested that the lowest part of reefal material was Pliocene. The Heron Island core was re-examined by P.G. Flood, and he distinguish six units within the reefal section, separated by disconformities with the Pliocene/Pleistocene boundary within the oldest unit (Flood 1993). If each unit is interpreted as the erosional remnant of reefal development during successive high stands, Heron Reef is in the order of 500ka old, the basal reefal unit corresponding to high stand of isotope stage 13.

The 1960s saw W.G.H. Maxwell of the University of Queensland herald another period of geological investigation of the GBR. With access to areal photography and better hydrographic maps, his *Atlas of the Great Barrier Reef* illustrated much of his work including the distribution of reefs, their great variation in zonation and morphology, and the distribution of surface sediments throughout the GBR. Like R.W. Fairbridge he saw growth of reefs dependent on the hydrological regime. He suggested that reefal development was relatively recent (<15ka).

Geophysical investigations and shallow drilling of the reefs and inter-reef areas by oil companies, government agencies, universities and various consortia have provided a better understanding of the stratigraphy of reefs and their foundations. The GBR is underlain by a faulted basement of Palaeozoic and Mesozoic rocks overlain by a Late Cretaceous-Cainozoic sequence consisting of five depositional sequences illustrated by a section across the central part of the shelf by Symonds et al. (1983). The shallow seismic and coring provided excellent resolution of the topmost sequence which includes the GBR, giving detailed evidence of facies development under high and low sea-level conditions. Symonds et al. (1983) showed that the reefs were commonly initiated on siliclastic fluviatile and deltaic low sea-level foundations and their distribution somewhat controlled by the inner- to middle-shelf hinge and the eastern boundary faults of the outer shelf. They also considered the reef to be no older than Pleistocene except for some drowned reefs on the continental slope. By tying this seismic information into dating of cores of three holes drilled into the shelf slope off Cairns during Leg 133 of the Ocean Drilling Program, the shelf-edge reefs were thought to be no older than 500 ka (Davies 1991).

In 1995, an International Consortium for Great Barrier Reef Drilling lead by P.J. Davies drilled Ribbon 5 and Boulder reefs off Cooktown. The former was a shelf edge reef and its core consists of three sections: a lower (210 to 158 m) of non-reefal limestones with scattered coral clasts; a rhodolith-rich mid-section (158 to 96m) with two horizons of coral framework at (138 – 131 m and 130 -117 m); and an upper 96 m reefal section in which five units and several erosion surfaces and palaeosols were distinguished. The lower section is interpreted as deep water with the coral clasts in debris flows; the middle section is probably a transitional stage of intermittent reef development; and the upper sequence is the main reefal development stage. The inner shelf core consisted of an upper section (0-36 m) comprised of four reefal units and a lower (36-86 m) siliclastic sequence with two thin, coral-bearing units. Ages from various dating methods are problematic. The best estimates suggest carbonate production in the outer shelf commenced 770ka ago and on the inner shelf much later, the base of the transitional section is somewhere between 600 and 520ka, and the main reefal section began 365-450ka covering isotopic stages 11, 9, 7, 5, with unit 1 representing post-7700 growth (Braithwaite et al. 2004). No direct correlation with the Heron core can be made.

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Five years of *Corallosphere:* A progress report

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Corallosphere (http://corallosphere.org) is a web-based tool that we are using to compile a genus-level taxonomic revision of the Scleractinia. The section on Scleractinia in the *Treatise of Invertebrate Paleontology* (WELLS 1956) and the *Traité de zoologie* (CHEVALIER & BEAUVAIS 1987) are currently the main authoritative references on the morphology, taxonomy, ecology and systematics of both extinct and extant scleractinians. However, progress continues in coral systematics and taxonomy, and continued revision of taxonomic treatises is required. A large obstacle to producing these revisions is the work involved to produce a synthesis of large volumes of information extracted from sources such as existing taxonomic publications, museum collections, web-based data sets, and particularly the cumulative expertise of the community of experienced taxonomists. Our approach has been to work as a team, with individual authors contributing information for subsets of taxa. *Corallosphere* has been developed to facilitate the assembly of disparate data required by authors and to publish working drafts of taxonomic summaries so that the information is accessible before the final publication of the *Treatise* volume. The main areas covered in *Corallosphere* include text descriptions for diagnoses of valid genera, as well as tools for managing taxonomic synonymies, images, a bibliography, and an illustrated glossary of morphological terms. A flexible work-flow allows registered users with variable levels of access to compile, edit, review, and annotate generic diagnoses directly from the internet. The ultimate aim is to produce a system that will facilitate the rapid publication of the next version of the *Treatise* based on community-wide consensus, and help remove the taxonomic impediment that slows progress towards an increased understanding of the biology, ecology, and evolutionary history of the Scleractinia.

Since *Corallosphere.org* was first deployed in 2006, our team of nine editors and 25 authors have contributed tens of thousands of nuggets of data to the system. As of April 2011, 1831 taxa are listed in *Corallosphere.org*, including 1651 genera and subgenera that are the main focus of the revision (Fig. 1). Most genera are considered available for use (93%), and two-thirds of genera are available and valid. Completeness of information within genera varies according to the information type. Overall, over 60% of genera and subgenera are currently associated with diagnosis, descriptions, and information about types. The proportion of taxa with information about classification of genera and subgenera is less (around 50%) and distribution data is provided for approximately 40% of the genera and subgenera. In contrast, relatively few taxa are associated with images of type specimens, with only 21.9% of valid and available names for genera and subgenera associated with images. The relatively low number of images contributed to date is mostly likely a result of difficulty in finding type material and acquiring high quality illustrations. In many cases the specimens have been lost or are reposited in institutions without strong support for providing images of type material. Overall, the system contains identity of 622 type specimens from 65 repositories, but images are only included for 261 taxa.

During the XI Symposium on Fossil Cnidaria and Porifera, the *Corallosphere* project members will meet to discuss our progress and plans for future development. In particular, we plan to consider the following areas:

1. Contributors: strategies for recruiting new contributors, and encouraging existing contributors

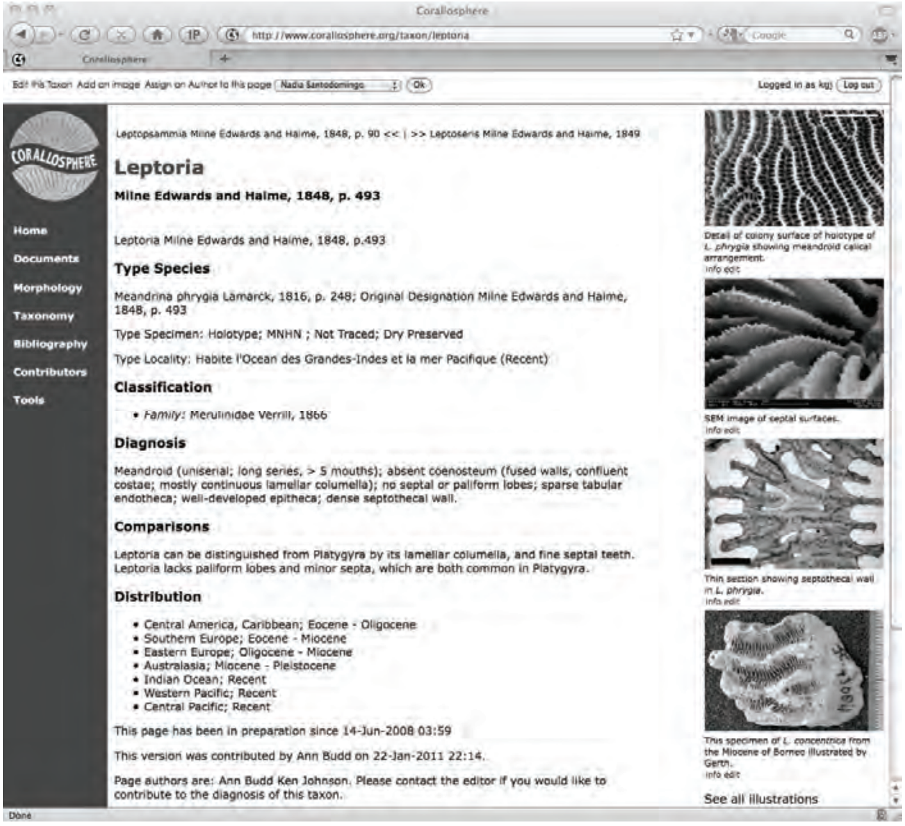
2. Content: strategies for increasing the rate of addition of new content, in particular images of type material and an atlas of morphological terms; strategies for reviewing and increasing the quality of existing content.

3. Infrastructure: discussion of priorities for future development of the *Corallosphere* infrastructure, include improvments to the user interface, establishing links to other biodiversity informatics project (for example Encyclopedia of Life, World Registry of Marine Species, Global Names Index, Paleobiology

Database, or links to specimen repositories), increased functionality of an online peer-review system, extension of the system to species-level name, and potential for migration to alternative platforms.

	Number of Taxa	Types	Diagnosis	Images	Classification	Distribution
All Taxa	1831	1127 (0.616)	1243 (0.679)	261 (0.143)	862 (0.471)	676 (0.369)
Genera + Subgenera	1651	1125 (0.681)	1124 (0.681)	261 (0.158)	856 (0.518)	676 (0.409)
Valid Genera + Subgenera	1113	712 (0.64)	712 (0.64)	244 (0.219)	566 (0.509)	465 (0.418)

Fig 1.: Completeness of taxonomic information in *corallosphere.org*. Numbers of taxa for which information has been contributed for several categories of information. Proportions of completed taxa are indicated in parentheses. The numbers are tabulated for all taxa, for all genera and subgenera, and for all genera and subgenera currently considered to be available and valid.



Leptopsammia Milne Edwards and Haime, 1848, p. 90 << | >> Leptoseris Milne Edwards and Haime, 1849

Leptoria

Milne Edwards and Haime, 1848, p. 493

Leptoria Milne Edwards and Haime, 1848, p.493

Type Species

Meandrina phrygia Lamarck, 1816, p. 248; Original Designation Milne Edwards and Haime, 1848, p. 493

Type Specimen: Holotype; MNHN ; Not Traced; Dry Preserved

Type Locality: Habite l'Ocean des Grandes-Indes et la mer Pacifique (Recent)

Classification

- *Family:* Merulinidae Verrill, 1866

Diagnosis

Meandroid (uniserial; long series, > 5 mouths); absent coenosteum (fused walls, confluent costae; mostly continuous lamellar columella); no septal or paliform lobes; sparse tabular endotheca; well-developed epitheca; dense septothecal wall.

Comparisons

Leptoria can be distinguished from Platygyra by its lamellar columella, and fine septal teeth. Leptoria lacks paliform lobes and minor septa, which are both common in Platygyra.

Distribution

- Central America, Caribbean; Eocene - Oligocene
- Southern Europe; Eocene - Miocene
- Eastern Europe; Oligocene - Miocene
- Australasia; Miocene - Pleistocene
- Indian Ocean; Recent
- Western Pacific; Recent
- Central Pacific; Recent

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This version was contributed by Ann Budd on 22-Jan-2011 22:14.

Page authors are: Ann Budd Ken Johnson. Please contact the editor if you would like to contribute to the diagnosis of this taxon.

Detail of colony surface of holotype of *L. phrygia* showing meandroid calical arrangement.
info edit

SEM image of septal surfaces.
info edit

Thin section showing septothecal wall in *L. phrygia*.
info edit

This specimen of *L. concentrica* from the Miocene of Borneo illustrated by Gerth.
info edit

See all illustrations

Fig. 2: A typical page from *Corallosphere.org* showing information available for the genus *Leptoria* MILNE-EDWARDS and HAIME 1848.

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Southeast Asian and Caribbean Cenozoic Reef-coral diversity and the importance of large new collections

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Analysis of specimen-based compilations of reef-coral species occurrences indicate widely differing Late Oligocene to Recent histories of coral reef ecosystems in Southeast Asia and the Caribbean. Caribbean reef ecosystems were altered by regional extinction during the Oligocene/Miocene and the Pliocene/Pleistocene (BUDD 2000; KLAUS et al. 2011). The Oligocene/Miocene extinction was associated with the collapse of reef building in the region, but contrary to expectations, the Pliocene/Pleistocene extinction is associated with regional reef recovery (JOHNSON et al. 2008). The depauperate extant Caribbean biota includes survivors of this extinction, and very few new species have appeared since.

Contrary to the Caribbean record, SE Asian reef ecosystems were apparently not strongly altered by extinction events (Fig. 1). In this study, we make use of the collections of fossil corals from the region held by NCB Naturalis (LELOUX & RENEMA 2007) that were mainly collected as part of geological resource mapping in modern-day Indonesia and Malaysia during the late nineteenth and earliest twentieth centuries. The NCB collections include coral collections from 210 localities, with a total 1459 specimens, 1320 of which have been identified to species-level during the past century. We have attempted to bring species-level identifications up to date through examination of material and via species-level taxonomic revision, resulting in a reduction of species names applied from 305 to 271. However, this taxonomic revision had limited impact on the observed pattern of taxonomic turnover, suggesting that the observed pattern is in part controlled by uneven sampling intensity.

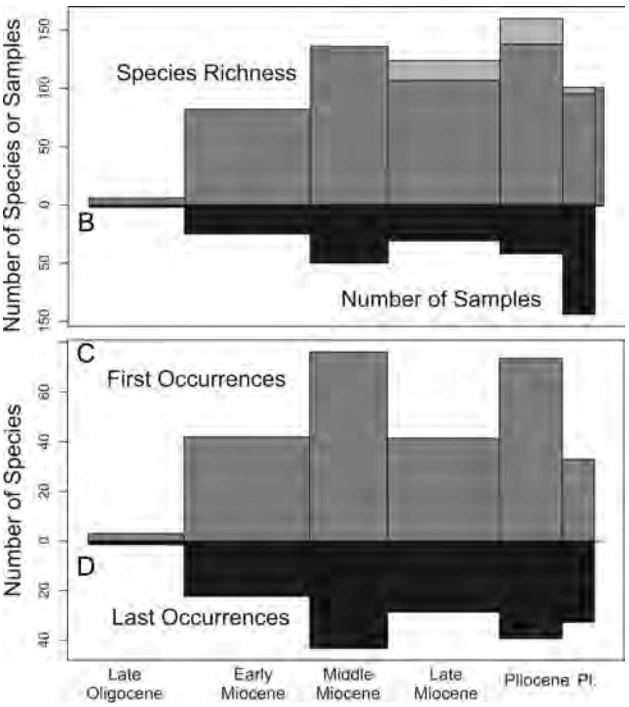

Fig. 1: Turnover rates for reef-coral species estimated using the collections of Cenozoic fossil corals from Indonesia in the collections of NCB Naturalis. Estimates are sub-epochs bins using weighted methods (JOHNSON & JACKSON 2000). A. Species richness including both range-through (light shading) and observed (dark shading) richness within each bin, B. the number of samples with age assignments crossing the bin, C. Numbers of first occurrences, and D. last occurrences within each bin.

Stratigraphic ages of samples were also revised based on examination of associated larger benthic foraminifera (Fig. 2). Revised ages are now available for 79 sampling localities represented in the NCB collections. Age assignments changed in both position of midpoint and precision. Adjustments in midpoint were up to 17 Million years (from an Early Miocene to Pliocene age), but the distribution of changes is symmetrical about zero with a mean of 0.05 million years. As for the taxonomic revision, applying an updated stratigraphy had little effect on the observed pattern of faunal turnover.

These analyses suggest that in Southeast Asia, the Late Oligocene and Early Miocene is an interval of increased diversification (Fig. 2) that coincides with an expansion in coral-reef development in the region (Wilson 2008). No intervals of accelerated extinction have yet been discovered in the Southeast Asian Neogene, suggesting that the high diversity of the regional reef biota is a function of continuous diversification. These results suggest that the regional response of coral reef ecosystems to global environmental change is strongly modulated by regional historical factors. Attempts to understand long-term global patterns of diversity and ecosystem distributions are enhanced by analysis of variation at non-global scales.

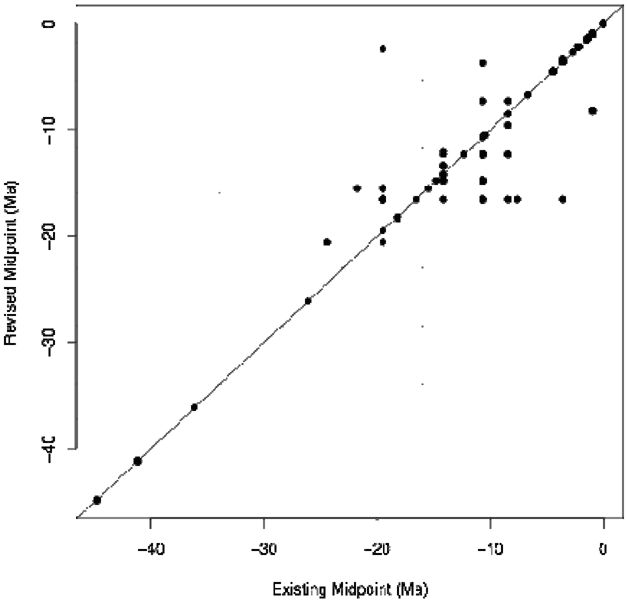

Fig. 2: Changes in the midpoint of ages assigned to coral samples from the collections of NCB Naturalis. New ages obtained after examination of associated larger benthic foraminifera.

New initiatives that are currently in progress include study of large new collections from well localized samples within well-resolved stratigraphic frameworks including a study of a new Late Oligocene biota from Malaysian Borneo (McMonagle et al. 2011) and the Throughflow Marie Curie Initial Training Network, a large-scale collaborative project supported by the European Union to study the Miocene shallow marine ecosystems of East Kalimantan (http://ipaeg.org/throughflow). The throughflow project includes partners from 9 institutions in Europe and Indonesia, including a range of sub-projects designed to independently reconstruct the geological, environmental, and biotic history of the Indonesian Throughflow (ITN) within a well constrained stratigraphic framework. This project has completed two 5-week long field seasons in East Kalimantan and is currently processing samples. Access to this much needed new information will allow for the first time a rigorous analysis of changing patterns of reef-coral diversity in the Neogene of SE Asia.

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Middle Devonian reef facies in the Pistalitau and Khanbandy mountains, Middle Tien Shan

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The different types of biogenic carbonate build-ups and morphologically similar bodies are spread widely in the Uzbek part of Middle Tien Shan, including Khanbandytau and Pistalitau mountains, which probably reflect a former existence of a warm climate, small depth and normal salinity of the Devonian sea in the region. The carbonate units range from a few tens to one thousand five hundred metres in thickness. They are formed of interbedded siltstones with dolomites and clay limestones of the Lower Uchkulach Formation (Eifelian-Lower Givetian), dolomite and dolomitic limestone of the Upper Uchkulach Formation, organogenic limestone of the Khanbandytau Formation and limestone-dolomitic deposits of the Pistalitau Formation (Givetian), organogenic limestone of the Ment, Ustkuruksay and Kolsuyuk formations (Frasnian), and also bedded micritic limestones of the Semizsalpa Formation (Famennian). Among these formations the Pistalitau and Khanbandytau formations are relatively rich in reefal faunas.

The Pistalitau Formation comprises from thin to thick-bedded dark-grey biomicritic and sparitic limestone with singular thin beds of mudstones and lenses of cherts. The Pistalitau reef episode consists of coral and stromatoporoid bioherms and biostromes with a local appearance of mud mounds. This succession is a well exposed, continuous and fossiliferous limestone sequence is located on the southern slopes of the Pistalitau Mountain. The thickness of the Formation is about 150-300 m. The carbonate build-ups are situated at some levels. In most cases there are monotaxonic bioherms and biostromes, combined exclusively by numerous representatives of stromatoporoid genera such as *Actinostroma*, *Idiostroma*, *Syringostroma*, *Hermatostroma*, *Clathrocoilona*, *Anostylostroma*, *Simplexodictyon*, *Stromatopora*, *Trupetostroma*, *Stachyodes*, and *Amphipora*. Stromatoporoids are quite large, have dome-like skeletons and grow on each other. Lagoonal facies are represented by biomicritic limestones and include layers with *Amphypora*, colonies of tabulate and rugose corals and brachiopods. The amphyporal layers are stretched up to a few tens kilometers. (Kim at al. 2007; Salimova & Karimova 2006).

The Khanbandytau Formation is formed of massive light-gray micritic and crinoid limestone with banks of stryngocephalids and amphiporal interbeddings and also massive dolomites with rare stromatoporoid and coral faunas. The deposits compose a watershed part of the Khanbandy Mountain. The thickness of the Formation is about 500 m. Preliminary analysis of existing sedimentological data suggests that the Khanbandytau-Pastalitau reef deposits represent a lateral row of reefogenic facies. The Khanbandytau Formation may represent reef platform and the Pistalitau Formation probably belongs to a back-reef lithofacies. Existing data require further confirmation and research.

The stratigraphic location of these deposits and also their relationships to the surrounding facies suggest that the appearance, distribution and the architecture of carbonate build-ups were governed by eustatic cyclicity with local tectonic movements (Burtman 2006). There are grounds to assume that the Khanbandy-Pistalitau reef deposits were formed in conditions of an island-arc basin (Troitsky 2005).

The research is supported by the Paleontological Society International Research Program - Sepkoski Grants (RUG1-1648-XX-06).

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Masao MINATO (1915-1984)

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The late Professor Masao MINATO was very prominent in geological circles of Japan. He was a founding member of the International Association for the Study of Fossil Cnidaria and Porifera and attended the first (Novosibirsk, 1971) and the second (Paris, 1975) International Symposia of the Association and served as its Vice-President for the first two terms.

MINATO was born in 1915 in Akita Prefecture and graduated from Hokkaido University in Sapporo in 1939. Upon graduation he became an assistant in the Department of Geology and Mineralogy, Hokkaido University, in 1955 he was appointed Professor, and he retired from his position in 1979, and was named Professor Emeritus. Unfortunately, he was killed by an accident at his home on Toubetsu, on April 16, 1984, at the age of 68 years old while still very vigorous and active in his specialty.

MINATO'S area of expertise was remarkably diverse, covering Palaeozoic stratigraphy, palaeontology, Cenozoic tectonism, structural geology, Quaternary geology, archaeology, and applied geology. His main research theme, however, was the tectonic history of northern Japan during the Palaeozoic. And his study of fossil corals was made in conjunction with this main theme. MINATO published no less than 360 scientific articles and books, nearly one third of which are somehow connected with corals, including mention of their geographic and stratigraphic occurrences, correlations based on them; as well as the illustration and description of them, with appropriate discussions, etc.

His major coral works are the Monograph of "Japanese Carboniferous and Permian corals" (1955), "Ontogenetic study of some Silurian corals of Gotland" (1961), and comprehensive treatments of such families of the Rugosa as "Waagenophyllidae" (1965a), "Durhaminidae" (1965b), "Geyerophyllidae" (1975a), and "Pseudopavonidae" (1975b). He created two new families in the Rugosa, and numerous new genera and species. He coined such descriptive terms as "septal grating," "pseudoherringbone dissepiments," and "clinotabulae." The genus *Minatoa* was named for him by FLÜGEL (1974) based on an Iranian Carboniferous coral species.

MINATO was a demanding and inspiring teacher. He trained no fewer than 160 undergraduate geology students during his 40 years time at the university. MINATO used to say, "We should never forget that we owe much to society for what we are. We are fortunate to do things we enjoy doing. So we ought to concentrate and work hard on those things that we do, because we are professionals." Students afterwards kept this spirit in mind, with reference to his daily life and called it "Minatoism."

MINATO had a very intriguing character, an extremely interesting speaker and with an attractive personality. He was gentle, but at times short-tempered. He was kind and warm, although some regarded him as cool. He was knowledgeable with a full stock of topics. His talk was witty, sometimes sarcastic, and always informative.

The late Professor MINATO is still survived by Mrs. Chiyoko MINATO, three children, and is preserved in our memory.

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ARCHAEOCYATHA: Computer-aided identification of genera

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Archaeocyatha are a key-group in different fields of Life and Earth History. Assigned to various phyla, they are now recognized as a class within the Phylum Porifera. The discovery of living aspiculate sponges with a calcified skeleton by scuba divers in sub-marine caves of the Caribbeans in the late seventies, has renewed interest in the biology, phylogeny and ecology of related fossils with previously problematic status, such as Archaeocyatha. Morphological structures shows a great similarity in growth pattern, immune reactions, and types of asexual reproduction (intercalicular budding) in both groups. Presently, the class consists of 6 orders, 120 families and 307 genera.

They are an important group of marine sessile organisms almost entirely Early Cambrian, with some relicts persisting into the Middle and Late Cambrian. Due to counter-clockwise rotation of Gondwana, the only archaeocyaths species of post-Early Cambrian age are found in Antarctica which alone remained in low latitudes.

They provide reliable basis for biozonation in key regions. The first stage subdivision based on Archaeocyatha was established on Siberian Platform. Morocco, Western Europe, Australia, China and Laurentia have provided regional scales.

Reef dwellers, they are necessary substrate for calcified cyanobacteria and cement but they seldom produced a true framework to reefs. The Cambrian system is generally characterized by the absence of any climate indicators useable as constraints for tectonic reconstructions. Then the distribution of Early Cambrian reefs may provide suitable constraints to settle tropical paleolatitudes. Early Cambrian provinces and realms are delimited using an exhaustive compendium of archaeocyathan genera.

Since Archaeocyatha are important Cambrian organisms, it is necessary for scientists dealing with Paleozoic rocks to identify those fossils. But keys, easy to use and adapted even to incomplete specimens, are lacking. Up to now, a knowledge-database in English, carried out with the software XPER^2, is now available online free: http://www.infosyslab.fr/archaeocyatha

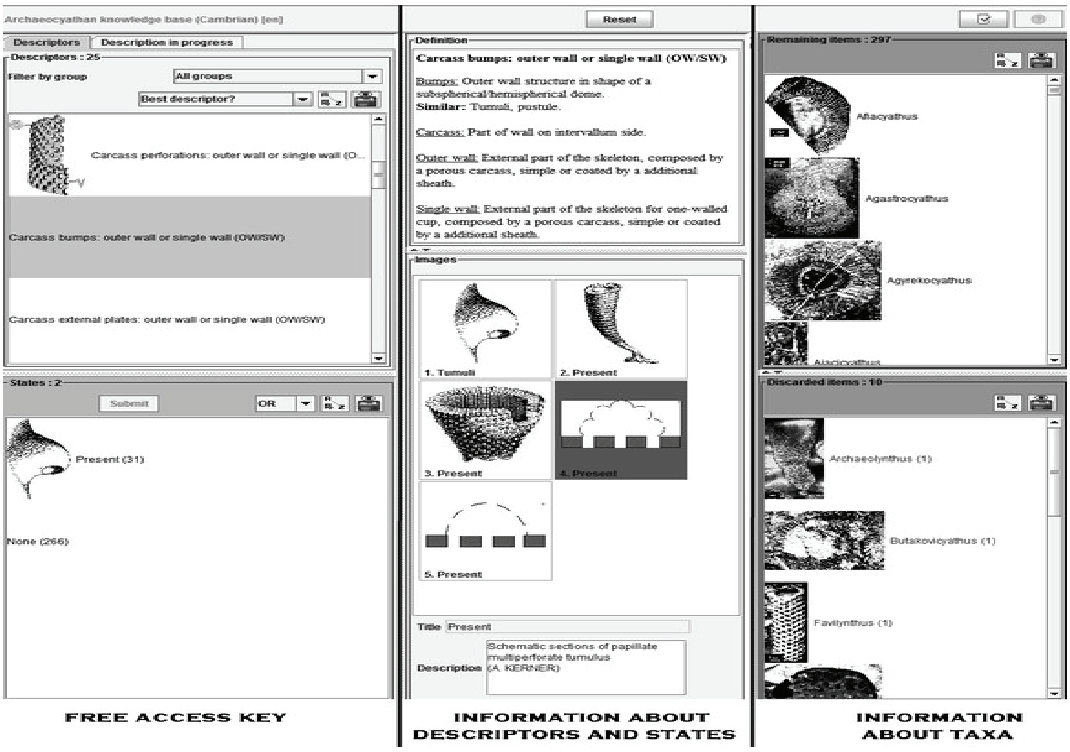
It comprises the 307 valid genera described with 120 descriptors (85 morphological and ontogenetic, 8 stratigraphic and geographic and 27 taxonomic).

This site comprises information about Archaeocyatha (morphology, bibliography…), detailed descriptive cards with figures of type-specimens and eventually additional figures to illustrate morphological details. Information of the database is used to build an identification unit as an interactive key with free access.

Results of this study allow the standardization of currently used descriptors, the definition of a revised terminology and the possibility to identify synonyms. The need of establishing new characters and/or states of characters may appear during the work.

Fig. 1 is an example for the identification module. The interface is composed of three parts: on the left, the list of descriptors to be chosen by the user, at the center, information about the descriptors (definitions, figures) and on the right, the lists of remaining and discarded taxa. Identification consists of the repetition of successive steps: firstly, the choice of a descriptor, secondly, the choice of one or several states of the descriptors and finally a confirmation with the submit button. At each validation, lists of remaining and discarded taxa and list of possible descriptors are updated. Descriptors can be sorted to facilitate identification.

With this interactive key, different lists (i.e. all Australian genera during Atdabanian…) may be rapidly established. Another possibility is to bring into light similarities and differences (i.e. between genera of the same family).



Carcass bumps: outer wall or single wall (OW/SW)

Bumps: Outer wall structure in shape of a subspherical/hemispherical dome.
Similar: Tumuli, pustule.

Carcass: Part of wall on intervallum side.

Outer wall: External part of the skeleton, composed by a porous carcass, simple or coated by a additional sheath.

Single wall: External part of the skeleton for one-walled cup, composed by a porous carcass, simple or coated by a additional sheath.

Title: Present
Description: Schematic sections of papillate multiperforate tumulus (A. KERNER)

Fig. 1: A screen of the free access key for the archaeocyathan genera

In conclusion, this is the first knowledge base enabling identification with free access key, which includes the up to-date descriptions of all valid genera with the figures of their holotype

The first version is available freely online. It will be completed and updated to follow the evolution of scientific researches.

It is a first step to refine descriptions for paleontological studies and to develop tools for analysis descriptors.

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Correlation of Mid-Devonian coral deposits of the Carnic Alps across the Austro-Italian border

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Mid-Devonian strata of the Carnic Alps are distinguished into ten different units representing a neritic to pelagic succession within an area of approx. 240 km^2. Here we mainly concern Middle Devonian coral-rich deposits of the neritic succession assigned to the Spinotti and Kellergrat Reef limestones and distal slope sediments of the Hoher Trieb Formation (Fig. 1).

The Spinotti Limestone is well exposed at the Mount Seewarte and represents the Eifelian to Givetian shallow water platform facies. According to Schönlaub et al. (2004), this formation is divided into four units, bioclastic crinoid limestone (unit A), stromatoporoid debris limestone (unit B), and birdseye limestone (units C and D) in ascending order. Units A and B of the Spinotti Limestone are regarded as Eifelian in age (Kreutzer 1992a,b; Hubmann et al. 2003). Although Unit A, at the base of the formation, yields abundant and well preserved tabulate and rugose corals, they have not been studied in detail yet. The birdseye limestone of units C and D yields distinctive intervals of branched stromatoporoids (*Amphipora*) which are succeded by dolomitic beds rich in brachiopods, that, following Schönlaub et al. (2004), might already indicate Givetian age. Near Costone Stella, *Amphipora*-rich horizons (generally called *Amphipora* Limestone) are interfingering with birdseye limestone. Apart from stromatoporoids, these horizons include solitary rugose corals (Schönlaub et al. 2004). That unit is continuously exposed towards the south side of Mount Hohe Warte (track #143a) where it is succeded by the Kellergrat Reef Limestone. At Forcella Monumenz near the Marinelli Refuge (Fig. 1.1), the massive limestone is unconformably overlain by Carboniferous sediments of the Hochwipfel Formation. Approx. 185 meters below the top, single broken specimens of *Thamnopora* (Fig. 2.1) are found together with other tabulate corals, high trochospiral gastropods and brachiopods. Near the top of the Devonian limestone *Amphipora* is observed (Fig. 2.2) just before the first lithoclastic breccias appear. Conodonts from those breccias indicate already an early Carboniferous age. Unfortunately, the complex tectonic overprint in this area conceal the original depositional relations, in particular at the top of the massive limestone with the Hochwipfel Formation and in correspondence of a large limestone block at Cra. Val di Collina (Fig. 1.2: abandoned quarry at trail #149). Within the limestones of the abandoned quarry abundant reef organisms are found that belong to the Kellergrat Reef Limestone (Figs. 2.3, 2.4). Ten rugosan species belonging to nine genera are described from this limestone (Oekentorp-Küster & Oekentorp 1992; Flügel & Hubmann 1994). They are *Favistella* (*Dendrostella*) *trigemme*, *Battersbyia* sp., *Acanthophyllum concavum*, *Acanthophyllum* sp., *Grypophyllum* sp., *Stringophyllum* sp., *Cyathophyllum*? *bathycalyx*, *Columnaria* sp., *Alaiophyllum jarushevskyi*, and *Temnophyllum* sp. cf. *T. latum*. Tabulate corals consisting of 13 species in 8 genera are reported e.g. by Vinassa de Regny (1918), Heritsch (1943) and Flügel (1956): *Favosites fidelis fidelis*, *F. forojuliensis*, *F. forojuliensis pinnatus*, *Pacypora coralloides*, *Striatopora major*, *Alveolites collinensis*, *A. crinalis*, *Caliapora*? *julica*, *Squameoalveolites* sp., *Coenites carnicus*, *C. mariae*, *C. polonica* and *Plasmopora carnica*. The Kellergrat Reef Limestone also yields *Amphipora rudis*, which is considered to indicate a Givetian to Frasnian age (compare Hubmann et al. 2004).

A similar succession is observed in the Cason di Lanza area at Mt. Zermula, Italy (Figs. 1.3, 1.4). Here *Amphipora* Limestone (Figs. 2.5, 2.6) and Devonian carbonate platform sediments, which probably correspond to the Kellergrat Reef Limestone, are exposed. This Devonian carbonate platform is overlain in places by Famennian-Tournaisian Clymeniae limestones. The succession is unconformably capped by siliciclastic deposits of the Hochwipfel Formation. The Carboniferous unit is thrusted on top of a deeper marine Upper Ordovician-Upper Devonian sequence, which includes deposits of the Hoher Trieb Formation (Eifelian/Givetian in age) that typically consists of several limestone breccia levels bearing silicified corals (Figs. 2.7, 2.8). In the Carnic Alps such horizons with silicified corals are generally found in the distal slope facies. In literature these corals are reported from the "Bank mit verkieselten Korallen" which is considered to be Givetian? in age (Flügel & Hubmann 1994; Hubmann 1995). Following corals are described. Rugosa: *Cystiphyllum*? *geyeri*, *Grewingkia*? *carnica*, *Barrandeophyllum carnicum*, *Entelophyllum articulatum*, *Entelophyllum*? *alpinum*, *Pycnactis mitratum*, *Sociophyllum torosum*, *Cyathophyllum*? *taramelli*; Tabulata: *Caliapora heritschi*, *Caliapora*? *carnica*, *Favosites forbesi forbesi*, *F. thildae*.

Our preliminary study revealed that the conodonts obtained from the breccia levels bearing the silicified corals at Lanza indicate not exclusively Givetian but also Eifelian age (*kock. kockelianus* to Lower *varcus* conodont zones). This shows that the silicified corals were accumulated as re-deposited material derived from either Eifelian or Givetian reefal limestone of the carbonate platform. Silicified coral taxa discussed by Flügel & Hubmann (1994) and Hubmann (1995) seem to be different from those of Givetian age reported from the Kellergrat Reef Limestone. Comprehensive study in future should help to clarify the relation of Middle Devonian coral species obtained from neritic and pelagic strata of the Carnic Alps.

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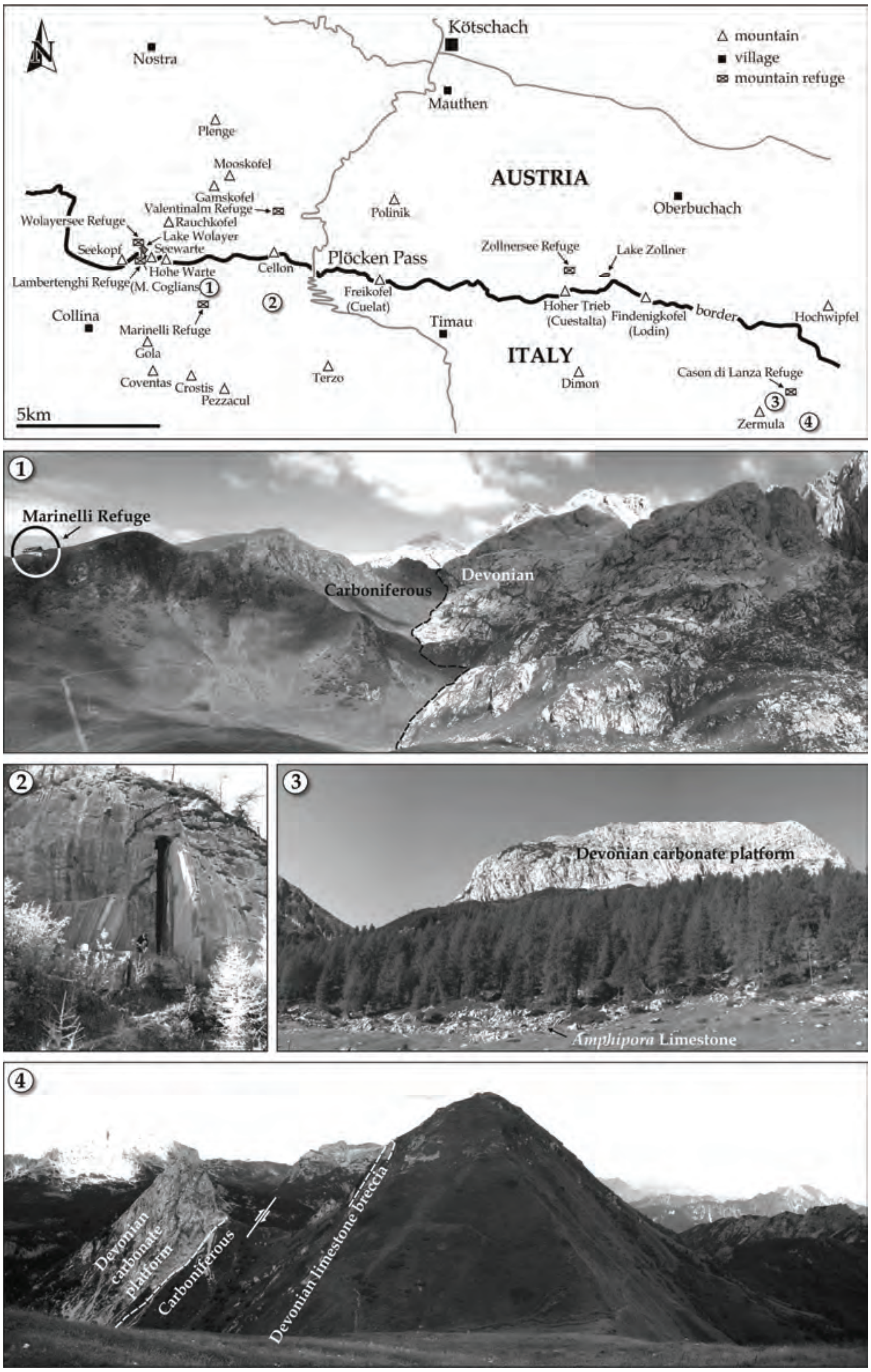

Fig. 1: Map of the Carnic Alps with four localities indicated that represent Middle Devonian coral bearing units. (1) Unbedded limestone of the Devonian carbonate platform succeeded by Hochwipfel Formation (Carboniferous) at Forc. Monumenz near Marinelli Refuge, (2) Kellergrat Reef Limestone of the abandoned quarry at the trail #149 to Marinelli Refuge, (3) Amphipora Limestone outcropping in the meadow and wood below the northern wall of the Devonian carbonate platform of Mount Zermula, Lanza, (4) View of the Devonian carbonate platform succeeded by the Hochwipfel Formation which is bounded by fault with the Devonian limestone breccia levels of the Hoher Trieb Formation.

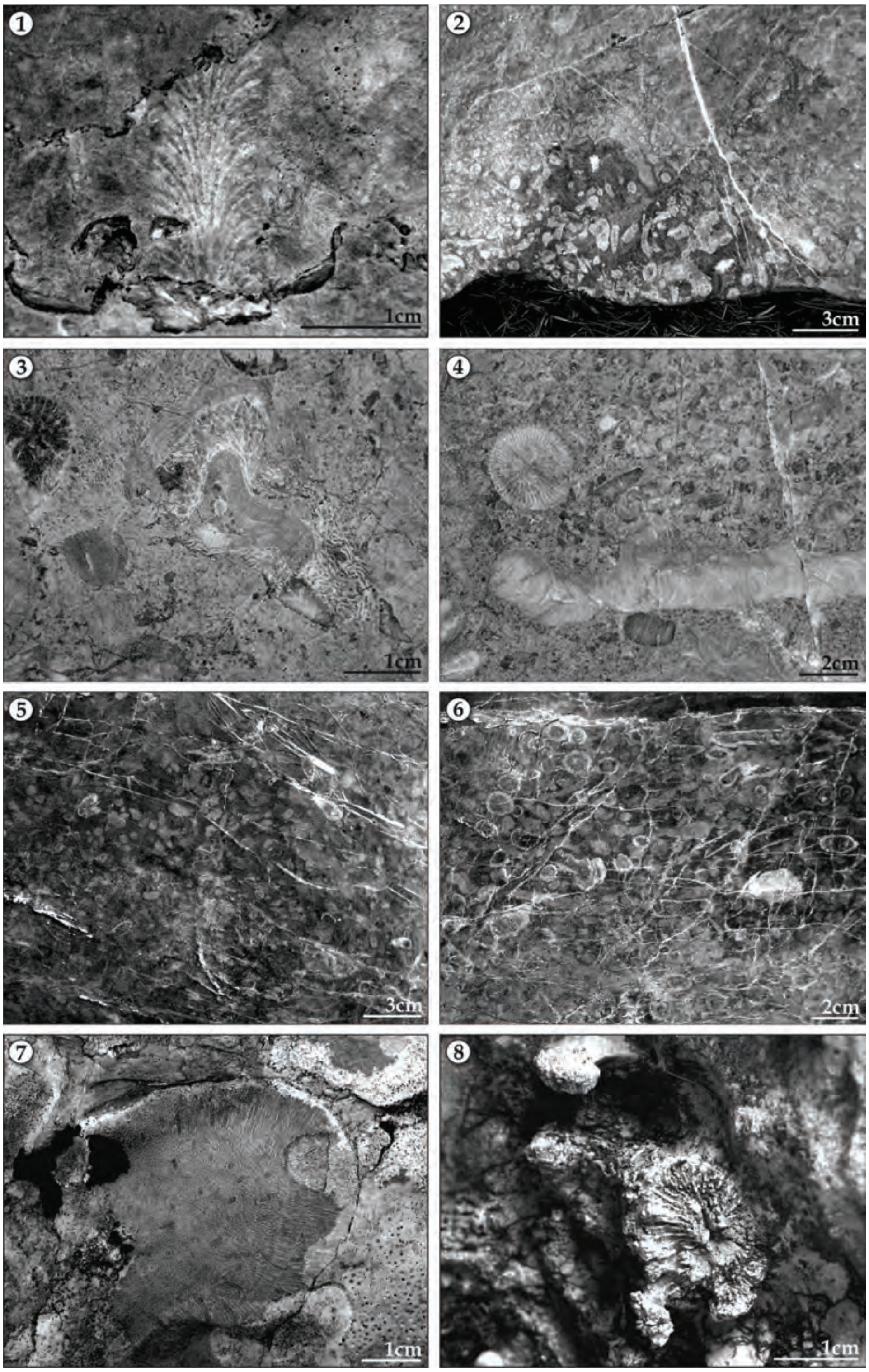

Fig. 2: (1) Within the massive limestone single specimens of *Thamnopora* are observed along trail #143 to Mount Hohe Warte, (2) Amphipora Limestone (photo was taken at Forc. Monumenz, near trail #143, north of Marinelli Refuge), (3, 4) *Alveolites*, rugose corals and branching stromatoporoids (both abandoned quarry at the trail #149 to Marinelli Refuge), (5, 6) Beds with *Amphipora* are alternating with rugose coral biostromes (Amphipora Limestone along the base of the northern wall of Mount Zermula at Lanza), (7, 8) Silicified tabulate (e.g. *Heliolites*) and rugose corals from limestone breccia levels of the Hoher Trieb Formation at Cadin di Lanza Parete between Zuc della Guardia and Mount Pizzul, Lanza.

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Barremian–Aptian coral facies from Romania

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Barremian–Aptian carbonate platforms occur in several geotectonic units in Romania: Eastern and Southern Carpathians, Apuseni Mts., Moesian Platform and Dobrogea (BUCUR 2008). Corals are known in some areas, but there is only one detailed taxonomic paper on Lower Cretaceous corals from Romania (MORYCOWA 1971). The present studies are focused on Aptian coral reefs and the coral facies representing different geotectonic and sedimentary settings: (1) Rarău Mts. (Transilvanian Nappe, Eastern Carpathians, NE Romania), (2) Reşiţa–Moldova Nouă zone (Getic Nappe, Southern Carpathians, SW Romania), and (3) Pădurea Craiului Massif (Apuseni Mts., NW Romania).

Rarău Mts. 54 scleractinian species, mostly small colonies, with well preserved skeletal microstructures, were described by MORYCOWA (1971) from Lower Aptian marls of the Rarău Mts. These marls occur throughout the Wildflysch of the Bucovinian nappe. The wildflysch is partly covered by huge thrust sheet fragments of Urgonian (Late Barremian–Early Aptian) limestones (Transilvanian nappe). The locality described by MORYCOWA (1971) was not found during recent studies, but numerous and diversified corals were revealed in the Urgonian limestones. They contain *Calamophylliopsis* spp. including *C. fotisaltensis* (BENDUKIDZE); *Microsolena* sp. and other microsolenids, *Latiastraea* sp., *Latusastraea* sp., *Eohydnophora* sp. and related hydnophoroid-meandroid genera, *Columnocoenia ksiazkiewiczi* MORYCOWA, *Clausastraea* spp. including *C. alloiteaui* MORYCOWA and *Thecosmilia* sp. Associated biota include benthic orbitolinids, dasycladalean algae, chaetetid sponges and molluscs. Corals are commonly encrusted by the microproblematicum *Lithocodium aggregatum*, while microbial encrustations are moderately common. The skeletons of some microsoleninian corals from the Lower Aptian contain spectacularly preserved (red-stained and iron-enriched) assemblage of microbial euendoliths representing algae similar to the modern siphonalean chlorophyte *Ostreobium*, and possible also fungi. They penetrated into skeletons during coral's growth (Fig. 1A–B). Microeuendoliths inhabiting skeletons of modern corals during their life are common, however their fossil record is surprisingly poor. Dissolution cavities that occur locally within limestone, filled with reddish-brown siliciclastic sediments (possibly *terra rossa*) may represent evidence of synsedimentary emersion of the carbonate platform or younger processes.

In the **Reşiţa-Moldova Nouă zone** corals are present in Valea Nerei Limestones (Lower Barremian), but spectacular coral limestone occurs within the Valea Minişului Limestone Formation of Late Aptian (Gargasian) age. Thick bioconstructions composed of coral platestones occur along the Valea Minişului river over the distance of approx. 1100 m. They are grouped in two lithosomes with thickness 16-17 m and 38-42 m, separated by 15-30 m thick limestones generally devoid of corals. Coral density is high: 50–90 % (Fig. 1G–I). The individual colonies have platy to dish-like shapes, attain 8-50 cm in diameter, and are 1-15 cm thick. Corals are poorly diversified and dominated by the suborder Microsolenina: *Fungiastraea crespoi* (FELIX), *Latiastraea* cf. *kaufmanni* (KOBY), *Microsolena* sp., and a heterocoenid *Latusastraea* sp. (suborder Heterocoenina or Pachythecaliina). Phototrophic organisms include red algae: coralline *Sporolithon rude*, peysossonneliacean *Polyastra alba* (Fig. 1I), rarely problematic microencrusters *Lithocodium aggregatum*/*Bacinella irregularis*; dasycladalean algae are lacking. Coral-bearing sediment consists predominantly of dark gray wackstones to grainstones, subordinately clayey calcimudstones and marls. Bioerosion of corals is moderate to high. Coral assemblages, associated biota and inter-colony sediment suggest environment of the outer carbonate platform. The studied platy coral assemblages can be attributed to lithosomes formed in at the depth calculated as 20-80 m, with a low background sedimentation rate. In respect of thickness the described coral platestones represent one of the most spectacular fossil example among platy coral assemblages (ROSEN et al. 2002).

In the **Pădurea Craiului Massif** Upper Aptian (Gargasian)–?Lower Albian corals occur within the Vârciorog Formation. The succession in the Subpiatră quarry consists of limestones containing rudist biostromes (lower part of succession), coral biostromes (upper part), while the middle part is dominated by *Bacinella irregularis* facies (mostly oncoids) (BUCUR et al. 2010). Coral biostromes contains among others *Cyatophora* sp., *Latusastraea* sp., *Calamophylliopsis* sp. and *Amphiaulastraea* sp. (Fig. 1C). *Bacinella* facies contains rare, and small corals (Fig. 1E). Corals occur also within intercalations of black limestone and sandy limestones within siliciclastic parts of the Vârciorog Formation. Sandy limestones contain poor diversified corals, mostly *Calamophylliopsis fotisaltensis* (BENDUKIDZE) (Fig. 1F) and *Cyatophora steinmanni* FRITZSCHE. Low taxonomic diversity indicate a stressful environment (high input of siliciclastic sediments). Digitate colonies of *Cyatophora steinmanni* and large skeletons of *Calamophylliopsis* preserved *in situ,* lack of encrustations and borings indicate that they were adapted to enhanced sedimentation, continuously baffled by sediment during their growth, and formed a constratal growth fabric. Corals from black limestones are more diversified. Some of them are encrusted by microbial crusts or by photrophic *Lithocodium/Bacinella* consortium.

It is worth to underline that coral assemblages from two analysed areas have developed during the Late Aptian (Gargasian). It is well recognized worldwide that during the late Early Aptian (Oceanic Anoxic Event 1a) and mid-Late Aptian warming interval many carbonate platforms were drowned on the northern Tethyan and Atlantic realms. Some sub-tropical carbonate platforms which did not drown during that time were affected by increased terrigenous input (HELDT 2010). The dominance of *Bacinella* facies in Pădurea Craiului (Subpiatră limestones) may be a similar response of neritic platform system to factors that caused OAE1a reported in basinal facies. *Bacinella* facies, with rare corals, were reported from Lower Aptian (Oman: IMMENHAUSER et al. 2005; Croatia: HUCK et al. 2010) and Middle Aptian (Slovenia: KOCH et al. 2002) of the southern and central Tethyan domain. Thus, if the hypothesis of a northwards decreasing *Lithocodium–Bacinella* facies during Aptian is justified (HUCK et al. 2010) that suggests the central Tethyan platform domain of Padurea Craiului during that time.

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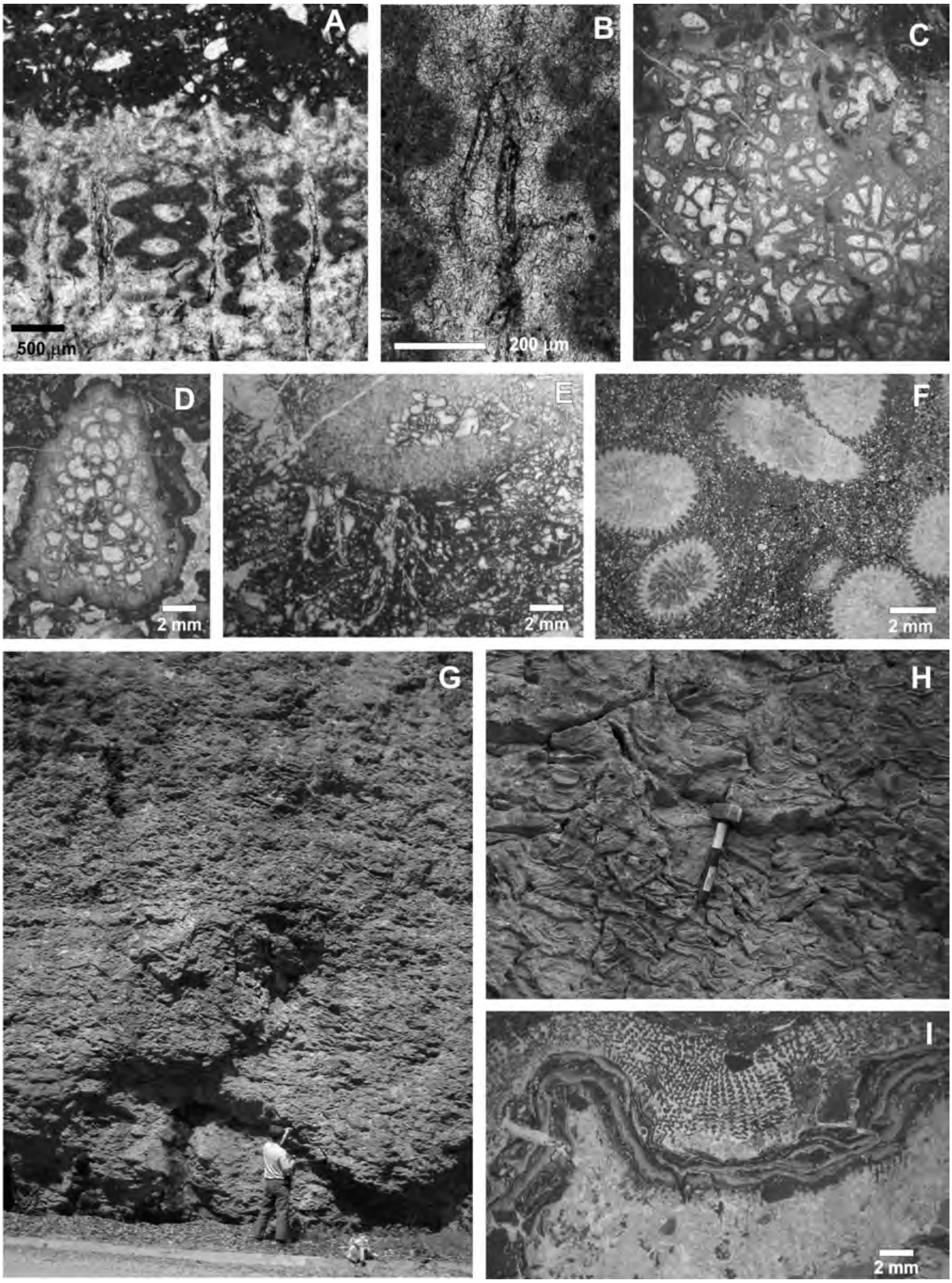

Fig. 1: A, B. Large, tubular microeuendolithic filaments inside the skeleton of microsolenid coral. Filaments are arranged parallel to the coral growth direction. Lower Aptian, Rarău Mts. C–F. Corals from Upper Aptian–? Lower Albian , Pădurea Craiului. Amphiastreid (C) and heterocoenid (D) from coral biostromes. E. Coral from *Bacinella* facies. F. *Calamophylliopsis fotisaltensis* from intercalation of sandy limestones. G–I. Dense, coral platestones. On I undetermined coral encrusted by coralline *Sporolithon rude*, peysossonneliacean *Polyastra alba* and microsolenid coral. Upper Aptian, Reşiţa-Moldova Nouă zone.

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Unique Early Cretaceous development of phaceloid pachythecaliines (Scleractinia?, Hexanthiniaria?): Upper Barremian, Bulgaria

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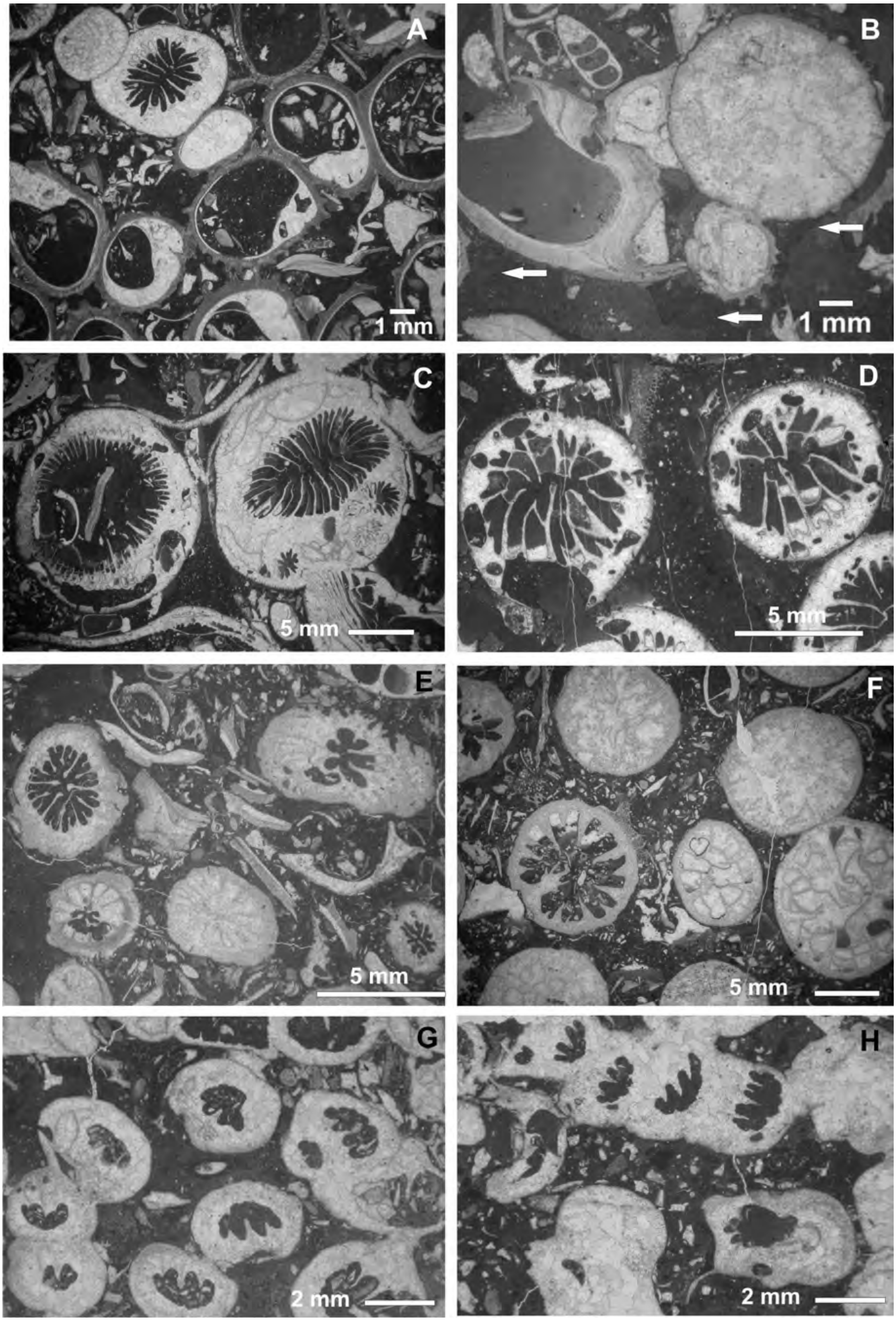
The suborder Pachythecaliina ELIÁŠOVÁ 1976 (=Amphiastraeina ALLOITEAU 1952) represents an unique coral group among the order Scleractinia BOURNE 1900 or – as assume some authors – belongs to the suborder Hexanthiniaria MONTANARO-GALLITELII 1975 (e.g. ELIÁŠOVÁ 1976; RONIEWICZ 2008). Their skeletal architecture, especially of Late Triassic zardionophyllids, similar to late Palaeozoic plerophyllines causes that their rugosan ancestry is also considered (see RONIEWICZ & STOLARSKI 2001). The other question is the taxonomic position of heterocoeniids, usually classified to the suborder Heterocoeniina BEAUVAIS 1974, but also to Pachythecaliina (e.g., KOŁODZIEJ 2003; BARON-SZABO 2002).

Abundant and highly diversified pachythecaliines have been recognized recently in three localities (Rusalya, Vishovgrad, Zarapovo) of Upper Barremian limestones of the Emen Formation, north-west of Veliko Tarnovo, Central Northern Bulgaria (Central Fore-Balkan). They represent 14 species (3 new) and 9 genera (3 new) (families: Amphiastraeidae, Carolastraeidae, Donacosmilliidae, ?Heterocoeniidae). Most of them – 10 species, 7 genera represent phaceloid (pseudocolonial) growth form (Fig. 1). Particularly common are specimens of the genus *Pleurophyllia*. Their large skeletons commonly preserved in growth position attain 1 m in high. In contrast, coral assemblages from other localities of the Emen Fm and other formations (both siliciclastic and carbonate) contain only cerioid amphiastreids (*Amphiaulastraea*), and heterocoenids (*Latusastraea*) (IDAKIEVA 2003).

Pachythecaliines are known from the Late Triassic to Late Cretaceous. Except of heterocoenids, they were poorly diversified during Cretaceous times. Till now the richest Early Cretaceous pachythecaliines were described by BARON-SZABO & STEUBER (1996) from the Aptian of Greece. However among 11 species, only 3 are phaceloid. Thus, the assemblage from the Emen Fm dominated by phaceloid forms is the most remarkable during Cretaceous. Pachythecaliines, mostly phaceloid, were more common only during Late Jurassic, and are particularly highly diversified in the Tithonian–lowermost Cretaceous Štramberk Limestone (Czech Republic; 35 species, 17 genera; e.g., ELIÁŠOVÁ 1978) and their equivalents (exotic pebbles/boulders) in the Polish Outer (Flysch) Carpathians (22 species, 14 genera; e.g., KOŁODZIEJ 2003).

The section in the Rusalya quarry provides the sedimentary and environmental context of the pachythecallines-bearing limestones. This section consists of five units: (1) The lower part (ca. 10 m thick) is composed of bioclastic limestone with boundstone patches with small coral colonies (without Pachythecaliina) and their fragments, chaetetids, stromatoporoids, microproblematicum *Lithocodium aggregatum–Bacinella irregularis*, and subordinately microbial crusts; (2) Rudist limestone with bioclastic alternations (ca. 15 m); (3) Bioclastic limestone with chaetetids, stromatoporoids, subordinately rudists and small corals (without Pachythecaliina) (ca. 8 m thick); (4) Biostromes (ca. 2 m thick) composed of dense assemblages of small rudists *Mathesia darderi* (ASTRE) and corals, mostly phaceloid pachythecaliines, rarely others. *Mathesia darderi* and corals appear to occur mostly as separate patches, but they also occur closely associated (Fig. 1A, B; FENERCI-MASSE et al. 2011). Associated macrobiota are poorly diversified and consist mainly of gastropods; (5) Limestone composed of large rudists and subordinately chaetetids (ca. 6 m thick).

In general this section shows a transition from the outer to inner platform. Biostromes built by rudists and Pachythecaliina were possibly developed in the outer part of the platform, but rather in its more inner part, with lower energy, in comparison with the lower part of the section at Rusalya. Environmental factors which permitted flourishing growth of small rudists and pachythecaliine corals are not well established. Co-occurence of *Mathesia darderi* and pachythecaliines was recognized only in the Emen Fm in the studied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area. Dense microbial encrustation (automicrites) (Fig. 1B) on corals are common, while *Lithocodium/Bacinella* are very rare. That suggests higher nutrient level as one of the main controlling factor because the moderate development of *Lithocodium/Bacinella* encrustations (as on corals in the lower part of the studied section) is commonly assumed as the indicator of oligotrophic/mildly mesotrophic environment. By contrast, Late Jurassic phaceloid pachythecaliines are known to occur within diversified coral assemblages, and are commonly associated by *Lithocodium/Bacinella*.

These studies were supported by a research grant from the Polish Ministry of Science and Higher Education (No. 2P04D 028 29).

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Fig. 1: (previous page): A, B. Dense aggregation of individuals of small rudist *Mathesia darderi* (Astre) and pachythecaliine corals. On B arrows show dense microbial crusts (automicrite). C. *Aulastraea* sp. D. *Pleurophyllia* sp. E. *Carolastraea graeca* Baron-Szabo. F. *Gen. nov. 1. sp. nov. 1.* G–H. *Gen. nov. 2. sp. nov. 1.* Upper Barremian.

Clear- and turbid-water coral assemblages from Barremian–Lower Aptian of Bulgaria

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During Barremian–Early Aptian times several carbonate platforms existed on the northern Tethyan margin in Bulgaria. In particular the Lovech Urgonian Group (Fig. 1A) in the Central Fore-Balkan contains abundant and diversified corals (about 120 species). Occurrence of turbid- and clear-water environment is a characteristic feature of this mixed siliciclastic-carbonate Urgonian system. Taxonomy of corals from turbid-water environments (mainly from marls) where studied already in the 19th century (F. TOULA), but mostly since the 1960s (V. ZLATARSKI, V. TCHECHMEDJIEVA, V. IDAKIEVA). Recent studies were particularly focused on corals from carbonate units (clear-water environments), coral palaeoecology and palaeoenvironmental factors controlling development of coral assemblages.

Turbid-water coral assemblages form segment or cluster (matrix-supported) reefs and level-bottom assemblages, rarely small frame (skeleton-supported) reefs. Usually massive colonies formed the core of the isolated patch reefs, whereas phaceloid, dendroid or ramose corals grew on the periphery of the buildups (IDAKIEVA & IVANOV 2002). These later, often still in life position, indicate constratal growth fabric (low syn-depositional relief). Corals are represented mainly by stylininans, cyathophorids, actinastreids, faviids (*Eugyra, Hydnophora, Felixygyra*), clausastreids and microsolenines (e.g, IDAKIEVA 2003). Coral skeletons show features typical for turbid-water and soft-substratum environments, such as growth anomalies due to partial colony mortality, reorientation of growth direction (Fig. 1F), and the presence of colony and corallite morphologies adapted to stressful factors of turbid-water settings (Fig. 1E, F; cf. Sanders & Baron-Szabo 2005). Platy and low domal colonies dominate as possible response to a soft, unstable substrate and decrease in light intensity. Among them clausastreids (Fig. 1E) and *Amphiaulastraea* attain the largest size suggesting their high resistance to sedimentation. Some corals as hydnophoroid-meandroid faviids show significant morphological plasticity (from platy to branching growth forms). Small-sized colonies, common encrustations by heterotrophic organisms (very rare microbial crusts) on the lower parts of coral colonies (Fig. 1D), and rare on the upper ones indicate changes in sedimentation rate with intermittent rapid sedimentation events of lethal or sublethal effects. Some localities show diversified coral assemblages and high coral density, as result of low sediment input.

Level-bottom coral assemblages are dominated by solitary forms: *Montlivaltia multiformis* TOULA, *Axosmilia* spp., *Actinoseris alloiteaui* BEAUVAIS & ZLATARSKI (Fig. 1J). An interesting assemblage is dominated by abundant small fungiform colonies of the endemic species *Dimorphocoeniopsis beauvaisorum* ZLATARSKI (ZLATARSKI 1967) (Fig. 1G–I), recently discovered also in the Vratsa Urgonian Group.

Clear-water coral bioconstructions (mainly biostromes) differ in significance of microbialites, presence or absence of microencrusters, particularly phototrophic ones (*Lithocodium aggregatum, Bacinella irregularis*), as well as in bioerosion rate, what were presumably controlled by sedimentation rate and trophic regime (Fig. 1K–M). Chaetetids and other calcified sponges locally participate in frame construction. Rudists co-occur with corals; however they usually form biostromes without or with rare corals. The Emen Fm, in localities NW of Veliko Tarnovo, contains abundant and diversified corals of the suborder Pachythecaliina associated with small rudists (Fig. 1M; KOŁODZIEJ et al., this volume). *Lithocodium–Bacinella*-dominated facies (with rare corals) facies is poorly developed. Microbialite-dominated reefs do not occur.

Growth and demise of clear- and turbid water coral assemblages occurred in various eustatic, tectonic and climatic contexts, which resulted in such environmental factors as water depth, nutrient and siliciclastic input, oxygenation or hydrodynamics. The depositional pattern was controlled mainly by synsedimentary extensional tectonics, increased weathering and siliciclastic supply. Various types of bioconstructions were developed preferentially during the late TST and the early HST of the third-order sequences. During Aptian shallow-water Urgonian sedimentation was reduced. As many carbonate platforms on the northern margin of Tethys (see Heldt et al. 2010) during the Early–Middle Aptian platforms in Bulgaria were progressively drowned, and carbonate sedimentation disappeared (Minkovska et al. 2002).

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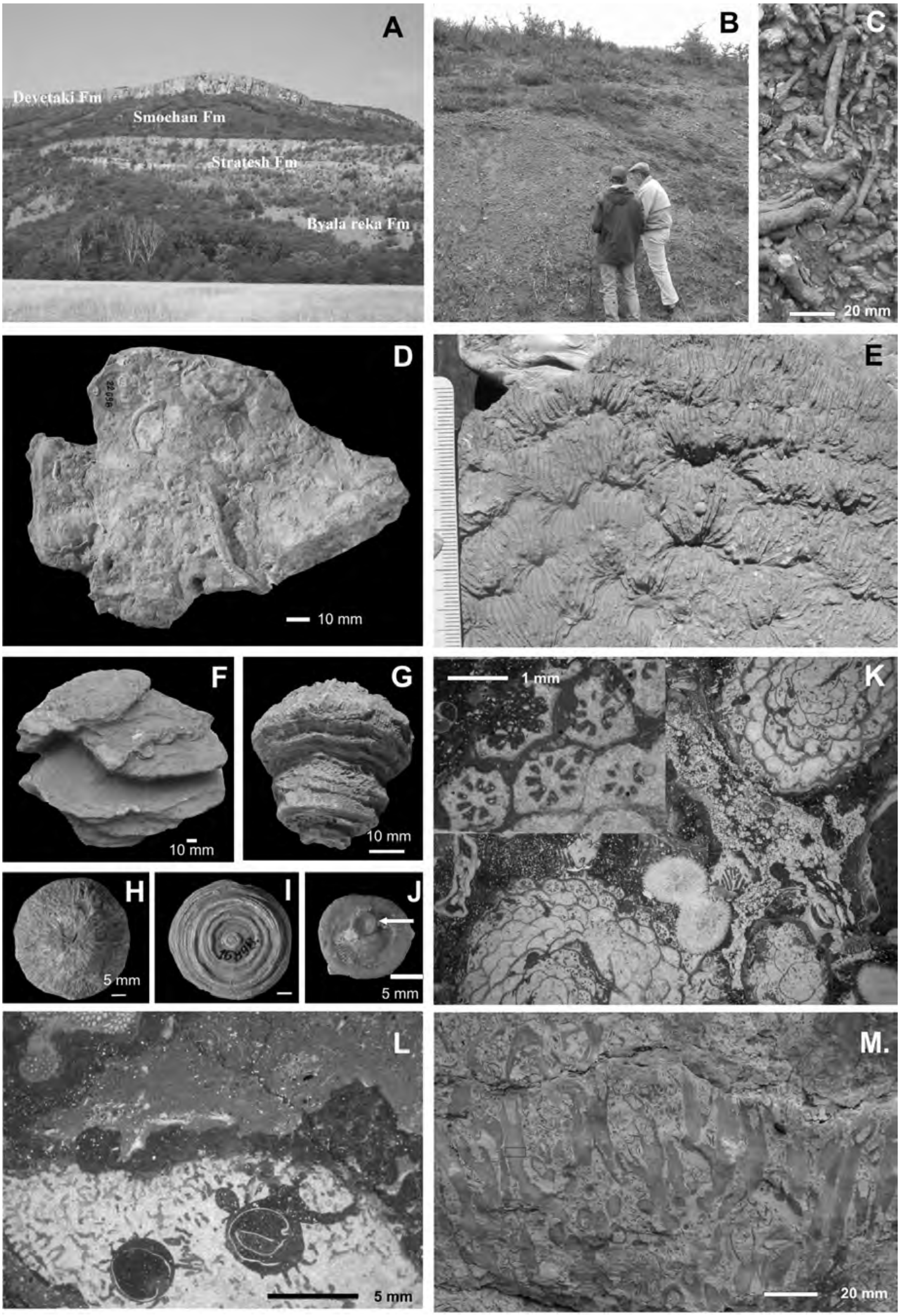
Fig. 1 (next page): A. Upper part of the Lovech Urgonian Group showing intercalations of carbonate and siliciclastic formations. B, C. Marls with abundant branching (phaceloid, ramose) corals preserved in growth position. Coral debris visible on C is due to recent weathering. Lovech –Goznica (Upper Barremian). D. Lower part of a platy colony preferentially encrusted by heterotrophic organisms: serpulids, ostreids, thecideid brachiopods, bryozoans and sponges. E. Example of clausastreid corals which attain the largest colony size, possibly representing the most sediment resistent taxa. F. Massive, thamnasteriod coral colony, subject a few sedimentation/tilting events. G–I. *Dimorphocoeniopsis beauvaisorum* Zlatarski. On G conical pedestal morphotype. J. Lower surface of *Actinoseris? alloiteaui* Beauvais & Zlatarski. Orbitolinid test often provided a suitable substrate for settling of larvae of this species. K. *Floria planinensis* Turnšek & Mihajlović from carbonates. L. Clear-water coral bioconstruction. Numerous borings, encrustation by microbialites and heterotrophic organims and lack of *Lithocodium* encrustation suggest higher nutrient level. M. Large skeleton of pachythecaliine coral.


A
Devetaki Fm
Smochan Fm
Stratesh Fm
Byala reka Fm
B
C
20 mm
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I
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L
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M.
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Transitional Moscovian-Kasimovian rugose corals – event analysis and some evolution tendencies

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The strong reorganization of the biota composition near by the Moscovian/Kasimovian boundary (in its traditional understanding) is emphasized by the restriction of the Petalaxidae diversity, some simplification of the survival colonial taxa (for example *Petalaxis (P.) baculatus* BAMBER & FEDOROWSKI 1998) and morphological rearrangement of the phyletic branch of Bothrophyllidae. Our study from the East-European Platform shows some heterochrony and selectivity of the event – thus the last colonial corals occur in the Moscow basin in the Domodedovo Fm. (middle Moscovian) (ALEKSEEV & GOREVA 2009), in Spitsbergen in the late Moscovian (SOMERVILLE 1997), in Northern Timan in the Late Moscovian (KOSSOVAYA 1997), in Arctic Canada in the Kasimovian (or even Gzhelian?) (BAMBER & FEDOROWSKI 1998). In the Donets Basin the reliable occurrence of astreoid *Donastraea cystiseptata* (FOMICHEV) (FOMICHEV 1953, Kossovaya 1998) is known from the Limestone O_1 correlated with *Idiognathodus sugittalis* Zone. The uppermost transitional forms of the Donets Basin are represented by asteroid colonies in contrast to the *Petalaxis* colonies occupying in the northern part of the basin. Taxonomic analysis shows some similarity of the morphology, generic and specific composition for the Late Moscovian. The provinciality increases at the end of Myachkovian and is considered to reflect the see level drop and diminishing connection between marginal basins. The strong regression is mirrored by widespread paleosoil distribution in the Afanasievo and Domodedovo quarries and also in the recently studied Kasimov quarry (KOSSOVAYA et al. 2011). The data on stable isotope composition obtained from the bulk specimens from the Moscovian-lower Kasimovian transition show a negative shift of $\delta\ ^{13}C$ supporting the regression interpretation. The negative shift of $\delta^{18}O$ can be considered as increase in temperature. The impoverishment of other fauna groups in the Peski Fm. demonstrates the general character of event. The rather short duration and possible area restriction within the central part of the East-European platform allow proposing the El Nino scenario for the event.

The replacement of the diverse assemblage of the Middle Carboniferous by sparse, abundant and often monotypic in occurrences, caninomorph association at the beginning of Late Pennsylvanian was earlier mentioned by VASILJUK & KOZYREVA (1981). The uncertainty of the correlation of the Moscovian – Kasimovian boundary in the different regions was also briefly discussed. Material for the recent comparative study was obtained from several sections of the Moscow basin, Donskaya Luka (south of the East-European platform), Central Urals ("Orel" section), Samarskaya Luka, and Volonga River (Northern Timan). The collections of T.A. DOBROLYUBOVA and N.V. KABACKOVITCH published in 1941-1948, and FOMICHEV (1953) were studied too. The assemblage of caninomorph rugosa demonstrates a strong provinciality on the species level. However a similar generic composition seems to be characteristic for the whole marine basins located in the Northern Hemisphere. Few genera are mostly widespread: *Siedleckia*, *Bothrophyllum*, *Gshelia* and *Pseudotimania*. Two controversial opinions on the taxonomy of *Bothrophyllum conicum* (FISCHER) are discussed herein. The first idea arose from Dobrolyubova's works (partly supported by the recent authors) who outlined the great variability of morphs and subspecies. The second idea united most subspecies as synonyms of *B. conicum* and considered this species as a long living during Moscovian – Gzhelian (OGAR' 2009). The simplification of the mature stages (mentioned earlier by FEDOROWSKI 1975: 33 and later by KOSSOVAYA 1989) and the development of caninomorph features in *Bothrophyllum* not before the end of the Myachkovian (Peski Fm.) are the most important trends both in its evolution and connected genera. The lineage continues in the middle Kasimovian (Moscow basin, Afanasievo section) (GOREVA et al. 2009). *Bothrophyllum domheri* (FOMICHEV) (= forma a, FOMICHEV 1953) demonstrating simple and inconstant axial structure and long minor septa was studied in serial sections of the rather large corals found in the middle Kasimovian in Donskaya Luka (*sagittalis* zone, Seleznev Fm., GOREVA et al. 2009) (Fig. 2). The great similarity to the type material (FOMICHEV 1953) allows to establish the species range from the latest Myachkovian to the *sagittalis* zone of the Kasimovian. *B. timanoides timanoides* FEDOROWSKI 1975, Ambigua Lm., Svalbard also bears the rather simple axial structure, but shows shorter minor septa (FEDOROWSKI 1975: 61, fig.8). The group of corals possessing simplified features is different from the topotypes of *B. conicum* demonstrating well developed axial structures. The typical *B. conicum* is similar with the specimen assigned to a new *Bothrophyllum* species determined in the Donskaya Luka at the basal Kasimovian (in its traditional meaning).

Siedleckia FEDOROWSKI 1975 is another abundant genus among the caninomorph corals of the transitional interval. It appeared in the Moscovian (the type species *S. mutafii* (GORSKY 1978) and it also occurs in the lowermost Kasimovian in the Donskaya Luka and is known from the Kasimovian of the Ambigua Lm. and the Urals (GREK 1936).

The specific ontogenetic development of the specimens from the Donskaya Luka seems to be a strong reason to propose a new genus. It shows the long duration of the primitive amplexoid neanic stage. By the short minor septa, general caninomorph habitus of the mature stage the new genus is similar with *Caninophyllum domheri* FOMICHEV 1953, forma b. The long counter septum brings it together with *B. timanicum timanicum* (FEDOROWSKI 1975) and some *Timania* species, but the difference in ontogeny contradicts the typical succession of the evolution stages of both genera. *Pseudotimania* DORBOLYUBOVA & KABAKOVICH 1948 bearing caninomorph features at the mature stages has long cardinal septa at the early stages and more or less visible alar fossules. In the Urals *P. kasimovi* was found in the Podolskian and *P. irregularis* - in the Myachkovian. *Pseudotimania* is typical for the Myachkovian in the Moscow Basin (*P. mosquensis*, *P. kasimovi*) and occurs at the base of the Kasimovian in Donskaya Luka *(P. kasimovi).*

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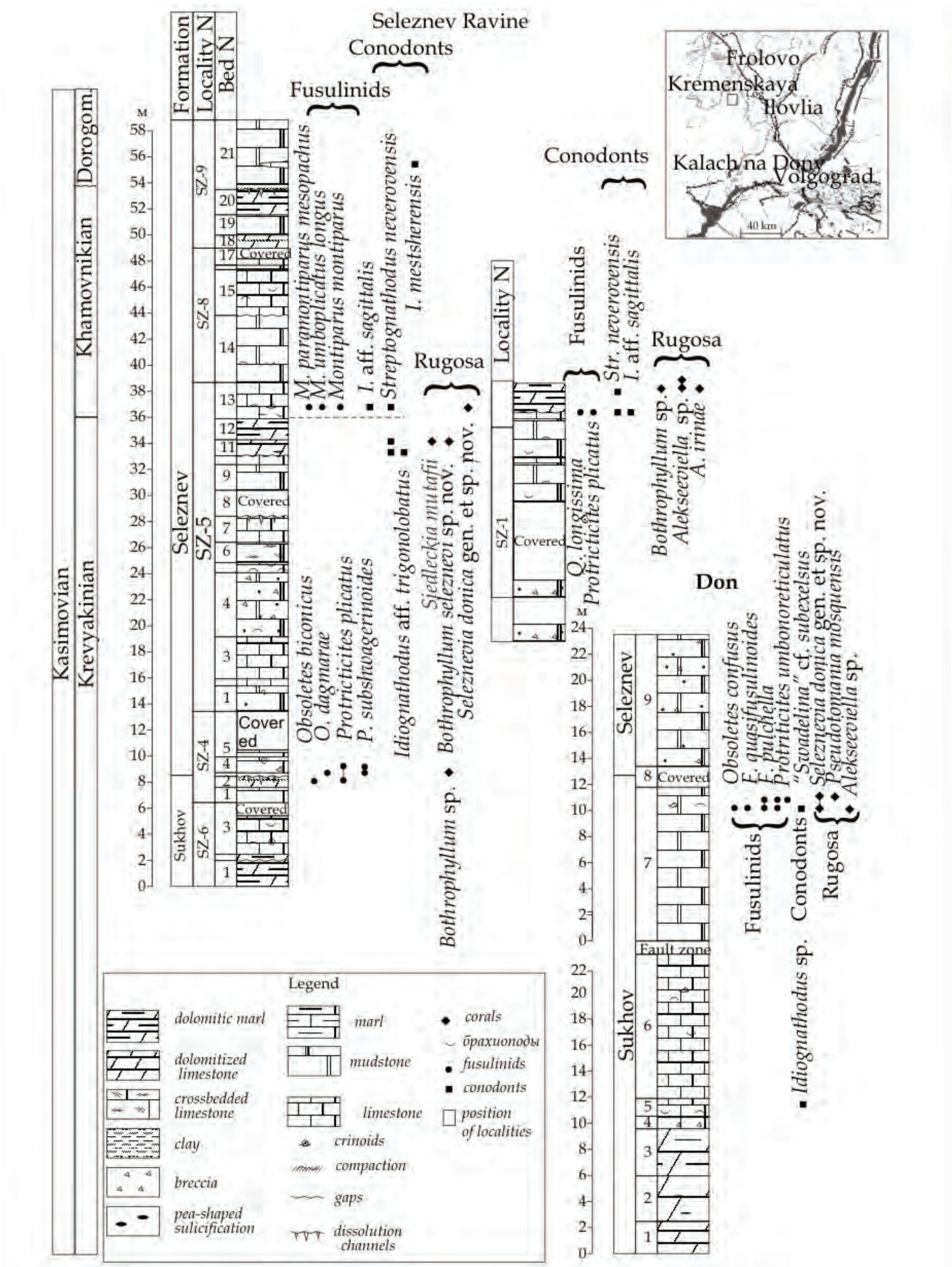

Fig. 1: Fauna distribution in the Kasimovian deposits of the Donskaya Luka (Volgograd region, Russia). For stratigraphy see Goreva et al. 2009

Fig. 2:
1- 5. *Bothrophyllum domheri* (Fomichev), 1-2 - x 3, 3 - x 2, 4-5 – x 1,5. Specimen Sz-7-1. Donskaya Luka, Seleznev Ravine, Seleznev Fm., Locality 5, uppermost part. Khamovnikian Substage, Kasimovian Stage.
6-8. *Bothrophyllum domheri* (Fomichev). Neanic stages in the incomplete specimen Cz-1-2, x 3. Ibid.
9-11. *Pseudotimania mosquensis* (Dobrolybova), x 3. Specimen Don- 1-4-2. Donskaya Luka, Section Don, Sukhov Fm., Locality 1, Krevyakinian Substage, Kasimovian Stage.
12-15. Gen. et sp. nov.1 12-14 x 3, 15 x 1, 5. Specimen D-1-4a. Donskaya Luka, Section Don, Sukhov Fm., Locality 1, Krevyakinian Substage, Kasimovian Stage.
16. Gen. et sp. nov.1 Late neanic stage. Specimen SZ-5-4, x 3. Donskaya Luka, Seleznev Ravine, Seleznev Fm., Locality 5, uppermost part. Khamovnikian Substage, Kasimovian Stage.

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A new genus of ahermatypic Rugosa from the basal Permian (Asselian) of Slovenia

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Traditionally, aphotic coral communities of cold and deeper waters are named *Cyathaxonia* facies (according to HILL (1938: *Cyathaxonia* fauna). This originally Lower Carboniferous term is in common use for all such Rugosa faunas (from Ordovician to Permian times) which often are associated also with some special Tabulata. The name-giving genus *Cyathaxonia* MICHELIN 1847 (Lower Famennian – Permian) seems to be well defined, but a partially homoeomorphic, phylogenetically unrelated taxon which sometimes caused misidentifications was found recently.

The best material of 11 specimens was jointly collected in 2010 in the Dovžanova Soteska section (Devil's Gorge) NE of Tržič (Neumarktl in German language literature), Karawanke Mountains of the Southern Alps, Slovenia, where HERITSCH (1933, 1938) had already described some Rugosa. Our sample comes from the Dovžanova Soteska Formation of the middle Asselian (Lower Permian, Cisuralian) according to fusulinid and conodont data (FORKE 2002, NOVAK 2007).

The main diagnostic features of the new genus are a simple septal columella and long contratingent minor septa. Subtabular sections with a strong stereoplasmatic thickening of all septa seem to be identical with *Cyathaxonia*. Lower calicular views differ: there is no circular aseptal columella, genetically derived from tabulae after an everted growth of a former aulos in the phyletic line *Laccophyllum*→*Cyathaxonia*. Here the axial structure shows clear septal lamellae.

Two additional records of the new genus outside of Slovenia are already available. The first is a misinterpreted "*Cyathaxonia cornu cornu* MICHELIN 1847" of FLÜGEL (1972) from the Lower Permian (Sakmarian?–Artinskian?) basal Jamal Formation of East Iran. The other is an isolated specimen without precise stratigraphical data (Moscovian–Dzhulfian) from the Bükk Mountains, Hungary.

The classification is somewhat difficult in view of the hitherto few records. Provisionally we propose the probable development *Rotiphyllum* HUDSON 1942 → *Variaxon* FEDOROWSKI 2010 → new genus. This implies a now no longer monotypic subfamily Variaxoninae FEDOROWSKI 2010 (at least Serpukhovian—Asselian) within the family Antiphyllidae ILINA 1970 (suborder Zaphrentoidina SCHOUPPÉ & STACUL 1959), whereas the somewhat homoeomorphic genus *Cyathaxonia* MICHELIN 1847 is a member of the suborder Cyathaxoniina SPASSKIY 1977 (family Cyathaxoniidae MILNE-EDWARDS & HAIME 1850, subfamily Cyathaxoniinae together with their ancestors, the Laccophyllinae GRABAU 1928). Also the enigmatic *Epiphanophyllum* ILINA 1970 (Middle Permian, Pamirs) must be compared.

Preliminary data of DE GROOT (1963), RODRÍGUEZ & KULLMANN (1999), and FALCES & RODRÍGUEZ (1994) might indicate a farther distribution of our new genus in space and time: their Moscovian "*Cyathaxonia*" from Spain seem to comprise both aseptal and septal columellar structures. Perhaps, *Cyathaxonia degrootae* RODRÍGUEZ 1984 is a member of the new genus. For sure identifications, often neglected studies of the calice are demanded to see the columella in statu nascendi without later stereoplasmatic thickening and diagenetic recristallisations.

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Archaeocyaths of the White Point Conglomerate, Kangaroo Island, South Australia

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Kangaroo Island, off the coast of South Australia, is primarily an amalgam of shallow shelf, mixed carbonate-terrigenous Kangaroo Island Group along the central northern coast, and a larger area of deep marine terrigenous Kanmantoo Group to the south. These early to middle Cambrian sedimentary rocks were deposited on the platformal part of the Stansbury Basin and in its constituent rift-related Kanmantoo Trough respectively. The two successions were juxtaposed along the east-west-trending Kangaroo Island Shear Zone during the Cambro-Ordovician Delamerian Orogeny, when oblique transpression thrust metamorphosed Kanmantoo Group against relatively undeformed Kangaroo Island Group resting on shallow basement, albeit with imbricate thrust repetition of the latter (BELPERIO et al. 1998; FAIRCLOUGH 2008).

A discontinuously exposed succession of constituent units of the Kangaroo Island Group, notionally totalling at least 2000 m thickness (BELPERIO et al. 1998), can be traced along the central northern coast of Kangaroo Island. Until recently, these constituent formations were interpreted as a stratigraphically continuous succession comprising, from base to top, Mount McDonnell Formation, Stokes Bay Sandstone, Smith Bay Shale, White Point Conglomerate, Emu Bay Shale and Boxing Bay Formation (SPRIGG et al. 1954, SPRIGG 1955; DAILY 1956, 1969; HORWITZ & DAILY 1958; DAILY et al. 1979, 1980). Most were deposited in a shallow subtidal setting subject to strong east-west, shore-parallel current and tidal influence (DAILY et al. 1979; MOORE 1983).

The notionally lowermost unit, Mount McDonnell Formation, comprises green-grey shale, siltstone and fine sandstone altogether in excess of 900 m thick. A thin ooid limestone interbed in the upper part of the formation at Cape Cassini yields archaeocyaths, trilobites and small skeletal fossils; the poorly studied archaeocyaths are assigned by GRAVESTOCK & GATEHOUSE (1995) to what is now the *Jugalicyathus tardus* Zone (regarded as late Atdabanian equivalent by GRAVESTOCK et al. 2001) or younger.

The 700 m-thick Stokes Bay Sandstone, predominantly of red arkose, transitionally overlies. This formation is conformably overlain by Smith Bay Shale, of interbedded arkose and micaceous siltstone (GRAVESTOCK & GATEHOUSE 1995). A constituent thin intraclast-bearing limestone within the latter formation has yielded fragments of the trilobite *Redlichia* (DAILY et al. 1979).

The notionally overlying White Point Conglomerate, Emu Bay Shale and Boxing Bay Formation together denote a migrating lithofacies complex some 1300 m thick. Red, feldspathic fine sandstone with minor siltstone and shale constitute the lower White Point Conglomerate. This interval is erosively overlain by polymict, mostly framework-supported conglomerate in a distinct sandstone matrix. The lithologically varied clasts, up to boulder size, include gneiss, chert, sandstone, dolostone and archaeocyath-bearing biohermal limestone (DAILY et al. 1979, 1980). Conglomerates of the White Point Conglomerate are considered to be the result of extensional tectonism that initiated the Kanmantoo Trough (BELPERIO et al. 1998; Kangarooian Movements of DAILY & FORBES 1969).

GEHLING et al. (2011) have recently distinguished a new unit, Marsden Sandstone, stratigraphically between the White Point Conglomerate and the Emu Bay Shale, with basal conglomerate of the latter indicating a sequence boundary. The Marsden Sandstone comprises a basal 3 m-thick buff muddy limestone (constituent Rouge Mudstone Member) with burrows and the trilobite *Balcoracania dailyi*, overlain by some 40 m thickness of calcareous feldspathic sandstone, succeeded by mudstone and minor sandstone, and in turn by medium-coarse sandstone with gravel conglomerate beds. This interval was formerly assigned to the upper White Point Conglomerate. These authors see no necessary stratigraphic continuity between the 'older' Mount McDonnell Formation to Smith Bay Shale succession west of Cape d'Estaing, and the 'younger' White Point Conglomerate to Boxing Bay Formation succession to the east. Indeed, they have tentatively correlated the Stokes Bay Sandstone and Smith Bay Shale collectively with the White Point Conglomerate to Boxing Bay Formation succession.

Deeper water mudstone dominates the overlying Emu Bay Shale. Trilobites including *Redlichia takooensis* and *Estaingia bilobata* date the diverse fauna of this formation to the Botoman-equivalent *Pararaia janeae* Zone (Jell in Bengtson et al. 1990). The Boxing Bay Formation surmounts the succession and comprises feldspathic and micaceous sandstone with minor conglomerate beds, the latter incorporating abundant gneiss and rare limestone clasts. Conglomerate beds with carbonate clasts identical to those in underlying formations reportedly recur in the upper part of the Boxing Bay Formation (Belperio in Gravestock & Gatehouse 1995: 17).

Within the Stansbury Basin, the finer details of correlation between the exposed successions on Kangaroo Island and adjacent Yorke and Fleurieu Peninsulas, and subsurface in intervening Gulf St Vincent, are a matter of ongoing debate. A particularly intractable issue is correlation of the essentially unfossiliferous Kanmantoo Group (Haines & Flöttman 1998). Archaeocyaths in transported clasts of the White Point Conglomerate offer a potential biostratigraphic constraint on timing of deposition of that formation, and thereby contribute to testing the competing correlation hypotheses outlined above. In the present study, five transported clasts were sampled from the bedded cobble to boulder conglomerate facies association (Daily et al. 1980) in the upper White Point Conglomerate at Cape d'Estaing. Initial indications suggest the presence of a Botoman-equivalent archeocyathan fauna.

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On the coral genera *Endophyllum* Milne-Edwards & Haime and *Parendophyllum* Liao & Ma

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Endophyllum was established by MILNE-EDWARDS & HAIME (1851). They published two species: *Endophyllum bowerbanki* and *Endophyllum abditum*, but they did not appoint the type species to the genus. Later, SCHLÜTER (1889) chosed the former as the genolectotype. Unfortunately, the type material of *E. bowerbanki* is lost. JONES (1929) designated and first illustrated the neotype and PEDDER (1980) refigured, including a ×10 photo of septal structure of the neotype.

Endophyllum are subfasciculate, cerioid or aphroid corals. Corallites large, with septal stereozone broken up by large irregular lonsdaleid dissepiments. Major septa long, attenuate, and commonly convolute in the tabularium. Tabulae showing the shape of a saddle in the longitudinal section: tabulae are flattened or slightly subsided in the central portion of the tabularium; obviously arched periaxially; and visibly concave close to the dissepimentarium. The minute skeletal structures of septum is composed of monacanth in the axis and lamellar skeleton at the marginal area. The lonsdaleoid dissepiments and tabulae both consist of lamellar skeleton. *Endophyllum* is a cosmopolitan genus in the Middle Devonian (Givetian) of Europe, Australia and Asia including South China.

Specimens referred to so-called "*Endophyllum*" were reported from northern Xinjiang, NW China (CAI 1983; LIAO & CAI 1987). However, they differ obviously from the *Endophyllum* of Europe and South China in the morphology of their epitheca, septa, dissepiments, tabulae and even in their minute skeletal structures. The major septa of "*Endophyllum*" from northern Xinjiang are not convolute in the tabularium. Its tabularium is rather simple and the minute skeletal structures of the septum are probably composed of composite rhabdacanth. We transfer the Xinjiang materials to a new genus, *Parendophyllum*.

Parendophyllum LIAO & MA 2011 (Type species: *Parendophyllum stereoplasma* LIAO & MA 2011)

Diagnosis: Corallum is cerioid; corallites are large, with a thick septal stereozone and a large irregular lonsdaleoid dissepiments; Septa of two orders, major septa are long but not convolute in tabularium; Tabularium is rather simple and tabulae are convex or horizontal. The minute skeletal structures of septum are composed of composite rhabdacanth probably.

Discussion: *Parendophyllum* is different from *Endophyllum* in epitheca, septa, dissepiments, tabulae and the minute skeletal structures. The major septa of *Parendophyllum* are not convolute in the tabularium. Its tabularium is rather simple and the minute skeletal structures of septum are probably composed of composite rhabdacanth. However, the major septa of *Endophyllum* are long and commonly convolute in tabularium. In longitudinal sections, tabulae are rather complicated, domes axially and concave peripherally. The minute skeletal structures of the septum are composed of monacanth in the axis and lamellar skeleton at the marginal area. The lonsdaleoid dissepiments and tabulae both consist of lamellar skeleton.

Distribution and Range: Northern Xinjiang and Kazakhstan probably; Eifelian.

Endophyllum MILNE-EDWARDS & HAIME 1851 (type species: *Endophyllum bowerbanki* MILNE-EDWARDS & HAIME 1851) belongs to the family Endophyllidae TORLEY 1933 of the suborder Ketophyllina ZHAVORONKOVA 1972. *Parendophyllum* LIAO & MA 2011 (type species: *Parendophyllum stereoplasma* LIAO & MA 2011) is attributed to the family Mucophyllidae SOSHKINA 1947 of the suborder Streptelasmatina WEDEKIND 1927.

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Late Visean to Early Serpukhovian Rugose corals from Yashui, Guizhou, South China

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The use of rugose corals for biostratigraphic correlation is always underestimated due to the difficulties in identification and overemphasis on facies control on coral distributions. Especially in such strata as the Late Visean-Serpukhovian, the frequent appearance of sedimentary disruptions brought further trouble in rugose coral biostratigraphic studies. Thus, the problem of using rugose corals to recognize the base of Serpukovian still remains unsolved.

The Yashui section in the Guizhou Province, South China contains a late Visean-Serpukhovian shallow water sedimentary succession mainly composed of light coloured bioclastic limestone, which is rich in rugose corals and foraminifers. The section was recently dated by foraminifers (Wu et al. 2009). Rugose corals have been collected from 90m of strata. The fauna is diversified and 23 species have been identified (including four in open nomenclature). They belong to 14 genera. All are shallow water inhabitates and can be included in four families: Aulophyllidae, Palaeosmiliidae, Lithostrotionidae and Axophyllidae. Lithostrotionidae and Aulophyllidae are the most diversified in the section.

The ranges of coral species are shown in Fig. 1. Most of the corals occuring in the sampling interval indicate the *Yuanophyllum* zone as proposed by Yü (1931), which was further divided into three subzones by Wu (1964). A correlation to the European coral zonations can be attempted based on species such as *Dibunophyllum bipartitum konicki* and *Siphonodendron irregulare*, which are also common faunal elements in the Visean and Early Serpukhovian of Europe. *Aulina rotiformis* is a typical species for strata of Visean/Serpukhovian transition. This species occurs at Yashui about 20 m below the Viséan/Serpukhovian boundary based on foraminifers.

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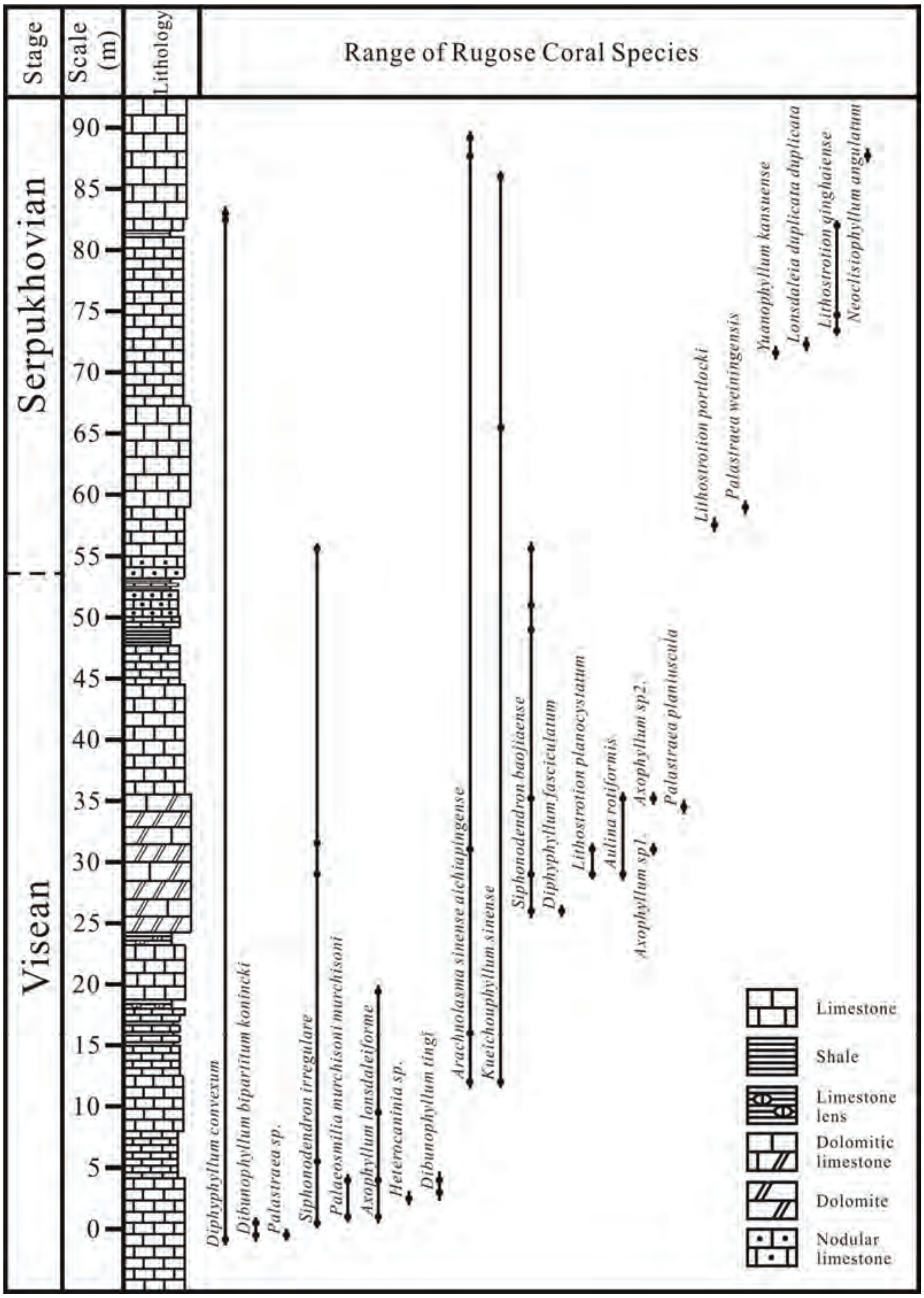

Fig. 1: The ranges of the rugose coral species from Yashui section. The approximate Visean/Serpukhovian boundary is according to the Foraminifers study of Wu et al. (2009).

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Infraspecific variation in actinastreid corals (Scleractinia; Jurassic-Cretaceous) and implications for the species concept

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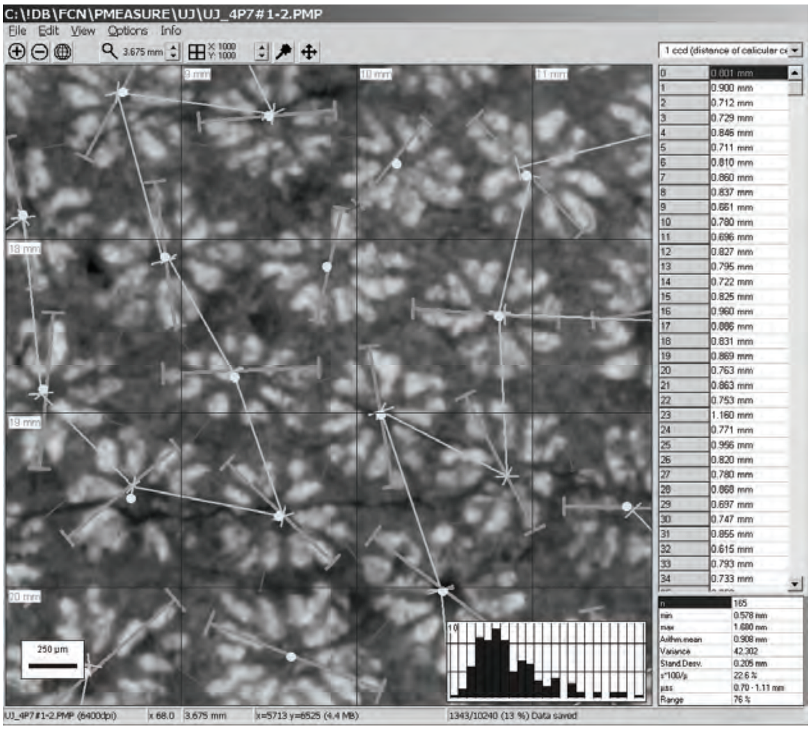
Corals of the family Actinastraeidae are extremely common in the Late Jurassic and Early Cretaceous and various genera have a high number of species. Species separation is generally based on calicular dimensions (diameter, distance, amount per given area), septal symmetry, and septal number. To obtain better insight into intraspecific variation and results for species separation, systematic measurements of the corals were taken and statistically analysed. As a preliminary study, ten type specimens were selected for analysis. In large thin sections a large number of calices (up to 200) were measured, including their diameter, distance and the thickness of the wall and coenosteum. For all values, the arithmetic mean, standard deviation and the coefficient of variation were calculated. It was observed, that the calicular diameter is the character with the lowest variation whereas the distance of the calicular centres, the thickness of the wall, and the number of calices per a given area show a much higher variation and are therefore not suitable for distinguishing samples within a population or species of different faunas. It was found that about 70% of all values of the lumen diameter fall in the first interval (range of the arithmetic mean ± standard deviation). Hence, the first interval is a good representation for most types of measured values in fossil corals.

To obtain a representative value for the arithmetic mean, only a low number of measurements is required (20-30), but in order to obtain representative values for the standard deviation, the coefficient of variation and the first interval more values are necessary (> 50). The results are compared to traditional methods by remeasuring published material. It is concluded that the application of systematic measuring should be extended to other species rich coral genera.



0	0.801 mm
1	0.900 mm
2	0.712 mm
3	0.729 mm
4	0.846 mm
5	0.711 mm
6	0.810 mm
7	0.860 mm
8	0.837 mm
9	0.661 mm
10	0.780 mm
11	0.696 mm
12	0.827 mm
13	0.795 mm
14	0.722 mm
15	0.825 mm
16	0.960 mm
17	0.886 mm
18	0.831 mm
19	0.869 mm
20	0.763 mm
21	0.863 mm
22	0.753 mm
23	1.160 mm
24	0.771 mm
25	0.956 mm
26	0.820 mm
27	0.780 mm
28	0.868 mm
29	0.697 mm
30	0.747 mm
31	0.855 mm
32	0.615 mm
33	0.793 mm
34	0.733 mm

n	165
min	0.578 mm
max	1.680 mm
Arithm.mean	0.908 mm
Variance	42.302
Stand.Desv.	0.205 mm
s*100/µ	22.6 %
µ±s	0.70 - 1.11 mm
Range	76 %

```
UJ_4P7#1-2.PMP (6400dpi)   x 68.0   3.675 mm   x=5713 y=6525 (4.4 MB)   1343/10240 (13 %) Data saved
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Fig. 1: Screen shot of the program used to measure the dimensions of the corals (PaleoTax/Measure).

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An exotic Late Albian coral fauna from the Prebetic Platform (Betic External Zone, South Spain)

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After the disappearance of the Late Triassic coral reefs, the development of extensive reefs started again in the Middle Jurassic and lasted into the Latest Jurassic. Reef formation ceased with the beginning of the Cretaceous, primarily caused by a falling sea level. Not only was reef formation inhibited, but coral diversity was also affected by the sea level low-stand. Reef formation did not recover in the Cretaceous due to a high Calcium/Magnesium proportion in the seawater, but diversity increased again with the transgression of the Early Hauterivian and reached its highest value in the Early Aptian. The Oceanic Anoxic Event 1a of the Early Aptian had an immediate effect on coral faunas. The number of faunas decreased at the beginning of the Late Aptian and this decrease continued until the Late Albian. Whereas Barremian to Early Aptian coral faunas are geographically widely distributed, those of the Late Aptian are mainly restricted to the Iberian Peninsula, the Western Pacific and the Western Atlantic. Caused by OAE 1b in the Early Albian, only a few faunas of shallow marine corals are known from the central Tethys (northern Spain, southern France) during this time span. Early Albian faunas are known from North America, which was less affected by anoxic events. In the Western Atlantic, coral faunas existed throughout the Albian, but from the Middle Albian on, they were poor in species. In the Western Pacific, shallow marine corals are not found at all from the Albian on because of the absence of carbonate sedimentation probably caused by changes in ocean currents and temperature decreases. The diversity of coral faunas recovered in the Early Cenomanian, being initially more common in Boreal regions than in the Tethys and Western Atlantic.

A recently discovered Late Albian coral fauna in the Sierra de La Llorençá (Alicante, Spain), belonging to the easternmost part of the Betic Cordillera, is therefore of important interest because it provides links between the Early and Late Cretaceous corals. The La Llorençá fauna is the first central Tethys shallow marine coral fauna of the Late Albian described in detail. It encompasses 35 species in 28 genera of the suborders Amphiastraeina, Faviina, Fungiina, Heterocoeniina, Microsoleniina, Rhipidogyrina, and Stylinina. The fauna counts with three new genera of the families Heterocoeniidae and Lasmogyridae, and seven new species. The faunal composition shows both Early Cretaceous elements (*Aulastraea, Aulastraeopora, Complexastrea, Diplogyra, Metaulastrea, Tiarasmilia*), as well as elements known only from the Late Albian/Early Cenomanian of the Boreal and central Tethys (*Confusaforma, Eocomoseris, Parnassomeandra*). The fauna contains the last known indication of the genera Aulastrea, Metaulastrea and Mitrodendron whose last occurrence was previously known as being Aptian. This finding extends the range of the Amphiastraeina suborder until the Late Albian. One new genus is known from the Aptian to Albian worldwide, but the other two new genera are known only from the Aptian to Albian of the Iberian Peninsula and Southern France. The Late Albian fauna is a true link between corals from the Early and Late Cretaceous, and it comes with a high number of new and short-lived taxa. The outcrop area was probably in an isolated geographic position less affected by OAE 1c, which allowed carbonate production and coral growth.

Preliminary list of species: *Acrosmilia fraterculus, Actinacis magna, Astraeofungia nagaoi, Astraeofungia* sp., *Aulastraea* n. sp., *Aulastraeopora harrisi*, *Brachyseris* sp., "*Columastrea*" sp., *Complexastrea dollfusi*, *Complexastrea* sp., *Confusaforma* n. sp., *Cryptocoenia aguilerai*, *C. almerai*, *C. párvula*, *Dimorpharaea* aff. *williamsonensis*, *Dimorphastrea hiraigaensis*, *D. regularis*, *Diplogyra* sp., *Diplogyra vivesi*, *Eocomoseris raueni*, *Eugyra affinis*, *Heterocoenia* sp., *Metaulastrea* n. sp., *Microsolena haldonensis*, *Mitrodendron* n. sp., *Paraacanthogyra* n. sp., *Parnassomeandra* sp. 1, *Parnassomeandra* sp. 2, "*Pseudopistophyllum*" *quinqueseptatum*, *Polyphylloseris polymorpha*, *Stelidioseris* cf. *hourcqi*, *Thecosmilia rutogensis*, *Tiarasmilia casteri*, n. gen. n. sp. 1, n. gen. n. sp. 2

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Mississippian (Serpukhovian) framework reef in Northwestern Georgia, USA

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This study documents the occurrence of a lower Carboniferous (Serpukhovian, 326-318 mya), shallow water, microbially-bound metazoan framework reef in the Bangor Formation of Walker County in Northwestern Georgia, USA. The reef measures 2.7 m at its thickest point, and extends laterally approximately 400 m. The reef is exposed inside two neighboring caves on Pigeon Mountain as well as where it crops out on the surface. This unique location allows for a 360-degree view of the reef complex. Inside the caves, the reef can be seen from underneath as well as a vertical section that encompasses the reef framework with underlying and overlying strata. Outside the caves, where the reef intersects the topography, the reef is seen from above as evidenced by in situ coral colonies.

The reef framework is dominated by a chaetetid sponge-coral association. Microbialites extensively coat much of the metazoan framework adding secondary stabilization. Individual chaetetids range from a few centimeters to 45 cm in diameter; although extensive cloning occurs, producing masses of chaetetids that may reach sizes of up to 1 meter. *Caninostrotion* colonies (rugose corals) may grow up to 1.5 m in width. Other reef-dwelling organisms include *Pentremites*, crinoids, regular echinoids (based on spines), *Archimedes* and other fenestrate bryozoans, fistuliporid bryozoans, gastropods, brachiopods, and foraminifera.

The 2.7 meters of reef facies is comprised of 3 repeating growth cycles. Biological succession appeared to occur within each of these 3 cycles. The base of each cycle is colonized by a monoculture of chaetetids. These chaetetid layers can be observed from underneath within the cave (Fig. 1). Contemporaneous to, or shortly after chaetetid growth, microbialites began encrusting the tops and interstitial space between the chaetetids. This initial framework created hard surfaces, suitable for coral nucleation, and colonies of *Caninostrotion* soon after began to take root, greatly adding to the framework (Fig. 2). During the main phase of reef growth, all reefal organisms, including skeletal metazoans, encrusters, bafflers, and mobile organisms, continued to appear throughout the section until the subsequent cycle begins with another chaetetid monoculture.

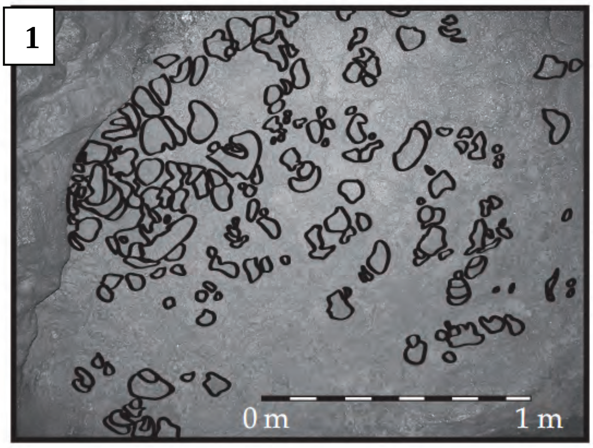

Fig. 1: Chaetetid monoculture at the base of reef framework, seen from underneath (chaetetids outlined to show contrast).

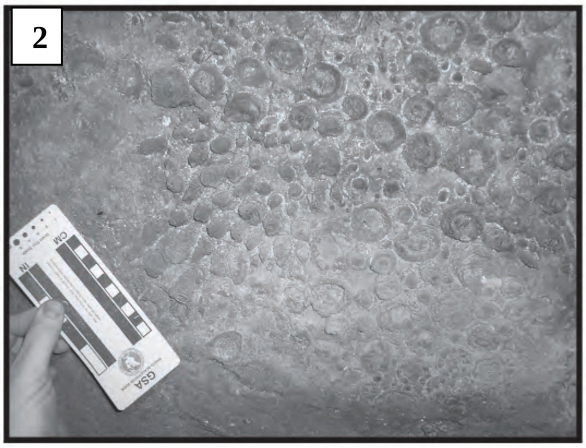

Fig. 2: Colony of Caninostrotion (rugose corals).

Petrographic and X-Ray Fluorescence analyses indicate that a late stage dolomitization event occurred. Microbialites created a permeability barrier that may have selectively blocked the flow of Mg-rich fluids. Interstitial matrix within the microbially-cemented framework is comprised of micrite and bioclasts, whereas regions above the microbial influence had a dolomite/bioclast matrix.

Carbonate reefs and bioherms were scarce during the Carboniferous (Mississippian). Bioherms during this time were generally limited to mounds and microbialite/stromatolite boundstones with very little metazoan influence related to the end-Devonian extinction events (Webb 1987, 2001; Lees & Miller 1995; Stearn et al. 1999; Droser et al. 2000). Metazoan-based framework reefs did not die out all together at the end of the Devonian. There are several documented Mississippian reefs and bioherms with sponge-coral-microbialite frameworks from places such as Australia, Western Europe, China, and North Africa (Pickett & Wu 1990; Aretz & Webb 2003; Aretz & Herbig 2008). In North America, several Mississippian buildups and bioherms contain sponges and corals as minor constituents, but their framework fabrics are predominantly microbialitic with encrusting and baffling organisms (West 1988; Kopaska-Merkel & Haywick 2001). Thus, this reef in NW Georgia appears to be the first documented skeletal metazoan-based framework of this type in North America during the Mississippian.

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Pragian (Lower Devonian) stromatoporoids and rugose corals from Zújar (Sierra Morena, Southern Spain) and their palaeogeographic affinities

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A first investigation of the Lower Devonian rugose corals in the Sierra Morena (Badajoz and Córdoba provinces, Southern Spain) was made by Rodríguez García (1978). Based on this study, since 2003 a group of palaeontologists from the universities of Valencia, León and Madrid is studying the main outcrops of Devonian reefal carbonates in Sierra Morena (Research Projects BTE2003-2065 and GR-UCM/910231). At first, we studied the locality Guadámez-2 (with Emsian reefal carbonates) in the Badajoz province and the locality Peñón Cortado (with Pragian reefal carbonates) in the Córdoba province (May 2006; Valenzuela-Ríos et al. 2006; Rodríguez et al. 2010). Later we studied the locality Zújar at the boundary between the Badajoz and Córdoba provinces (38º29'30''N, 1º46'W) with reefal carbonates of Pragian age (Pardo Alonso & Valenzuela-Ríos 2006).

Up to now, in the Pragian limestones from Zújar 10 stromatoporoid species and 5 rugose coral species could be identified. Stromatoporoids: *Nexililamina dipcreekensis* Mallett 1971, *Plectostroma altum* (Ripper 1933), *Stictostroma gorriense* Stearn 1995, *Stictostroma nunavutense* Prosh & Stearn 1996, *Stromatopora* ex gr. *rarissima* Počta 1894 - *polaris* (Stearn 1983), *Pseudotrupetostroma* cf. *pellucida* (Javorskij 1955), *Syringostromella zintchenkovi* (Khalfina 1961), *Coenostroma* aff. *pustulifera* (Winchell 1867), *Habrostroma centrotum* (Girty 1895), *Amphipora* sp. Rugose corals: *Martinophyllum ornatum soraufi* (Rodríguez García 1978), *Grypophyllum jenkinsi* (Strusz 1966), *Loyolophyllum (Fasciloyolopyllum) qunlingensis* (Cao in Cao et al. 1983), *Joachimastraea barrandei* Galle, Hladil & May 1999, *Rhizophyllum* ex gr. *bohemicum* Počta 1902.

Hexagonaria soraufi Rodríguez García 1978, described from the Pragian of the locality Peñón Cortado by Rodríguez García (1978: 340-342), is very similar to *Martinophyllum ornatum* Jell & Pedder 1969, but has slightly smaller corallites and slightly less septa.

Distribution of the referenced species: *Nexililamina dipcreekensis*: Emsian-Eifelian of Queensland; *Plectostroma altum*: Pragian of Victoria; *Stictostroma gorriense*: Lower and Upper Emsian of Arctic Canada and Ontario; *Stictostroma nunavutense*: Lower Emsian of Arctic Canada; *Stromatopora rarissima*: Wenlockian of Bohemia (May 2005); *Stromatopora polaris*: Upper Lochkovian to Upper Emsian of Arctic Canada and similar forms in the Emsian of Victoria and Sierra Morena (May 2006); *Pseudotrupetostroma pellucida*: Lower Devonian and Givetian of Siberia; *Syringostromella zintchenkovi*: Upper Lochkovian of Russia, Pragian of Victoria, Lower Emsian of Arctic Canada and Pragian to Emsian of Sierra Morena (May 2006); *Coenostroma pustulifera*: Middle Devonian of Michigan; *Habrostroma centrotum*: Lochkovian of New York and Arctic Canada (Stock & Burry-Stock 2001, 2007) and Pragian of northern Spain (Fernández-Martínez et al. 2010); *Martinophyllum ornatum*: upper Lochkovian or lower Pragian of Queensland; *Grypophyllum jenkinsi*: Lochkovian or Pragian of New South Wales and Givetian of Queensland; *Loyolophyllum (Fasciloyolopyllum) qunlingensis*: Lower Devonian of northwest China; *Joachimastraea barrandei*: Pragian of Koněprusy (Bohemia); *Rhizophyllum bohemicum*: Pragian of Koněprusy (Bohemia).

The Pragian fauna of Zújar is a typical fauna of the Old World Realm with remarkable close relationships to Arctic Canada and Australia (New South Wales, Queensland, Victoria). No significant relationships to the Eastern Americas Realm are visible. *Habrostroma* is a characteristic stromatoporoid genus of the Eastern Americas Realm (May 2006: 36). However, *H. centrotum* is known to have immigrated into the Old World Realm (Stock & Burry-Stock 2001, 2007; Fernández-Martínez et al. 2010). *Coenostroma pustulifera* is known from Michigan (Eastern Americas Realm), but *Coenostroma* is widespread in the Old World Realm (Stearn et al. 1999: 53). Remarkable is, that none of the stromatoporoid species of Zújar is known from the famous Pragian reef complex of Koněprusy (Bohemia) (compare May 2005), meanwhile the rugose coral fauna show relations. Zújar has only *H. centrotum* in common with the Pragian fauna described by Fernández-Martínez et al. (2010) from Northern Spain.

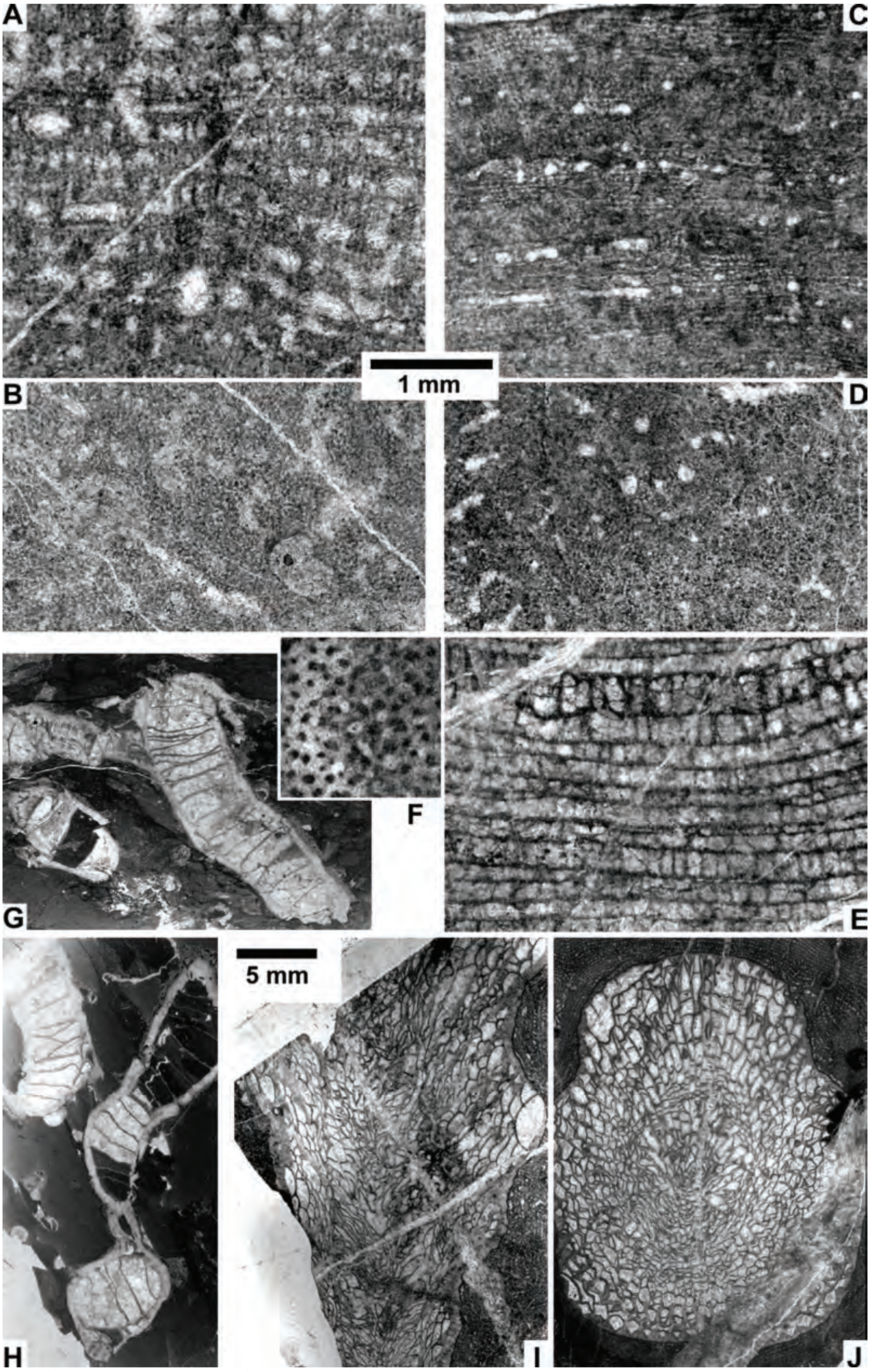

Plate 1: A-B: *Habrostroma centrotum* (Girty 1895), DPM-00276/Z10; A) longitudinal section, B) tangential section; C-D: *Coenostroma* aff. *pustulifera* (Winchell 1867), DPM-00276/Z33; C) longitudinal section, D) tangential section; E-F: *Nexililamina dipcreekensis* Mallett 1971, DPM-00276/Z18; E) longitudinal section, F) tangential section; A-F) scale bar is 1 mm; G-H) *Joachimastraea barrandei* Galle et al. 1999, DPM-00276/Z35; I-J: *Grypophyllum jenkinsi* (Strusz 1966), DPM-00276/Z24; I) longitudinal section, J) vertical section; G-J) scale bar is 5 mm.

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Early Jurassic corals of the Pamir Mountains - a new fauna of transition between the Triassic and Jurassic

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Early Jurassic corals are known in the SE Pamir Mountains beginning in the Hettangian/Sinemurian (Fig. 1). In the Pamirian Jurassic sequences, two structural zones with differing facies development can be distinguished: the south-western Ghurumdy zone, and the north-eastern Mynhadjir zone. Strata in both zones were deposited in the same southeastern Pamirian sedimentary basin, on two sides of an inner, Istyk Uplift (Dronov & Melnikova 1987) attaining considerable thicknesses.

Jurassic sedimentation began on both sides of the uplift by deposition of two suites of transgressive conglomerates discordantly overlying Permo-Triassic sequences: the Darbazatash suite on the south and the northern Kizylbeless suite. In both zones, sedimentation was followed by deposition of carbonate suites provided with the same names as the zones: Ghurumdy suite and Mynhadjir suite. They are composed of limestones with diverse lithologies, in the Ghurumdy suite, with a Hettangian-Sinemurian age indicated by ammonites of the Schlotheimiidae. The lower part of Mynhadjir suite is considered to be of the Hettangian-Sinemurian age as well. The above suites are covered by suites Sedek and Zormynhadjir, composed of black, well striated limestones.

Series	Stage	Structural Zones	
		Mynhadjir zone at NE 300-900m	**Ghurumdy zone** at SW 560-1275m
Middle Jurassic	**Aa**	Zormynhadjir suite	Sedek suite
Lower Jurassic	**T**		
	P		
	S	*corals* Mynhadjir suite *corals*	*corals* Ghurumdy suite *corals*
	H	Kizylbeless suite	Darbazatash suite

Fig. 1: Distribution of Early Jurassic corals in the SE Pamirs

In the lower Ghurumdy sub-suite, a well diversified coral fauna is known: the solitary forms *Archaeosmilia, Cylismilia,* phaceloid genera, *Archaeosmiliopsis, Prodonacosmilia, Intersmilia, Proaplophyllia* and lamellate colonial forms *Eocomoseris* (Melnikova 1975, 1989, Melnikova & Roniewicz 1976; Melnikova et al. 1993). In the coeval lower part of the Mynhadjir suite, *Cylismilia* has been found.

In the both suites, the upper sequences contain organo-detritic limestones and fine-grained oolitic limestones, and are considered to be of the Sinemurian age. In the upper Ghurumdy sub-suite, phaceloid corals, *Pachysmilia* and *Stylosmilia* are present (Melnikova 1989). Different ecological types of corals, massive colonial forms, are known in the upper Mynhadjir sub-suite, mentioned in Dronov & Melnikova (1987).

Among the earliest Early Jurassic corals from the Pamirs, Triassic genera such as *Stylophyllopsis* and *Elysastrea* are recognizable. A coral of special interest is the phaceloid pachythecal genus *Pachysmilia,* a Triassic relic of the family *Zardinophyllidae*. Another Triassic relic is a regularly porous, meniana-bearing coral, *Eocomoseris (*MELNIKOVA et al 1993). With this coral, the *Microsolenidae*, one of the most abundant and important families of the Late Jurassic and Early Cretaceous, here makes its appearance in the Early Jurassic. Another family typical of the Late Jurassic, the *Stylinidae*, also being known from the Early Jurassic of Morocco, and the *Archaeosmiliidae* known from the Moroccan Early Jurassic (BEAUVAIS 1986), are present. The remaining genera, *Cylismilia* (*Donacosmiliidae), Prodonacosmilia,* and *Intersmilia (Intersmiliidae*) are represented in Late Jurassic faunas of Europe (MELNIKOVA & RONIEWICZ 1976).

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French palaeontologists and the study of Palaeozoic corals in North Africa in the XXth century.

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The Devono-Carboniferous strata of Northern Africa, which rich in corals and other reefal organisms, were not well known prior to the First World War. Later, intensive research was carried out, often for natural resources as petroleum and gas, in those countries then depending on France (mostly in Morocco and Algeria), but also in neighbouring regions. The first palaeontologists which worked on corals and reefal organismens were Dorothée LE MAÎTRE and Geneviève TERMIER – the later usually publishing papers with her husband, Henri TERMIER.

Dorothée LE MAÎTRE (1896-1990) was born in Brittany. She studied in Lille at the Université catholique, where she presented in 1928 for her first degree a work on Devonian faunas from the Avesnois (Northern France), and six years later, in 1934, her doctoral thesis on the Devonian limestones of the Loire region (Ancenis). She concentrated her attention on corals, Tabulata and Rugosa, and on stromatoporoids. Already before the Second World War, she took part in field campaigns in Morocco, and later in Algeria, to study numerous outcrops and to gather large collections. She carefully described these faunas in thick monographies, but she also published many short notes on new taxa, or on the stratigraphical value or palaeogeographical significance of the fossil corals. A large monography on the Devonian tabulate corals of Northern Africa was in good way of preparation when she retired in 1966 from Lille to Britanny, where shed died in 1990, without finishing the work which remains unpublished. In the same way, many faunal lists, where she identified fossils collected by petroleum geologists, remained in unpublished reports of oil companies.

Geneviève DELPEY (1917-2005), born in Paris, was a very skillfull student, not only in Science but also in Art, where she exceled in drawing – this explains why she drawed thousands of fossils and animal during her long scientific career! After a brilliant thesis on Mesozoic gastropods from Lebanon, at the Sorbonne in 1939, she went to Morocco in 1942, where she married in 1945 Henri TERMIER (1897-1989), the nephew of the famous French geologist Pierre TERMIER (1859-1930). Henri TERMIER was then the director of the geological survey of Morocco. They moved in 1946 to Algiers, to teach at the university, and returned in 1955 to France, where Henri obtained a chair at the Sorbonne University. They published together many books, treatises (e.g. Histoire géologique de la biosphère, 1952) and of course a huge quantity of papers on all possible subjects in palaeontology. A small part of this very large scientific production is dealing with corals and "sponges" sensu lato. Even if their interpretations are often questionable, the observations always revealed a very acute look, reflected in the numerous inimitable drawings – making from these works an interesting contribution to the knowledge of the faunas.

All these faunas are in urgent need of revisions – they of course constitue a fondamental element to understand the palaeogeography of the Devono-Carboniferous.

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Tithonian-Berriasian shallow-water corals from Poland

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In Poland, Tithonian and/or Early Berriasian shallow-water corals occur in exotic limestones in the Outer Carpathian flysch sediments and in Tithonian-?Early Berriasian carbonates of the Carpathian Foreland.

Outer Carpathians (Tethyan realm). Abundant shallow-water corals occur in creamy, rarely in grayish, organodetritic, exotic Štramberk-type limestones (olistholites, blocks and pebbles) from the uppermost Jurassic, Cretaceous and Paleogene flysch deposits of the Skole, Subsilesian and Silesian units, rarely also in the Magura Unit.

The Tithonian, mainly Late Tithonian and/or Early Berriasian age of corals from these exotic limestones is exactly determined on the basis of abundant macrofaunas, stomiospherids, calpionellids and foraminiferids, which co-occur with the corals.

The taxonomic composition of the coral assemblages from these limestones (about 100 species of about 40 genera; OGILVIE 1897; GEYER 1955; MORYCOWA 1964, 1968, 1974; KOŁODZIEJ 1995, 1997, 2003) is close to, but less diverse than, the Late Tithonian-Early Berriasian limestone assemblages from the Štramberk region (120 species of 50 genera; ELIAŠOVA 2008) in the Silesian Unit of the Czech Outer Carpathians (e.g., OGILVIE 1897; GEYER 1955; e.g. ELIAŠOVA 1973, 1975, 1976a, 1976b, 1981).

In the Štramberk-type limestones, the species from the order Hexanthiniaria MONTANARO-GALLITELLI, suborder Pachythecalina ELIAŠOVA and from the order Scleractinia BOURNE, suborders: Stylinina ALLOITEAU, Rhipidogyrina RONIEWICZ, Faviina GREGORY dominate. These coral assemblages are in particular characterized, e.g. by the abundance of species and genera from the suborder Pachythecalina (22 species of 14 genera, while in Štramberk limestones in Moravia: 35 species of 17 genera; KOŁODZIEJ 2003).

According to the generally accepted view, the Tithonian-Berriasian exotic limestones have been derived from shallow-water northern marginal part of the Carpathian basins, as well as from the inter-basinal ridges (cordilleras).

Carpathian Foreland (Peri-Tethyan region). The shallow-water scleractinian corals have been investigated in cores from several boreholes located in the central part of the Polish Carpathian Foreland. They are from the upper part of the Upper Jurassic deposits, almost entirely from the "coral and algal limestone formation" (Swarzów Limestone Formation; MATYJA & BARSKI 2007). This formation, 140-180 m thick (MORYCOWA & MORYC 1976), accumulated in the shallow, epicontinental, northern margin of the western Tethys Ocean. The Tithonian age of this formation was assumed on the basis of the the organic cysts of Dinoflagellata (MATYJA & BARSKI 2007) and calpionellids (MORYCOWA & MORYC, in press). The upper part of this unit may belong to Lower Cretaceous, to the Berriasian (MATYJA 2009; MORYCOWA & MORYC , in press).

In the investigated formation, corals occur as dispersed coralla or as small patches (MORYCOWA 1985). About 40 coral species of 26 genera were described from the deposits of this formation. All taxa, except one (from Hexanthiniaria), belong to the order Scleractinia BOURNE. The most frequent and diversified are corals from the suborders: Stylinina ALLOITEAU, Faviina VAUGHAN & WELLS, Fungiina VERRILL (mainly Thamnasteriidae) and Microsolenina MORYCOWA & RONIEWICZ. The almost complete absence of the representatives of the suborder Pachythecalina ELIAŠOVA (order Hexanthiniaria) is a characteristic feature of this assemblage. In contrast, the representatives of this suborder are abundant in the Štramberk limestones in Moravia (Czech Outer Capathians) and in the Štramberk-type limestones in the Polish Outer Carpathians.

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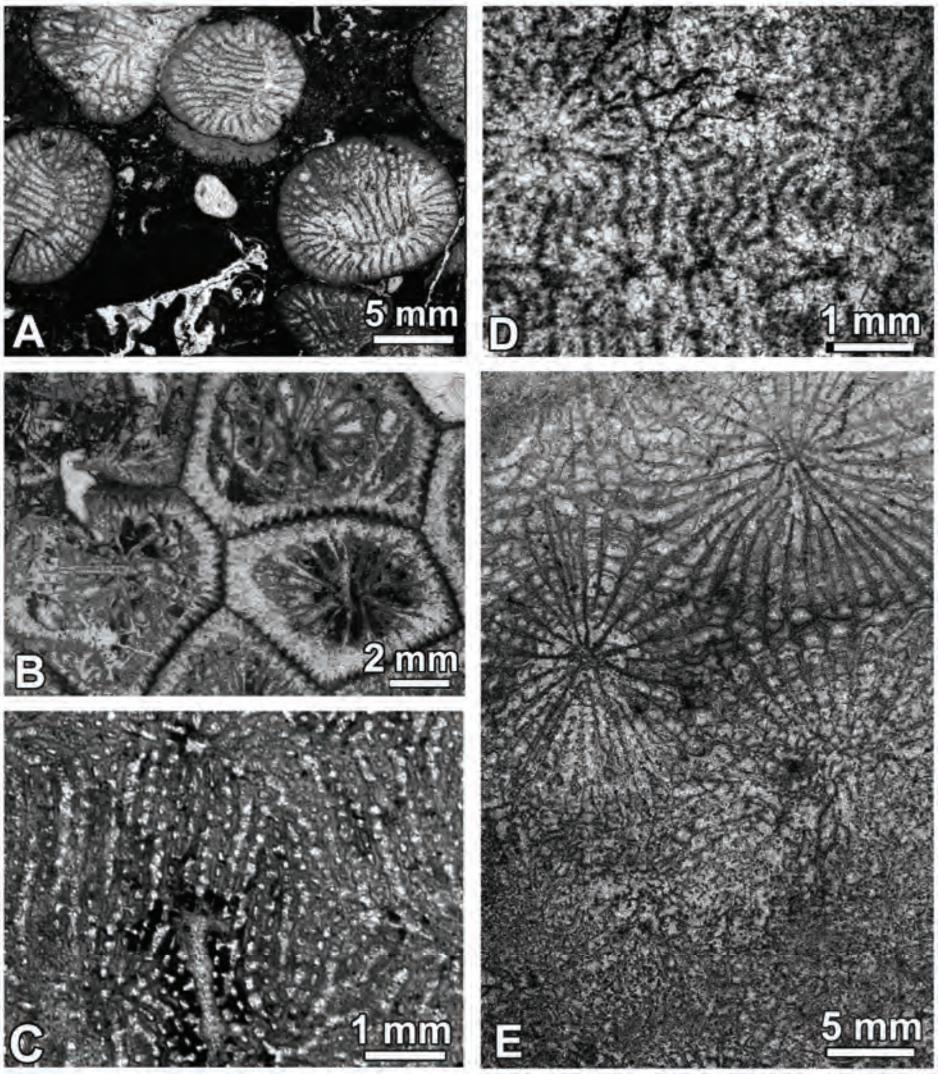

Fig. 1: A. *Pseudopistophyllum woznikensis* Morycowa, Upper Tithonian (exotic), Outer Carpathians (Morycowa 1974). B. *Amphiastrea basaltiformis sensu* Koby, Upper Tithonian (exotic), Outer Carpathians (Morycowa 1964). C. *Microsolena exigua* Koby, Tithonian, Carpathian Foreland. D. *Thamnasteria concinna* (Goldfuss), Tithonian, Carpathian Foreland. E. *Isastraea bernensis* Etallon, Tithonian, Carpathian Foreland.

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The Belgian collections of fossil Cnidaria and Porifera

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The main Belgian collections of fossil Cnidaria and Porifera are housed at the Geology Department of the Liège University and at the Royal Belgian Institute of Natural Sciences (Brussels), respectively. However, it was GOLDFUSS (1826) who collected the first Devonian corals in this country, but these specimens are stored in the Paläontologische Institut of the Bonn University in Germany.

The historical collections of fossil corals curated at the Liège University were gathered chiefly by G. DEWALQUE (1826–1905) and H. FORIR (1856–1907), who were involved in the geological mapping survey of Belgium at the end of the 19th century and at the beginning of the 20th century. Most of these specimens were recovered from the Devonian and Carboniferous marine succession of southern Belgium (Namur-Dinant Basin). These historical collections notably include a huge amount of specimens coming from the historical type area of the Tournaisian Stage, i.e. the Tournai area, which were acquired mainly by purchases. Nonetheless, the core of the coral collections of the Liège University has been made since the 1970's by E. POTY and his MSc and PhD students (e.g. POTY 1981 and references below, BOLAND 2002), whose research was mostly dedicated to the rugose coral faunas from the Tournaisian and Viséan of the Namur-Dinant Basin. Furthermore, they also constituted an important collection of rugosans, tabulates and heterocorallians containing several thousands of specimens, which were recovered from contemporaneous strata in various parts of the world (e.g. Australia, China [XU 1996], France, Ireland, Poland, Russia, Turkey, etc.). The Devonian collection is less developed and essentially includes material from the Givetian, Frasnian and Famennian of southern Belgium. Accessorily, we can also mention the small collections of Ordovician (Asghill) rugose corals (TOURNEUR et al. 1993) from the Sambre-et-Meuse strip (Belgium) and of Jurassic hexacorallians (LEJEUNE 1935) from the Belgian Lorraine.

Numerous types and illustrated specimens are stored at the Liège University such as those described by DE KONINCK (1876), SALÉE (e.g. 1910), and, more especially, POTY and his students (e.g. POTY 1981, POTY & BOLAND 1996).

The Royal Belgian Institute of natural Sciences (RBINS) has a very rich collection of fossil corals and stromatoporoids coming mostly from the Devonian of Belgium.

The main part of the Devonian collection of the RBINS was gathered by E. MAILLIEUX (1875–1946) and M. LECOMPTE (1902–1970). During the working years of M. LECOMPTE at the Institute, more than 29,000 specimens of stromatoporoids, rugose and tabulate corals were sectioned and converted into thin sections. Moreover, M. LECOMPTE became a famous specialist in tabulate corals and stromatoporoids and he published several monographs on these subjects between 1933 and 1952 (e.g. LECOMPTE 1939, 1951, 1952). He was also the contributor for the chapters devoted to the rugose and tabulate corals in the *Traité de Paléontologie* directed by J. PIVETEAU in 1952 and for the stromatoporoids in the Treatise on Invertebrate Paleontology edited by R.C. MOORE in 1956.

Some of the Devonian rugose corals stored in the Museum of Brussels were investigated by SORAUF (1967) from the USA and by H.H. TSIEN. The latter, who was attached until 1990 to the Palaeontology Laboratory of the Catholic University of Louvain, first in Leuven, then in Louvain-la-Neuve, published several important papers (e.g. TSIEN 1969, 1978). The collection of tabulate corals studied by M. LECOMPTE was partly revised by TOURNEUR (1985) during his PhD thesis. From 1974, detailed field studies allowed M. COEN-AUBERT to constitute a new collection of rugose corals composed of more than 10,000 specimens. They were mostly sampled in the Middle Devonian and the Frasnian of Belgium, but also in the Eifel Hills in Germany, the Holy Cross Mountains in Poland, the Tafilalt and the Ma'der in Morocco (e.g. COEN-AUBERT 2009). It can be added that during the years 2009 and 2010, some Devonian rugose corals collected by M. COEN and H.H. TSIEN and previously stored in the Geological Institut at Louvain-la-Neuve were moved to Brussels.

Carboniferous corals are not so well-represented in collections of the RBINS contrary to their Devonian counterparts. As for the Belgian material, the collection of L. G. de KONINCK (1809–1897) comes mainly from the Tournaisian of Tournai and the Viséan of Visé. Some of these specimens were revised by POTY (1981) who also investigated some rugose corals collected by E. DUPONT and F. DEMANET. Finally, the Devonian and Carboniferous corals collected by CHARLES (1933) in Anatolia (Turkey) are also curated at the RBINS though his study was carried out at the Liège University. Of course, the types and illustrated specimens of all the papers mentioned in the paragraphs about the RBINS are housed in this institution.

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Preliminary data on Early and Middle Famennian (Late Devonian) rugose and tabulate corals from southern Belgium

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Corals were severely affected by the Late Frasnian mass extinction and it is generally admitted that this major biological crisis preferentially affected the taxa living in shallow waters (e.g., Sorauf & Pedder 1986). In southern Belgium (Namur-Dinant Basin), the last Frasnian corals disappeared in the Late *rhenana* conodont Biozone, ie. below the Upper Kellwasser Event. Their decline, which began in the Early *rhenana* Biozone, is a progressive phenomenon as is the case for the brachiopods (e.g., Poty & Chevalier 2007, Mottequin & Poty 2007). Their rarity in the Early and Middle Famennian siliciclastic succession of the Namur-Dinant Basin is probably due to unfavorable facies and ecological conditions. From the rugose coral standpoint, it was not until the base of the Latest Famennian (Strunian) that a major radiation began with the appearance of several new taxa developing morphological features, which are, for some of them, usually typical of those of Carboniferous age (e.g., Poty 1999).

Early Famennian rugose corals are particularly rare in southern Belgium as only a single reliable occurrence has been reported until now. Paquay (2002) illustrated small solitary non-dissepimented forms assigned to *Metriophyllum* from the lowermost part of the Hodimont Formation in the Vesdre area (Lambermont). These corals were collected from the beds immediately above an oolitic ironstone level (Dreesen's (1982) level I), which corresponds to a condensation horizon comprising least the Late *triangularis* and the Early *crepida* biozones (Dreesen 1982). Poty's (1986) record of *Neaxon* in the early Famennian-aged Famenne Formation has been rejected subsequently by this author (Poty 1999) as a thorough revision of the specimens and the sections yielding them has not confirmed this record. Although they are not frequent, Early Famennian auloporids (Tabulata) occur in the shaly Famenne Formation. They are found attached to brachiopods, which represented most probably the only hard substrate available for these encrusting organisms, such as those, illustrated by Mottequin (2008), fixed on the ventral and dorsal valves of the orthotetid *Floweria pseudoelegans* from the Early (?)/Middle *triangularis* biozones.

Middle Famennian rugose corals have been reported on several occasions in the calcareous siltstones of the Souverain-Pré Formation, notably by Bouckaert & Dreesen (1977), who pointed out the presence of solitary forms in the Badon section among a rich brachiopod fauna (Latest *marginifera* Biozone) (see also Dreesen 1978). They were subsequently assigned to an unidentified small-sized species of *Breviphrentis* by Poty (1999), who also reported the occurrence of an undescribed species of *Catactotoechus* (=*Hillaxon*?) in the Chevetogne section (Late or Latest *marginifera* Biozone). Furthermore, the Chevetogne section has yielded some auloporids. Recent sampling of the Sivry section, where Marion & Barchy (2004) previously reported small solitary rugose corals, led us to enlarge the number of representatives of this small coral fauna, which is associated with crinoids, bryozoans, and spire-bearer (spiriferids and athyridids), orthid, and rhynchonellid (*Centrorhynchus letiensis* group) brachiopods.

The shales of the Sains-du-Nord Formation in the Etroeungt area (N. France) also belong at least partly to the *marginifera* Biozone. They have yielded large-sized solitary corals (Poty 1999) which could be assigned either to *Breviphrentis* or to *Breviphyllum* on the basis of the development or not of dissepiments in relation with constrictions and rejuvenescences. Therefore, they belong to a "Lazarus taxon" as *Breviphrentis* and *Breviphyllum* have never been recorded after the Givetian (Middle Devonian).

All these Middle Famennian corals became extinct well before the first Famennian coral radiation, which took place in the upper part of the stage.

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Early Katian heliolitids of Estonia

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The oldest heliolitids (Coccoserididae) of early Katian age from Estonia are analysed. Only two species appeared in the Oandu Stage. One species is found in the reef facies of the Vasalemma Formation and the other is collected from the marls of the Hirmuse Formation. The first species grew wide on the sediment surface and it formed tabular coralla with irregular shapes. The second species encrusted brachiopods, gastropods and it formed small domal and bulbous coralla. Their affinities with *Coccoseris ungerni* EICHWALD and *Protaraea richmondensis* FOERSTE are discussed.

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Devonian Stromatoporoids from Vietnam: biodiversity and affinities.

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Publications devoted to Devonian stromatoporoids in Vietnam including some systematic aspects are relatively numerous (more than twenty) and probably more than in a lot of others countries, excepted Russian areas.

In fact, if more than twenty papers are involved with stromatoporoid description and distribution in Vietnam, essentially published during the last sixty last years, rarely the Vietnamese faunas are cited or used in order to develop analyses or interpretations such as palaeobiogeographic reconstructions. The mean reason is the fact that many of those palaeontological studies have been published in local journals through low diffusion level and generally not accessible to other researchers interested on the group. Only three of these papers were published in journals in foreign countries (Dong De Yuan 1964; Tong-Dzuy Thann et al. 1988; Nguyen Huu Hung & Mistiaen 1997). Consequently, the majority of those papers are not really diffused. As a direct result, for instance in the Stearn et al. (1999) - abridged presentation of the new Treatise - only five stromatoporoid genera (*Actinostroma, Plectostroma, Trupetostropa, Hermatoporella* and *Vacuustroma*) are cited from the Devonian of Vietnam, and two genera (*Clathrodictyon* and *Amphipora*) considered as cosmopolitan are considered as beingpresent, whereas looking to the data base elaborated from the listed papers for the present purpose, nearly thirty other genera have been recognized in Vietnam. Thus, only about 20% of the present genera are documented.

In the same way, none stromatoporoids genus is referred with a Famennian age, even if in reality they are abundant and well diversified for instance in North Central Vietnam (Phong Nha – Ke Bang National Park outcrops).

Always on a generic level, two new genera have been proposed, based on material from Vietnam i.e. *Vacuustroma* Hung & Mistiaen 1997, *Vietnamostroma* Hung & Mistiaen 1998, (and also another one *Truongsonella* Hung & Mistiaen in press). But at that time, only the genus *Vacuustroma* is in addition recognized in another country.

On the same manner and on a specific level, between 1965 and nowadays, more than twenty five species have been proposed as new species, based on material from the Devonian of Vietnam, but, at the present time, none of them has been recognized in other places in the world.

Thus the purpose of the present work is to establish a data base, as complete as possible, for all Devonian stromatoporoids from Vietnam and also to analyse and point out a number of palaebiogeographic affinities relatively to the Vietnamese stromatoporoid faunas.

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Skeletal fusion of probable clonal fragments in *Acropora*

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Modern reef-building corals inhabit high energy environments. Waves and currents are capable of causing physical damage to coralla, such as fragmentation, as well as generating and mobilizing large sediment clasts. Corals have developed various defence mechanisms to adapt to sedimentation events (e.g., HUBBARD & POCOCK 1972). Scleractinia can reject sediment to a certain degree by means of morphological adaptations and by directed behaviour of the soft parts. Some studies have documented coral communities in gravel-cobble dominated environments (e.g., BRAGA et al. 1990; PERRY & SMITHERS 2009), but the effects of such large sediment on corals is poorly understood. Relatively little research has been conducted on the incorporation of foreign material into scleractinian coral skeletons, and incorporation of gravel and pebble sized sediment has only rarely been documented. Regardless, corals in reef environments are commonly impacted by large debris, and that debris is in some cases incorporated into the growing colony (e.g., NOTHDURFT et al. 2011). Most of the gravel produced in clean reef environments consists of broken skeletal material, such as coral branches. Here we report on two different outcomes when a colony received pebble-sized coral debris during a sedimentation event.

Pebble sized *Acropora* branch sections were observed enclosed within the skeletons of subfossil *Acropora* coral skeletons collected from a beach at Bargara, Australia. They are encased within the skeleton in the same way as other – non-carbonate clasts (Fig. 1A). In all cases, the cavities are primarily lined by obvious clypeotheca. These coral branches are interpreted to have been dead when deposited on the living coral surface becausethey are moderately adraded. In other cases, clearly broken and redeposited *Acropora* fragments were found to have been incorporated onto existing colonies (Fig. 1B) on the reef flat on Heron Reef, an enclosed lagoonal platform reef, approximately 70 km from the mainland coast of Australia in the southern Great Barrier Reef. In this case, the branches rested at odd angles on the larger colony and were then fused into place by coral growth both from the underlying colony and the branch itself. Samples were collected for microstructural analysis on polished and etched sections with scanning electron microscopy (SEM) and x-ray computer tomography.

The fused coral branch has come to rest in horizontal orientation amongst surrounding branches in the underlying corallum that are predominantly upright (Fig. 1B). The axial corallites of the horizontal clast and the upright branches that it is fused to are perpendicular to each other. Either end of the broken branch is completely covered with growing corallites of similar architecture to those in the rest of the corallum. At the depressed junction between the fused branches closely-spaced smaller corallites occur with no lips. Underlying and overlying corallites directed toward the junction of the branch and corallum do not appear to change direction and must terminate, but the exact nature of the process is not clear. Corallites over the top of the fused branch appear to originate from the branch and from the underlying colony with no discernable juncture. There appears to be a large amount of thickening deposits in the broken branch (Fig. 1C) where synapticulae have completely filled areas between septa, costae and ceonosteum. Importantly, the broken end of the clast branch was completely covered by subsequent corallite growth.

We interpret the fused branches as most likely representing sections of the same genotype (i.e., genetic clones) as they were so readily incorporated into the underlying colony. However, no genetic analyses have so far been carried out to test that hypothesis. It is possible that they might represent a different genotype within the same species, but it seems more likely that the branches came from clones. Fragmentation of coral colonies is an important mode of reproduction for certain corals (HIGHSMITH 1982) and asexual reproduction and fragmentation is an important process of replication/propogation of colonies in high energy reef settings. This process has been documented particularly in branching colonies of the genus *Acropora*. The degree to which this process occurs is largely dependent on the morphology of the colony and recurrence rate of disturbances, such as storms or cyclones that can cause physical damage to coralla, but it is likely that on a given section of reef flat many nearby colonies of a given *Acropora* species could represent clones. Hence, disturbance events causing fragmentation and resedimentation could in some cases distribute branches of one genotype onto a colony of like genotype. Significantly, the coral branches did not obviously appear to have been broken off of the host colony, although that is a possibility, but they may have been transported laterally. Regardless, they were not washed off of the colonies subsequently. Rather, they must have been held down, perhaps partly by interaction of the polyps in the underlying corallum and or the branch. That soft tissues responded relatively quickly to the clast is suggested by the fact that the broken end of the branches were not colonised by other benthos before they were overgrown by new coral skeleton. Hence, soft tissues may have expanded over the broken branch ends relatively quickly and this may help anchor the branches into place before skeletal fusion occurred.

Hence, we have demonstrated that live coral branches produced during a disturbance event may come to rest on probable genetic clone colonies and become fused. The retention of branch fragments on colonies in high energy reef flat settings suggests an active role of coral polyps to recognise and fuse with each other. This ability may represent an adaptation to help heal damaged colonies where branches were broken, but not removed from the host colony. Such an adaptation may be important for protecting colonies from invasion by parasites and other benthos following disturbance events.

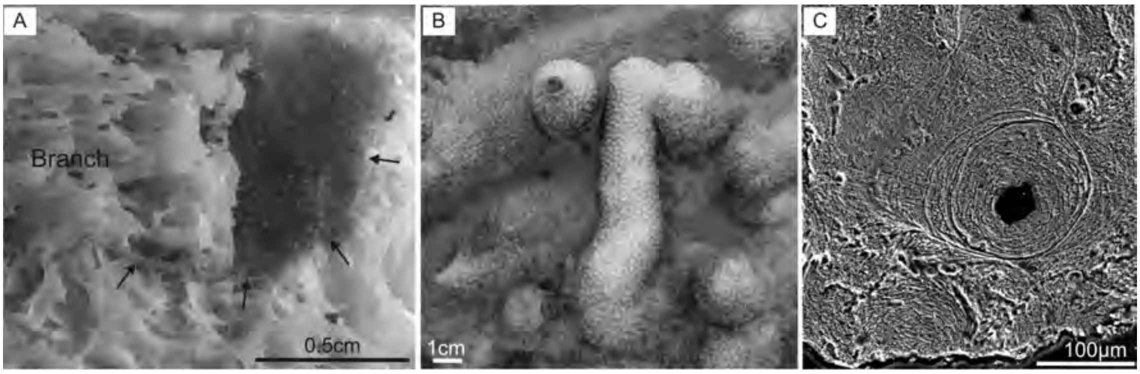

Fig. 1: A) Pebble clast of an *Acropora* branch encased with a cavity in another colony of *Acropora sp.* lined with clypeotheca (arrows). B) Photograph of fused coral branch alive on the reef flat of Heron Reef. C) SEM image on a polished and etched section of large amount of thickening deposits in the broken branch.

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Incorporation of gravel into coral skeletons: Formation of clypeotheca during sediment contact

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Knowledge of the skeletal response of corals to environmental stress may enable the frequency of certain types of stress (e.g., disease, bleaching, inundation by sediment) to be documented in past environments. Such data are important for understanding the nature of reef dynamics through intervals of climate change and for monitoring the effects of possible anthropogenic stress in modern coral reef habitats. Understanding the mechanisms of coral resistance to stress is particularly important given the recent increase in prevalence of disease, thermal anomalies and pollution.

Clypeotheca (Nothdurft & Webb 2009) represents a new mechanism of skeletal repair in scleractinian corals in response to sedimentation stress and provides further insights into biomineralisation and colonial biology of corals. Clypeotheca is recognised as a layer of skeleton that is secreted over the surface of the coral colony sealing off former corallites from beneath as the living tissues retract. It forms from inward centripetal skeletal growth at the edges of corallites and by the merging of flange-like outgrowths that surround individual spines over the surface of the coenosteum. Clypeotheca construction may allow scleractinian corals to rapidly respond to stress by adjusting their colonies in response to particular threats from invasion of unhealthy tissues by parasites or disease by retracting tissues in areas that have become unhealthy for the polyps. Production of clypeotheca records a clear and identifiable record of stress in the skeletal morphology, making it preservable in the fossil record.

The aim of this study was to determine if clypeotheca represents a protective function against skeletal damage from individual sediment particles. It has previously been observed that clypeotheca occurs around areas of damage in coralla, and in some cases areas that may have been damaged by sedimentation events. We have also observed clypeotheca distributed at irregular horizontal intervals on branching corals that may be related to intermittent partial burial events on reef flats. However, the preservable skeletal effects of sedimentation involving larger clasts, such as granules and pebbles, have not been well documented. Here, we present results on the modification of coral skeleton formation to deal with such larger sediment clasts. Samples represent Mid-Holocene and live-collected coralla from four locations on the southern coast of Queensland including both gravel-rich beaches, fringing reef flats and platform reefs. In both cases the corals occurred in high-energy littoral settings among abundant coarse debris. The samples were characterised using optical microscopy, scanning electron microscopy (SEM) and computer tomography (CT).

Several types of grains were observed enclosed within the skeletons of the corals selected for study, including non-carbonate laterite, basalt and quartzite grains and carbonate grains, including *Halimeda*, mollusc fragments and coral branches. All types of grains were observed to be encased completely within cavities within the coral skeleton by subsequent coral growth. The cavities are primarily lined by obvious clypeotheca (Fig. 1).

Few examples of skeletal modification as a result of environmental stress have been documented previously in scleractinian corals. However, clypeotheca has now been observed in at least four common reef-building coral genera, including mid-Holocene corals from the Great Barrier Reef, dead reefs in

Moreton Bay and rocky headlands along the Queensland coast. Recognition of stress-related coral morphology may aid identification and interpretation of environmental stress events in ancient and living coral reefs, providing both a management tool and a new data set for understanding the effects of climate change and human interference in reef environments.

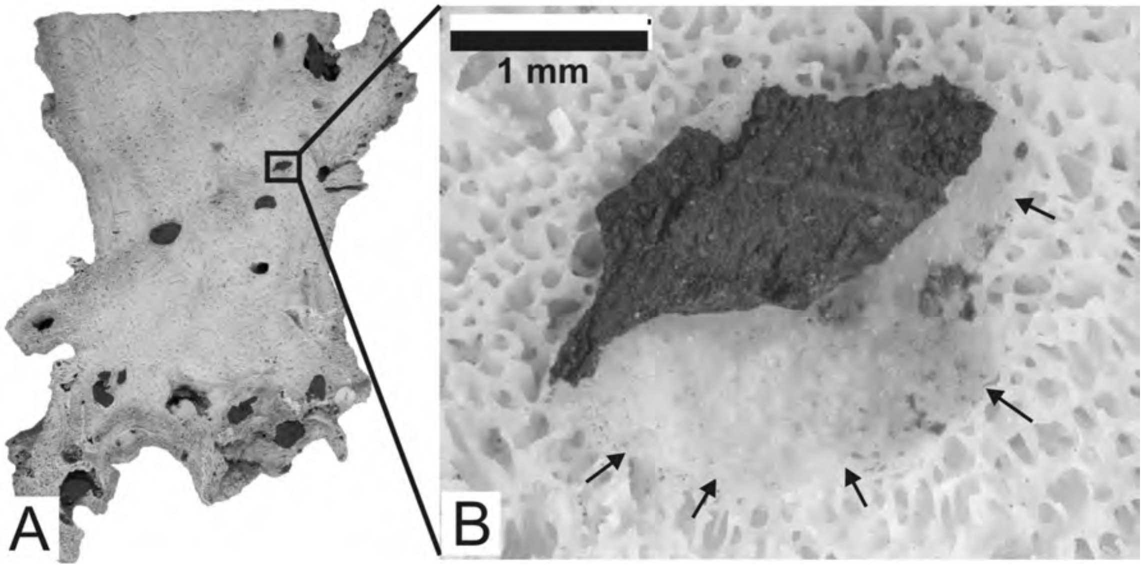

Fig. 1. Photographs of a section cut through an *Acropora* sp. sample collected from Moreton Bay, Australia. A) Numerous laterite pebbles contained within the corallum. B) Enlargement of one pebble contained within a cavity lined by clypeotheca as marked by arrows.

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Carboniferous buildups in the Donets Basin (Ukraine)

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The Carboniferous deposits of the Donets Basin contain organic buildups at different stratigraphic intervals and built by various organisms (Fig. 1). Some of these buildings were known previously, but many of them are described for the first time. Among organogenic constructions studied in this region biostromes and bioherms are identified.

The Tournaisian and most of the Visean deposits are represented by a half kilometer thick layer of laminated bioclastic limestones formed in carbonate platform conditions (the Mokrovolnovakha series). From the top of the Visean Stage up to the top of the Upper Carboniferous the section is represented by cyclic coal-bearing series. This multikilometer series was formed as a result of frequent alternation of marine and continental conditions.

The Upper Visean coral buildups are studied in the Southern Donets Basin for the first time. In the middle part of the Donetsk suite C_1^vf near the village Styla a coral biostrome build by fasciculate colonies of *Siphonodendron junceum* (Fleming) with a visible length of about 3 m and height of about 1 m is distinguished among the layered limestones with gigantoproductid brachiopods. The Upper Serpukhovian coral bioherms were described in detail by Poljakova (1986). These rather complex bioconstructions are built up by colonial rugose corals (*Siphonodendron, Lonsdaleia, Aulina,* and *Lithostrotion*), chaetetids (*Chaetetiporella*) and stromatoporoid-like fossils (*Kyklopora*). Colonies form a carcass enclosing solitary rugose corals, as well as algae, bryozoans, foraminifera, brachiopods, gastropods and other organisms. Bioherms and biostromes compose a group of continuous limestone D_1 and D_5. Their thickness ranges from several to 11 meters. Drilling results show that the thickness of these structures can grow to several tens of meters.

Lower Carboniferous coral biostromes similar to those described in the Donets Basin are known in Western Europe – in Belgium, North-western Ireland, Spain and other countries where bioconstructors are also consist of *Siphonodendron* colonies and other colonial rugose corals and chaetetids (Aretz & Webb 2007; Kuznezov & Antoshkina 2006; Somerville et al. 2003).

Middle Carboniferous organic constructions of the Donets Basin were not previously documented. Considerable in size colonies of the rugose corals *Lytvophyllum*, tabulate corals *Multithecopora* and chaetetids *Chaetetes (Boswellia)* occur in the lower part of the Bashkirian stage near the village Starobeshevo (limestone D_5^9, E_1, E_2).

Coral limestone K_8, L_5, and partly L_6 are studied in the Moscovian stage. They are regarded to be coral biostromes. The central parts (cores) of these constructions are composed of coral baundstone (colonies of *Donophyllum, Petalaxis*, and chaetetids). Along strike it is replaced by packstones and wackstone. The thickness of the limestone surrounding coral biostromes reaches 10 m.

For the first time probable microbial bioherms of Moscovian age were described in the Northern Donets Basin (Ogar 2007). They are located in the limestone L_6 and L_7. Unlike coral biostromes these buildings have a lenticular shape. Their cores are composed of massive biomicritic limestones. Macrofauna is rarely found. The characteristic feature of limestone texture is the presence of cylindrical channels, which are probably the traces of life of unknown biodestructors for which the author proposed the name *Tubulus* (from Lat. tubulus - tube). Nucleuses of bioherms are overlapped by loose crinoidal limestone with frequent fragments of other groups of fauna, among them massive rugose corals *Ivanovia* and *Petalaxis* and chaetetids. There is no doubt that these layers are part of the bioherms and can be regarded as reef trail. The apparent length of them ranges from a few tens to a few hundred meters with maximum thickness of 6-8 m.

Chaetetid-sponge biostromes are associated with the upper part of Moscovian deposits in the northern Donets Basin (limestone N_2 and N_3 near the village Kalynove). The height of chaetetid colonies forming these bioconstructions reaches 30-40 cm with strike length of 1.2 m. The biostrome consists of *Chaetetes* *mosquensis* Stuckenberg. Similar chaetetid biostromes are described in similar stratigraphic levels in the Moscow region and the USA (West & Clark 1984).

An Upper Carboniferous (Gzhelian) bioherme was earlier described in the same section. It is algal buildup up to 5,2 m in size that is associated with limestone O_6^1.

Thus, our data show that the formation of buildups occurred at various stages during the development of the Donets paleobasins. However, the compositions of bioconstructors have changed over time. In general, the appearance of the Carboniferous buildups in the Donets Basin corresponds to the periods of maximum diversity of various marine organisms.

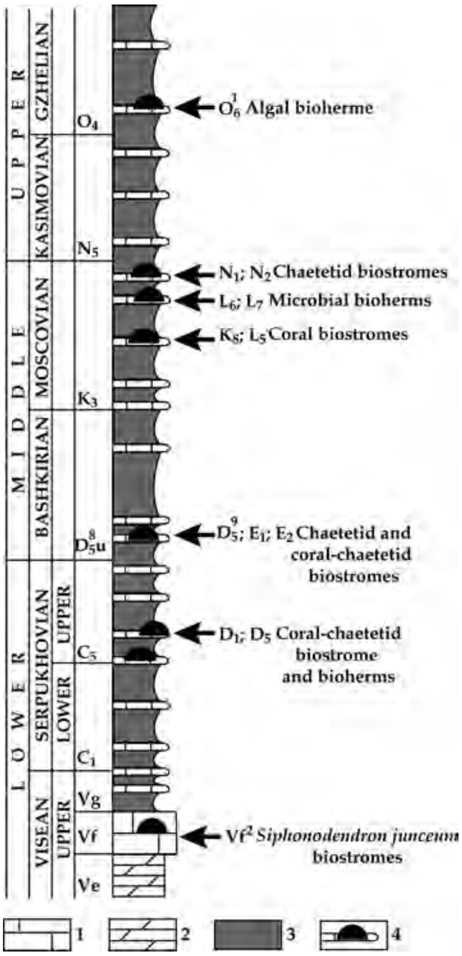

Fig. 1: Distribution of the Carboniferous buildups in the Donets Basin; 1: limestone; 2: marl; 3: alternation of sandstones, siltstone, shale and coals; 4: limestone with buildups.

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Visean corals of the Kiyasar area (North of Iran)

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Lower Carboniferous corals in the North of Iran have been studied in detail by FLÜGEL (1963) and KHAKSAR (1996). FLÜGEL studied mainly the Upper Visean corals from the Talartal and Semnan sections. From the Lower Visean he indicated only three species: *Siphonophyllia cylindrica cylindrica* MCCOY, 1844, *S. cylindrica latitabulata* (GORSKY, 1932) and *Caninophyllum archaici archaici* (MILNE-EDWARDS & HAIME, 1852).

Later KHAKSAR studied corals of the Mobarak formation in 8 outcrops, but they were mainly Tournaisian in age. For the Visean part of the sections he indicated only three species, also known in the Tournaisian sediments of the central Alborz Mountains. These are: *Amplexizaphrentis iranensis* KHAKSAR, *Kueichouphyllum alborence major* KHAKSAR and *Zaphriphyllum mobarakense* KHAKSAR. Thus, there were only fragmentary data on Lower Visean corals in the north of Iran.

The authors studied corals in the Kiyasar section, which is located in Northern Iran and the eastern limit of Alborz Mountains (latitude N: 36 14'18", longitude E: 53 32'57"). During the Early Carboniferous time the Alborz Mountains were part of the Gondwana margin (BRENCKLE et al. 2009). The Mobarak Formation includes alternations of thin to thick-bedded limestone, dolomitic limestone with interbedded shale and dark marl. Facies analyses show that this formation is composed of shallowing upward cycles, which are deposited on carbonate ramp.

The Mobarak Formations is conformably overlain by sandy limestone of the Geirud Formation (Upper Devonain) and covered with sandstones of the Dorud Formation (Lower Permian) (Fig. 1). The thickness of the Mobarak Formation in the Kiyasar section is 250 m. This formation can be divided into 4 units. Studied corals were collected from Unit 3 and partly from lower part of Unit 4. Unit 3 is 106 m thick, and starts with thick-bedded limestone and continues with alternations of medium-bedded limestone to a layer with ichnofossils and black shales and marl. Unit 4 has a thickness of 50 m which starts with dark marls and medium-bedded dolomitic limestone then continues with medium-bedded limestone and interbedded shale.

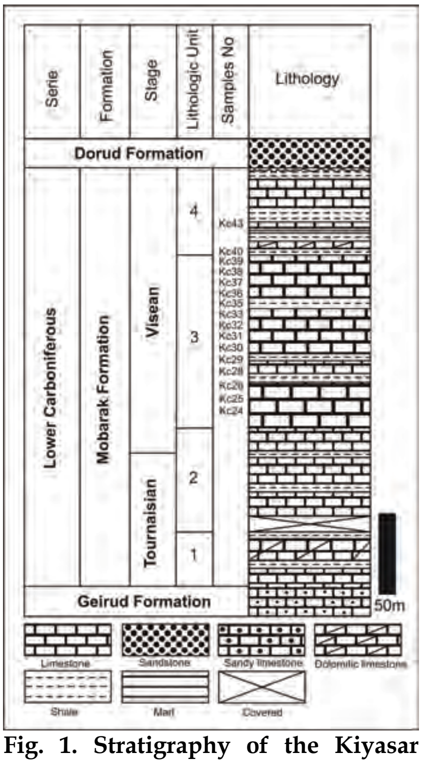

Fig. 1. Stratigraphy of the Kiyasar section

Most of the studied specimens are rugose corals (Fig. 2). Dominant genera are *Siphonophyllia*, *Bifossularia*, *Kueichouphyllum* and *Amygdalophyllum;* subordinate occur *Adamanophyllum*, *Clisiophyllum*, *Arachnolasma* and *Amplexizaphrentis*. Among the corals there is also the tabulate corals ?*Turnacipora* and the heterocoral *Hexaphyllia mirabilis* (DUNCAN, 1867). For many taxa it is the first record in this region.

Bifossularia from the Mobarak Formation is very similar to *B. ussowi* (GABUNIA 1919) from the lowermost part of the Visean of the Kuznetsk Basin (DOBROLYUBOVA et al. 1966). Many specimens belong to *Kueichouphyllum*. We have determined one as *K. gracile* YÜ, 1933. It was described for the first time in China as subspecies and then diagnosed as independent species in Armenian (PAPOJAN 1969). In Armenia this species occurres in uppermost lower Visean and the lowermost middle (?) Visean.

Turnacipora was separated from *Michelinia* by investigation of the fine microstructure of the walls (LAFUSTE & PLUSQUELLEC 1985). The specimens described by LAFUSTE & PLUSQUELLEC as *T. megastoma* occurred in the Visean and are similar to ours. *Hexaphyllia mirabilis* is also found only from Visean in many regions of the world.

Thus, in our opinion the studied corals can confirm the Lower-Middle Visean age of this part of the Mobarak Formation. They are different from those described by KHAKSAR (1996). A considerable amount of specimens belong to new species. In general, our conclusion about the age of the studied deposits corresponds to the determinations by foraminifera (BRENCKLE et al. 2009).

The peculiarity of the studied corals has their endemicity, appearing in a large number of new species of rugose corals. The absence of Syringoporidae and colonial rugose corals in the studied, which are found at that time in many paleogeographic regions of Asia (China (XU & POTY 1997), Kuzbas, and Tien-Shan) is unusual and confirms the conclusions about the features of paleogeography of this region (BRENCKLE et al. 2009).

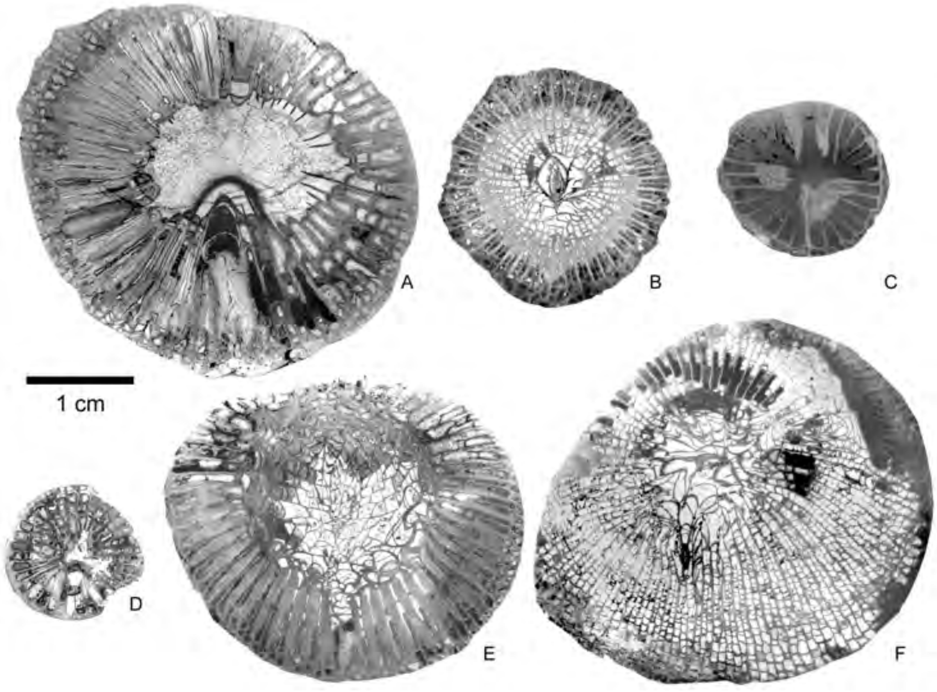

Fig. 2: Typical Rugose corals: A - *Bifossularia*; B - *Amygdalophyllum*; C - *Adamanophyllum*; D - *Amplexizaphrentis*; E, F – *Kueichouphyllum*

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Some problems of the taxa definition in the Heliolitida

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Different investigators use various taxonomical criteria for the description of the Heliolitida. It depends not only on (1) individual point of views, but also (2) on material that every investigator has and (3) the degree of the study of the group.

1. Individual point of view. Some investigators consider the colonies of the Heliolitida as polymorphic. They suppose that the coenenchyme is not a lateral or sole enlargement of polyps but small true polyps. So Bondarenko (1992) distinguished trimorphic, tetramorphic and pentamorphic colonies of the Heliolitida. Other scientists (Lindström 1899; Sokolov 1955; Beklemishev 1964; Ospanova et al. 2010) consider the coenenchyme only as connecting intermediate tissue between polyps.

2. Material. A long-term studies of the heliolitids of Central Tajikistan and their comparison with the heliolitids of other regions show that every region has their own "faunistical face" (Ospanova 2003). The complexes of the Heliolitida of different regions or limits of variation of the species can distinguish one from another. For example, the diameter of corallites of *Propora conferta* from Canada varies from 0.8 to 1.7 mm (Dixon 1974), and our specimens have corallite diameters of 0.5-2.0 mm. According to Bondarenko & Minzhin (1981), the diameter of corallites of *Propora speciosa* from different parts of the globe (Canada, Central Mongolia, Norway, Sweden, Latvia and Estonia) varies from 1.3 to 3.2 mm. However, our specimens have the diameter of corallites from 1.8 to 4.0-4.5 mm. As a result, synonymic of these two species can be more exact.

For Ordovician and Silurian Heliolitida of Central Tajikistan a broad development of autotomy is characteristic. On the bases of that, the using of the term *autotomy* in relation to the Heliolitida has been defined by me. Four types of longitudinal rugosity of corallites' cavities have been also established: undulatory, septate, autotomic and coenenchyme-dependent (Ospanova 2009). They can be used as additional morphological feature for diagnostics of taxa of the Heliolitida.

3. Degree of the study of the group. It is clear that after additional collections of colonies of the Ordovician and Silurian heliolitids of Central Tajikistan and after studying the variability of *Propora speciosa* (Bondarenko & Minzhin 1981; Ospanova 2001), that the species *Proporella rubanovi* Leleshus is younger synonym of *Propora speciosa* (Billings). Thus the genus *Proporella* is a younger synonym of the genus *Propora*.

The species *Propora ornata* has been established by Leleshus & Ospanova (1979). More detailed studies of that species after additional collections (161 additional examples) have allowed to include the species *Propora ornata* in the synonymy of *Propora conferta*. It should be marked that *P. conferta* is a very variable form and its structure is not argues does not correspond to the genus *Propora*. Thus it should be referred into a new genus.

Another problem for the taxa definition in the Heliolitida is parallelism. Many investigators showed transformation of vesicular coenenchyme to tubular or vesicular-tubular (Lindström 1899; Bondarenko & Stasinska 1976; Ospanova 1979, 1989, 1998, 1999.). Transformation of vesicular coenenchyme to tubular or vesicular-tubular is characteristic for such families of heliolitids as Khangailitidae Bondarenko, Helioplasmolitidae Ospanova, Wormsiporidae Ospanova, Ducdoniidae Ospanova, for genera *Laminoplasma*, *Eolaminoplasma*, *Avicenia* and so on. On the bases of that, many genera have been transferred from the suborder Heliolitina to the suborder Proporina.

Broad development of processes of transformation of coenenchyme corroborates self-dependency of the Heliolitida. However, there are hardships of the taxa definition of that group of corals. For example, the genus *Heliolites* includes 180-200 species (Bondarenko 1992). Compound character of the genus *Heliolites* is obvious.

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A lower Givetian Patch-reef (Hanonet Formation) from the Mont d'Haurs fortifications (Givet, Ardenne, France): environment, stromatoporoids and tabulate corals

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The Mont d'Haurs section (50°07'43" N; 04°49'20"E) is located on the eastern part of the Meuse river, and belongs to southeastern border of the Dinant synclinorium. The fortification outcrop (269 metres thick) includes a lithologic interval from the upper part of the Hanonet through the Mont d'Haurs formations (lower to middle Givetian). The work focuses on a succession of three ovoidal and reefal lenses belonging to the last 15 metres of the Hanonet Formation (Hubert 2009). Each patch-reef is 0.5 to 1.5 metres thick. A detailed sedimentological analysis and biological determination were performed bed by bed to constrain facies and faunal occurrences.

The Hanonet Formation corresponds to an alternation of dark argillaceous limestone, with local nodules and nodular limestone, and regularly centimetre-thick yellow-brownish shaly interbeds. The patch-reef body is surmounted by a distinct argillaceous interbed containing the solitary rugose corals *Calceola sandalina*. Two main microfacies were recognized and correspond to 1/Argillaceous Wackestone-Packstone with abundant and diverses bioclasts and bioturbation (MF1b, Préat & Mamet 1989), 2/ Argillaceous Boundstone-Floatstone with laminar stromatoporoids and tabulate and rugose corals (MF4b, Préat & Mamet 1989).

The biodiversity and morphology of stromatoporoids and tabulate corals were performed on 250 collected samples. Six species of stromatoporoids assigned to *Clathrocoilona*, *Stromatoporella* and *Stromatopora* and 15 species of tabulate corals assigned to *Favosites*, *Cladopora*, *Alveolites*, *Crassialveolites*, *Platyaxum*, *Roseoporella*, *Remesia* and *Syringopora* were recognized. Stromatoporoids and tabulate corals are growing on soft substrate. Morphological trends are dominated by lamellar (or laminar) and low tabular and can be interpreted as an adaptation to open marine environment and low to moderate agitation.

Clustering analyses using Hierarchical Cluster Analysis were performed in order to identify groups of similar taxa and recognized possible assemblages according to the macro and micro-facies. Moreover, a Detrended Correspondence Analysis (DCA - Hill & Gauch 1980) was performed to identify indirectly environmental gradients that may have influenced the distribution of faunas. Such an environmental gradient has been identified from four successsive biological assemblages: 1/ Trilobite-Algae-Bivalves, 2/Crinoid-Brachiopod-Bryozoan-Ostracod, 3/ Stromatoporoid-Tabulate coral-Worm-Bioturbation, and 4/Rugose corals. This faunal distribution indicates an environmental gradient from classical open-marine to reefal faunas.

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New data on *Angustiphyllum* Altevogt 1965, automobile free-living rugose coral from the Eifelian of Western Massif Armorican (France)

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The discovery by one of us (P.-A. J.) of *Angustiphyllum* specimens in the middle part of the Saint-Fiacre Formation, Eifelian, *costatus* conodont Zone (Morzadec 1983) allows to describe two new species belonging to this genus and to bring new data on its structure and morphology.

The genus *Angustiphyllum* Altevogt 1965

Taking into account the original diagnosis of Altevogt the main features of the genus are as follows: small wedge-like solitary coral with ellipsoidal transverse section, only order I septa (= major septa) meeting along (or forming) a line corresponding to the large axis of the ellipse, some tiny sparse tabulae, dissepiment lacking.

Soto (1986) gives more or less the same diagnosis emphazising the wedge-like morphology of the coral and the presence of an axial line formed by the confluence of the curved major septa. Moreover, he indicates that the minor septa are lacking despite the doubts expressed by Hill (1981): "minor septa stunted to ?absent".

The numerous and well preserved specimens collected in the Saint-Fiacre Formation show that the main diagnostic feature of the genus has not been seen by the previous authors. The septal apparatus does not corresponds to septa but to closely united costosepta; it is why the so-called epitheca is not "nicht erhalten" (=not preserved) as wrote Altevogt (1965, p.88) but basically lacking.

Nevertheless, it should be mentionned that Soto (1986 p. 68) indicates in his description of the external side of *A. cuneiforme* that the wall shows a rather well marked costulation ("murallas…, las cuales presentan una costación grosera exértil bastante marcada") of which he gives a picture (fig. 1/6).

The number of costae is about twice the number of major septa displayed on the calicinal side and thus, about one to two of these, althought equal in size, represent in fact a minor costa. The corresponding minor septum is not morphologically expressed or only as a small low buttress at the basis of one side of the septum. Moreover, the costae show a more or less obvious bilateral setting on the cardinal side of the corallum, some of them being shorter on both sides of the cardinal costa.

Thin sections in the corallum confirm the presence, in some specimens, of small horizontal structures as described by Altevogt (interstitial tabulae or ?tabellae) and the fibrous –but probably not trabecular – microstructure of the (costo)septa as indicated by Soto.

At least, and as previously mentionned (Plusquellec 2006: 222), we do not agree with Soto who recognizes (partly ?) synapticular structures in the transverse median crest.

Family Hadrophyllidae Nicholson 1889
Subfamily Hadrophyllinae Nicholson 1889 (emend. Plusquellec 2006)

Genus *Angustiphyllum* Altevogt 1965

Angustiphyllum n. sp. 1. Large species of *Angustiphyllum* with a flat prominent columella-like structure rising in the axial part of the transversal crest.

Angustiphyllum n. sp. 2. Small species of *Angustiphyllum* with gently convex to flat calicinal outline on broad side of wedge.

Mode of life

According to the morphology of the corallum, the genus *Angustiphyllum* shares numerous characteristics with 1) the Emsian Rugosa *Combophyllum* MILNE-EDWARDS & HAIME 1850 and 2) the Eocene-Recent Scleractinia *Flabellum* LESSON 1831 and its mode of life could be similar.

The presence of costae and consequently the lack of the so-called epitheca indicates that the polyp was fully covered with living tissue. Thus, *Angustiphyllum* belongs to the automobile free living coral group and was probably able to move (lateral migration) on the soft bottom of the Saint-Fiacre sea, or at least capable of vertical movement to right or exhume itself (PLUSQUELLEC et al. 1999).

The sedimentological/sequential study of the Lochkovian to Famennian formations of the Rade de Brest (GUILLOCHEAU 1991) shows that the maximum flooding surface occurs in the Eifelian during the deposit of the Saint-Fiacre Formation (mainly dark shales with a middle level of nodular limestones). The environment varies from lower offshore to distal upper offshore.

Paleobiogeography

The genus *Angustiphyllum* is known in the Eifelian of the Cantabrian Mountains and in the western part of the Massif Armorican, the two areas forming the Ibero-armorican Domain situated on the north-western margin of the Gondwana on the shelf of the Rheic Ocean.

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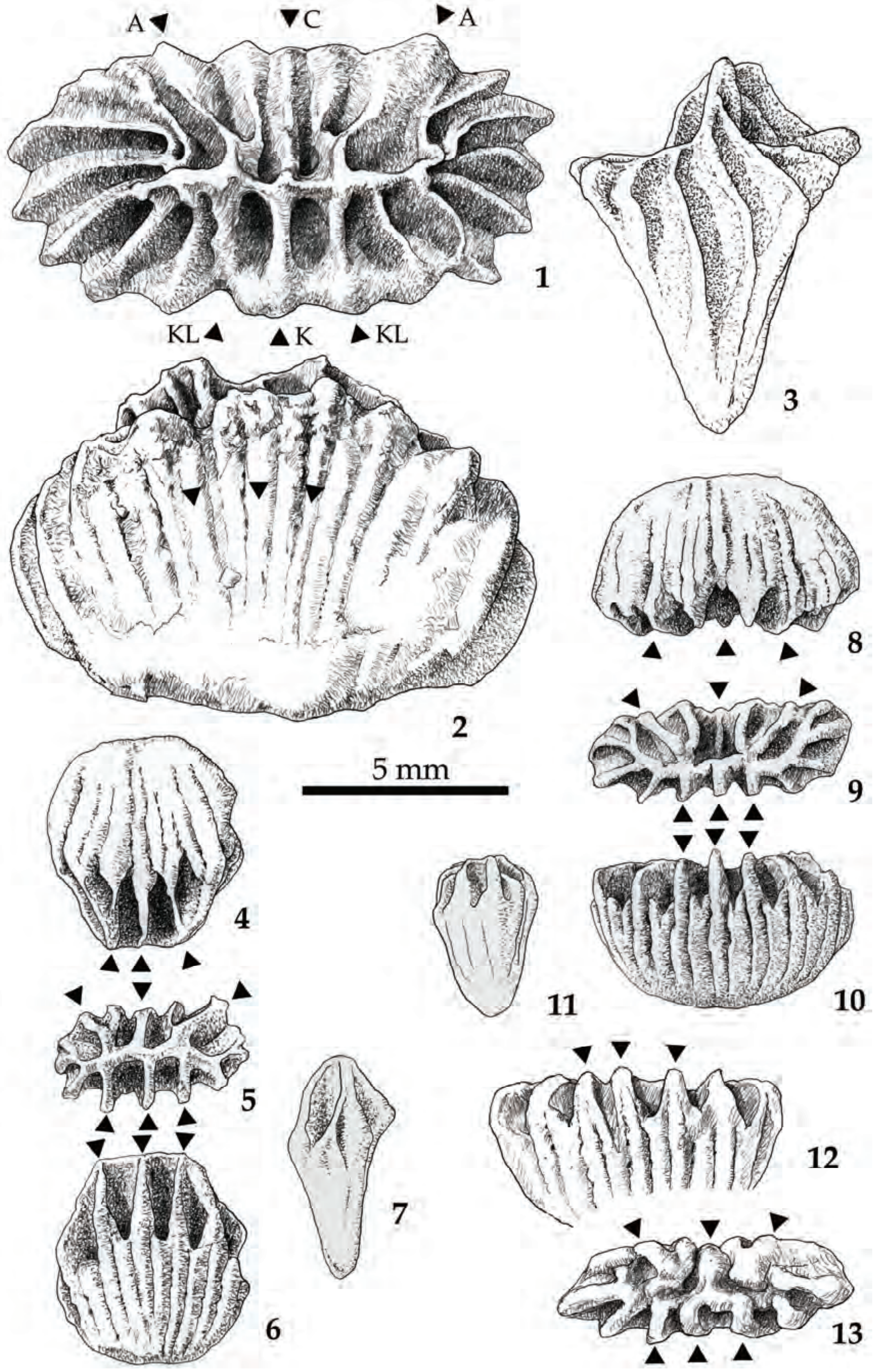
Fig. 1 (next page): *Angustiphyllum* n. sp. 1 (fig. 1-3 specimen LPB 15 347, fig. 4-7 LPB 15 348) and *Angustiphyllum* n. sp. 2 (fig. 8-11 specimen LPB 15 349, fig. 12-13 LPB 15 350). All calicinal views (1, 4, 9, 13) with the same orientation: cardinal costoseptum (C) and alar (A) on top of figure, counter (K) and counter-lateral (KL) on bottom. Lateral views of broad side of wedge: 2, 6, 10, 12 (counter side), 4, 8 (cardinal side). Lateral views of narrow side of wedge: 3, 7 (cardinal side on left), 11 (cardinal side on right). All specimens at same magnification (scale bar 5 mm).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Alcyonarian spiculites as possible proxy climate archives: Preliminary results

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Alcyonarian spiculite (KONISHI 1981) is a carbonate rock built by a few soft coral species, notably *Sinularia minima* VERSEVELDT 1971**,** *Sinularia polydactyla* (EHRENBERG 1834), *Sinularia leptoclados* (EHRENBERG 1834) (the latter two are common in the tropical Indo-Pacific) and possibly *Lobophytum pauciflorum* (EHRENBERG 1834) (PAULAY & BENAYAHU 1999). The corals excrete 1-3 mm long sclerites (also called spindles or spicules) of high Mg calcite from the base of the stalk which become cemented by marine cements as the coral grows upwards (Fig. 3, A, B). In the tropical Pacific Ocean pedestals up to 1.5 m high with living *Sinularia* colonies on top have been described in the literature and by eye witnesses (CAREY 1931, SCHUHMACHER 1997, R. KELLEY, written com. 2008). Spiculites were found in sediment cores as old as 7,500 years (KLEYPASS 1996, southern GBR). ACCORDI et al. (1989) reported Quaternary Alcyonarian spiculites from the coast of Somalia. The spicules (or sclerites) are cemented soon after deposition by several generations of aragonite and high-Mg calcite cements. X-ray analyses of sawn slabs of spiculite rock show that the spicules are arranged in layers and that density bands are present (Fig. 3, D). These bands may contain paleoclimate information enclosed in either cements or spicules or both, similar to hard corals.

Sinularia spiculites were investigated at three different sites in Viti Levu, Fiji: Caqalai, Nananu-i-ra and Nukubuco. Analyses of the sclerites show that all spiculites are formed by S. *polydactyla* (EHRENBERG 1834). The soft coral cover at the three different sites can be as high as 30 to 40 percent of the total coral cover. The tallest pedestals, 90 to 100 cm high, were found on the reef flat of Caqalai Island. A 40 cm long pedestal with a *Sinularia* colony on top was harvested from the Suva Barrier Reef and sectioned. The polished slab was X-rayed and showed 10 dark and ten light bands in the lower portion (10 cm long).

The spiculite samples were sent to Core Scientific International in Canada for ^{210}Pb analysis. Age calculations were completed for the 40 cm long *Sinularia* pedestal using the Constant Flux and Constant Sedimentation rate (CF: CS) model. Sedimentation rate is calculated from the slope of the line derived from the linear regression of ln^{210}Pb$_{\text{UNSUPPORTED}}$ and sample depth in the equation as shown by KRISHNASWAMY et al. (1971) (Fig. 1). The equation is further simplified to sedimentation/accumulation rate (cm/year) = (radioactive decay coefficient of Pb^{210}: 0.03114) / slope of the linear relationship.

Using the (CF:CS) model and slope regression method, a slope was obtained from a linear curve formed by logarithm of excess ^{210}Pb activity which was plotted against depth on horizontal axis. The equation from Table 1 is y = -0.04 (x) -0.412, therefore the slope was -0.040 with a R^2 value of 0.865. Accumulation rate (growth rate in this context) was then calculated and found to be 0.7cm/year using the aforementioned equation. Age of the sample was derived from equation; T= m/s where m- cumulative dry weight of sediment or sample depth and s is the sedimentation rate derived from the slope of the linear regression, T- Age of the sample. Since the depth ranged over an interval of ten centimeters, the midpoint of the two depth values were used for calculation. For example for the first sample, the depth was from 0-10 cm and therefore 5 cm was used in place of m (in the equation) and divided with the growth rate of 0.7 cm/year to give an age of 7.14 years (Fig. 2).

The results suggest that the observed banding could be annual, similar to the density bands found in some hermatypic corals such as *Porites*. Although a 7.14 year old pedestal growing at 0.7 cm pa should be only 5 cm high, the distortion probably stems from the fact that the cut through the pedestal was oblique because the growth direction of the animal seems to change over time and often goes sideways instead of

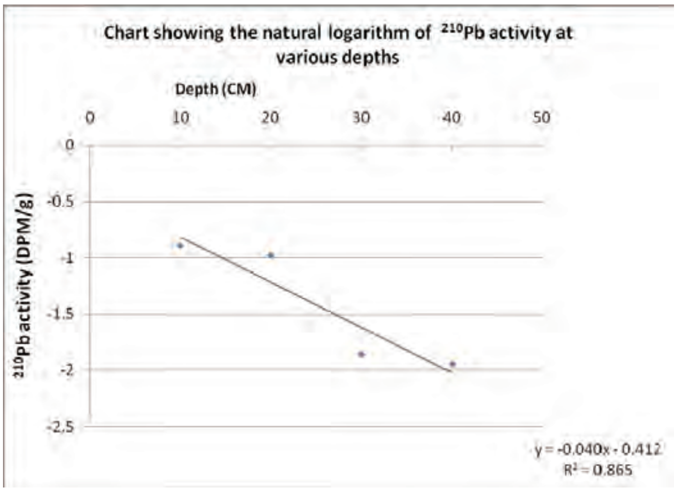

Fig. 1: Plot of natural logarithm of 210 Pb with depth for the four samples from the Sinularia pedestal collected at Nukubuco.

Sample #	Depth (CM)	Age (years)
1	0-10	7.14
2	10-20	14.29
3	20-30	21.43
4	30-40	28.6

Fig. 2: Age of 40 cm long Sinularia pedestal using 210Pb activity.

straight up. Alternatively, later cementation has increased the thickness of the column which contains 30-40% of cements that formed after excretion of the spindles. Because bulk samples were used for the age dating it could also be that the lower portion of the pedestal contains younger cements which distort the results slightly. Schuhmacher (1997) calculated a growth rate of 3-8 mm per year from the banding pattern in a spiculite from the Red Sea. The species was *S. minima* rather than *S. polydactyla* but the growth rate is in good agreement with our specimen.

Polished thin sections were used to unravel the sequence of cementation which enables the build up of spiculitic rock. Petrographic studies showed that the first cement formed on the spindles was an aragonitic botryoidal cement. Later followed fibrous needle cements (aragonite) and high Mg blocky cements. The blocky cements are less abundant in the upper part of the pedestal and more abundant in the lower part, suggesting that occlusion of the remaining pore spaces is a continuous process.

Electron Probe Microanalyses (EPMA) of a polished slab of *Sinularia* spiculite were made using a JEOL 733 Superprobe. The selected area of spiculite was a segment of a spindle with overgrowing botryoidal cement 80 µm² in size (Fig. 3, C). The distribution of the 6 elements Ca, Mg, Na, Si, Sr and Zr was mapped. The analysis confirmed that the *Sinularia* spindles are composed of high Mg calcite. The presence of Si and Zr is very low and the elements are evenly distributed throughout the sample with no apparent trend. The Mg shows a concentric zoning pattern with increasing concentrations from the interior of the spindle to the surface. Mg is practically absent from the extra-spicular area of the analysed segment which consists of a botryoidal cement. This cement is high in Ca and also Sr. Mg shows negative correlation with Ca (R^2>0.99) suggesting Ca/Mg substitution in the carbonate phase. Sr is very low in the spindles and higher in the cements, suggesting that the cement is aragonitic. For the zoning observed in the image of the spindle, the dark bands correlate to a higher Mg content with the highest Mg content in the dark outermost layer of the sclerite. The botryoidal cements are also zoned (Fig. 3, B) but the Sr content does not conform with the banding but instead is evenly distributed.

Distribution of Mg suggests that spindles are composed of two different calcite types: a thin, high-Mg outer layer, and primary inner low-Mg layers. The data could suggest that two biomineralization pathways are employed in the formation of the different calcite types. However, in foraminifera the strong concentration in Mg is associated with organic matter or primary organic membranes (POM) (e.g. Hemleben et al. 1986; Bentov & Erez 2005). Magnesium is known to exert a significant control on calcium carbonate precipitation and, when present in sufficient amount, the precipitation of aragonite rather than calcite results (Reddy & Wang 1980; Mucci & Morse 1983). This might explain the presence of botryoidal aragonite cements as the first phase of cementation following excretion of the spindles.

Cohen et al. (2002) showed that significant distortion of the Sr/Ca temperature record in coral skeletons occurs in the presence of algal symbionts. In *Porites* skeletons only the cements formed during night time are in equilibrium with sea water but up to 65% of the Sr/Ca variability in the symbiotic skeleton is related to symbiont activity and does not reflect ambient water temperature. The implication is that the Sr/Ca ratio of hermatypic coral skeletons is a reliable gauge of SST variability only when applied to parts of the skeleton that accreted in the absence of direct symbiont activity.

This suggests that the aragonitic cements found in the *Sinularia polydactyla* columns can probably be used as reliable temperature recorders. The high Mg-calcite seen in the spindles formed in contact with a symbiont-bearing tissue and is not suitable for SST measurements. The high Mg cements which are precipitated after formation of the aragonitic cements maybe giving a faithful signal of ambient seawater temperatures but the age of their formation is not resolvable.

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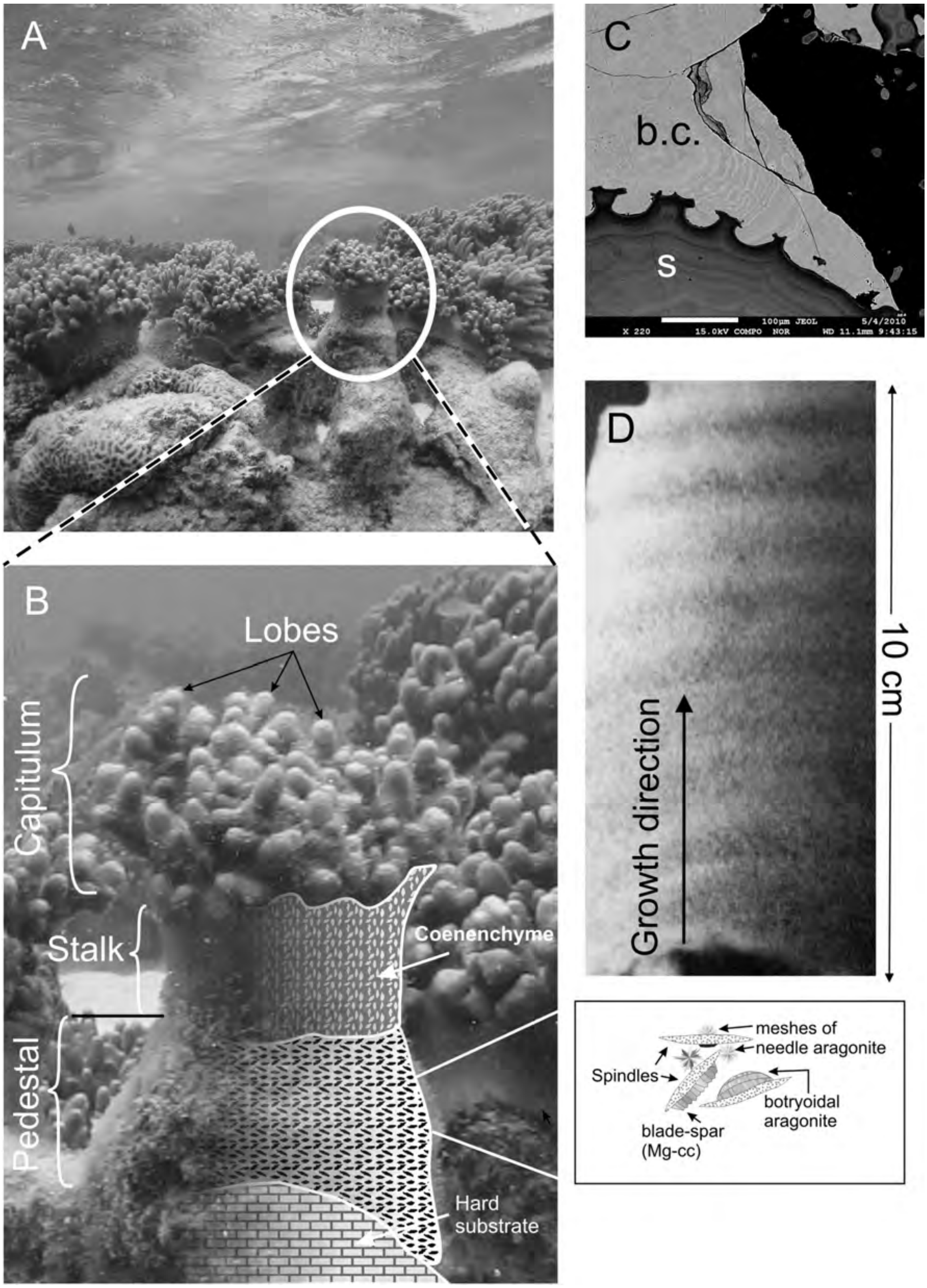
Fig. 3 (next page): A. Colonies of *Sinularia polydactyla* (Ehrenberg 1834) in shallow water of the Suva Barrier Reef. The colony in the oval circle is shown in detail in figure B below. The bulbous pedestals can be seen clearly to the lower left of the central colony. B. A colony of *Sinularia polydactyla* on a short (about 20 cm high) pedestal of spiculite. The sclerites in the pedestal (spiculite) are oriented sub-parallel to the substrate (black ellipsoids) whereas those in the stalk of the living animal are oriented perpendicular to the stalk's surface (grey ellipsoids). The hard substrate at the base is probably also spiculite possibly formed by an earlier animal. The small inset (right) shows sclerites with the different types of cements that bind them together to form a hard limestone. C. Spindle (S) with zoning and lighter botryoidal cement (b.c.), also zoned but at an angle to the spindle. The darker bands in the spindle correlate to higher Mg content. D. Photograph of an X-ray from the base of a *Sinularia* pedestal showing growth bands.


A
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b.c.
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B
Lobes
Capitulum
Stalk
Pedestal
Coenenchyme
Hard substrate
D
Growth direction
10 cm
meshes of needle aragonite
Spindles
botryoidal aragonite
blade-spar (Mg-cc)

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A comparison of Mississippian colonial rugose corals from Western Europe and South China

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Sections in Hunan, Guanxhi and Guiyang were investigated or revised during the last years and their biostratigraphy (foraminifers and rugose corals) and sequence stratigraphy were precised (Poty et al. 2006; Hance et al. in press). They provide a composite section from the uppermost Famennian to the lowermost Serpukhovian which was correlated with Western Europe. The systematics and the stratigraphy of the South-Chinese colonial rugose corals of this interval were revised and allow to do comparisons with those present in Western Europe and to precise their relationships and their palaeogeography.

From the lower Tournaisian to the lowermost Namurian (Serpukhovian), 14 genera of colonial rugose corals were recognized in Western Europe (WE) and 11 in South China (SC), that is a total of 17, 8 being common to both regions. But these latters have not the same stratigraphic distributions, none of them appearing at the same level in the two regions (Fig. 1).

The oldest Tournaisian colonial rugose coral is *Parastelechophyllum* which appeared only in China. It is closely related to *Stelechophyllum* (Poty & Xu 1996) which is known in the North-American realm and in Central Asia. Its stratigraphic distribution is limited to the *Uralinia tangpakouensis* Coral Zone (MFZ3). *Heterostrotion* and its closely related *Solenodendron* (Poty & Xu 1997) are the oldest European Tournaisian colonial genera, the first being previously known in the Uppermost Famennian of Poland. Both appeared in the RC3α Coral Subzone (base of MFZ5) in the lower part of the Ivorian (Upper Tournaisian). *Heterostrotion* is known only from one locality in North France and limited to only one level, but the second extends up to the uppermost Viséan. Both can be considered as migrants from an outside area. In SC, *Solenodendron* was not recorded, but *Heterostrotion* got into a little later than in WE (upper MFZ5). It became very common and extended up to the top of the Livian (Middle Viséan). It gave rise to a cerioid form (possibly corresponding to the not well defined *Lithostrotionella* Yabe & Hayasaka 1915) at the base of the *Keyserlingophyllum-Dorlodotia* interval Coral Zone (base of MFZ7) and to *Stylostrotion* possibly in the upper part of the same Coral Zone (base of MFZ10). That evolution can be considered as parallel to the evolution of Lithostrotionids in WE and its surrounding regions. *Dorlodotia* is known from the RC4β1 Coral Zone (MFZ7) in WE and from the base of the *Dorlodotia* Zone (MFZ11) in SC. It extends up to the top of the Moliniacian (RC5 – MFZ11 Zones) in WE, but up to the top of the Livian (top of MFZ12) in SC. *Siphonodendron* introduced in WE from the base of the RC5 Zone (upper MFZ11) was common until the Namurian. It gave rise to *Lithostrotion* during the earliest Livian, and to *Diphyphyllum*, *Nemistium* and *Orionastrea* during the Warnantian. *Siphonodendron*, *Lithostrotion* and *Diphyphyllum* got into China later, during the late Warnantian (MFZ15). *Aulina* is the only genus recorded earlier in SC (late Warnantian, MFZ15) than in WE (Namurian, RC9-MFZ16).

Therefore, most recorded colonial genera in SC are late migrants from outside regions, regional radiation being traced only for heterostrotionids. Note that some solitary genera known in WE got also later into SC, for example *Axophyllum* and *Palaeosmilia*. Migrants got usually earlier into WE, giving rise to lineages into the lithostrotionids, whereas originations can determined for *Lonsdaleia*, *Palastraea* and possibly *Corwenia*.

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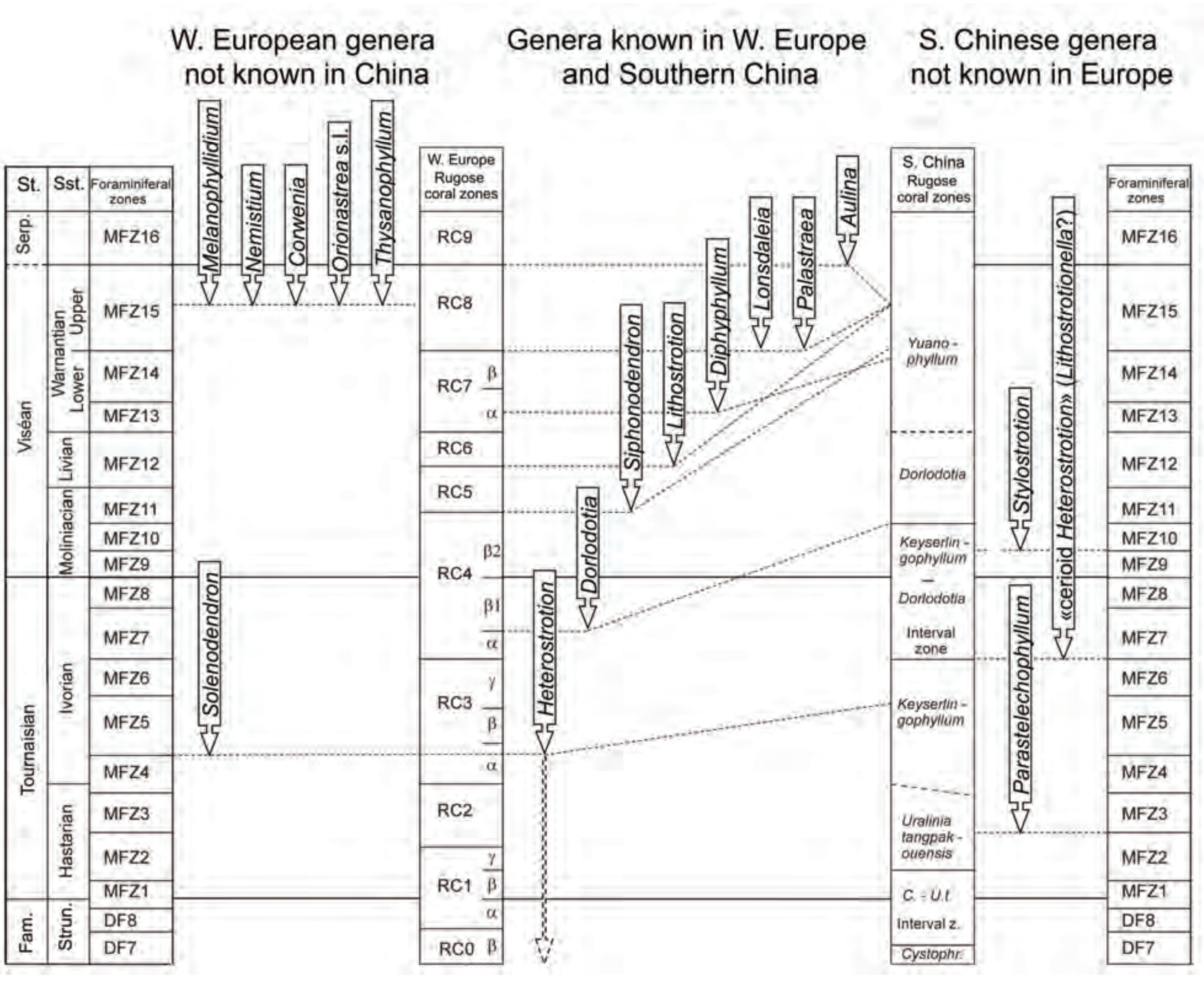

Fig. 1: Correlation between the Western European and the South Chinese coral zonations with regard to the Foraminifer zonation. The doted lines indicate the first appearances of the recorded colonial rugose coral genera. Their stratigraphic distributions are not traced here.

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Middle and Late Frasnian (Late Devonian) sea-level changes in southern Belgium: their consequences on corals and brachiopods

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In the Namur-Dinant Basin (southern Belgium), the end of the Middle Frasnian recorded the development of an extensive carbonate platform and large stromatoporoid-coral reefs, which was induced by a significant progradation during the highstand systems tract (HST) of a third-order sequence. The subsequent fall of the sea level caused their emersion and the end of the carbonate production (Poty & Chevalier 2007).

The rise of the sea level (Fig. 1) during the following sequence (Aisemont sequence *sensu* Poty & Chevalier 2007) was marked by a huge input of argillaceous sediments more or less mixed with carbonates, which progressively covered the previously exunded reefs and carbonate platform (Denayer & Poty 2010). At the onset of the sea-level rise, the tabulate and rugose coral faunas were identical to those previously known in the carbonate and shaly facies, comprising numerous thamnoporids (Tabulata) and fasciculate (e.g. *Disphyllum*) and cerioid (e.g. *Hexagonaria*) disphyllids (Rugosa). However, the latter disappeared during the transgressive systems tract (TST) (Early *rhenana* conodont Biozone) and were replaced by representatives of the family Phillipsastreidae (e.g. Poty 1999), such as *Frechastraea* and *Phillipsastrea* (Fig. 1). The maximum of the TST is characterized by the development of argillaceous deposits with dysaerobic–anaerobic facies (occurrence of lingulid brachiopods and bivalves of the "paper pecten" morphotype), which can be correlated with the Lower Kellwasser Event (LKW) (Poty & Chevalier 2007). Therefore the initial decline among corals and stromatoporoids was not related to the LKW *sensu stricto*, which happened later and induced strictly no extinction in corals and brachiopods, as the taxa occurring after the first crisis were still present above the LKW.

Later, in the Late *rhenana* Biozone, rugose corals progressively disappeared along with tabulates, before the Upper Kellwasser Event (Fig. 1). Therefore, the gradual coral extinctions during the Late Frasnian were not the result of sudden events, but were triggered by a relatively continuous degradation of the environments, including the local development of dysaerobic–anaerobic facies. The latter, in conjunction with an increase of turbidity due to huge detrital inputs, were not responsible for coral and stromatoporoid extinctions but prevented local recolonization. In southern Belgium, rugose corals were absent from the *linguiformis* Biozone to the Early *crepida* Biozone in which rare small solitary forms re-appeared (see Mottequin et al. 2011 for more details).

In parallel, the brachiopod decline occurred in three steps within the interval spanning the Early *rhenana* Biozone to the *linguiformis* Biozone (Fig. 1). Most brachiopod orders suffered severely and the major losses occurred at the top of the Late *rhenana* Biozone (e.g., Mottequin 2008a). These extinction episodes were linked principally to diachronous regional facies changes related to transgressions. For example, atrypids and pentamerids became extinct within the Late *rhenana* Biozone in the shallow parts of the Namur-Dinant Basin whereas they had already disappeared at the top of the Early *rhenana* Biozone in its distal part, just before the deposition of the dark shales of the Matagne Formation indicative of hypoxic bottom conditions (Godefroid & Helsen 1998, Mottequin 2008b). Contrary to corals, post-extinction brachiopod recovery was rapid in the basal Famennian but, despite their great abundance, their diversity was quite low. New cosmopolitan genera appeared at this time especially among the athyridids, rhynchonellids, and spiriferids concomitantly with new species of pre-existing orthid and orthotetid genera (e.g., Mottequin 2008a, c).

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Palaeosoil draping a remarkable *Disphyllum* autobiostrome: a case study from the Middle Frasnian, Southern Belgium.

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The lower part of the Middle Frasnian Lustin Formation – also known as the "Biostromal Unit" – consists of shallow-water limestones that crop out in the northern part of the Namur-Dinant Basin (Southern Belgium). The unit is densely populated by disphyllid corals and stromatoporoids and present well-established stacking patterns. In the western part of the Vesdre-river area, the Prayon section recorded plurimetre-thick shallowing-upward sequences. From base to top, a typical sequence shows: (1) a rudstone with coarse debris of rugose and tabulate corals and stromatoporoids in a wackestone to packstone matrix (parabiostromes), (2) boundstone with lamellar to tabular stromatoporoids in an slightly-argillaceous mudstone matrix with some rugose and tabulate corals, (3) bioturbed mudstone to bioclastic wackestone with brachiopods, gastropods, crinoids, *Amphipora* and algae, (4) wackestone to packstone with small-sized gastropods and ostracods to floatstone-rudstone with *Amphipora*, (5) laminated stromatolitic mudstone. But one of the sequences comprises an autobiostrome mainly composed of *Disphyllum goldfussi* and *Alveolites suborbicularis*, some of them being a little disturbed and sometimes overturned, capped by an argillaceous palaeosoil. The exceptional outcropping setting of this autobiostrome allows for a semi-quantified palaeoecological study. Skeletal features and morphologies of corals demonstrate a significant turbidity, with seasonal variations and a high rate of sedimentation. The biostrome was buried and preserved in-situ by a cinerite. The latter evolves later to a palaeosoil. Although palaeosoils are known in the Lustin Formation, the calcrete layer in Prayon is unique and evidences the development of an arborescent palaeoforest.

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The Upper Jurassic coral community of the Ellipsactinia Limestones reef complex (Central Apennines, Italy)

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In the history of the Earth, the Late Jurassic is generally known to be a time when reefal activity was widely expanded (Kiessling 2002; Wood 1999), with a greater diffusion and differentiation of reefs in the Tethys realm (e.g. Cecca et al. 2005; Leinfelder et al. 2002). On the basis of their biotic composition and their paleogeographic setting, Upper Jurassic reefs have been subdivided into distinctive types of reef complexes (Crevello & Harris 1984; Leinfelder et al. 2002; Scott 1988). Mixed coral- stromatoporoid reefs dominate Isolated Intra-Tethys platform margins, whereas in the North Tethys/North Atlantic reefs, corals largely out-competed stromatoporoids (see Leinfelder et al. 2002; 2005 for a review). Unlike other Upper Jurassic reefs, which have been the subject of numerous and detailed studies, Intra-Tethyan reefs have received little attention. Studies are in large part descriptive and only rarely contain sedimentological, taxonomical or paleoecological contributions. Recently Rusciadelli et al. (2011) have proposed an innovative zonation model for Upper Jurassic Intra-Tethys reef complexes. This model is based on excellent exposures in central Apennines (Italy) that allow the reconstruction of the reef profile across the Upper Jurassic platform margin. The zonation is revealed by the distribution of main reef builders (corals and calcified demosponges) and sedimentological characteristics along the reef complex (Fig. 1).

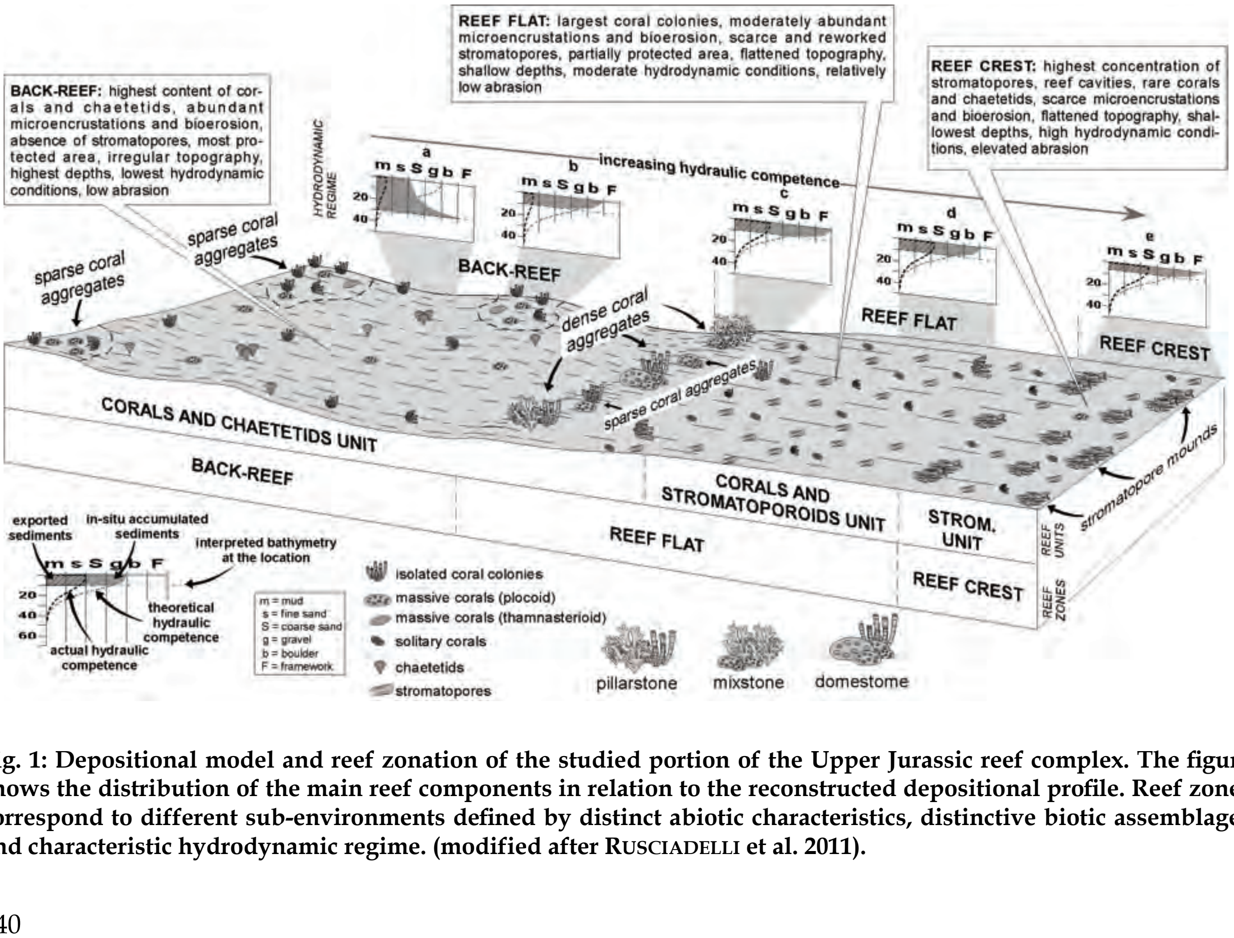

Fig. 1: Depositional model and reef zonation of the studied portion of the Upper Jurassic reef complex. The figure shows the distribution of the main reef components in relation to the reconstructed depositional profile. Reef zones correspond to different sub-environments defined by distinct abiotic characteristics, distinctive biotic assemblages and characteristic hydrodynamic regime. (modified after Rusciadelli et al. 2011).

The aim of this work is to illustrate the coral community that characterized the inner zone of the Upper Jurassic platform margin of the central Apennines proposed by RUSCIADELLI et al. (2011). The collection contains over 105 coral samples and more than 220 thin sections. The coral determination is still in progress, a number of taxa is left in open nomenclature and some new genera and species need to be assigned. This collection provides the first comprehensive study of coral taxonomy carried out in the Upper Jurassic shallow-water carbonates of the Central Apennines after the pioneering work of PREVER (1909).

Corals colonies are generally *in situ* or with a low degree of reworking. They can be found as isolated bioconstructions or as metric scale (1 to 10m^2 extended) dense and sparse aggregates with a variable, but generally high density. In general, corals display a wide range of features in terms of growth fabric, morphology (branching ramose, phaceloid, massive and solitary) and diversity of families and genera (ca. 30). The genera *Amphiastrea*, *Pleurophyllia*, *Aulastraea*, *Thecidiosmilia*, *Intersmilia*, *Cyathophora*, *Pseudocoenia*, *Stylosmilia*, *Stylina*, *Heliocoenia*, *Montlivaltia*, *Clausastrea*, *Placophyllia*, *Dermosmilia*, *Calamophylliopsis*, *Eugyriopsis*, *Ironella*, *?Ogilvinella*, *Pruvostastraea*, *Psammogyra*, *Microsolena*, *Comoseris*, *Dimorpharaea*, *Thamnasteria*, and *Solenocoenia* have been detected among others.

The reconstruction of the depositional profile and the sedimentological characteristics of the environment where corals thrived open up major new perspectives for their paleoecological and biogeographical interpretation. These perspectives make the central Apennines reef complex a possible landmark case study to investigate more objectively and thoroughly the role of the main factors, such as light, sedimentation and wave energy, that concur in the formation of the zoned character of the Intra-Tethyan reefs.

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Coloniality in the rugose coral family Geyerophyllidae MINATO 1955

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The family Geyerophyllidae MINATO 1955 includes corals having clinotabulae, lonsdaleoid dissepiments and a variably complex axial structure formed as an extension of the cardinal septum. Within this family, MINATO & KATO (1975) included three genera originally considered to have a colonial (fasciculate) growth habit – *Carinthiaphyllum* HERITSCH 1936, *Lonsdaleoides* HERITSCH 1936 and *Darwasophyllum* PYZHYANOV 1964. More recent studies (e.g. FEDOROWSKI 1980) and a review of the type specimens of *Carinthiaphyllum* and *Lonsdaleoides* have shown them to be solitary corals with a gregarious growth habit, which is also common in most other genera of the family (COCKE 1970; RODRÍGUEZ 1985).

In its original description and in all subsequent works, *Darwasophyllum* is consistently referred to as a fasciculate coral, but the presence of offsets has not been illustrated in the genus and a colonial growth habit has not been clearly demonstrated. Specimens of *Darwasophyllum* from the Etherington Formation in Canada, collected near the Viséan-Serpukhovian boundary, were initially regarded as fasciculate colonies with long, sub-parallel, closely spaced corallites. When they were studied in detail by means of serial sections, however, these corals were found to be solitary individuals grouped into gregaria, without shared structures or offsets. Thus, true colonies are unknown in the Geyerophyllidae and all genera described as colonial in that family consist of gregarious, solitary corals.

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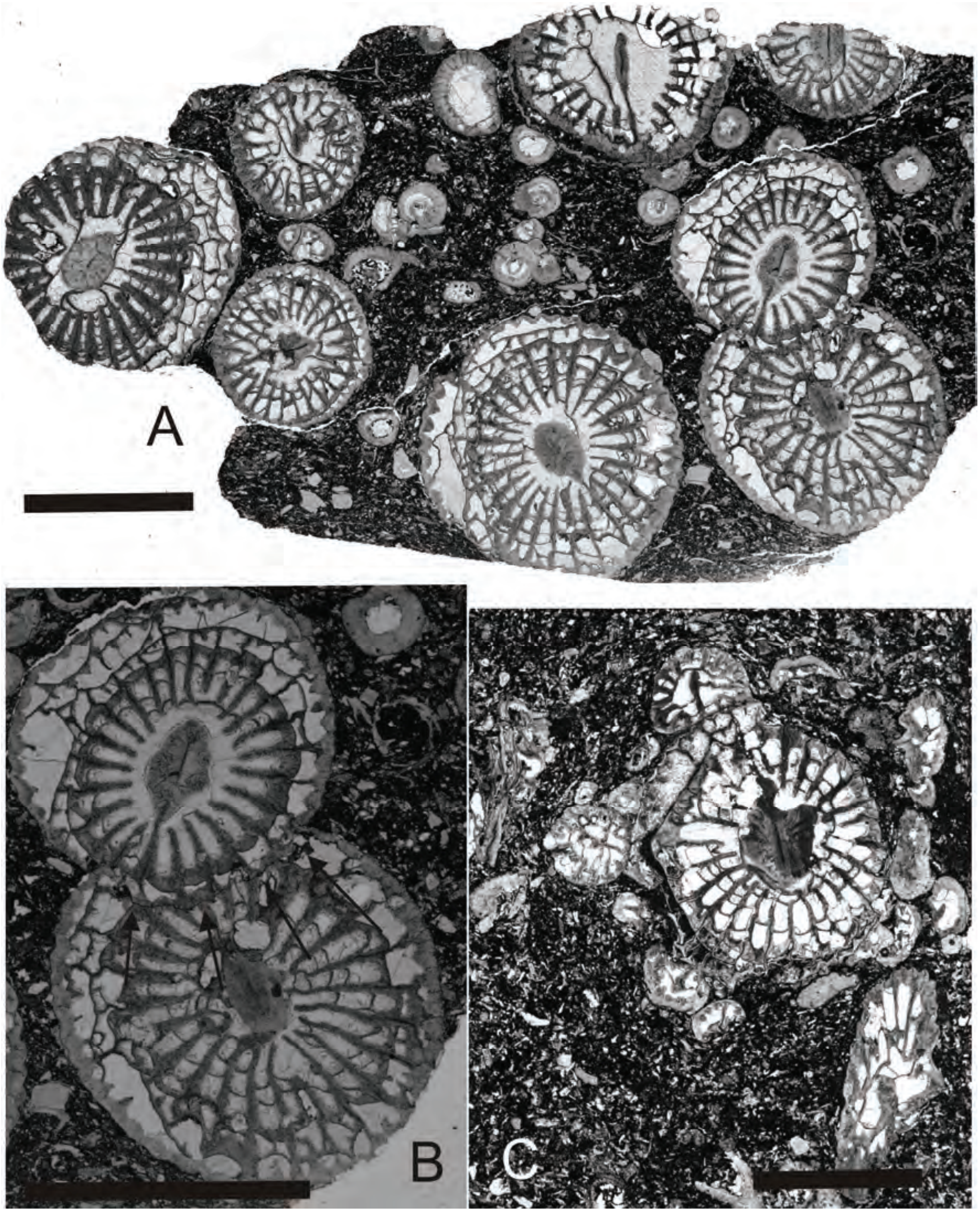

Fig. 1: Gregaria in *Darwasophyllum* sp. from the Etherington Formation. A- Group of individuals growing together. Note that the two corallites at the lower right seem to share structures. B- Close-up of figure A, showing stylolite (arrows), which produces the false impression of shared structures common to these neighbouring corallites. C- Numerous young corallites surrounding an adult corallite. None of them is an offset, but several are attached to the wall of the largest corallite.

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An upper Viséan (Asbian-Brigantian) coral succession at Djebel Ouarkziz (northern Tindouf Basin, Morocco)

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The Tindouf Basin is a large syncline which crosses the border between NW Algeria and S Morocco, south of the Anti-Atlas Mountains. Four formations have been distinguished in the Carboniferous succession in southern Morocco (Conrad 1972; Conrad in Wagner et al. 1985): Djebel Tazout Sandstones, Betaina Formation, Djebel Ouarkziz Formation and Betana Beds.

The Djebel Ouarkziz Formation is composed mainly of shales with interbedded limestones, dolomites and thin sandstone beds. It has been dated as upper Viséan-Serpukhovian by means of foraminifers (Mamet et al. 1966). Although some of the limestone beds are quite thin (less than 1 m in some cases), they are very persistent and can be followed along strike East-West for tens of kilometres. We have identified 19 limestone beds in two main sections; one logged along the road from Assa to Zag (Fig. 1), and the other in the Tisguiz-Rems Valley, 15 km to the east.

The first coral beds occur in the upper part of the Betaina Formation, which is mainly siliciclastic, but shows some thin marly beds in its upper part. Those marly beds provided large in situ colonies of *Siphonodendron* sp. (-A coral bed, Fig. 2). This species shows similar dimensions to *S. irregulare*, but the number of major septa is similar to *S. sociale.* Near the top of the Betaina Formation, several beds containing corals have been identified (coral beds A-D). The coral assemblage here is dominated by *Siphonodendron martini* and *S. sociale*. The next assemblages are more diverse, containing both solitary (*Axophyllum* sp. and *Palaeosmilia murchisoni*) and colonial corals (*Siphonodendron martini* and syringoporoids, coral beds E and F).

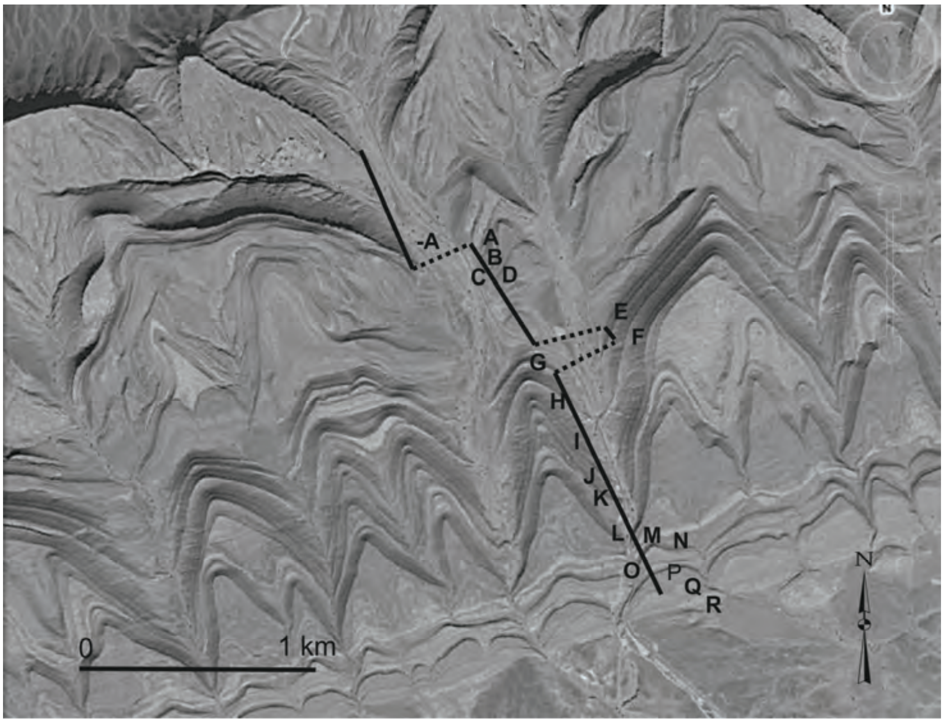

Fig. 1: Location of limestone/coral beds (A-R) in the section along the road from Assa (northwards) to Zag (southwards).

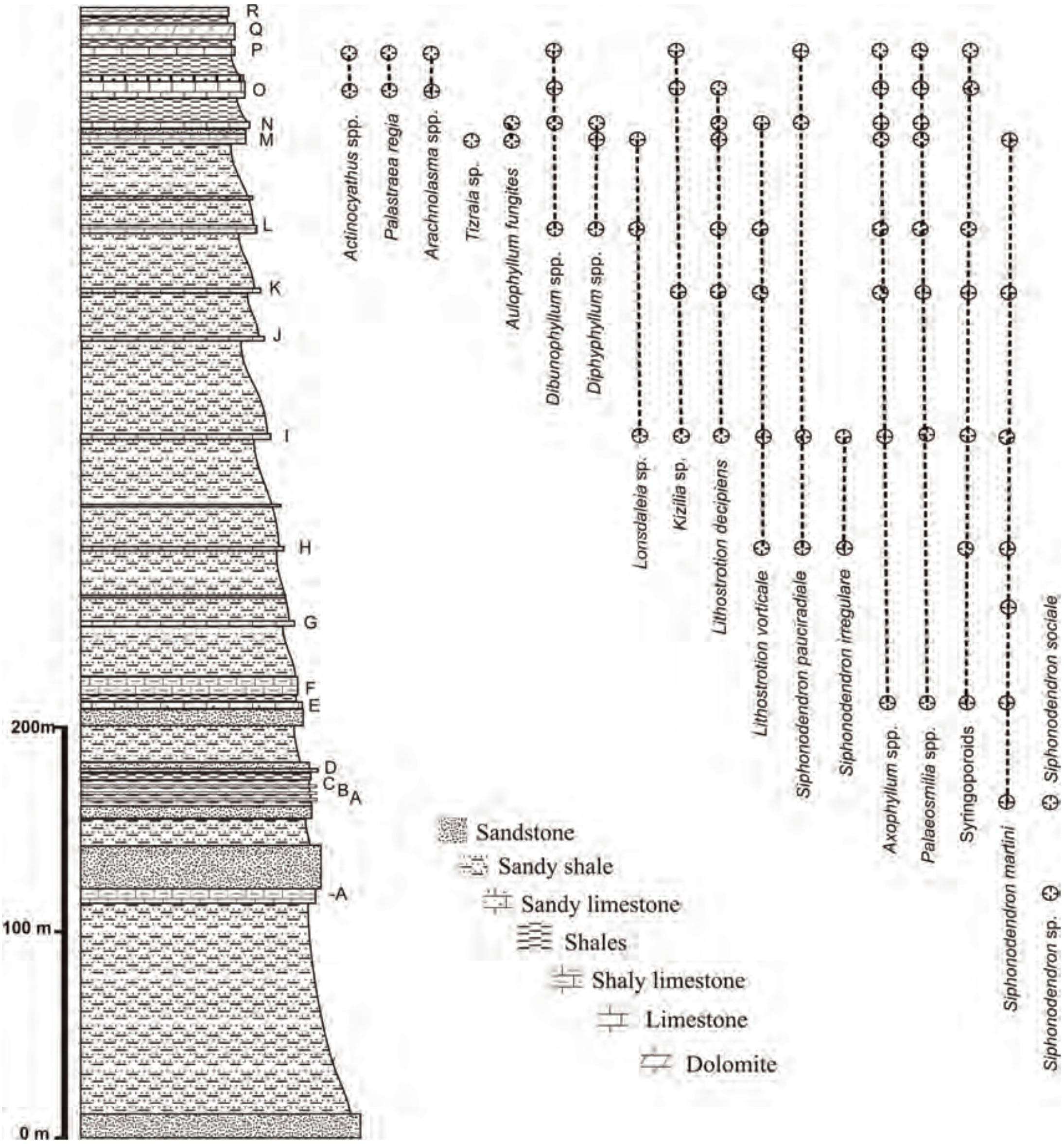

Fig. 2: Coral distribution in the section along the road from Assa to Zag.

Coral bed H shows a diversification of colonial corals with the first occurrence of *Siphonodendron pauciradiale, S. irregulare* and *Lithostrotion vorticale*. Diversification increases significantly in the next coral bed (I), where also *Lithostrotion decipiens, Lonsdaleia* sp. and *Kizilia* sp. have been recorded. A similar assemblage was recorded in coral bed K, whereas only fragmentary unidentifiable corals have been recorded in the oolitic limestone, bed J. First occurrences of *Diphyphyllum* spp. and *Dibunophyllum* spp. are recorded in coral bed L.

Coral beds M and N show the first occurrences of *Tizraia* sp. and *Aulophyllum fungites* and the last occurrences of *Diphyphyllum* spp., *Siphonodendron martini*, *Lonsdaleia* sp. and *Lithostrotion vorticale.* This part of the section shows important silicifications and corals show usually well preserved external morphology, but almost complete destruction of the microstructure. Coral beds O and P show new occurrences of *Palastraea regia, Arachnolasma* spp. and *Actinocyathus* spp. Corals are absent in limestone beds Q and R, which show pervasive dolomitization.

The coral assemblages from Djebel Ouarkziz Formation show some peculiarities:

1) Occurrence of a new species of *Siphonodendron* in the lowest coral bed.

2) Increasing diversity, that reaches its maximum in the coral beds M to P.

3) Occurrence of the genera *Lonsdaleia* and *Actinocyathus* that have never been recorded in the northern basins from Morocco or in Sierra Morena (SW Spain) (SAID et al. 2007;ARETZ 2010).

4) Abundance of the genus *Kizilia* in Viséan beds. This genus is common in the Serpukhovian, but has been rarely recorded in the Upper Viséan (POTY 1981).

5) Late occurrence of the genus *Tizraia*, which is common in the lower Brigantian from the Azrou-Khenifra Basin (SAID et al. 2007; RODRÍGUEZ et al. 2010), but in the Tindouf Basin occurs first in the late Brigantian.

The differences with assemblages from Northern Morocco and SW Spain could be explained by palaeogeography, but assemblages from Djebel Ouarkziz Formation show higher similarities with those from NW Europe (POTY 1981; MITCHELL 1989; ARETZ 2002; RODRÍGUEZ & SOMERVILLE 2007). Alternatively, the differences in the assemblages could be explained by ecologic factors; the succession in the Djebel Ouarkziz Formation shows some similarities with the successions described from the Brigantian in the British Isles (main intervals of shales with limestone intercalations), but are very different from the successions in SW Spain (CÓZAR & RODRÍGUEZ 1999) and North Morocco (SAID et al. 2007; ARETZ & HERBIG 2008; ARETZ 2010), where the formations contain large mud mounds.

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Late Viséan coral fringing reef at Tiouinine (Morocco): implications for the role of rugose corals as building organisms in the Mississippian

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Coral reefs have been regarded as being scarce or absent in Mississipian times (Newell 1972; Copper 1988). Large structured reefs in the Mississippian have been built mainly by calcareous algae (Wolfenden 1958) or Chaetetids (Nagai 1985). In some of those instances, corals played a secondary role (Adams 1984). Recent works have demonstrated the existence of patch reefs and reefal structures where corals were the main, but not the unique buildings organisms (Rodríguez et al. 1994; Aretz 2002; Aretz & Herbig 2003, Somerville & Rodríguez 2007). But either complete structure of reefs was not preserved or reefs did lack such a structure.

However, a Mississippian fringing reef with excellent preservation and showing a coral framework is located at Tiouinine, near Khenifra (Central Moroccan Meseta). The excellent preservation of that reef is due to lack of main tectonic alterations in the zone and to a selective erosional preservation that eliminated the superimposed Mesozoic sediments, but preserved the Mississippian rocks.

The reefal facies rest directly on Devonian sandstones. There is a complete zonation from tidal deposits to reefal talus. Tidal deposits occur in a narrow band and are composed of sandy packstones. There is a transition to reef flat deposits composed of packstones-grainstones with patchy distribution of coral colonies. Fasciculate corals of the genera *Siphonodendron* and *Tizraia* are dominant there. Also a transitional change to core reef facies is shown at the field outcrops (Fig. 1).

The core reef facies are composed of fasciculate and massive corals reinforced by algal masses around corals and microbial micropeloidal mudstone to wackestone coating the corals and algae. The spaces between corals and algal masses are infilled by crinoidal and coral grainstone. Dominant building organisms are corals of the genera *Siphonodendron, Lithostrotion, Diphyphyllum* and *Tizraia*. But diversity is quite high; colonies of genera *Palastraea, Michelinia* and *Syringopora* are also common, and solitary corals are diverse and abundant (*Axophyllum, Gangamophyllum, Pareynia, "Amplexus", Clisiophyllum, Arachnolasma, Koninckophyllum, Aulokoninckophyllum, Palaeosmilia, Kizilia, Haplolasma, Semenoffia*, etc.). Some chaetetids also occur in the reef core.

The proximal talus is represented by packstones and rudstones containing highly diverse bioclasts, corals, crinoids, foraminifers, gastropods, bivalves, etc., large fragments of reworked coral colonies and some coral colonies in growth position. These beds show erosive surfaces and amalgamation of beds. A somewhat distal talus is located at south, and it is represented by well-bedded marly limestones containing mainly crinoids and branches of fasciculate corals.

The existence of the Tiouinine reef is an evidence of that Mississippian corals had the potential to built large structured reefs. The rarity of these structures may be related to the tectonic and climatic instability.

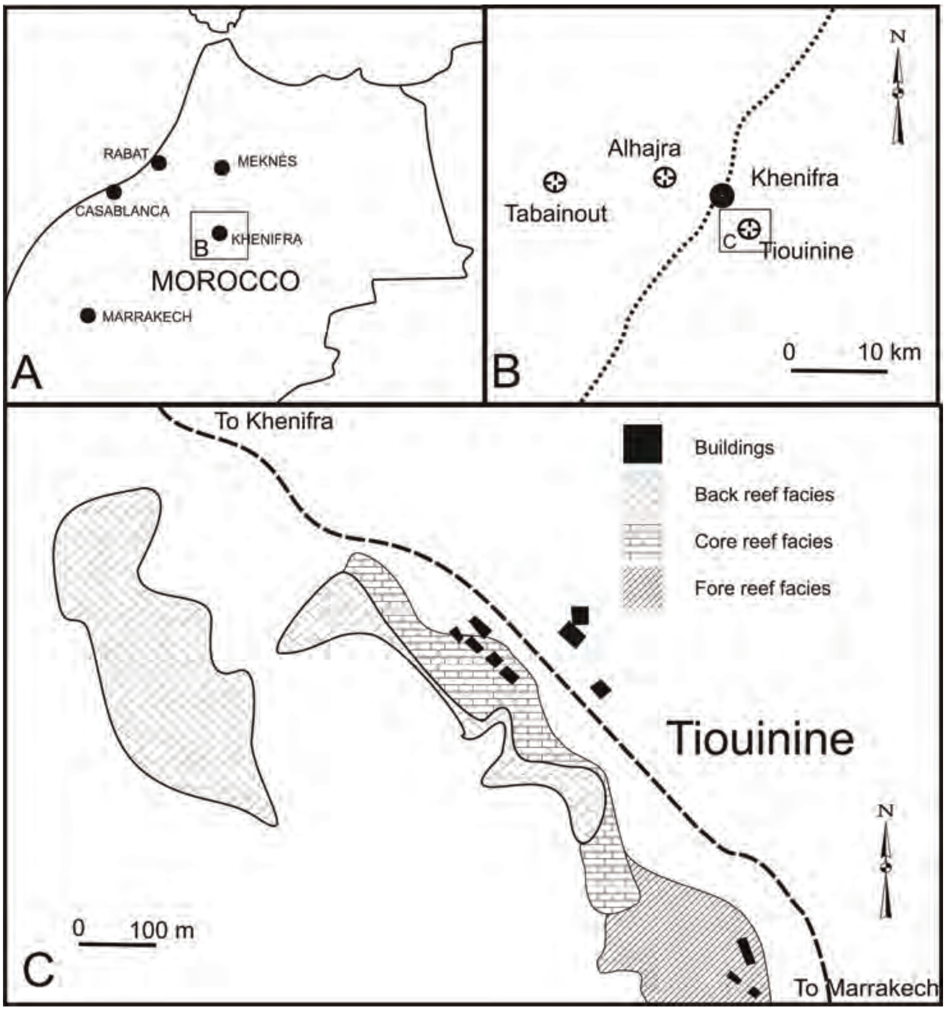

Fig. 1: Location and distribution facies in the Tiouinine reef. A.- Location of the Khenifra area. B.- Location of the Tiouinine reef in the Khenifra area. C.- Distribution of facies in the Tiouinine reef.

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Dr. James ALLOITEAU 1890-1969

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James ALLOITEAU was an initiator of coral studies at the Sorbonne in the 1950s. In the early 1960s, he continued the investigations in the Laboratoire de Paléontologie du Muséum National d'Histoire Naturelle in Paris and formed a special team of paleontological specialists which became during approximately 30 years "the French school of Corals".

James Henri Ernest ALLOITEAU was born in Chartres on April the 20th, 1890 in the family of a gardener, died on February the 11th 1969. The early years of childhood he spent in a small village, Lève, where he began his formal education. In Illiers he attended École primaire supérieur, and in Chartres he graduated from the École normale in 1911, and began to work as a teacher in the village Eure-et-Loir. He began studies in the Conservatoire des Arts et Métiers in Paris, but this was interrupted by the First World War. After the war he continued teaching in a country school, and started studies at the Sorbonne, and in 1926 he obtained a diploma in geology. While working as a teacher, he maintained his contact with the Laboratory of Geology at the Sorbonne. In 1939 he started his paleontological researches in the Centre National de Recherches Scientifiques. During the Second World War he joined the underground movement, La Resistance, was arrested in 1943, and then suspended from his position. After the war he returned to his researches at the Sorbonne, and due to an upsurge of geological investigations involved in postwar industrial development, he could obtain and collected himself large numbers of Mesozoic corals, and began intensive research on this material.

In 1952, he presented his systematics of the scleractinians in the Traité de Paléontologie edited by J. PIVETEAU, predominantly based on the septal microstructure and its external expression, septal micromorphology (ornamentation). His proposed scheme of coral systematics has, in a great part, survived to the present despite more than a half of century of research by many since its publication. He defended his doctorat thesis in 1955, and in 1957 published his book "Contribution à la systématique des Madréporaires fossiles".

In the Sorbonne Laboratoire de Paléontologie, in the 1950s, J. ALLOITEAU recruited young palaeontologist; Jean–Pierre CHEVALIER worked with Caenozoic scleractinians, Marcel and Louise BEAUVAIS with Cretaceous and Jurassic corals, and in the Paleozoic corals, Jean LAFUSTE studied tabulates while Pierre SEMENOFF-TIAN-CHANSKY the rugosans. Except the two BEAUVAIS who joined the University at Jussieu, most of the members of this first team moved to the MNHN. Under ALLOITEAU'S guidance, Jean-Pierre CUIF completed his thesis for the Doctorate of the State, on Triassic Scleractinia, becoming professor in Orsay, Sylvie BARTA-CALMUS (in Jussieu; then in MNHN) completed her thesis on Tertiary corals. For stages as resident scientists, young coral workers came from abroad; these were Gabriel GILL from Israël who came to study Jurassic corals, then took a permanent position in CRNS, Elżbieta MORYCOWA and Ewa RONIEWICZ came from Poland to study Cretaceous and Jurassic corals. Thanks to a very friendly atmosphere created by M. ALLOITEAU and his secretary, Mme. Josélianne MARÉCHAL, members of this coral team maintained personal contacts with numerous geographic areas. This policy was pursued by his disciples. Thus, Vassil ZLATARSKY from Bulgaria worked with J.P. CHEVALIER, Suzana MORSCH from Argentine with L. BEAUVAIS, Francis TOURNEUR from Belgium with J. LAFUSTE and Markus ARETZ from Germany with J. P. SEMENOFF-TIAN-CHANSKY.

All the members of the "French Coral Group" use microstructure as a practical criterion of suprageneric taxa. The results obtained by the Alloiteau team as a group, have contributed greatly to the advancement of understanding of scleractinians. It is satisfying that molecular results confirm those obtained by microstructural studies: a good example is given by the results obtained by J.P. CHEVALIER or by the recent coral studies carried out by J-P. CUIF and his colleagues, comparing microstructures with molecular methods.

For his scientific achievements and societal activity, Dr James Alloiteau was awarded the titles Officier d'Académie, Officier de l'Instruction publique, Chevalier de la Légion d'honneur and Commandeur des Palmes académiques.

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Darwin, pioneer of reef transects, reef ecology and ancient reef modelling: significance of his specimens in the Natural History Museum, London.

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Most ecological studies of ancient and modern reefs make use of the concept of ecological zonation, and data are generally collected and presented in relation to some kind of transect. Where orientation and aspect of the reef are also known (or self-evident) the usual convention is to collect and present at least some of the data along transects perpendicular to the strike of the perceived reef front, not least because of the widely perceived ecological importance of hydrodynamic energy and water depth.

Here we make the case that Charles Darwin was probably the first person to adopt this approach, and in this respect could be said to have 'invented' studies of reef ecology, reef zonation and their dynamic implications for reef growth, ancient and modern. Even after many years of evaluation of Darwin's biological and geological work, his particular contribution in this area has received little historical attention (but see SPONSEL 2009), and in any case, without reference to the actual reef specimens he collected. The NHM holds 29 reef specimens of Darwin's, of which 13 are modern organisms, and 16 are geological specimens of fossils and rocks (Holocene-Recent). All but one he collected from the atoll of Cocos (Keeling) in the eastern Indian Ocean, which he visited during April 1-11, 1836. By that stage in the *Beagle* voyage, he had already worked out his famous subsidence theory of oceanic atolls (DARWIN 1835, 1842), somewhere between Tahiti and New Zealand (DARWIN 1835 in STODDART 1962, SPONSEL 2009), so it was critical for him that the only opportunity he had to 'ground-truth' his ideas with surveys and specimens, came late in the voyage at Cocos (Keeling).

A key part of his subsidence theory was that reef-builders (corals, coralline algae, etc.) grew most vigorously along reef fronts and edges since this, for him, was the main reason for the characteristic rim-and-saucer-like surface morphology of atolls. He therefore concentrated his efforts in making numerous reef transects between shore and reef-edge, even tackling the heavy surf and rocky structure of the outer edges on his "leaping pole", to ascertain the ecological and geological nature of this relatively inaccessible part of the reef. At the same time, assisted by Captain FitzRoy and numerous members of the *Beagle*'s crew, he gathered information about the deeper reef front through strenuous and methodical use of wax-armoured soundings, itself a pioneering exercise in oceanography (SPONSEL 2009). Results were synthesized on to a generalized reef transect. His idea of zonation drew on work in other contexts by Alexander von Humboldt (SPONSEL 2009)

The specimens Darwin collected included both biological and geological material and served his purpose in showing both the zonal distribution of reef-builders and their zone-related transformation into reef-rock ("… and I collected a very interesting series [of specimens] beginning with fragments of unaltered coral, and ending with others, where it was impossible to discover … any trace of organic matter." – DARWIN 1842, p.12). He subsequently donated most if not all of these same specimens to the NHM (ROSEN & DARRELL 2011).

Of particular interest is that these specimens are also accompanied by a little explanatory set of captions in Darwin's handwriting, which he probably prepared for his presentation of his atoll subsidence theory on May 31st 1837 (DARWIN 1837) to the Geological Society of London (ROSEN & DARRELL 2011). The same exhibit and captions subsequently went on display in the galleries of the NHM. Unfortunately, when the specimens were removed to storage around 1973, they became separated from their captions, so their relation to Darwin's transects is no longer directly clear. We have therefore tried to reconstruct his exhibit, which in most cases can be done without too much uncertainty. We will be presenting our results here, an example of which is shown in Fig. 1.

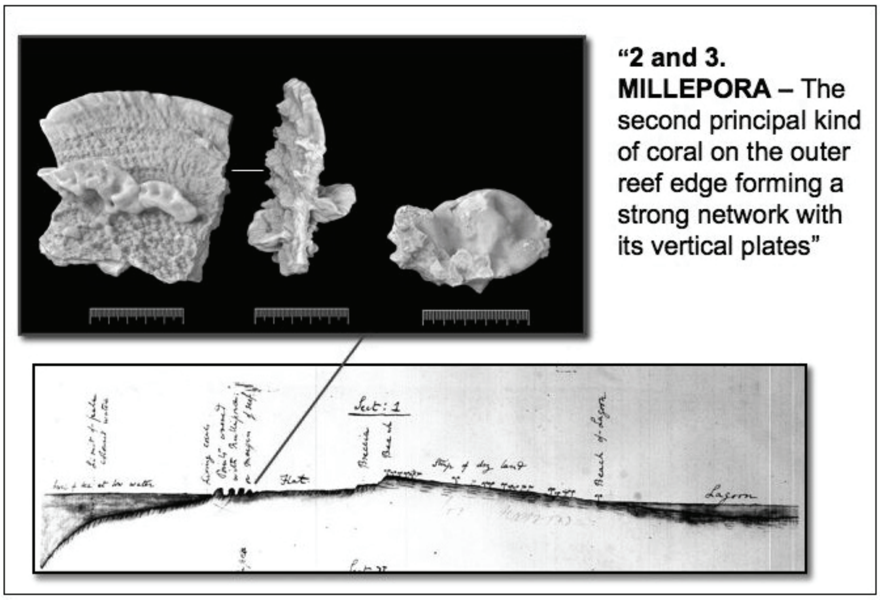
"2 and 3. MILLEPORA – The second principal kind of coral on the outer reef edge forming a strong network with its vertical plates"

Fig. 1: Reconstruction of Darwin's coral reef specimen exhibit and its likely relationship to his generalized reef transect for Cocos (Keeling) atoll (published in simplified form in Darwin 1842). We infer that caption "2 and 3" refers to these two specimens of *Millepora platyphylla* Hemprich & Ehrenberg 1834.

How does Darwin's work at Cocos (Keeling) relate to ancient reefs? Around that time, Darwin made an intriguing and important sketch (CUL DAR 41.83, Stoddart 1995) of how he envisaged a subsiding atoll's growth through geological time. Although he never published a fair copy of this, his long footnote (1842, pp. 116-118) is conceptually related to his sketch ("I may take this opportunity of briefly considering the appearances, which would probably be presented by a vertical and deep section across a coral formation …. This is a subject worthy of attention, as a means of comparison with ancient coral strata.").

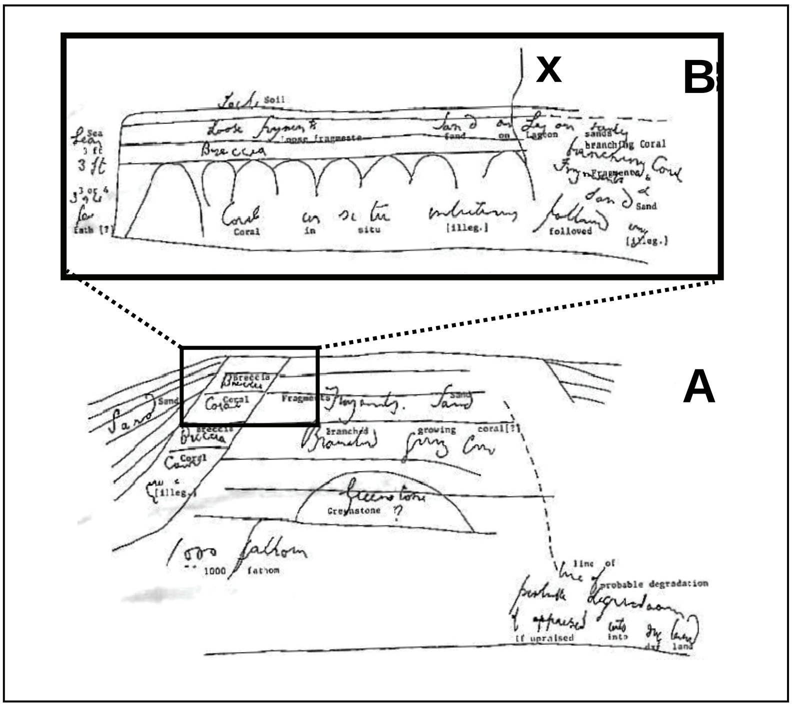

Fig. 2: Darwin's sketched reef model (CUL DAR 41.83 in Stoddart 1995) envisages reef breccia and detrital material etc. prograding seawards (i.e. to left) over *in situ* corals, and this process repeating itself as successive subsidence creates new accommodation space for the corals to start again. A and B were parts of a single diagram by Darwin, here separated into atoll rim (A) with inset (B) of seaward reef. Symbol 'x' indicates Darwin's imagined outcrop profile of an upraised or ancient reef.

Much attention has been paid to Darwin's subsidence theory and its durability, but very little to the more detailed ideas in his sketch. In modern terms it shows: (1) zonation of in situ reef-building facies, (2) shoreward accretion of reef detritus to form coral cays, (3) seaward progradation of the coral key material over the reef flat, (4) cyclical rejuvenation of this pattern when (as he envisaged it) the foundation subsides suddenly and intermittently, and (5) conceptual transformation of the horizontal relationship of these surface patterns and processes into a vertical sequence, anticipating Walther's Law (Walther 1893-94) by more than 30 years. The model also shows the influence of the then new uniformitarian principles of his mentor, Charles Lyell. Of course, in modern terms this model is also too simple, not least because we now know we have to take eustasy as well as subsidence into account. Also reinterpretations of some of Darwin's reef specimens are needed in the light of modern knowledge. But the important thing is that in a historical context, we can now see how and where his model of reef growth is actually anchored (at least in part) to his own 'ground-truth' specimen evidence (i.e. as he saw it). Regardless of modern ideas, and hindsight re-interpretations, this demonstrates the value of historical study of his specimens in understanding his work, additionally to study of his writings alone. It also locates his work historically as pioneering approaches and concepts which have been absorbed into, and taken for granted in, methods used by modern reef ecologists, palaeoecologists and sedimentologists.

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Late Ordovician-early Silurian Tabulate Corals and Stromatoporoids of the Zeravshan Range, Central Asia

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The Late Ordovician to Llandovery faunas of the Zeravshan Range are relatively well documented (Kim 1966; Kim et al. 1978, 2007). In general, the Late Ordovician faunas of the Zeravshan Range show distinct Gondwanan signatures, in such groups like trilobites and brachiopods, which have strong similarity to the contemporaneous faunas of temperate latitude peri-Gondwana and especially to those of Central Iran, Byrma, South China and Kazakhstan. The Upper Ordovician sequence in the Zeravshan Range comprises mainly siliciclastic rocks with a brief episode of carbonate sedimentation in the late Katian (Archalyk Beds), suggesting warming prior to the terminal Ordovician glaciation during the Hirnantian. This warming episode coincided with the invasion of a moderately diverse fauna of tabulate corals and stromatoporoids dominated by *Ecclimadiction*, *Lyopora*, *Nyctopora*, *Catenipora*, *Reuchia*, *Agetolites*, *Agetolitella*, *Palaeofavosites*, *Plasmoporella*, *Granulina*, *Acdalopora*, *Acdalina*, *Paolites*, *Propora*, *Visbilites*, *Stelliporella*, *Taeniolites*, *Sumsarolites* and *Pycnolithus*. The associated faunal assemblage includes also rugose corals and early pentameridines *Holorhynchus* and *Proconchidium*. The coelenterate fauna shows distinct affinity to the late Ordovician faunas of South China, Kazakhstanian terranes and Baltoscandia (partly). The Rhuddanian coelenterate assemblage is also documented in the Zeravshan Range from the overlying Minkuchar Beds (Kim et al 1978, 2007). It differs from the Archalyk Assemblage to a considerable extent and includes representatives of *Labechia*, *Clathrodictyon*, *Ecclimadictyon*, *Actinodictyon*, *Halysites*, *Acidolites*, *Syringopora* and also transitional genera *Palaeofavosites, Catenipora* and *Propora*. In taxonomic composition the Minkuchar Assemblage shows similarity to the coral and stromatoporoid faunas of the Baltoscandia and Kazakhstanian terranes.

Early Palaeozoic palaeogeography of Central Asia is still very poorly understood. According to Biske (1995) and Burtman (2006) the Zeravshan Range is situated within the boundaries of the peri-Gondwanan Karakum-Tajik microplate but the time of its separation from mainland Gondwana is not defined.

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How diverse where reef corals of South East Asia during the Miocene?

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The maximum centre of marine biodiversity (MCMB) is located in the South East Asia region. Corals play an important role in the concentration of this extraordinary diversity, not only due to their high diversity within this region (approx. 500 species), but also because they are the main constructors of the carbonate framework that supports high diversity of other taxa characteristic of reef habitats (HOEKSEMA 2007). The origins of this high diversity remain obscure. By studying fossil corals, this study aims to start to fill gaps in our knowledge of the long-term biological and environmental history of the region to better understand the timing, environmental conditions, and ecological processes involved in the development of the MCMB. Some palaeontological and molecular evidence (WILLIAMS 2007; RENEMA et al. 2008) suggest that the formation of the ancestral centre of diversity could be related to the constriction of the Indonesian Throughflow current (ITF) during the Cenozoic (HALL 2002; KUHNT et al. 2004; WILSON 2008), resulting in increased speciation and/or immigration during the Miocene age.

Our methods include building extensive new collections of thousands of specimens from hundreds of well-localized samples to overcome the lack of specimens in museum collections and the consequent taxonomic limitations. The study area is East Kalimantan, with local influence of the Mahakan River Delta in the Kutai Basin (WILSON 2005; 2008). In our first expedition (Nov-Dec 2010), we found that corals were a common component in almost all the outcrops visited. Twenty-five sections were stratigraphycally logged and coral specimens were systematically collected. Based on preliminary observations of larger benthic foraminifera and nannofossils, our samples are of Burdigalian to Tortonian age (Miocene, 7-20 Ma).

Two main coral assemblages were observed:

Platy coral assemblages, mainly common of Burdigalian to Serravallian age (11-20 Ma). Our observations suggest that the coral succession starts with very thin platy coral forms (1-10 mm) able to settle directly on soft sediments (Fig. 1A), or using fine sand grains, mollusks, or forams, as substrate to initiate growth. These initial stages are characterized by a high diversity, which is slowly replaced by a community dominated by few coral species that develop thicker and larger tabular colonies (Fig. 1B). Some of the most representative genera were *Porites*, *Cyphastrea*, *Hydnophora*, *Pachyseris*, *Echinopora* (Fig. 1C), *Echinophyllia*, and *Leptoseris*. Although scattered, some colonies of branching *Porites* and *Acropora* were also observed within the platy coral matrix. Platy coral communities could be interpreted as an adaptive response to extreme environmental conditions around the Kutai Basin: poor light levels in waters with high sedimentation rates (ROSEN et al. 2001; WILSON 2005).

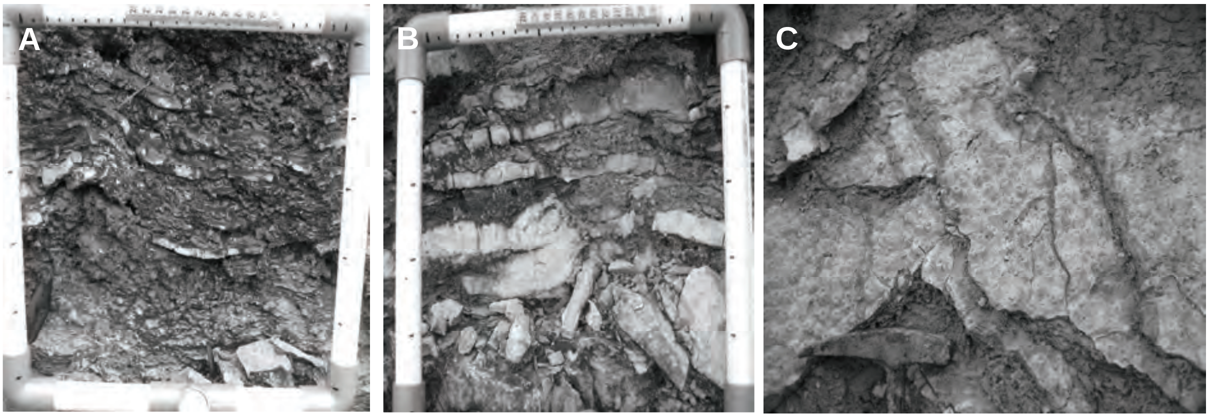

Fig. 1: Platy coral assemblages during the Miocene in East Kalimantan: (A,B) Section TF126 Serravallian (11.6-13.8 Ma), predominance of thin platy coral colonies at lower units (A) followed by the accumulation of thicker tabular coral colonies at upper units (B). (C) Section TF153, Burdigalian (16-20.4 Ma), showing a large platy colony of *Echinopora* sp.

B. **Branching coral assemblages** of Tortonian age (7 Ma). Mainly composed by *Seriatopora*, *Stylophora*, *Dyctyaraea*, and *Goniopora* species. These communities might have developed in shallower bottoms with more light and less sediments, and higher water currents. These settings were located at the northernmost part of the study area.

A detailed morphological examination of the specimens will allow an inventory of the Miocene coral species. The resulting taxa and their occurrences will be analyzed at various geographical and temporal scales.

Further research and the integration of our results with parallel studies of palaeoenvironments, chronostratigraphy, and high-resolution environmental proxies will allow a test whether the observed differences in coral composition (platy vs. branching forms) have been controlled by differences of sediment flux depending on the proximity to the Mahakan Delta, or there are additional controls related to regional changes at the temporal scale (Early to Late Miocene).

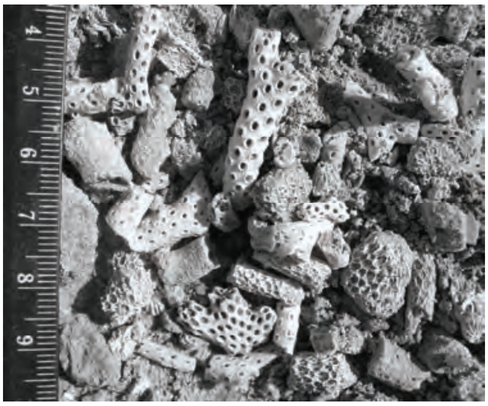

Fig. 2: Branching coral assemblages of Tortonian Age (7-11 Ma). TF154, Bontang, East Kalimantan.

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Regularity in budding mode and resultant growth morphology of azooxanthellate colonial scleractinian *Cyathelia axillaris*

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Azooxanthellate corals obtain nutrients by the capture of plankton and suspended organic particles without symbionts. Their colonial growth is therefore not influenced by light. This study examines regularity in budding in the branching (bushy), azooxanthellate scleractinian oculinid species *Cyathelia axillaris*, with the aim of better understanding developmental constraints on the formation of colonies.

A sympodial form of *Cyathelia axillaris* develops its bushy morphology by repeated dichotomous branching here and there with no corallites clearly axial. Two buds often originate simultaneously on opposite sides, at individual distal ends of corallites. The parent corallites are in some instances immersed in coenosteum occurring between two branching corallites. Their aragonite skeletons are hard and fine-grained. The largest colonies known attain about 20 cm in height, and consist of approximately 150 individuals. Corallites are circular in outline when small, and become elliptical, or medially constricted if located at the proximal parts of branching corallites. The greater part of its calice forms according to two directive septa. The calicular long diameter is approximately 1.0 cm, whereas the calicular short diameter is about 0.6 cm. In order to decipher regularity in budding processes, the following features are noted in particular.

(1) The offsets (lateral corallites) always occur in the vicinity of two parental second-order septa, not in the sectors of the two first-order directive septa; (2) the two directive septa of lateral corallites are oriented perpendicular to the directive septa of the immediate parental corallites; (3) the lateral corallites grow more-or-less diagonally upwards; and (4) these regularities remain valid from parental to derived lateral corallites throughout colony growth. Apparently, complex bushy corals are thus formed according to certain rules, irrespective of generation of individual corallites.

It is highly probable that the presence of these strict developmental constraints on asexual reproduction greatly affects colonial growth of the Scleractinia, both extant and extinct. In addition, these regularities in budding revealed by azooxanthellate scleractinians, as one of the representative colony-bearing metazoan groups, provide us with fundamental data towards the understanding of how colonies are constructed.

Coral assemblages from a Mississippian mud-mound complex, Central Morocco

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Microbial mounds are common in the Carboniferous from Western Palaeotethys. A conspicuous Mississippian example is located close to Tabainout village in the southern part of the Azrou-Khenifra Basin, west of Khenifra in Central Morocco. The mud mounds from Tabainout lie almost directly on Ordovician sandstones. Basal Carboniferous deposits are polymictic conglomerates, sedimented in a palaeorelief on the Ordovician sandstones during the upper Viséan (Asbian). Calcareous breccias and bioclastic limestones with a diverse assemblage of corals occur in the overlying beds representing the base for the core facies of the mounds (Fig. 1).

The basal bedded bioclastic limestones contain abundant colonial and solitary rugose corals: *Amplexizaphrentis* sp., *Amplexocarinia* sp., *Arachnolasma cylindricum*, *Clisiophyllum keyserlingi*, *Dibunophyllum bipartitum, Lithostrotion vorticale, Palaeosmilia murchisoni, Pseudozaphrentoides* sp., *Rotiphyllum* sp., *Siphonodendron irregulare, S. martini, S. pauciradiale, S. sociale, Siphonophyllia* sp., as well as tabulates (*Michelinia*) and heterocorals (*Hexaphyllia mirabilis).* This upper Viséan (Late Asbian) shallow-water assemblage is accompanied by abundant algae and algospongia (*Koninckopora*, kamaenids, *Fasciella*) and foraminifers (*Howchinia* and *Archaediscus* at *angulatus* stage).

The succeeding massive mounds are over 100m thick and form a NW-SE trending ridge. They are composed of micropeloidal mudstones-wackestones with stromatactoid cavities and contain very scarce corals of the genera *Amplexus* and *Axophyllum*. Foraminifers are very rare and calcareous algae absent. Fenestellid bryozoans can be locally common.

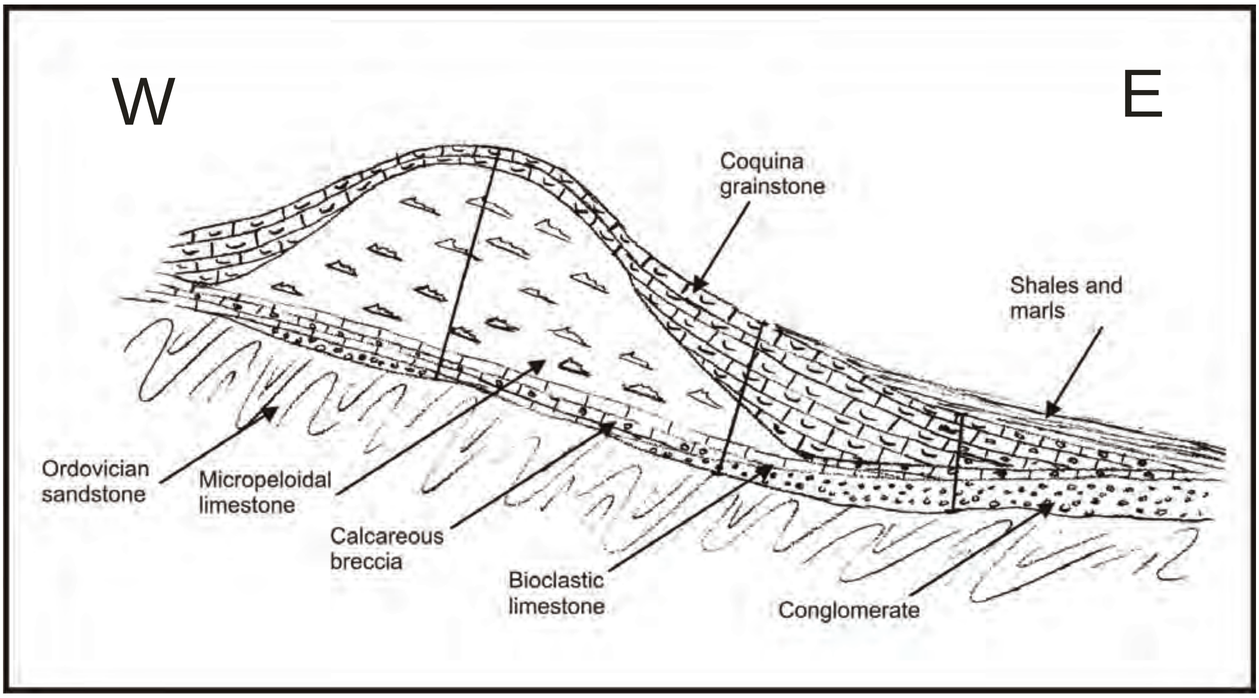

Fig. 1: Schematic W-E profile across the Tabainout mound.

The capping and flank beds of the mounds are composed of cemented coquinas with abundant brachiopods, bivalves, corals and crinoids, that yielded lower Brigantian foraminifera and algae. The coral assemblage can be locally rich in *Pseudozaphrentoides juddi* and *Palaeosmilia murchisoni*. The diversity of these upper flank beds is shown by the presence of *Amplexocarinia* sp. (gregarious form), *Arachnolasma cylindricum*, *Diphyphyllum lateseptatum*, *Kizilia* sp. *Lithostrotion vorticale*, *Michelinia* sp., *Haplolasma* sp., *Rotiphyllum* sp., *Siphonodendron martini,* and *S. pauciradiale*.

Shales with some interbedded marls containing deep-water *Cyathaxonia*-fauna corals occur around and above the microbial mounds.

The mound faunas are similar to those reported at Adarouch at the northern end of the Azrou-Khenifra Basin (SAID et al. 2007; CÓZAR et al. 2008), and have some taxa in common with coral assemblages reported from the Jerada mounds in NE Morocco (ARETZ & HERBIG 2008; ARETZ 2010). Preliminary sampling of the Tabainout mound ridge (ARETZ & HERBIG 2010) yielded only a sparse suite of corals, with only 7 rugose species recorded.

In all documented cases reported in Morocco late Visean mudmounds are generally very sparse in corals (SAID et al. 2007, 2011; ARETZ & HERBIG 2008, 2010; ARETZ 2010). However, in many instances, rugose corals tend to become more abundant towards the top of the mound and in the immediately overlying bedded limestones. Also, marly beds adjacent to the mounds often record a dominance of small solitary rugose corals and tabulates (*Cyathaxonia* phase) often indicting a deeper water facies.

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Marius LECOMPTE, Professor and student of Stromatoporida, Tabulata, [I] and Devonian reefs

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Marius LECOMPTE died on August 21, 1970, at the age of 68. He was born on May 16, 1902, in Morlanwelz, Belgium. His family had originated in the small town of Binches, in southwestern Belgium (UBAGHS 1977). Thus, he was a true Walloon in origin, and indirectly, from Binches, the famous carnival town. He probably grew up enjoying a party, but coming from a family of modest means, he also knew the value of hard work in the effort to get ahead in the world. Thus, M. LECOMPTE was a prodigious worker, but also one who instigated the parties in Louvain to celebrate the feast day of Ste. Barbara (the patronness of miners, quarrymen, and geologists). M. LECOMPTE began his career as a student of the classics and was at the top of his school class. His first teaching position was in 1924 in a high school in Chimay, where he taught the natural sciences (UGBAGHS 1977). It may be here that he learned to enjoy the beer of the Trappist monks. When the Louvain group went into the field each week in 1960-61, the day was always finished with several *Trappistes de Chimay* at Phillipeville, on our way back to Genval, the home of the Lecomptes.

As a new young graduate of the Catholic University of Louvain, geologist Marius Lecompte went to Katanga, the copper-rich province of the Congo in 1927, directly after gaining his baccalaureate. On the money he saved from this work, he married, Raymonde LEURQUIN in 1930 and enrolled as a doctoral student at the University of Louvain. Madame LECOMPTE was a very gracious hostess and known as such to all of M. LECOMPTE'S advanced students and to professional visitors. Additionally, each morning during my stay (academic year 1960-61), she telephoned to the laboratory when M. LECOMPTE left home so that he could be met at the front door of the institute by his two preparators at Louvain. Claude drove his car to find a parking place and Raoul carried his heavy briefcase up to the laboratory.

M. LECOMPTE began his paleontological career in 1933, mentored by Achille SALÉE in Louvain, and working with Eugene MAILLEUX at the Royal Museum of Natural History in Brussels beginning in 1934. At the museum, he rose through numerous intermediate stages to Director of the Paleontology Laboratory in 1952. During the 1930s, Lecompte traveled throughout Europe and the U.S., and spent several months at the Carnegie Institution of Washington research laboratory in the Dry Tortugas of Florida. His career at the University of Louvain began in 1945 when he was named instructor and he rose to Professor in 1949. It was during this period that LECOMPTE produced his classic monographs on the tabulate corals and stromatoporoid sponges of the Middle and Upper Devonian of Belgium, and his contributions of sections on the stromatoporoids, tabulates and rugosans to the French *Traite de Palèontologie* edited by J. PIVETEAU, and wrote the section on the Stromatoporoidea for Volume F of the Treatise on Paleontology (1956), edited by R. C. MOORE. At the same time, he was focusing more on Devonian stratigraphy and paleoecology through field studies in the 1940s, 50s, and 60s.

The contributions of LECOMPTE were multiple; first, his systematic work on the Tabulata and Stromatoporida, culminating in the monographs published by the Royal Museum of Natural History. Following publication of this set of 4 monographs and his writing sections for the *Traite* (1952) and the Treatise on Paleontology (1954), M. LECOMPTE focused more on unraveling the facies relationships and stratigraphy of the Devonian of the Ardennes, work that began on bicycle during World War II. It was at this time that he developed and refined his methods for correlation by understanding the paleobathymetry of the Devonian strata, in main part as reflected by their coral and stromatoporoid faunas. This allowed him to develop correlations between outcrops within the Dinant Basin and extend them to the Namur Basin (Fig. 1), with these correlations based overwhelmingly on cycles of bathimetric change indicated specially by colony shapes and types of fauna, reflected in the development of reefal and near-reef carbonates. In the Ardennes, these occur in Devonian strata that were deposited in marginal, subsiding shelf areas, thus characterized by large bioherms, while areas of lesser subsidence were characterized by very shallow water carbonates changing cyclically from high- energy to low energy facies, thus biostromal in part.

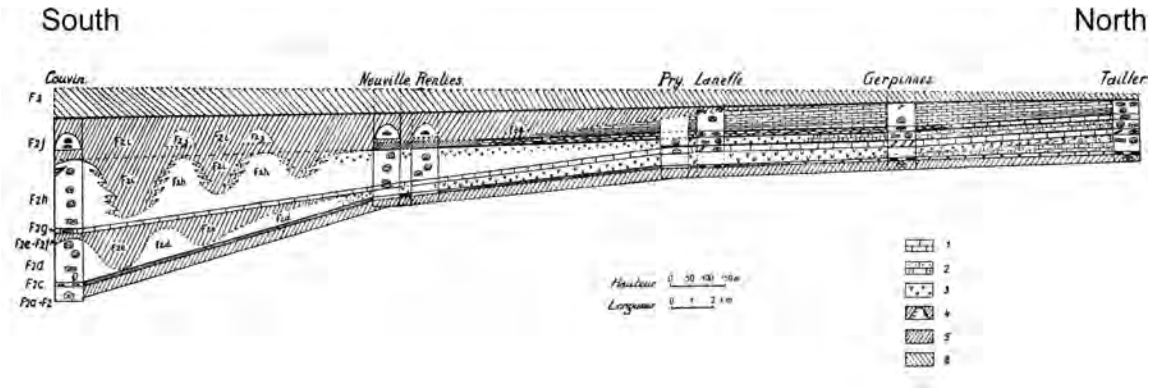

Fig. 1: North-south cross section of the Middle Frasnian of the Dinant Basin restored to horizontal. 1) biostromal Is., 2) dolomitic ls., 3) dolomite, 4) bioherman Is., 5) shale, 6) Upper Frasnian, F3 cover.

M. Lecompte was a scientist driven to succeed. He was a near personification of the ficticious but clearly Walloon, Belgian detective Hercule Poirot (Agatha Christie), a short, somewhat stout man in a dark suit and vest, a smoker who walked along with his hands clasped behind his back, an indefatiguable mind, incisive, with a ready sense of humor that was slight in the presence of strangers, but very well-developed and apparent when among friends. In addition he had a huge heart. One of my most vivid memories of M. Lecompte was him standing on the sidewalk in Prague in August of 1968, as invading tanks rumbled past us on the street. He had tears in his eyes and said to me, "This is just how it was in 1940." His compassion for the underdog was immense. This was a man who smiled easily when he was happy, was demanding in his professional life, enjoyed the presence of other scientists, truly enjoyed the café stop for beer after a day in the field, and was extremely kind to his friends. He was a man who rose from humble beginnings to earn international status as the leading student of his time in tabulate corals, stromatoporoid sponges and Devonian reef development in Belgium.

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Rugosans immured in Silurian *Paleofavosites* coralla; Brassfield Formation (Llandovery) of Ohio

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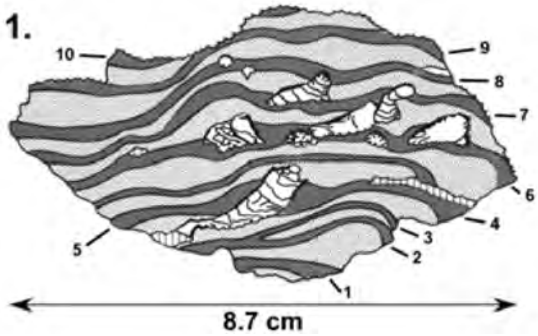
Field study of the Lower Silurian (Llandovery) Brassfield Formation exposed in abandoned quarries near Fairborn, Ohio, USA (KISSLING 1977) yielded a total of 274 tabular to columnar coralla of the tabulate species *Paleofavosites prolificus*. Fifty five (55) of these were from a hard-ground and high-energy sequence of strata forming the uppermost 30 cm of the formation. Of this collection (of 55), three exceptional *Paleofavosites* coralla contain symbiotic rugose corals of *Tryplasma* sp. partially or wholly imbedded within their skeleton, here reported for the first time. The rugosans are largely, but generally not totally immured within the favositid coralla, and as bioclaustrations (PALMER & WILSON 1988; TAYLOR 1990; TAPANILA 2005), permit further inferences on the paleobiology of both *Tryplasma* and *Paleofavosites.*



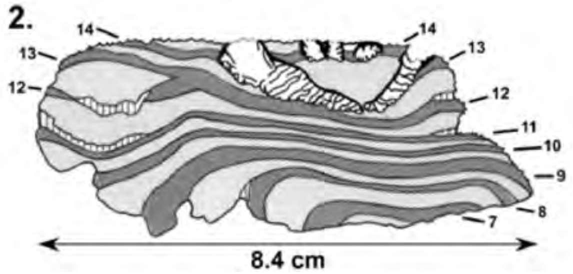


Fig. 1: Transverse section of *Paleofavosites* corallum with presumed annual couplets of zones based on varied spacing of tabulae, showing time equivalence of closely spaced tabulae (numbered dark bands) and the settling and growth of *Tryplasma* sp. associated with them.

Fig. 2: Transverse section of same corallum as shown in Fig. 1, separated from it laterally by approximately 70 mm, showing the weakly fasciculate nature of *Tryplasma* sp. and the occurrence of these and later, newly settled rugosans in the uppermost 2 bands of closely spaced tabulae (nos. 13 & 14).

All *Paleofavosites* coralla display growth banding of alternating zones of closely spaced and widely spaced tabulae, each couplet presumed to represent annual growth layers. Larvae of *Tryplasma* apparently settled on the upper surface of the *Paleofavosites* colonies, tending to grow roughly parallel to the upper surface of the favositid, with later growth of the tabulate around and over the rugosan. Covering of the *Tryplasma* corallite by *Paleofavosites* coralla did not affect its occupancy or growth, as the polyp was restricted to the last cm of skeleton formed. Commonly the rugosan was completely overgrown, but not in all instances, as calice openings of some individuals occur at the corallum surface of the tabulate. The close association of rugosans and zones of closely spaced tabulae within *Paleofavosites* coralla (Fig. 1) suggests that settling of rugosan larvae leading to competition for areal space was apparently most successful during periods of slow growth. The rugosan is largely solitary in its habit, but also occurs as a weakly colonial, fasiculate form (Fig. 2). It is characterized by extremely simple morphology, comprising only a few short simple septa and widely spaced, irregular tabulae. Epitheca is partially present on the external walls, this may reflect contact of the wall with sea water. Internally, where the rugosan lies directly on tabulate skeleton, the rugosan wall is commonly undeveloped, indicating that the polyp body of *Tryplasma* lay in direct contact with tabulate walls and tabulae.

Complete immuration (or overgrowth) indicates that the rugosan no longer competed for growth space; whether complete entombment occurred after the death of the rugosan or whether the overgrowth was the cause of its death is generally not knowable. The benefits for *Tryplasma* in becoming thus associated with the tabulate are assumed to have been that, by living while anchored in the larger, more stable colonial form of *Paleofavosites prolificus*, these rugosans were able to exist in vigorous, current-swept environments with enhanced opportunities for feeding on current borne particles, as hypothesized by KERSHAW (1987) for *Tryplasma flexuosum* living anchored within stromatoporoid sponges seen in the Silurian of Gotland. This high energy environment would have been inimical to the small, light weight rugosans living as isolated corallites. Interspecies aggression (LANG & CHORNESKY 1990) of the rugosans on tabulate polyps suggests the higher rank of the former in an aggression hierarchy, here recorded in their species to species interaction. The occurrence indicates an early Paleozoic development of a type of coral-to-coral relationship in the Phylum Cnidaria that is still recognizable in modern oceans.

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The naked Lazarus effect and recovery of corals after the end-Permian mass extinction

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The collapse of corals and reef systems at the end of the Permian is recorded as a gap which extends through the Early and part of the Middle Triassic and is well known to mark an absence of metazoan reefs. Perplexing problems of the origin of modern corals and the delayed recovery of corals and reefs can be explained by an extended Early to Middle Triassic geochemical perturbation of the world's oceans. Ocean acidification and the "naked coral" hypothesis help explain some aspects of the Middle Triassic recovery.

Through the Late Permian, reefs constructed by corals, *Tubiphytes,* algae and a variety of other organisms collapsed suddenly at the end of the Permian and did not recover until the Middle Triassic (Flügel & Stanley 1984; Weidlich 2002). What caused the extinction is being discussed and the delayed recovery is among the unresolved issues (Bowring et al. 1999). Stanley (1988) proposed that protracted sea chemistry perturbations of the ocean held back reefs from recovering and this was borne out of subsequent research (Payne et al. 2006). The perturbation of the marine carbon cycle continued throughout Early Triassic time, and corals, reefs and many skeletonizing metazoans virtually disappeared.

All corals of the Paleozoic died out (Scrutton 1999) so the great coral and reef gap of Flügel & Stanley, (1984) appears to be real and not an artifact of incomplete sampling. Lazarus taxa have bearing on this issue but the dynamics of survival and the idea of refugia are not well resolved. Anisian skeletal metazoans marked the beginning of the recovery, and carbonate mounds of late Anisian age in the Tethys and South China are the first examples of Mesozoic reef-like deposits (Flügel 2002). They contain small-scale framework, similar to bioconstruction of the Late Permian, with *Tubiphytes*, calcimicrobes, calcareous red algae, foraminifers, sponges, bryozoans, serpulids, crinoids and problematica. Scleractinians did not appear at the onset but appear later in the Middle Triassic, some 8 million years after the end-Permian. Corals functioned as dwellers in these early reef-like mounds and also into the subsequent Middle Triassic where spinctozoid sponges and red algae dominated. Middle Triassic corals were not simple and were high in diversity, being differentiated into 6-8 superfamilies. Guizhou province, south China, shows four superfamilies as well as six families displaying highly integrated corallites (Qi & Stanley 1989).

The idea that Scleractinia evolved from surviving Paleozoic Rugosa is not supported by the evidence (Oliver 1996). Rare sporadic occurrences of Permian and Ordovician aragonitic scleractinian-like scleractiniamorphs (Scrutton 1999) provided new insight into the problem. Unlike Paleozoic Rugosa, scleractiniamorphs has 6-fold septal insertion and favored aragonite biomineralization. Ezaki (1998) viewed scleractiniamorphs as Paleozoic progenitors of modern corals, including them in the clade Scleractinia. Scleractiniamorphs as Paleozoic "Scleractinia" make sense as molecular clocks pinpoint a scleractinian origin deep in the Paleozoic (Romano & Palumbi 1996). A possible polyphyletic Scleractinian tree, also resolved, complicates the issue of stem and crown groups, especially if clades of "Scleractinia" evolved more than once from different "naked" ancestors. Stanley (2003) viewed biocalcification responses to seawater chemistry between Early and Middle Triassic time, as triggers for sudden appearances of corals during the recovery. The "naked coral" hypothesis (Stanley 2003) helped answer some aspects of the delayed recovery. The Early Triassic was a time of anoxia, injection of greenhouse gases, high pCO_2 and possible introduction of hydrated sulfuric acid. Such geochemical conditions would lowered pH and adversely affected calcifying organisms, shutting down most of the carbonate factories and, of course, strongly discouraging mineralization of skeletons.

Results from aquaria experiments assisted understanding survival and recovery. Fine & Tchernov (2007) tested survival of living coral in marine aquaria where pH was elevated to simulate a much higher CO_2 world. After one month, all corals in the lower pH aquaria experienced complete skeletal dissolution but continued to live as soft polyps. Even after 12 months in such low pH water, the polyps continued to metabolize and reproduce without protective skeletons. After a year, pH was changed back to normal and, astonishingly, the coral polyps reacquired skeletons. This demonstrated experimentally the effects of acidification on coral survival and recovery, providing support for the "naked coral" hypothesis.

The Middle Triassic delayed recovery of calcified corals through millions of years of geologic time is attributed to long lasting Early Triassic perturbation of the world's oceans in which "naked" corals sought out isolated refugia. These sorts of organisms surviving the extinction were effectively censored from the fossil record. In this form, coral may have survived for six million years. Their apparently sudden appearances constitute biocalcification responses to ameliorating conditions of ocean chemistry so it likely coincided with the point where biogenic $CaCO_3$ could be secreted. This was a different kind of long-term refugia and what I call the "naked Lazarus" effect. The "naked Lazarus" effect best explains the sudden appearance of corals and other anomalous aspects of the Middle Triassic recovery and it may apply to other organisms as well. Investigations to substantiate these conclusions must likely delve into lagerstätten, molecular biology, seawater experiments and metazoan physiology.

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Caribbean reef recovery in the early Cenozoic - Mixed azooxanthellate and zooxanthellate faunas in the middle Eocene of Jamaica

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Reefs and corals in the Caribbean were severely affected by the biotic crisis at the terminal Cretaceous. The diverse Caribbean coral associations of the latest Cretaceous left few descendents in the Paleogene. Caribbean coral faunas of the early Cenozoic are scarce and species poor (Budd et al. 1992). No real coral buildups appear in the region until middle – late Eocene time and most faunas are comprised of only small (<10cm) encrusting/massive forms or thin branched colonies. By late Eocene-Oligocene time, however, corals and build-ups are common and conspicuous across Jamaica and the entire Caribbean/Western Atlantic region (Stemann 2004; Johnson et al. 2008).

In Jamaica, the middle Eocene Chapelton Formation of the Yellow Limestone Group has long been recognized as one of the few important coral-bearing units of this age in the Caribbean. Over the last 150 years, a handful of taxonomic works have described about 10 distinct species from this unit based on small scattered collections (for review see Budd et al. 1992; Stemann 2004). However, no work has been done to describe coral distributions and palaeoecology in the Yellow Limestone. In fact, corals are the most conspicuous macrofauna in much of the Chapelton Formation and therefore offer a critical window into the early establishment of reef corals in the Cenozoic of the Caribbean. The present study uses large bulk and surface collections from multiple exposures across central and western Jamaica to examine coral palaeoecology, species richness, relative abundance and coral growth fabric in different facies in the middle Eocene of Jamaica.

Recent work has yielded over a thousand middle Eocene coral specimens from the Chapelton Formation. Corals come from shallow water marls and bioclastic limestones that also contain a diverse fauna of very large benthic foraminifera, echinoids and molluscs. Most corals are thin ramose or dendroid forms and are not in growth position. Throughout the outcrop belt, however, there are scattered, small (<1m) patches of coral growth fabric. Over 20 species have now been recognized from the Chapelton Formation. Some taxa were likely apo or azooxanthellate (e.g. *Dendrophyllia* spp.) while others were clearly zooxanthellate (e.g. massive meandroid *Colpophyllia*). Still other taxa belong to extinct groups with uncertain trophic strategies.

Ordination and cluster analysis of coral abundance data from Chapelton Formation collections reveal no distinct clusters that could be considered biofacies or coral assemblages. Instead, variation between samples appears chiefly related to differences in species richness with lower diversity found in more marly sediments. Massive and more robust ramose or phaceloid forms are more common in purer carbonate facies, while thin branched forms are widely distributed. Patches of coral growth fabric are only found in limestone units. Most of these patterns in coral distribution and growth appear to have been governed by variation in substrate stability, sedimentation and turbidity.

Likely azooxanthellate or apozooxanthellate taxa are conspicuous in all sampled sites, marls, impure and pure limestones. The higher frequency of colonial and solitary azooxanthellate "non-reef forming" species throughout the Chapelton coral bearing units contrasts markedly with their scarcity in typical shallow water coral assemblages from younger units (Stemann 2004). This suggests that the middle Eocene Jamaican coral community possessed a trophic structure distinct from later reef building faunas. More sampling is needed to determine if this pattern can be seen across the Caribbean as a whole.

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Biological spherulite: Record of physiological activity in stony coral skeleton

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The spherulitic model of the skeleton growth (Bryan & Hill 1943) was a breakthrough in providing a coherent mechanism of growth of the scleractinian skeleton and still remains an inspiration for some geochemical models of skeleton formation (e.g., Holcomb et al. 2009). According to this model, formation of the skeleton is explained in physico-chemical categories, the same that apply to the abiotic growth of various spheroidal bodies consisting of radiating crystals. However, structural and geochemical similarity between spherulites precipitated abiotically and those formed by organisms (including corals) is not sufficient to invoke similar controlling mechanisms. Fish otoliths (spherulite-like calcium carbonate structures involved in balance and hearing) provide an extreme example for the failure of such reasoning: their radial-concentric structure (or its lack) and selection of calcium carbonate polymorph (aragonitic vs. calcitic) is controlled entirely by expression levels of the *starmaker* gene (Söllner et al. 2003). Although, the role of distinct genes in the process of scleractinian coral skeletogenesis has not yet been precisely elucidated (preliminary hints e.g., Reyes-Bermudez et al. 2009) there is an increasing number of evidences suggesting the prevailing control of the structure and composition of the skeleton by the organism.

Scleractinian skeletons contain inclusions of organic macromolecules whose composition (acidic glycoproteins) and distribution pattern suggest their formative role during the skeletogenesis rather than passive entrapment in crystals which cyclic precipitation is driven by calcium carbonate saturation state. Similarly, concentrations and micro-scale patterns of some trace elements (e.g., Mg) differ essentially from those in minerals formed in equilibrium with the sea-water geochemistry (e.g., Meibom et al. 2008). Histological observations of intact tissue-skeleton interface (e.g., Tambutté et al. 2007) call into question the presence of an Extracellular Calcifying Fluid (ECF) zone as postulated by some geochemical models. In addition to the diversity in distribution patterns of Rapid Accretion Deposits („centers of calcification”) which traditionally was considered as an evidence of limited organismal control on mineralization, there is also large diversity in Thickening Deposits („fibers”) organization. Their distinct patterns are closely associated with members of molecularly distinguished clades (e.g., Kitahara et al. 2010; Janiszewska et al. 2011). Such precise biological control of formation of the thickening deposits and lack of ECF space is also suggested by skeleton isotope labeling experiments (Houlbreque et al. 2009).

Many of the above mentioned skeletal features that seems strongly biologically-influenced are evident also in coralla of the azooxanthellate genus *Desmophyllum* which otherwise can be considered as perfect model of “spherulitic” organization (Fig. 1). The goal of this presentation is to provide an overview of the most comprehensive up to date structural and biogeochemical analysis of the skeleton of *Desmophyllum* and dialectically confront competing arguments regarding the role of “biological” vs. “geological” factors in the growth of the skeleton of this coral.

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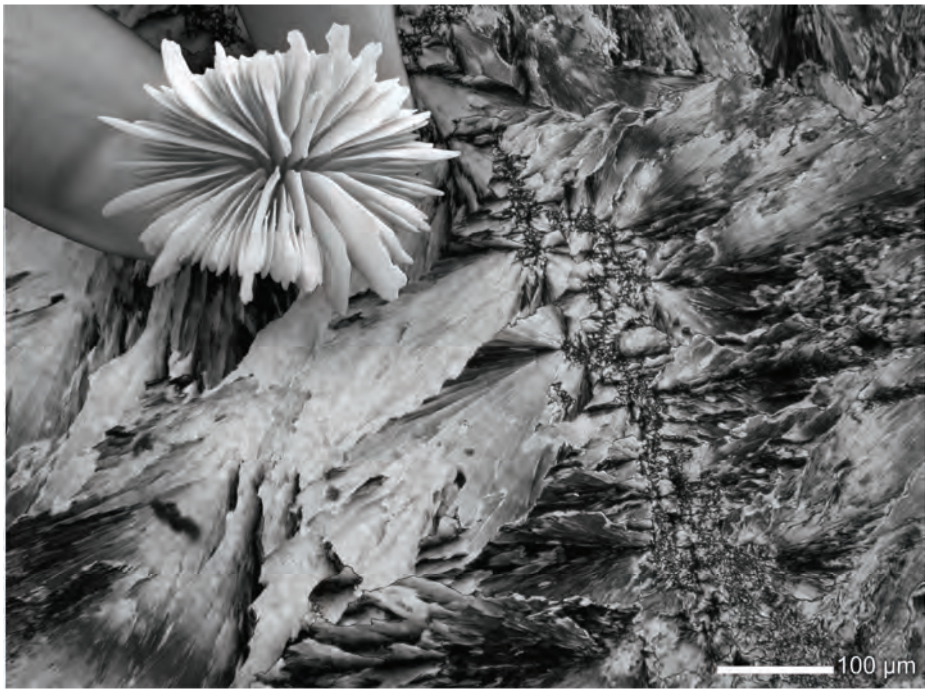

Fig. 1: Corallum of *Desmophyllum dianthus* (Esper, 1794) in left-upper corner and spherulitic organization of its septal skeleton.

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Upper Ordovician and Lower Silurian corals from the Pin Formation (Spiti Valley, Northern India)

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The late Katian is known as the time when reefs flourished and expanded globally (compare WEBBY 2002) before the onset of the Hirnantian ice age, which tremendously affected biota world-wide (SHEEHAN 2001). This interval conforms to the Boda Event (FORTEY & COCKS 2005), which is considered as interglacial phase during the late Ordovician ice-house. Faunal and floral climax conditions are documented especially by increased abundance and a widening of the latitudinal distribution-belt of carbonate factories (see WEBBY 2002) which produced limestone deposits at higher latitudes on the peri-Gondwana shelf interrupting clastic sedimentation dominant at that time (e.g., LOI et al. 2010).

During the early Palaeozoic the Indian subcontinent was part of northern Gondwana inheriting a palaeo-position of approx. 25-30°S. Among several localities, especially the succession in the Spiti Valley in northern India (recent geographic position) is known for shallow marine carbonate deposits of Ordovician to Silurian age yielding plenty of small patch reefs (Takche Member of the Pin Formation, compare Fig. 1). One of these coral bearing units was referred to as "Silurian reefal buildups" of the Takche Formation (syn. Pin Fm) by BHARGAVA & BASSI (1986). The age constrain of these bioclastic limestones was based on data from macrofossils provided by REED (1912), who described most of the material from the Himalayan fossil collection of Hayden and Krafft. Since then that unit remained assigned to Silurian age. In 2001 a first attempt was made to apply modern microfossil biostratigraphy by dissolving several hundred kilos of carbonate rock samples from the type section, which finally produced a quite diverse conodont fauna referring to Katian age (SUTTNER 2003).

Actually, the stratotype of the Pin Formation is exposed in the Pin Valley (Spiti) near the small village of Farka Muth (altitude: 3750m), Northern India. The Spiti region is part of the Himachal Pradesh district and lies in the high north-western Himalayas. The Pin Formation comprises a 280 m thick sedimentary succession of late Ordovician and Silurian rocks. HAYDEN (1904) divided the formation into horizon 1 to 8 (see Fig. 1). Some years later the Ordovician/Silurian boundary was fixed by REED (1912) between horizons 5 and 6 as he concluded that the assemblage of corals in Horizon 6 had affinities mainly with Silurian species (Horizon 6 equates with the above mentioned "Silurian reefal buildups" of the Takche Formation (syn. Pin Fm) by BHARGAVA & BASSI 1986). SUTTNER (2007) divided the Pin Formation into 17 lithological units (P/1-17) in ascending order and assigned P/1-6, P/7-13 and P/14-17 to the Farka Muth, Takche, and Mikkim members, respectively (Fig. 1). During the work on the lithostratigraphy and facies of this formation also the position of O/S boundary within the Pin Formation could be revised by the application of microfossil biostratigraphy and put between HAYDEN'S (1904) horizons 6 and 7 (unit P/13 and P/14 sensu Suttner 2007). It turned out that the entire Takche Member, which is correlated with HAYDEN'S horizons 2 to 6, yield conodonts referring to the *Amorphognathus ordovicicus* Zone (Katian, Upper Ordovician). However, age assignment for the other two members is still uncertain. Based on some few ozarkodinid conodont specimens an early Silurian (Llandovery?) age is suggested for the Mikkim Member. Hirnantian deposits are missing in this area, which is linked to the global lowstand. Solely a mixed conodont fauna (Ordovician and Silurian species) is observed in the uppermost part of unit P/13 (compare SUTTNER et al. 2007).

Apart from conodonts, abundant fossils, such as foraminifera, stromatoporoids, corals, gastropods, orthocerids, trilobites, tentaculites, brachiopods, bryozoans and graptolites, have been known from the Takche Member (e.g. REED 1912; BHARGAVA & BASSI 1986, 1998; SUTTNER & ERNST 2007). Quite well preserved tabulate and rugose corals are documented from the units P/7, 8, 10, 11 and 13 (Takche Member) and P/16 (Mikkim Member). The range chart in Fig. 1 shows that most of them appeared within the late

Katian in units P/7 and P/13. Only few coral colonies were observed from the Silurian part of the sequence (P/16). Reed (1912) described *Streptelasma* sp. aff. *S. corniculum*, *Streptelasma* sp. or *Zaphrentis* sp., *Streptelasma*? sp., *Heliolites depauperata*, *Heliolites*? sp., *Lyopora*? sp., *Propora himalaica*, *Calapoecia*? sp., *Protaraea kanaurensis*, *Favosites spitiensis*, *Halysites catenularia* var. *kanaurensis*, *Halysites wallichi*, *Halysites* sp. and listed the species of *Plasmoporella* from the Takche Member. Among them, the species, except for *Streptelasma*? sp., *Heliolites depauperata*, *Lyopora*? sp. and *Plasmoporella* sp., were ones that Reed (1912) described from Hayden's Horizon 6 as the Silurian species. According to Reed (1912), (?)Llandoverian strata (Mikkim Member) yielded *Favosites* sp. cf. *F. forbesi*?, *Favosites* sp. cf. *F. niagarensis*?, *Lindstroemia* sp. and *Calostylis dravidiana*.

Based on the present study of coral material collected from the type section we can confirm occurrences of following tabulate and rugose corals: *Favosites spitiensis*, *Favosites* sp., *Plasmoporella* sp., *Halysites wallichi*, *Halysites*? sp., *Protaraea*? sp., Proheliotidae? gen. et sp. indet., *Calostylis*? sp., *Streptelasma* sp., Streptelasmatidae gen. et sp. indet. Of them, *Favosites* sp. and *Plasmoporella* sp. occurred in the unit P/13. *Streptelasma* sp., Streptelasmatidae gen. et sp. indet. and *Halysites*? sp. were found in the units P/8, 10 and 16, respectively. Others were collected in the well weathered rubble just below the section that derived from the Takche Member.

This is a contribution to IGCP 591.

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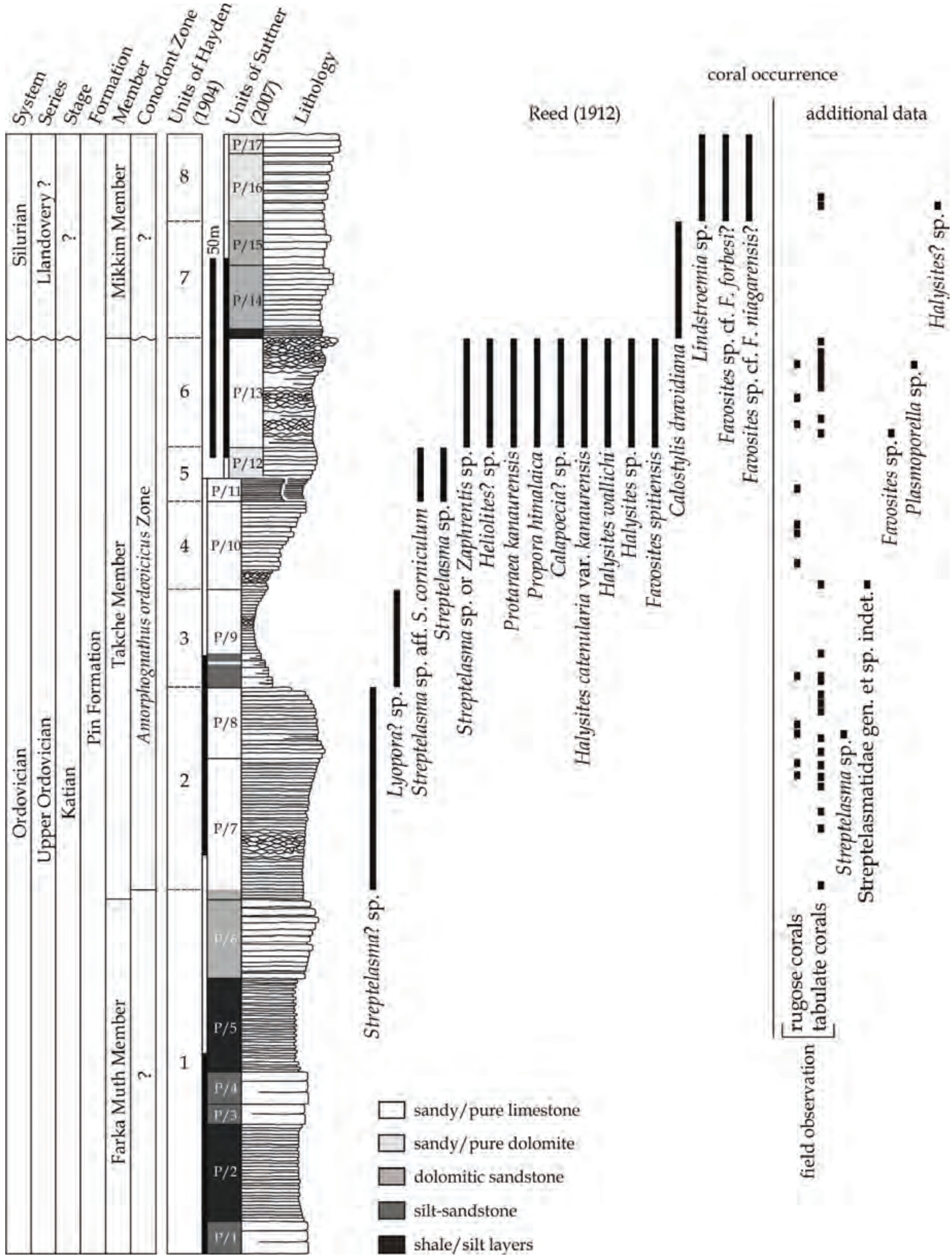

Fig. 1: Simplified log of the Pin Formation and the distribution of coral taxa. Historical units of Hayden (1904) are correlated to members which were proposed by Suttner (2007). Additional data based on this study are added here to the data provided by Reed (1912).

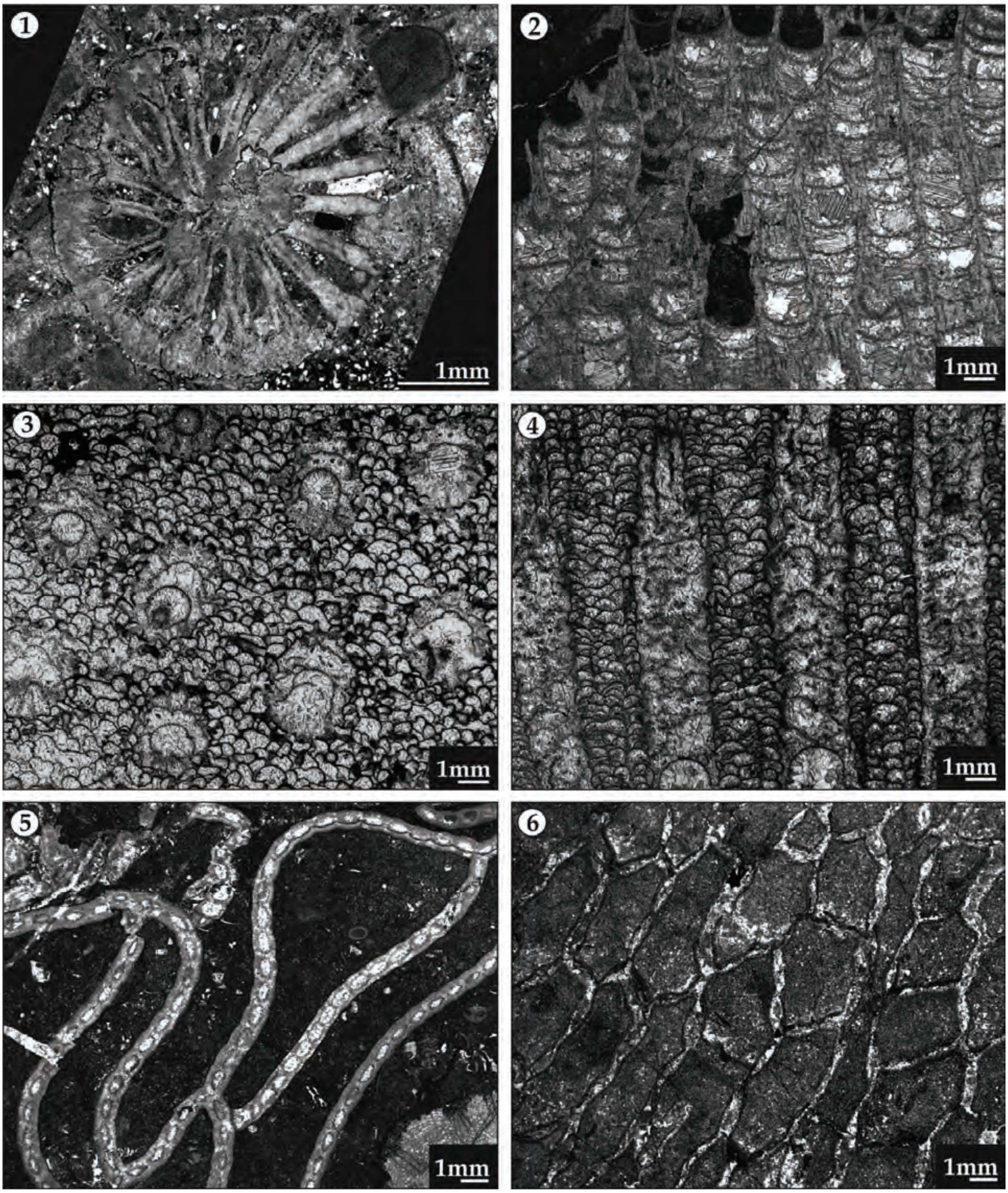

Fig. 2: Rugose and tabulate corals from the Pin Formation. (1) Streptelasmatidae gen. et sp. indet., transverse section, Takche Member (unit P/10). (2) *Favosites spitiensis*, longitudinal section, Takche Member. (3, 4) *Plasmoporella* sp., transverse and longitudinal sections, Takche Member (unit P/13). (5) *Halysites wallichi*, transverse section, Takche Member. (6) *Halysites*? sp., transverse section, Mikkim Member (unit P/16).

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Coral facies of a Burdigalian rocky-shore fringing reef (Bonifacio Basin, South Corsica)

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In the Cenozoic, especially during the Miocene, the Mediterranean region was characterized by the prolific development of different types of coral bioconstructions that occurred in a wide variety of structural and depositional settings.

In this study we investigate a peculiar coral bioconstruction developed on the southern margin of the Bonifacio Basin (southern Corsica) where, in the Burdigalian, mixed carbonate-siliciclastic sediments were deposited in a coastal environment during the Sardinia-Corsica block rotation. The marine transgression is represented by the Cala di Labra Formation (Ferrandini et al. 2002; Brandano et al. 2009) characterized by a coral bioconstruction unconformably lying on the granitic basement.

Based on depositional attitude and geometrical relationship with the granitic substrate, the investigated coral episode is interpreted as a fringing reef and represents one of the few known fossil example of a fringing reef attached to a granitic rocky shore (Johnson et al. 2006).

Two main reef facies can be distinguished based on their depositional attitude with respect to the substrate, type of coral fabric and sedimentary textures: (1) coral domestone and (2) coral platestone. The coral domestone is characterized by dense massive coral colonies forming a lens-shape framework with development of a concave-upward and planar-top profile filling the largest cavities among granitic blocks. The coral platestone is characterized by dominant growth of platy corals that drape and mantle the flat portion of the granitic substrate and overlay the coarse debris infilling smaller cavities. The domestone facies formed under moderate hydrodynamic energy, while the platestone facies indicates high hydrodynamic energy at water depth intervals between the SWB and FWWB and limited siliciclastic input during the coral growth.

The coral fauna is not very diversified at the generic level and dominant reef-builders are *Porites*, *Tarbellastrea*, *Thegioastrea*, *Favites* and *Favia*, together with subordinate *Astreopora*. Massive colonies with globous-domal shape and platy (encrusting and tabular) colonies are the dominant coral growth forms. Coral colonies are mostly in growth position, although a coral rubble associated with granitic cobbles and pebbles may be present at the base of the bioconstruction. Intercoral sediment is mainly represented by a bioclastic wackestone to packstone matrix with larger benthic foraminifera, red algae nodules and debris. Other components are articulated red algae fragments, bivalves and oysters, echinoids fragments, rotaliids, textularids, barnacles and bryozoan fragments.

The coral bioconstruction is overlain by a 10 m-thick fine conglomerate changing to coarse bioclastic quartz sandstone deposited in coastal settings near fluvial point sources. The C-isotope curve obtained from the Cala di Labra section does not show a significant shift in $\delta^{13}C$ values at the boundary between the coral facies and the siliciclastic-rich unit. This suggests that nutrification was not responsible for the demise of the fringing reef, while sudden burial by terrigenous sediment was a more likely factor. The increase of terrigenous input had various effects: increase of turbidity with consequent decrease of light in the water column, damage to coral tissue by abrasion and disruption of coral foundations because the high clastic accumulation formed a mobile substrate.

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Jean Gabriel LAFUSTE (1930-1990) and the « French » interpretation of microstructures in Palaeozoic corals.

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The French palaeontologist Jean Gabriel LAFUSTE was born in La Rochelle (South West France) in 1930, where he died prematurely at the age of sixty. After studies at the University of Poitiers, where he worked on Jurassic reefs, he quickly joined Paris, first at the Sorbonne and finally at the Institut de Paléontologie of the Muséum national d'Histoire naturelle, where he made most of his career. He was called by James ALLOITEAU (1890-1969) to join the « coral team » as the specialist of tabulate corals. Talented with a great manual skill, he prepared himself his specimens and thin sections and he invented different special technical improvements, allowing the thickness of the sections to be strongly reduced, until a few micrometers. This reduced thickness permits very subtle observations of microstructures, as the boundaries of the very thin crystals appear sharply in polarized light. As he was very curious, he prepared these « ultra-thin » sections or sections with polished sides (« lames à faces polies » or LFP) in a lot of different objects (corals of course, but also shells, eggs, bones, etc.), making comparisons between the different kinds of biomineralisation processes.

He studied most of the classical Tabulate corals faunas – Siluro-Ordovician of Scandinavia and of the British Isles, Devono-Carboniferous of Western Europe, Permian of Timor, etc. – during visits to the most important museums and collections in the world. But he also received many « fresh » collections from field geologists, among others from the Devono-Carboniferous strata of Northern Africa (Algeria and Morocco) – among others the very large collection of Henry HOLLARD. His approach was very carefull, beginning with observation of morphological characters of the colonies, then of thin sections and finally of the microstructure of the skeletons. Each step was connected with the other ones, to understand the growth form and the precise morphology of all these species. He used for these studies all the possible tools – thin and ultra-thin sections for optical microscopy but also SEM and other contemporary means.

As these studies were very carefully conducted, they were also rather slow and the main problem for J.G. LAFUSTE was to conclude them and to write communications. So many results unfortunately remained unpublished – as a comprehensive approach of the Alveolitids or an attempt to understand the complex relationships between *Favosites* and *Thecia*! Most of these « dossiers » were transmitted after the death of J.G. LAFUSTE to his co-workers, but it is difficult for them to conclude these researchs without the principal author.

It could be avanced that J.G. LAFUSTE was not sufficiently aware of the diagenetic evolution of carbonates and that its interpretations were too close to the rough observations. But the precision of these observations is without doubt a very precious contribution to the knowledge of the Tabulate corals, of their structure, microstructure and organization – with general trends, like the global evolution from (micro)lamellar in Siluro-Ordovician forms to fibrous ones in the Permian. Unquestionably a great « naturalist » in the best, noble meaning of the word!

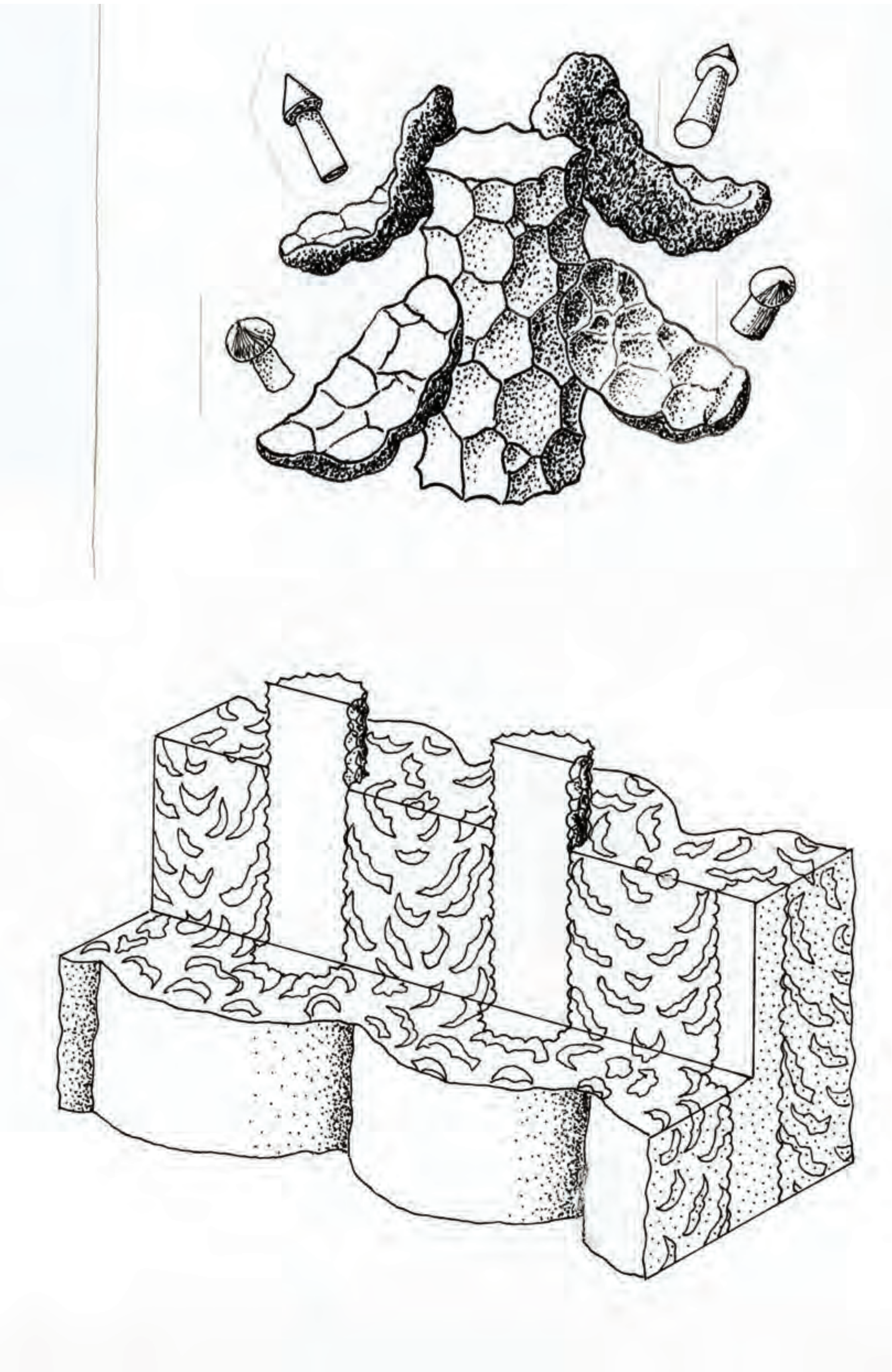

Fig. 1: Unpublished drawings showing the relationships of different kinds of crystals in the wall of the genus *Thecia* Milne-Edwards & Haime 1849.

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Modes of asexual reproduction and colony formation of zooxanthellate scleractinian *Oulastrea crispata*

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Oulastrea crispata is a zooxanthellate, colonial scleractinian that is broadly distributed in the western parts of the Pacific Ocean. The species inhabits specific environments, very shallow areas with turbid conditions. *O. crispata* is very resistant to low-temperature and temporary drying conditions. Its pigmented skeletons are very characteristic. The samples for this study were collected at a tide pool at the Hidaka area, Wakayama Prefecture, in southwest Japan.

O. crispata exhibits sub-cerioid to plocoid colonial forms, and a mixed structural organization, even within one colony, and is characterized by having both intratentacular and extratentacular budding (Lam 2000). Additionally, seasonal environmental fluctuations greatly influence corallite skeletogenesis and growth form (Chen et al. 2011), as well as mode of asexual budding. Individual corallite outlines vary between peripheral and central parts of the same colony. In addition, modes of asexual reproduction and its frequency also differ. Even if most individuals are covered and killed by calcareous algae, a few individuals survive as patches. Soon after environmental recovery, the remaining survivors give rise to offsets asexually so rapid as to spread over the whole corallum surface. The surviving individuals tend to be limited to the central parts of the colony. Interestingly, there also is known to be a difference in the frequency of egg production occurring in the colonial coral *Goniastrea aspera* (Sakai 1998). According to differences in position, a division of reproductive role contributes to nearly the whole growth of the colony. *O .crispata* transforms its structural organization from cerioid to plocoid by appropriately selecting more efficient modes of asexual reproduction.

O. crispata thus has an efficient reproductive strategy, according to subtle differences in position and resultant ambient environments, and exhibits very high tolerance of environmental fluctuations by the means of modifying their manner of colony formation and growth form.

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Devono-Carbonifeous carbonate platform systems of the Netherlands

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Paleozoic carbonate build-ups, globally important for hydrocarbon exploitation, are generally not associated with the Netherlands or with the larger Southern North Sea area. In the last ten years information of new wells and seismic have changed this perception. Recent seismic interpretations have indicated massive Mississippian carbonate bioherms far below conventional petroleum exploration targets in the Netherlands (Abbink et al. 2009; Van Hulten & Poty 2008; Kombrink 2008). Recent UK exploration on the Mid North Sea High also provides new insights. The amount of data on these reefs is very limited. The following summary is intended to provide an overview.

The recently released Dutch well information dates the platforms as Mississippian, with a Devonian core. Some of the reefs are very sizeable. In particular, the platforms in the Friesland and Groningen area are comparable with the well-known Caspian carbonate buildups (Weber et al. 2003). These Mississippian platform carbonates are also underlain by Devonian reefs. For years the same paleogeographic map could be used for North Western Europe because of lack of new data. A revised paleogeography of the West European Devonian and Mississippian is now required to fit the new data.

Because of the great present day depth, it is not clear if the reefs are a new frontier or are situated below the economic basement of hydrocarbon exploration. New insights may provide new opportunities for the petroleum industry but the presence of big reefal reservoirs can also be of importance for thermal exploitation in the densely populated Netherlands.

Paleogeographic reconstructions cannot be made without a good understanding of the structural framework of North West Europe. For the Devono-Carboniferous sedimentation systems, the Caledonian structuration is important. During the Devonian after the Caledonian events during the Silurian, deposition in the general North Sea area commenced. Most well information is available from two major highs, the Mid North Sea High in the North and the London-Brabant Massif in the South. They delineate a large intra-cratonic basin in the Netherlands. Perhaps more important than the highs, is the nature of this basin area in between. Based on crustal properties, a deep ocean area can be postulated over part of this basin area. This can be confirmed by subcrop maps of the Upper Carboniferous at the base Permian Unconformity. With such a map, general outlines of highs, coinciding with Mississippian carbonate platforms, can be deduced. The same highs, or at least parts thereof, are assumed existent during the Devonian. The resulting shape of the paleo-ocean combined with paleowind considerations, with trade winds from the south east in the Devonian and north east during the Mississippian, make it likely that some highs were created by fringed carbonate platforms.

The direction of the structuration in the Netherlands, as can be seen in the general fault patterns, parallels the Sorgenfrei and Teisseyre-Tornquist Zones in southern Scandinavia. Batholiths in the Netherlands are known of the Mid North Sea High and most likely of the Groningen area.

The Devonian is generally perceived to have little hydrocarbon potential and is hardly drilled into. There are no Devonian outcrops in the Netherlands. The nearest Devonian rock in outcrop is found in Southern Belgium, Germany, and the UK. Dutch Devonian well control is also sparse because of the depth of Devonian age sediments, generally exceeding 4,000 m. This means that the sedimentological setting is generally deduced from information of surrounding countries. The few wells that reach the Devonian are located close to the major highs and are of limited value for a representative paleogeography. The characteristic UK Old Red Continent fluvial facies may be present in parts of the Netherlands. However, part of the Netherlands is almost certainly deep oceanic. It is plausible that during the Givetian and Frasnian, carbonate platform growth starts at the fringes of this ocean area, comparable to the sequence in the southern part of Belgium. In the Middle Devonian, carbonate development is described, not just from the classical platforms in Southern Belgium, but also in the UK and Germany. Of importance are cored limestones in the UK well 38/3-1 close to the Mid North Sea High. The fossiliferous lime mudstones, wackestones, packstones and grainstones in this well suggest a marine connection of this area with the postulated Devonian ocean in the South East. Marine Givetian limestones are described in the German well Q/1 and in the German well Munsterland-1, not too far from the German Dutch border. In the Netherlands, mostly clastic sediments are found. Exceptions so far are some biostromal limestones in South Limburg. Frasnian marine shales in some wells like S05-01 make it certain that a coastline covered part of the Netherlands during the Middle Devonian. The new well information of the giant Devono-Mississippian Groningen (Abbink et al. 2009) and the Luttelgeest reef (Van Hulten & Poty 2009), suggest that the core of these reefs were formed during the Devonian. A proposal for a new Devonian paleogeography of the area will be made.

The new seismic interpretations have indicated massive up to 1-2000 m Mississippian carbonate build-ups over a large part of the Friesland province. The top of the Mississippian carbonates is at a depth of 3,000-6,000 m, sometimes exceeding 10,000 m. Like the Devonian, stratigraphic information is therefore seriously limited, because the few wells that have reached the carbonates are mostly clustered at the shallower basin fringes. In a number of Dutch wells, at the northern flank of the London-Brabant Massif, 900-1400 m thick light grey, brown carbonates have been encountered. Generally, it consists of a tight limestone that ranges in age from Tournaisian to latest Viséan and is called the Zeeland Formation. Sedimentologically they confirm a carbonate platform setting. These carbonates are very similar to platform carbonates described in the UK southern North Sea and onshore. It is likely that different facies belts exist related to the forming of half grabens. To the north fringe reefs or very thick carbonate microbialite reefs of Mississippian exist. Comparable bioherms exist with associated good reservoir quality in the Caspian region (Weber et al. 2003), not proven in the Dutch reefs. Grainstone shoal deposits in the Caspian display good reservoir potential where primary porosity is mainly controlled by intergranular porosity and mud-lean packstone lithofacies. Similar facies are not unknown in the Dinantian carbonate fringe area of Belgium. A big question is if they can be expected in the Dutch northern fringe reefs.

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Scleractinians from the Mediterranean: what has happened since the end of the Miocene?

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In the last 10 million years, geodynamic and climatic processes have caused important palaeogeographic and palaeoceanographic changes in the Mediterranean Basin which have strongly affected its pelagic and benthic biota. The most striking event occurred at the end of the Miocene when the Mediterranean was temporarily disconnected from the Atlantic and underwent the so-called "Messinian salinity crisis". However, as recorded in the Pliocene and Quaternary fauna, important environmental changes took place also after the Miocene.

Unfortunately, most of the scientific papers dealing with Mediterranean Plio-Pleistocene corals date back to the first half of the 20th century. Therefore, any palaeogeographic interpretation cannot prescind from a comprehensive critical review of the existing literature. This study represents a first step towards this goal and a contribution to better understand the effects of the Messinian salinity crisis, and the subsequent (mostly climate-driven) modifications, on the Mediterranean coral fauna.

Up to now, we have detected about 35 scleractinian genera in Plio-Pleistocene deposits from the Mediterranean area. Even if some of them are extinct in the modern basin, they are almost all extant genera. With the exception of *Cladocora*, *Balanophyllia* and *Siderastrea* (the occurrence of the latter genus needs to be verified), the recorded taxa are all azooxanthellate and include "reef-building" forms which thrive today in cold and deep environments.

Nearly all the Miocene hermatypic-zooxanthellate scleractinian taxa disappeared from the Mediterranean during the Messinian. Despite this crisis, there is a strong affinity between the Early-Middle Pliocene coral fauna and the Late Miocene one. Whereas all Pliocene genera, and most species, were already present in the Late Miocene, the Upper Pliocene(?) and Early-Middle Pleistocene scleractinian associations (particularly abundant in southern Italy) lack typical Mediterranean Neogene taxa (e.g., *Trochocyathus*) and show a very strong affinity with the modern NE Atlantic. Remarkably, in the Early Pleistocene, the variability of some genera (e.g., *Flabellum*), which eventually will disappear from the Mediterranean at the end of the Pleistocene, is already lower than in the Neogene. Further compositional modifications which presumably occurred during the Quaternary interglacial-glacial cyclicity are still unclear, but it is certain that, at the end of the Würmian age, most of the Atlantic-like bathyal species disappeared from the Mediterranean basin.

Our preliminary data highlight that the diversity patterns observed between Early Pliocene and Early Pleistocene coral biota are in accordance with those noticed in other taxonomic groups by previous authors (e.g., Di Geronimo et al 1995; Taviani 2002 and references therein). On the whole, the Mediterranean scleractinian diversity seems to have deteriorated since the Late Miocene up to now: apparently "abruptly" during the Messinian and more gradually since the Pliocene onwards. The modern Mediterranean coral fauna has an obvious NE Atlantic affinity but, lacking the most stenothermic cold ("psycrospheric") species, can be considered as a sort of Atlantic relict.

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Acroporidae of the Caribbean

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The fossil history of Caribbean reef-building Scleractinia has been documented in considerable detail, with two main turnover periods (Late Oligocene/Early Miocene and Plio-Pleistocene) being recognised as major influences. Within this history, family Acroporidae is represented by at least five genera, *Astreopora*, *Alveopora*, *Dendracis*, *Isopora* and *Acropora*, only the last of which is extant. Each genus follows a different trajectory, and although much remains to be discovered, indications are that taxon cycles within the Caribbean, as well as geographic distribution, stratigraphy, habitat range and even novel character states, provide insights into the broader evolution and biogeography of Acroporidae. Because this family reaches its greatest generic and species diversity in the Indo-Pacific today, these topics are of great interest in assessing the challenges faced by extant taxa under a regime of global climate change.

This very preliminary presentation looks at published and museum evidence of Caribbean Acroporidae, in relation to current molecular phylogeny of the extant genera. Some findings are:

- *Astreopora*, basal genus, widely distributed through the region possibly from the Late Cretaceous, and especially during the Oligocene to Miocene, demonstrates a unique branching form in Caribbean members, which finds a possible homologue in a later genus. *Astreopora* became extinct in the Caribbean in the Late Oligocene/Early Miocene turnover and probably did not contribute to an Indo-Pacific lineage, even though it has fossils in the Eastern Pacific.
- *Alveopora* (recently moved to this family from Poritidae), also a basal genus, and present from the Eocene, also became extinct in the Caribbean in the LateOligocene/Early Miocene turnover, but little can be said on any lineage in the Pacific, as fossils are infrequent.
- *Isopor*a, apparently restricted to the Netherlands Antilles, was an ecological dominant on reef-front assemblages there during a period of about 3.9Ma in the Late Miocene/late Pliocene. This genus, now widespread on reefs throughout the Indo-Pacific but not recorded in the European region, apparently originated in either the Caribbean or Indo-Pacific. At the time of finding, the Curacao deposits were the earliest record for *Isopor*a, and made it possible to extend back its date of origination for molecular clock purposes by three million years. Recently published Middle Miocene Pacific of *Isopora* in Fiji, Pacific Ocean, suggest origination in the Pacific. This raises an obvious hypothesis, that this genus entered the Caribbean from the Pacific and briefly had great ecological success.
- *Acropora* is now restricted to a single species group with two main species that are widespread and ecologically abundant from the Late Miocene or Plio-Pleistocene to the present. This genus has been represented in the Caribbean by other species and species groups, described and undescribed, up to the Late Miocene, indicating a more diverse history for this genus, which will be potentially very informative once studied.

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Patrick K. SUTHERLAND (1925-2000) - Mentor

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Pat Sutherland
Guilin, China, 1987

Patrick K. Sutherland was born in Dallas, Texas in 1925, and got his BSc in Geology from the University of Oklahoma in 1946 before working as a stratigrapher in western Canada with Phillips Petroleum until 1949. He then went to Cambridge University, England where he received his PhD in Geology in 1952. From there, he went back to Phillips Petroleum as a stratigrapher in West Texas, but left for an academic career at the University of Houston in 1953. He moved to the University of Oklahoma in 1957 and became a professor in 1964, serving in that capacity until his retirement in 1990. He also served as the Curator of Invertebrate Palaeontology at the Oklahoma Museum of Natural History (OMNH) from 1961 and the curator of Earth Sciences from 1975 until his death. Pat was a stalwart member of the International Association for the Study of Fossil Cnidaria and Porifera (IASFCP), proudly having attended the first international meeting in Novosibirsk in 1971. He is still well remembered as a worker on Carboniferous corals and brachiopods, but also Silurian corals, Palaeozoic reefs and regional stratigraphy. Some of his stratigraphic work was done for the Oklahoma Geological Survey, the Texas Bureau of Economic Geology and the New Mexico Bureau of Mines and Mineral Resources. Importantly, he also was an educator, supervising 36 MSc students, mostly in stratigraphy, and six PhD students and co-supervising another seven MSc students. Apart from his geological interests, Pat was very knowledgeable about Native American art and was a tireless campaigner to improve the curation and preservation of such art in the OMNH. He was also a patron of performance arts with a particular focus on opera and symphonic music; he was President of the OU Theatre/Opera Guild from 1997-1999. It was during an international trip to attend opera performances in Europe that Pat contracted the illness to which he succumbed back in Norman in 2000.

Although Pat worked primarily on Carboniferous corals, brachiopods and stratigraphy, he felt that his best known coral work may have been the Silurian corals of the Henryhouse Formation, southern Oklahoma (SUTHERLAND 1965). There he erected the Family Ditoecholasmatidae and documented the biform tabularium in Ditoecholasma, a feature that was later shown to be of great significance in laccophyllid corals by WEYER (1972). However, Pat published significant work on Carboniferous corals in British Columbia, Oklahoma, Arkansas and Texas as well as British heterocorals. He was particularly interested in Petalaxis and in intracolonial variation in colonial rugose corals. The rugose coral genus Sutherlandinia WEYER, 1972 was named after Pat, and Pat also had a tabulate coral, Sutherlandia COCKE & BOWSHER, 1968 named for him. Of course brachiopod workers also consider Pat to be one of their own. He did significant work on Pennsylvanian brachiopods in New Mexico, Oklahoma and Arkansas. Much of Pat's paleontological work was focused on biostratigraphy and his regional stratigraphic studies in Oklahoma, Arkansas and Texas are still highly valued. His integrated stratigraphy papers (e.g., SUTHERLAND 1988) are still generating citations in 2009 and 2010 (according to the ISI Web of Science database) and the guidebooks to stratigraphy in Oklahoma and Arkansas that he edited (SUTHERLAND & MANGER 1977, 1979; SUTHERLAND 1982) are as invaluable today as when they were first printed.

I first knew Pat as my undergraduate lecturer in stratigraphy and biostratigraphy, my Senior Honours supervisor and then as my MSc supervisor at the University of Oklahoma in the USA. Pat remained my mentor, colleague and good friend until his death in 2000. As a mentor, Pat was instrumental in guiding me into the field of fossil corals, ancient and modern reefs, and carbonate sedimentology/stratigraphy in general. I had previously had a fascination with echinoderms, but he quickly won me over to corals. Every time I now walk on the Great Barrier Reef or in the fossil reefs of the Canning Basin, Western Australia, I think about what a big debt I owe him for that. Reflecting on Pat as a mentor, I realise I owe him for many things.

Pat stressed breadth and utility in his research – from basic sedimentology and stratigraphy to descriptive paleontology through palaeoecology, evolution, and biostratigraphy, always within the broader context of regional geology. Hence, he taught me how the different scales of investigation must be integrated irrespective of whether one focused on the systematics or the more regional stratigraphy. Along the way, Pat taught me to make my first thin sections as well as measured sections (and his were always so informative), to do field work and laboratory work, to collect fossil corals, but also their surrounding lithology, all within a stratigraphic context. He taught me to write for publication, to whiten and photograph samples, to do my own darkroom work and make plates the good old fashioned way with photographs and scissors. He was a stickler for finding just the right pair of surgical scissors that would cut the sharpest images without deforming the edges of the photographs. As his assistant in the Oklahoma Museum of Natural History, Pat taught me how to organise a collection, do the necessary book keeping and cross cataloguing required of a curator, and gave me a real sense for the value of a good museum collection and a good library. He taught me the importance of collaboration with international colleagues and helped me start my reprint collection. Even as an undergraduate student, he gave me an interesting collection to work on for my Senior Honours Thesis, the Imo coral fauna from Arkansas, and then pushed me to have a paper for presentation at the 4th IASFCP Symposium in Washington DC in 1983. As his graduate student, Pat found ways to involve me in teaching (I got to teach six weeks of evolution theory to his graduate biostratigraphy class when he went on an overseas trip). Looking back now, I don't know how he fit so much in, but it is clear that he was preparing me for the academic career I now so greatly enjoy, and I think what made it all work was that he simply involved me in everything. He treated me like a colleague from early on, and I learned more than I ever really appreciated. And mentoring me could not have been easy. My writing was so bad as a student, that after I submitted my MSc thesis, I gave him a box of red pens to make up for some of the ones he used up commenting on my many drafts. He was as patient with my youthful ignorance and mood shifts as he was of my writing and always with good humor and the bearing of a real gentleman. Pat finally introduced me to John Jell and helped me get a scholarship to do my PhD in Brisbane in Australia, a place I now call home.

Pat's mentoring also went far beyond science. He was a master traveller. When I was a PhD student in Brisbane, he planned a trip for us to visit Prof. Makato Kato in Sapporo in 1987 before the Carboniferous Congress in Beijing. We met up first in Kyoto. Pat had chosen a relatively inexpensive Japanese inn and I found by looking at photos on their wall that it was visited by important U.S. politicians (like Ted Kennedy) and other rich and famous. Pat always researched out the best places to stay. On the other hand, I was a bit nervous to be presented with a good road map of China while in the Friendship Hotel, Beijing, for the Carboniferous Congress when I realised that it was stamped 'CIA' all over it. Pat had ordered it from Washington D.C as the best available map of China for tracking our position on the conference field trips. Pat always found ways to broaden my horizons. I have never again attended an opera with anyone else! Pat was a great friend and colleague and one I could always count on for scientific discussion or an interesting conversation about the arts. I miss him.

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William J. Sando (1927-1996) – Mentor

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Bill Sando and Tetsuo Sugiyama on the hill near Asby Scar, Northern England during the pre-excursion of IASFCP Symposium, 1991.

William J. Sando, or Bill as we mostly knew him, was an expert on the Mississippian corals and stratigraphy of the western United States and a long-term supporter of the International Association for the Study of Fossil Cnidaria and Porifera (IASFCP), having attended the initial First International Symposium in Novosibirsk in 1971 and being reasurer and co-editor of the Proceedings volume for the 4th International Symposium in Washington, D.C. in 1983. Bill was born in Washington, D.C. in 1927 and following a brief stint in the United States Naval Air Corps he received B.A., M.A. and Ph.D. degrees in geology from Johns Hopkins University in Maryland. After a short research fellowship at the University, he took up a position at the United States Geological Survey (USGS) in 1954 and remained there until his retirement in 1993. During his tenure he commonly represented the USGS at IASFCP meetings and also at the International Congress of Carboniferous Stratigraphy and Geology. Bill published more than 100 research papers on topics as broad as Mississippian coral systematics, biostratigraphy, palaeobiogeography, palaeobiology, stratigraphy, geological history/regional geology, palaeokarst and even pseudofossils. Fifty-five of those papers dealt specifically with fossil corals. He also published 12 guidebooks and wrote 25 contributions for *Fossil Cnidaria*, the newsletter. While Bill served the USGS in a variety of capacities, he was particularly proud of his editorial duties and of having initiated and edited the USGS series: *Shorter Contributions to Paleontology and Stratigraphy*. Following his official retirement, Bill maintained a vigorous research presence at the USGS as Geologist Emeritus and Research Associate of the Smithsonian Institution until 1996 when sadly he took his own life after a prolonged illness and long-term battle with depression. It was a major blow not only to the collective knowledge base of Mississippian corals and stratigraphy of the western United States, but also to the many young coral workers that Bill at one time or another took under his wing.

Bill Sando's name will forever be linked with the coral genera *Aulina*, *Lithostrotionella*, and *Ankhelasma* and he won an award for best paper in the Journal of Paleontology for his 1961 paper on the latter genus (Sando 1961, J. Pal. 35:65-81). Thirty-six years later his last paper won an Honourable Mention in the same journal for a coral-based investigation of Mississippian latitudinal diversity gradients (Webb, Sando & Raymond 1997, J. Pal. 71:780-791). The application of corals to solve broader stratigraphic and regional to global tectonic problems was a hallmark of Bill's work. He and Wayne Bamber combined to produce the coral-based biostratigraphic zonation of the Mississippian System in western North America, but he also provided biostratigraphic correlations for Pennsylvanian strata. Many of his works integrated his coral-based observations into larger concepts of basin development, sequence stratigraphy and carbonate factories to produce integrated geological histories for the western United States. In later years he grew increasingly concerned about the decline of coral workers and palaeontology as a field and began to investigate databases and other new ways of exploring and using corals and stratigraphy. He was very proud to be a scientist serving the needs of society, and had a distinguished record of service, but he sometimes regretted not being a university academic, so that he could have a greater impact on students. However, he made up for it by mentoring many younger colleagues both in the US and internationally. Two of those colleagues authored this abstract.

GEW - I first met Bill at the 4th IASFCP Symposium in Washington, D.C. My first recollection of him was a sympathetic face in the audience during my first international talk as a MSc student. His obvious attention to my talk and apparent agreement signalled by the occasional subtle nod instantly improved the confidence of an otherwise terrified student speaker. I found his calm, confident and knowledgeable approach to Mississippian corals and stratigraphy a great benefit thereafter. I was very fortunate to be able to visit Bill at the Smithsonian and always enjoyed my visits. It was especially exciting for a student to have access to the Natural History Museum of the Smithsonian Institution and wear a 'Visiting Scientist' badge and Bill's research collections were always open to a willing student or colleague. Staying with Bill in Alexandria was also a pleasure. We spent many interesting hours in his well appointed basement study discussing corals, stratigraphy, and about anything else, while listening to recordings of his Barbershop-style choral group, the Alexandria Harmonizers. Who knew that Bill was a singer! On those occasions and throughout my early academic career, Bill provided sage career advice along with interesting and far-ranging scientific discussions. He always advocated understanding the corals in an integrated way - from biology up to depositional environments and then through to useful applications in stratigraphy and palaeogeography and tectonic reconstructions. He occasionally reminisced about the fortunate timing of his career and lamented how it was getting tougher and tougher for young palaeontologists, but he always tried to help out. Many will remember that Bill had a great sense of humour but that he could be a pretty 'crusty' guy, particularly when the diabetes was giving him trouble, but he never stopped caring about his junior colleagues and students. When my father died while I was finishing my MSc degree at the University of Oklahoma in 1983, I got a letter addressed from Washington and opened it to find a postcard with a sunflower on one side. The other side said simply, "The sun will shine. Bill". Bill was a great mentor. I hope the sun is shining for him now.

TS – Bill helped and encouraged many young coral scholars who were not native to English. He was a most skilful reviewer and shaped up strange and disordered English in coral manuscripts. I first met him at Beijing around the reception area for the 11th International Congress on Carboniferous Stratigraphy and Geology in 1987. Before we met, he had already reviewed my poor English manuscript on heterocorals (Sugiyama 1984) three times from 1979 (five years!). During the congress he gave me a warm encouragement after my début in the international meeting, even though I could not react to some critical questions from participants, by using the Japanese word "Ichiban" which means "you are the best." After three years, I got a chance to share my sabbatical year with Bill in Washington D.C. from 1991 to 1992. In his office and his private area including some practices and concerts of the International champion of Barbershop chorus, Alexandria Harmonizers, he shared his happiness and sadness, pleasure and suffering, well-organized parts and disorganized ones. He always kept his mind open for this childlike oriental guy. Before we attended the Münster Cnidaria Symposium in 1991, he recommended that I open my mind for good communications with people, and this simple suggestion helped me so much during the first experience in this international community. He also suggested that I keep myself free in the scientific community. This mentor helped me keep a balance between independency and responsibility for my scientific freedom. We spent unforgettable happy days during the pre- and post-excursions and the days of conference. In this conference he presented an important caution for the future of Cnidaria research (Sando, 1994) based on his Carboniferous coral database, which was accumulated in his old PC after his long efforts. Unfortunately his conclusion turns out to be right: Late Paleozoic coral researchers are extinct in several countries, and he regretted that he did not pursue his career in the education sector. He strongly recommended that I mentor one or two good students during my career. I suppose everyone who "blew under his wind" share the same feeling with me; Bill made us realize where we stood on scientific research. Bill sang "Danny Boy" a cappella for us at a small Japanese style counter bar, when he stayed at my home to attend the IGC Kyoto 1992. When my wife, Kyoko, and I got the very sad news from Wayne Bamber in 1996, we understood that he finally became free.

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"Still-stand" Diagenetic Zone, Heron Reef, Great Barrier Reef: Implications for Dating, Reef models, Sea Level Reconstruction and Environmental Records

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Data from reef flats and shallow reef cores provide the basis for many Quaternary sea level curves, Holocene palaeoclimate reconstructions and reef growth models generally. Scleractinian coral skeletons are ideal for such studies as they are ecologically constrained to specific bathymetric ranges and some coral growth morphologies, such as microatolls, potentially provide high-resolution sea level data. Additionally, coral skeletons can be dated using both radiocarbon and U-series techniques, they have annual growth banding, and they preserve isotopic and trace element proxies for environmental parameters such as sea surface temperature, salinity, and productivity. Hence, coral skeletons provide a wealth of data for charting and understanding late Pleistocene and Holocene palaeoclimate. However, it has long been appreciated that geochemical data obtained from corals are subject to the quality of preservation of the skeletal aragonite and that meteoric diagenesis typically disrupts original geochemistry. Meteoric diagenesis involving the stabilisation of original skeletal aragonite to calcite in particular has been shown to disrupt trace element and isotope geochemistry so as to corrupt environmental proxies and make dates obtained from such corals unreliable. Recent investigations of living coral skeletons (NOTHDURFT & WEBB 2009) and shallow coring beneath the surface on the leeward margin of Heron Reef, southern Great Barrier Reef suggest that a zone of relatively intense marine diagenesis may exist immediately below the reef flat and marine diagenesis within this zone may have implications in particular for U-series dating.

A transect of five shallow(~4-10 m) cores was obtained at 5 m intervals from the same area of the leeward reef margin of Heron Reef as NOTHDURFT & WEBB (2009) demonstrated a variety of diagenetic processes in living coral skeletons on the reef flat. The skeletons of living corals were found to contain abundant aragonite, high Mg-calcite, low Mg--calcite and brucite cements suggesting a relatively extreme diagenetic environment. The high degree of diagenetic alteration was attributed to the intertidal position with abundant and frequent wave and tidal pumping of water masses, temperature extremes, evaporation, CO_2 degassing and, significantly, biological activity. In some cases, observed diagenetic effects could seriously compromise environmental proxies, such as calcite-filled borings, which could severely impact Sr/Ca coral palaethermometry (NOTHDURFT et al. 2007). The zone immediately below the reef flat is also characterised by high degrees of diagenetic alteration as generally evidenced by enhanced lithification by cryptic microbialites and a variety of marine cements.

Corals were selected from the shallow cores for dating on the basis that they were apparently in growth position and were well preserved with little cement and free of obvious microbialite. Corals were dated using the U-Th technique with elemental measurements by thermal ionisation mass spectrometry (TIMS) at the University of Queensland. Corals were found to have relatively high U concentrations and dates ranged from ~4 to 7.5 ka with most dates increasing with depth as expected. However, above depths of ~1.5 m coral dates show a significant deflection in the wrong direction (i.e., above 1.5 m depth corals appear to increase in age towards the surface; Fig. 1). Although such a pattern could be produced by accidental dating of redeposited, older coral debris, which can occur on reef flats, all samples appear to be in their position of growth and it is unlikely that all corals sampled from this zone would be redeposited from older parts of the reef. Hence, this dating anomaly may correspond with a zone of increased marine diagenesis that appears to have affected the U-Th dating system so as to make corals appear to be too old. Such an increase in U-series age could result from U loss or Th addition; either process would result in an apparent increase in the ^{230}Th/^{238}U ratio and thus the calculated ^{230}Th age from the ratio would be too old. However, in this case, the dated corals also contain high U values, making leaching of U an unlikely culprit. As this uppermost reef zone contains abundant microbialites (WEBB & JELL 1997) and the microbialites contain high Th concentrations rendering them unsuitable for U-series dating (Webb & Jell 2006) microbialite contamination could be a problem. However, the dated corals contain very little ^{232}Th, suggesting against incorporation of a large amount of microbialite-derived Th. Hence, against expectation there appears to be direct evidence of Th open-system behaviour that allowed preferential ^{230}Th mobilisation and enrichment in this environment. It is likely that this zone of intense and unexpected diagenesis may reflect long-term suspension of corals immediately below the reef flat within the intertidal zone during the relatively long 'still-stand' when local sea-level was maintained at or near its current elevation since ~7 ka (LEWIS et al. 2007; YU & ZHAO 2010). Coral skeletons that occur in this 'still-stand' environment for long intervals of time may be affected and have unreliable dates.

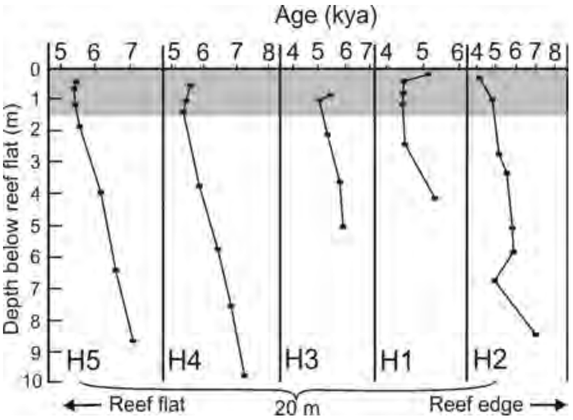

Fig. 1 U-Th age-depth profiles for five cores at 5 m intervals on the leeward margin, western end of Heron Reef. Ages increase with depth except within upper ~1.5 m (gray band), where they increase in apparent age towards the surface. This apparent dating anomaly may reflect open system Th behaviour in the diagenetically very active 'stillstand' zone. Age error bars are less than the width of symbols.

Shallow reef cores are only very rarely collected from closely spaced transects that can identify aggradation versus progradation ratios and many reef cores have only limited numbers of U-series dates in vertical sequence. Hence, zones of anomalous dates may not be recognised in some cases and some coral dates previously used for refining sea level curves, reef aggradation rates and for documenting reef growth models could be affected. Similar problems could exist for older corals obtained from current active reef flats. Hence, although the processes that might be responsible for preferential ^{230}Th uptake in coral skeletons are under investigation, recognition of the potentially significant impacts for both dating and environmental proxies of the 'still-stand' diagenetic zone in ancient and modern coral reefs is critical.

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WEBB, G.E. & JELL, J.S. (2006): Growth rate of Holocene reefal microbialites – implications for use as environmental proxies, Heron Reef southern Great Barrier Reef. - Extended Abstracts, Australian Earth Science Convention, Melbourne, 2-6 July, 2006, Searchable Compact Disc (ISBN 0-646-46265-2) doi: 10.1071/ASEG2006ab191.

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Different stromatoporoid species under the same specific name: implications for paleontology databases

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The recent development of global palaeontological databases allows for rapid retrieval of taxonomic information. The great improvement in the availability of palaeontological data is in contrast to the known decline in taxonomic studies. In case of Paleozoic stromatoporoids this tendency is also valid. Many collections were studied and described in detail in times when the availability of palaeontological data was hampered by the limitations of the traditional printed media. In addition, scientists in the former Soviet Bloc were further isolated from the research work carried on in other countries. This raises the question whether specimens described by different authors under the same taxonomic name indeed belong to the same species; and, conversely, whether the same species was described under different names. The answer to this question is crucial since biodiversity studies can result in incorrect conclusions when different species or genera are conglomerated under the same taxonomic name.

Taxonomic inconsistencies between two published studies (LECOMPTE 1951, 1952; KAZMIERCZAK 1971) on the Middle and Upper Devonian stromatoporoids from western and central Europe are discussed. Both collections have not been revised since 1971, although the taxonomic position of some species established by LECOMPTE (1951, 1952) was reinvestigated (e.g. STEARN 1966; KAZMIERCZAK 1971; MISTIAEN 1980, 1988; MAY 2005; SALERNO 2008). Not less than seven species described by Lecompte and Kazmierczak are included in the Paleobiology Database.

The current study focused on stromatoporoid species described by both authors and assigned by Lecompte and/or Kazmierczak to the order Stromatoporellida, which was established as an independent order within the class Stromatoporoidea by STEARN (1980), ten years after the paper by Kazmierczak has been published. Taxonomic inconsistencies are more likely to arise in clades that were not precisely defined when the studied collections were assembled. Thus, stromatoporellids were chosen as a test group. A total number of 93 specimens representing 12 species was studied. All specimens were examined personally by the author.

At least five species of stromatoporellids described from the Middle and Upper Devonian of both the Ardennes and the Holy Cross Mountains differ significantly in details of skeletal construction. Skeletal features considered to be of importance in assessing stromatoporoid systematics (the presence of peripheral vacuoles; microstructure of laminae) also vary considerably, suggesting that taxonomic position of at least some specimens described by LECOMPTE (1951, 1952) and KAZMIERCZAK (1971) should be revised.

The present contribution and earlier work by STEARN (1999) show that there is urgent need to revise at least some of the stromatoporoid species described from the Devonian of western and central Europe. This task should be accomplished before entering data into a database, since inconsistent taxonomic concepts may affect the outcome of palaeobiodiversity studies. As stated by PLOTNICK (2007), „without taxonomic expertise, there will be no way of assessing the quality of data entered into any (…) database”.

KAZMIERCZAK, J. (1971): Morphogenesis and systematics of the Devonian Stromatoporoidea from the Holy Cross Mountains, Poland. - Palaeontologia Polonica, **26**: 1-150.

LECOMPTE, M. (1951): Les stromatoporoides du Dévonien moyen et supérieur du Bassin de Dinant. - Institut Royale des Sciences Naturelles Belgique, **116**: 1-218.

LECOMPTE, M. (1952): Les stromatoporoides du Dévonien moyen et supérieur du Bassin de Dinant. - Institut Royale des Sciences Naturelles Belgique, **117**: 219-360.

MAY, A. (2005): Die Stromatoporen des Devons und Silurs von Zentral-Böhmen (Tschechische Republik) und ihre Kommensalen. - Zitteliana **B 25**: 117-250.

MISTIAEN, B. (1980): Stromatopores du Givétien de Ferques (Boulonnais, France). - Bulletin du Muséum national d'Histoire naturelle **2**, (4ème série): 167-257.

Mistiaen, B. (1988): Stromatopores du Givétien et du Frasnien de Ferques (Boulonnais - France). - In: Brice, D. (Ed.), Le Dévonien de Ferques. Bas-Boulonnais (N. France). Collection Biostratigraphie du Paléozoïque, **7**: 163-195.
Plotnick, R. E. (2007): SWOTing at paleontology. - American Paleontologist, **15** (4): 21-23.
Salerno, C. (2008): Stromatoporen-Fauna, Fazies und Paläoökologie von Plattformkarbonaten aus dem Unter-Givetium der Eifel (Devon, Rheinisches Schiefergebirge). – Zitteliana, **B 27**: 3-129.
Stearn, C. W. (1966): The microstructure of stromatoporoids. – Palaeontology, **9** (1): 74-124.
Stearn, C. W. (1980): Classification of Paleozoic stromatoporoids. - Journal of Paleontology, **54**: 881-902.
Stearn, C.W. (1999): Easy access to doubtful taxonomic decisions. - Palaeontologia Electronica, **2**: 4 pp.

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Comments on subspecies of *Calceola sandalina*

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The neotype of the type species of *Calceola*, *C. sandalina* LINNÉ, 1771, was selected and illustrated by Richter (1928). From the Eifel, it was originally illustrated by GOLDFUSS (1840), and is a complete specimen of the slipper coral with the operculum in place. The inner surface of the operculum is therefore not exposed. However, many well-preserved *Calceola* opercula are known from the Eifel and there can be no real doubt about the generic assignment of this specimen, despite studies (WRIGHT 2001, 2006) of operculate corals that have suggested that features of the inner opercular surface are crucial for generic assignment. But what are the diagnostic features of *Calceola sandalina sandalina*?

GOLDFUSS (1840) erected *C. s.* var. *dilatata* and *C. s. exaltata*, both of which were regarded by RICHTER (1928) as junior synonyms of the type subspecies. Other German subspecies of *C. sandalina* erected were *C. s. alta* RICHTER 1916; *C. s. lata* RICHTER 1916; and *C. s. westfalica* LOTZE 1928. RICHTER (1928) placed *lata* as a synonym of *sandalina*. More subspecies have been erected for material from other countries (mainly China) but, at this stage, they are irrelevant to the problems of German species.

The central question is what is the precise stratigraphic distribution (and, indeed, taxonomic status) of these German infra-specific taxa, and how can they be distinguished? Focussing on German subspecies, it is well known that these were largely based on the apical angle of the corallite, the curvature of the counter face, and the related length/width ratio of the corallite. No attention has been paid to other morphological features such as shape of the operculum, numbers of septa or patterns of septal insertion. RICHTER (1928, fig. 13) and LOTZE (1928, Sauerland) both showed that *sandalina sandalina* is from the Eifelian, *s. alta* is from the lower Givetian, and *s. westfalica* is from the late Givetian; an unassigned form was show by RICHTER (1928, fig. 13) from the early Eifelian "Cultrijugatus Schichten'. WERNER (1968) reported *C. sandalina* from the late Emsian. Recent detailed collecting from carefully documented stratigraphic locations in the Eifel should shed some further light on this problem.

GOLDFUSS, G.A. (1834-40): Petrefacta Germaniae. - Zweiter Teil, Dusseldorf: 225-312.

LOTZE, F. (1928): Beitrag zur Kenntnis der Mutationen von Calceola sandalina (L.). – Senckenbergiana, **10**: 158-169.

RICHTER, R. (1916): Zur stratigraphischen Beurteilung von Calceola (Calceola sandalina Lam. n. mut. lata und alta). - Neues Jahrbuch für Mineralogie, **1916/2**: 31-46.

RICHTER, R. (1928): Fortschritte in der Kenntnis der Calceola-Mutationen. - Senckenbergiana, **10**: 169-184.

WERNER, R. (1968): Calceola sandalina aus den Heisdorf-Schichten (Unter-Devon) der Eifel. - Senckenbergiana lethaea, **49**: 575-580.

WRIGHT, A.J. (2001): A new Early Devonian operculate coral genus from eastern Australia. - Records of the Western Australian Museum, Supplement **58**: 21-35.

WRIGHT, A.J. (2006): New genera of Early Devonian calceolide corals from Australia and France. - Palaeoworld, **15**: 185-193.

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Soft taxonomy – case of Devonian phillipsastreid rugose corals

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Analysis of nine genera or species groups of Devonian massive phillipsastreid rugose corals indicates difficulties in obtaining sharply distinguished taxa at genus level. This may indicate either close genetic affinity within the group studied, or/and its high phenetic plasticity. The other factor responsible may be small size of variability space analyzed.

Among the massive phillipsastreid genera analyzed, the most outstanding, but also dubiously phillipsastreid, is the Famennian *Sudetiphyllia* FEDOROWSKI 1991, and then follow *Smithicyathus* RÓŻKOWSKA 1980, and *Pachyphyllum* MILNE-EDWARDS & HAIME 1851. The remaining genera: *Chuanbeiphyllum* He 1978, *Frechastraea* SCRUTTON 1968, *Medusaephyllum* ROEMER 1855, *Phillipsastrea* D'ORBIGNY 1849 (sensu *Ph. hennahii* species group: WRZOŁEK 2005), *Phillipsastrea ananas* species group and *Scruttonia* CHEREPNINA 1974 form a tight agglomeration, with abundant intermediate morphologies, and thus defy simple "statistical" discrimination, i.e. if all characters analyzed are given equal weight.

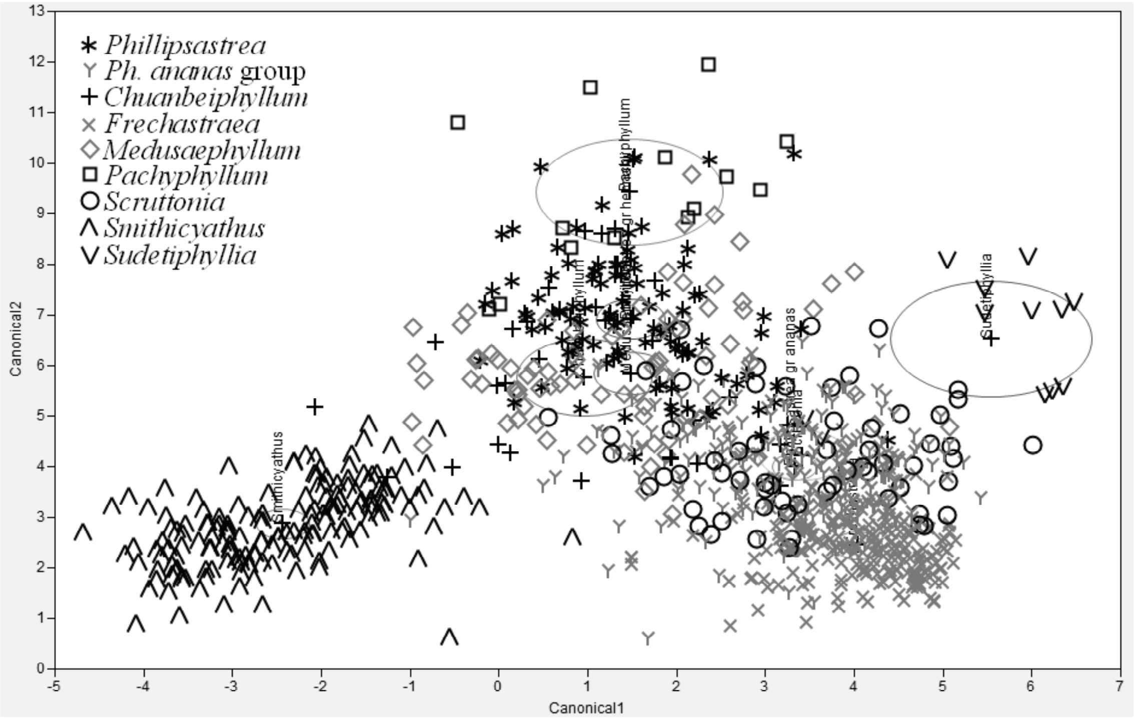

Fig. 1: Results of discriminant analysis of massive Devonian phillipsastreid rugosans / canonical plot / 929 records, classified into 9 "genera" / analysis is based on 22 measurements or counts for each record (see WRZOŁEK 2007)

In attempt to overcome the limitations of such a "statistical" analysis, the next step was comparison of genera, pair by pair and character by character. The following 11 characters were established as of primary importance, i.e. permitting in some cases sharp distinction between genera: MU - wall type; SC - septal continuity; IN1 - internal wall; IN2 - length of septal expansion; PP - horseshoe dissepiments; DIC - corallite size; #S1 - septal number; TM – tabularium diameter; L1 – length of major septa; D1 – septal thickness; TT – spacing of tabulae/tabellae. The other characters were found less significant, as their variability ranges always partly overlap between compared groups of specimens. These are: CO – ratio of space filling; CA –

	Ph hennah	*Ph ananas*	*Chuan*	*Frech*	*Medusae*	*Pachy*	*Scruttonia*	*Smith*	*Sudeti*
Phillipsastrea hennahii group		similar	>>SC	>>PP DIC	identical	<<TM L1	>>PP	similar	>>PP
Phillipsastrea ananas group	>CA <MU PP		>>SC	similar	similar	<<TM	similar	<<PP	<<TT
Chuanbeiphyllum	>MU TM <IN1 TB	>MU PP TM		<<SC	<<SC	<<SC	>>PP <<SC	>>MU <<SC	>>PP
Frechastraea	<#S1 TM	<CA PP DIC #S1 TM	>IN1 <MU PP DIC #S1		similar	<<PP DIC TM #S1 L1	similar	<<PP	>>IN1 IN2 <<TT
Medusaephyllum	identical	>MU PP <CA	<TM	>PP DIC #S1 TM		similar	similar	similar	>>IN1 IN2 PP
Pachyphyllum	>DIC #S1 <CO	>PP DIC <CO CA	>DIC <CO MU	>IN2 <CO	>DIC #S1 TM L1 <CO TC		>>PP DIC #S1 L1 TM	>>#S1 TM L1	>>IN1 IN2 PP TM L1 D1
Scruttonia	>DIC TM	>MU <CA TM L1	<DIC #S1 TM	>IMU <IN1	<PP #S1 TM L1	>CO MU TC		<<PP	<<TT
Smithicyathus	>IN1 IN2 <CO MU DIC L1	>IN1 IN2 <MU CA TB DIC	>IN1 IN2 <DIC TM L1	>IN2 TT <CO MU L1	>IN1 IN2 <CO MU DIC TM	>IN1 <MU D1	>IN1 IN2 D1 <CO MU TB		>>IN1 IN2 PP
Sudetiphyllia	>MU <IN1 IN2	>MU <IN1 IN2 CA PP	>SC TT <IN1 IN2 TM	>MU #S1 TM <SC	>TB TT <SC CA TC	>CO MU TB TT <#S1	>TB DIC #S1 <SC IN1 PP	>CO MU TT <TC	

Table 1. "Genus by genus, character by character" analysis of similarity of genera of massive phillipsastreid rugosans.

septal carination; TB – tabularium shape; TC – ratio of tabulae. Still other characters (W, Z, AZ, and AW) were not considered in the present analysis (for more explanations of characters see Wrzołek 2007: 630).

Table 1 presents the results of this analysis. Unmarked fields are for clearly distinguishable taxa, light-gray for morphometrically overlapping taxa, dark-gray for non-distinguishable. In the upper-right part of the Table 1 indicated are only those characters (if present) which clearly distinguish the compared taxa (indicated by symbols >> and <<, for significally larger, or smaller values for characters listed); in lower-left part of Table 1 presented are also characters which weakly distinguish the taxa (small overlap of variability ranges), with symbols > and < used for partially overlapping ranges.

The taxonomic status of groups of specimens analyzed here is as follows:

- *Phillipsastrea hennahii* species group: distinct genus, *Phillipsastrea* D'ORBIGNY 1849 *sensu stricto*; among 103 records analyzed there is also GSM 6185, the lectotype of *Astrea hennahii* LONSDALE 1840, type species of the genus *Phillipsastrea* (see SCRUTTON 1968: 215); the genus overlaps with *Ph. ananas* species group and *Smithicyathus*; possibly some or all specimens of *Medusaephyllum* might be included here;
- *Phillipsastrea ananas* species group: possibly no more than a separate subgenus; 247 records measured; among the important species of this group *Ph. ananas* (GOLDFUSS 1826) and *Ph. macrommata* (ROEMER 1855) need revision of the type material; *Ph. ananas* group is with overlap to *Ph. hennahii* group, *Frechastraea*, *Medusaephyllum*, *Pachyphyllum* and *Scruttonia*;
- *Chuanbeiphyllum* HE 1978: well-defined and distinct genus; 27 records measured;
- *Frechastraea* SCRUTTON 1968: distinct genus; 206 records measured, among them is GMBo 206, the lectotype of *Cyathophyllum pentagonum* GOLDFUSS 1826, type species of the genus (see PICKETT 1967: 60; SCRUTTON 1968: 233); there is overlap with *Ph. ananas* group, *Medusaephyllum* and *Scruttonia*;
- *Medusaephyllum* ROEMER 1855: possibly this material should be included wholly, or in part, into *Phillipsastrea* d'Orbigny; measured were 87 records; in any case the taxon and its type species (*M. ibergense* ROEMER 1855) need revision; it overlaps with all the other genera, besides *Pachyphyllum* and *Sudetiphyllia*;
- *Pachyphyllum* MILNE-EDWARDS & HAIME 1851: distinct genus with overlap only with *Ph. ananas* group and with *Medusaephyllum*; 14 records measured;
- *Scruttonia* CHEREPNINA 1974: distinct genus with overlap to *Ph. ananas* group, *Frechastraea* and *Medusaephyllum*; 63 records measured;
- *Smithicyathus* RÓŻKOWSKA 1980: distinct genus; overlaps with *Ph. ananas* group and with *Medusaephyllum*; 170 records measured;
- *Sudetiphyllia* FEDOROWSKI 1991: well-defined and distinct genus - morphometrically, but also stratigraphically; among 12 records measured there is also UAM Tc3-04, the holotype of *S. prima* FEDOROWSKI, type species of the genus (FEDOROWSKI 1991: 75).

FEDOROWSKI, J. (1991): Dividocorallia, a new subclass of Palaeozoic Anthozoa. - Bulletin de l'Institut royal des sciences naturelles de Belgique, Sciences de la Terre, **61**: 21-105.

PICKETT, J. W. (1967): Untersuchungen zur Familie Phillipsastreidae (Zoantharia rugosa). - Senckenbergiana lethaea, **48** (1): 1-89.

SCRUTTON, C. T. (1968): Colonial Phillipsastraeidae from the Devonian of South-East Devon, England. - Bulletin of the British Museum (Natural History) Geology, **15** (5): 21-281.

WRZOŁEK, T. (2005): Devonian rugose corals of the *Phillipsastrea hennahii* species group. - Acta Geologica Polonica, **55** (2): 163-185.

WRZOŁEK, T. (2007): A revision of the Devonian rugosan phillipsastreid genus *Smithicyathus*. - Acta Palaeontologica Polonica, **52** (3): 609-632.

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New data on Devonian phillipsastreid rugosan *Rozkowskaella*

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Over 30 specimens of solitary or weakly dendroid phillipsastreid Upper Frasnian rugosans, from the Holy Cross Mts, Poland, with anomalous, oval to triangular shapes, are identified here as *Rozkowskaella sandaliformis* (Różkowska 1980). New morphological characters observed in this species are regular budding, and overflowing of skeletal tissue over old calicinal margins.

Material presented here comes from: Grabina, set C - 1 specimen (GIUS 365 G 27); Jaźwica, set R – 4 specimens (UAM TcI-13, GIUS 402 J 39, 57, 139 [all illustrated in Różkowska 1980 and in Coen-Aubert & Wrzołek 1991]; road cutting Kowala – 1 specimen: GIUS 376 KD 19; Kowala quarry, set G – 19 specimens: GIUS 388 KK 22, 23, 28B, 46, 69, 146, 212, 231C, 242, 248, 249, 269, 281, 316, 327, 328, 330A, 330B, 330D; Psie Górki – 2 specimens: GIUS 401 PG 54, 90; Szczukowskie Górki – 2 specimens: GIUS 367 SC 57, 77; Wietrznia, point XV – 5 specimens: GIUS 387 WW37B, 38-3, 38A, 71B, 77E. Mostly these are specimens, and / or incidental sections, and so some less complete corallites may be considered as dubious *R.* cf. *sandaliformis*. The most part of the present material comes from detrital limestones of set G of the Kowala quarry, where it is accompanied, besides numerous taxa of massive phillipsastreids and solitary endophyllid *Hankaxis*, by "normal", i.e. circular in shape, solitary phillipsastreid *Macgeea*.

Presence of offsets in *R. sandaliformis* has been noted, as rarity (1 in 5 specimens) before (Coen-Aubert & Wrzołek 1991). The present material from the Kowala quarry contains 5 specimens with traces of budding. The most spectacular of these is illustrated in Fig. 1: 4. Most of corallites seen here are parts of the same colony, with a large mother corallite and a few large lateral offsets. In other, less fortunate specimens there are commonly only basalmost parts of some offsets preserved. Observed triangular shapes of offsets, as they form elevated branches in rigid dendroid colonies, can not be explained as adaptation to recumbent life-mode on soft-bottom; this is either an atavistic feature, or there is some other adaptive advantage to triangular shape of corallum.

The other feature, unnoted earlier, is overflowing of skeletal tissue over calicinal margins. This is an uncommon phenomenon, present in 3 specimens studied, and all are illustrated here. Firstly there are two small corallites (Fig. 1: 1 and 2 – protocorallites?) sectioned close to proximal tips, with overflowing tissue forming sort of a talon, fixing the young specimens. Similar features occur also within some large corallites of a big colony, best visible in Fig. 1: 4B. As it seems in the latter case observed feature did not fix the corallites. Similar, although much better developed structures can be seen in early phillipsastreid *Fromeophyllum climax* from Lower/Middle Devonian boundary interval of Australia (Wright 1981), where overflowing tissue produced lateral "cortical" expansions of proximal branches, and thus strengthened and fixed colonies. In *R. sandaliformis* this is probably atavistic, relict feature, potentially advantageous in case of corallites being broken-off in turbulent environment.

Coen-Aubert, M. & Wrozolek, T. (1991): Redescription of the rugose coral *Macgeea* (*Rozkowskaella*) *sandaliformis* (Rożkowska, 1980) from the Upper Frasnian of the Holy Cross Mountains (Poland). - Bulletin de l'Institut royal des Sciences naturelles de Begique, Sciences de la Terre, **61** (1): 5-19.

Różkowska, M. (1980) [imprint 1979]: Contribution to the Frasnian Tetracorals from Poland. - Palaeontologia Polonica, **40**: 3-56.

Wright, A.J. (1981): A new phillipsastraeinid tetracoral from the Devonian of New South Wales. - Palaeontology, **24** (3): 589-608.

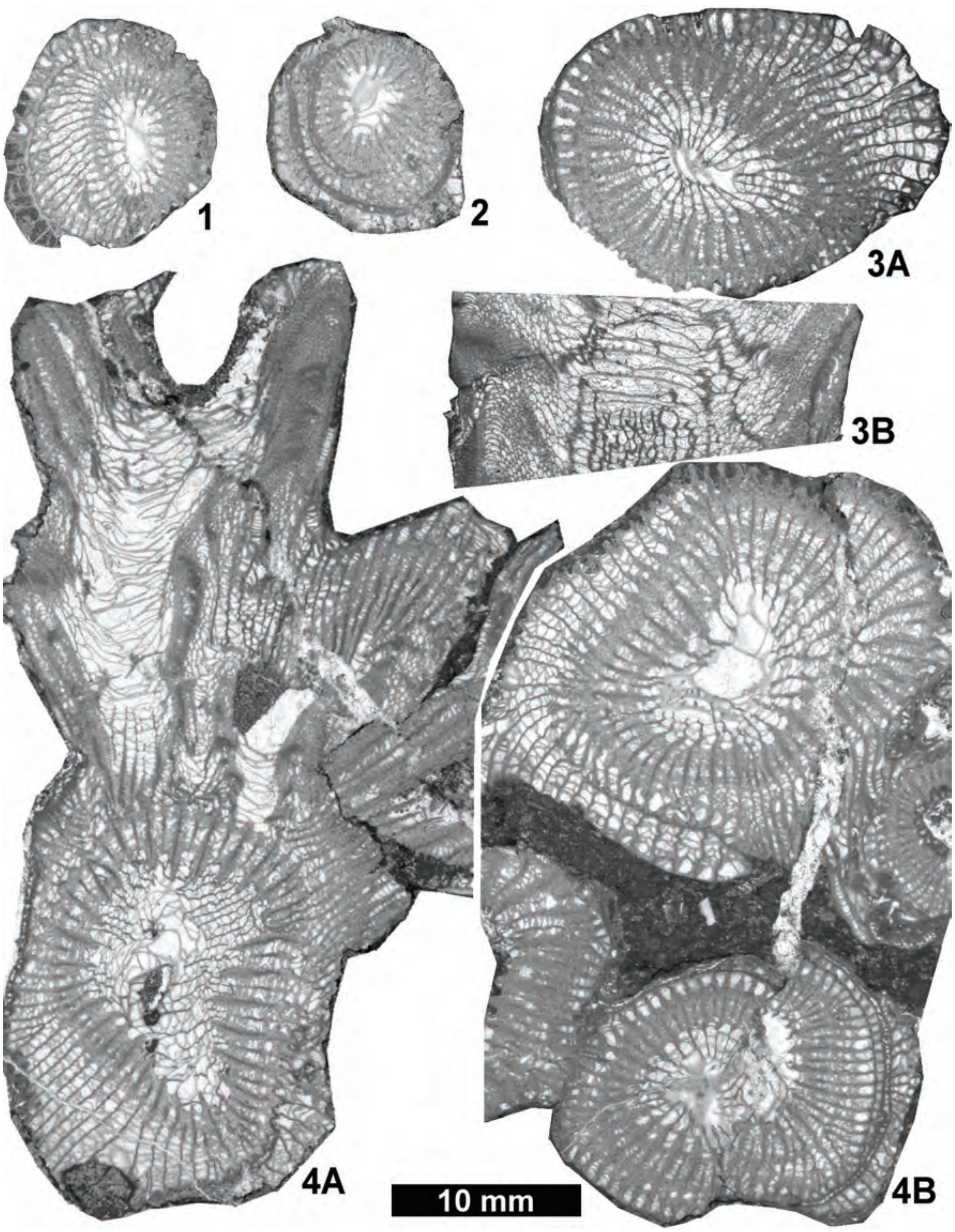

Fig. 1: ***Rozkowskaella sandaliformis*** **(Różkowska 1980), Kowala quarry set G (Upper Frasnian), Holy Cross Mts, Poland: 1 – GIUS 388 KK248C, traverse section; 2 – GIUS 388 KK330A T1, traverse section; 3 – GIUS 388 KK 46: 3A traverse, 3B longitudinal section; 4 – GIUS 388 KK328: 4A section T4, 4B section T6; all magnifications x3, length of scale bar: 10mm.**

The database of Fossil Cnidaria & Porifera newsletter, 1972 - 2010

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The database of almost 7000 entries has been compiled of publications, which were listed in current bibliographies of *Fossil Cnidaria & Porifera*, newsletters of the International Association for the Study of Fossil Cnidaria and Porifera (IASFCP) in the years 1972-2010.

The data records contain informations on authors, publication year and title, systematic group, stratigraphy, geography, abstract (full or abbreviated), journal, book, also DOI number or equivalent for some records. After meritorical and technical corrections this database will be presented on-line as a tool for students of fossil and living corals and sponges, and for editors of future volumes of *Fossil Cnidaria & Porifera.*

Analysis of publications of the database indicates, not surprisingly, that taxonomically the papers deal with sponges (about 20%) and cnidarians (ca 80%); among sponges roughly half of papers are concerned with Stromatoporoidea, whereas cnidarian papers are almost wholly dealing with corals: if specified, the corals are mostly Rugosa (24%), Scleractinia (14%) or Tabulata (ca 10%). Stratigraphically about 60% of papers deals with the Paleozoic, then Cenozoic (20%) and Mesozoic (16%); leading Periods are: Devonian (22%), Carboniferous (16%), and Neogene (18% - including Recent biota). Geographically listed are mostly Europe (38%), Asia (23%) and the Americas (16%); the oceans are represented by 13% of publications.

As for numbers of publications there is a significant decrease during the last fifteen years (Fig. 1). In the beginning there was a lucky time with about 850 publications in the years 1971-1975, then 1015 in the years 1981-1985. On average, there were from 170 to 200 articles each year. The 1991-1995 interval marks the beginning of falling numbers, caused, among others factors, by a "significant decline in the size of the workforce" (SANDO 1997: 27). Also analysis of details shows negative trends in all our "publication" (if not research) areas: both thematical and geographical. As it seems from the preliminary analysis of our database, the negative trend has been slightly delayed (by 5 or 10 years) by numerous East-Asian (Chinese and Japanese) publications, but also this group of papers is in numerical decline now.

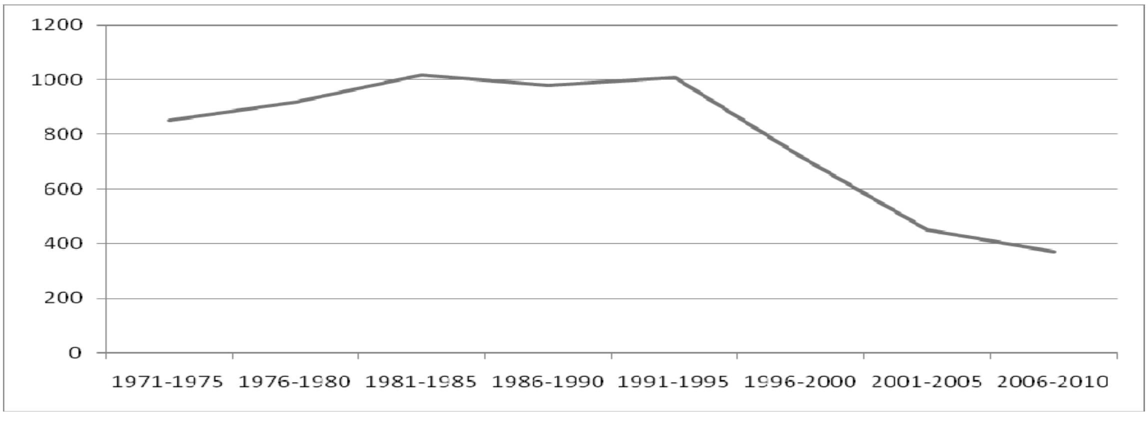

Fig. 1: Changing numbers of current publications, as listed by Fossil Cnidaria & Porifera newsletter, per 5-years intervals.

SANDO, W.J. (1997): A silver platter-History of the International Association for the Study of Fossil Cnidaria and Porifera and trends in cnidarian and poriferan research, 1971-1994. - Boletín de la Real Sociedad Espanola de Historia Natural (Sección Geológica), **91** (1-4): 5-33.

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Microarchitectural typology and variability of auriculae in Mesozoic corals and their interest in systematics

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For a long time, the ornamentation of the inner margin of septa was mentioned by authors in the literature (e.g. Koby 1889; Alloiteau 1957). *Auricula* is a term that Gill (1977) introduced in the paleontological literature of corals to designate a particular fork-like microarchitecture at the inner margin of septa in the family Stylinidae (Gill 1977). During our studies on Jurassic plocoid corals, two new types of auriculae were observed and studied in two plocoid genera: *Pseudocoenia* and *Ironella*. We propose new terms in order to describe more accurately auriculae. Many auriculae are known only in section. As it is difficult to infer volumes from the sections we propose the use of a double nomenclature for the auriculae which must be considered according both to their section and their volume. We call auriculae a microarchitecture located at the inner margin of septa and expanded inward at periodic vertical intervals. The Latin word auricula means: small ear. This term explains well the character of an expansion but it does not explain its shape in volume. Then we propose to specify different kinds of auriculae according to their shape.

Koutaliform auricula (Fig. 1A; Fig. 2)
This term typically corresponds to the auriculae described for the first time by Gill (1977). We decided to name it "koutaliform auricula" (in Greek κουταλι: spoon) to refer to its aspect in volume and its upward concavity. As Gill (1977) showed, the koutaliform auricula takes place obliquely and is oriented downward at the inner margin of the septa. In fact, it is the concavity of this ornamentation that causes the fork-like shape of this auricula in transverse and longitudinal sections. In the first cycle Gill showed symmetrical lobes at both sides of the septa and named them also auriculae. These particular lobes were not observed in our studied samples but perhaps T-like sections observed could result from these lobes. The koutaliform auriculae are observed for instance in the genera *Stylina*, *Heliocoenia* and rarely in the genus *Pseudocoenia*.

Hastiform auricular (Fig. 1B; Fig. 2)
This new type of auricula was observed for the first time in transverse serial sections of *Pseudocoenia* sp. (Middle Oxfordian, Dompcevrin, Meuse, France). This particular type of auricula takes place exclusively at the inner margin of the first cycle of septa. They are not prominent in the axial cavity of the calice. The second cycle is always without auriculae. In serial section, this type of auriculae is observed from the first stages of development to the adult stage. In transverse sections, it is lanceolate, so we propose the name hastiform auricula (from the Latin name hasta: lance) for such a particular type of auricula. In longitudinal sections they appear as symmetric bulges on both sides of the septum, without upward concavity. They are not located at the same levels in neighboring septa. Consequently, in a single transverse section, the simultaneous occurrence of hastiform auriculae at all inner margins of septa is rare. The spiral arrangement of auriculae proposed by Gill (1982) could be also considered here for hastiform auriculae.

Flabelliform auriculae (Fig. 1C&D; Fig. 2)
This term is coined for a particular type of ornamentation observed in *Ironella*. It derives from Latin flabellum: fan. Historically, this type of auricula was illustrated by Roniewicz (1976) in her description of the microstructure of *Ironella*. It is characterized by a wide fan shaped expansion without upward concavity. It appears as symmetric with regards to the septal plan but also with regards to a perpendicular plan slightly oblique and sloping down to the calicular center. Flabelliform auriculae may occur on S1 but also S2 sometimes at the same level. In longitudinal sections, they appear as lozenges at equal distances from each other.

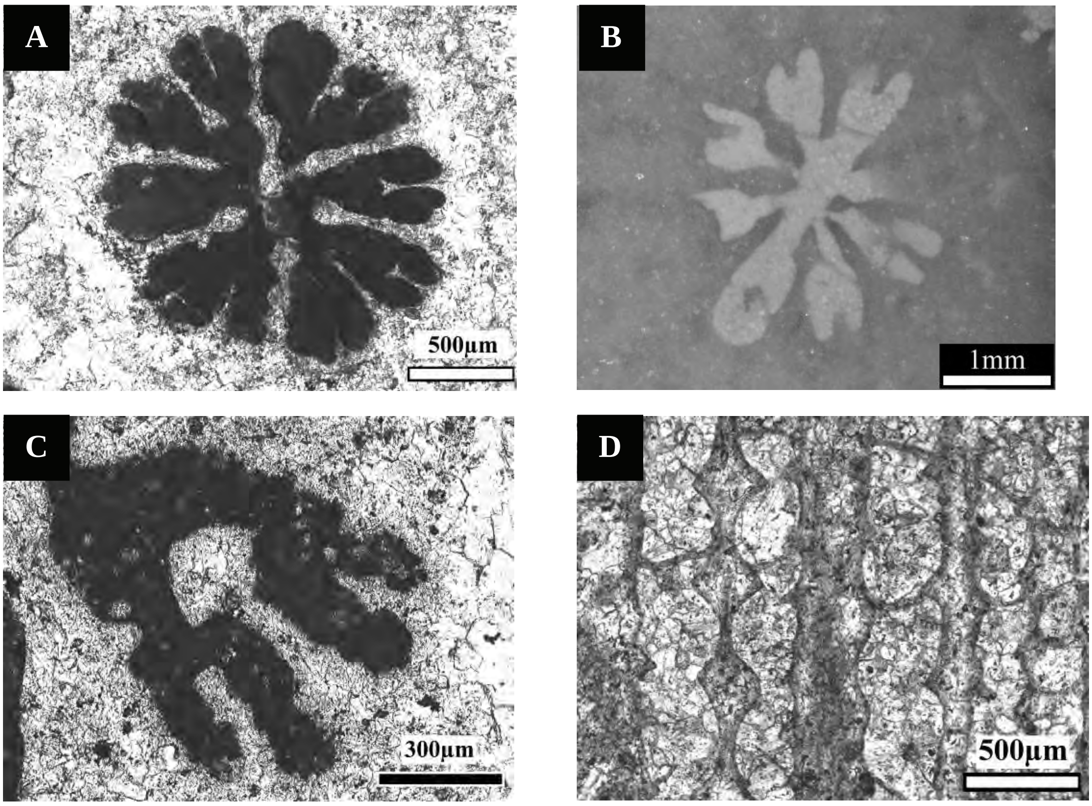

Fig. 1: A: Koutaliform auriculae at the second cycle of septa in transverse section in *Heliocoenia sp.* (Middle Oxfordian, Sorcy, Meuse, France). First cycle ornamented by rhopaloid or claviform sections of auriculae. B: Hastiform auriculae at the first cycle of septa in transverse section in *Pseudocoenia sp.* (Middle Oxfordian, Dompcevrin, Meuse, France). C: Flabelliform auricula at the second cycle of septa in *Ironella rutimeyeri* (Middle Oxfordian, Dompcevrin, Meuse, France). Third cycle rhopaloid/claviform or lanceolate in transverse section. D: longitudinal section of flabelliform auriculae of the same species.

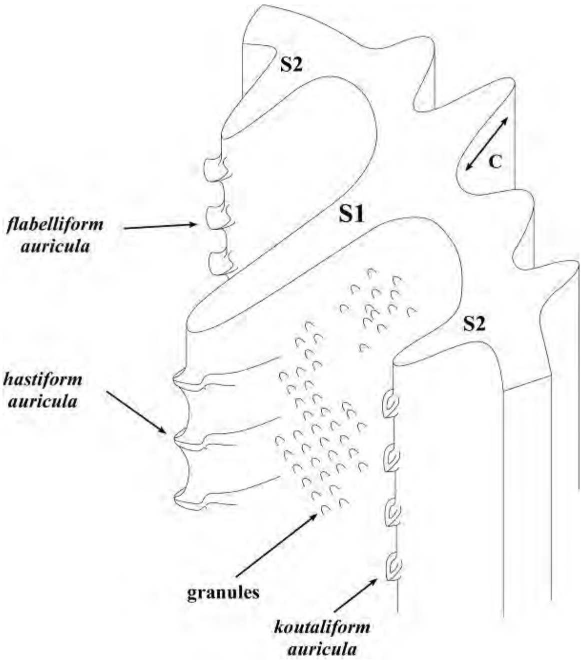

Fig. 2: Schematic of the detailed structure of the tree types of auriculae and their relations with septa. S1: first cycle septa, S2: second cycle septa, c: costae. The grouping of the three types of auriculae in a single corallite is purely artificial.

From volume to sections

In section, these different types of auriculae are cut in various orientations and levels and then produce different shapes at the inner edge of septa. The rhopaloid or claviform sections of the auriculae represent potentially the section of many different inner edges including in corals devoid of auriculae. Nevertheless it is a common feature in corals that bear koutaliform or flabelliform auriculae.

The **podoid** section of the auricula is like a man's foot with a swollen and terminal asymmetric elongation. The interpretation of the section is similar to rhopaloid/claviform sections (Fig. 3).

The **T-form** section of the auriculae is not very common and not clearly specific of a special kind of auricula (Fig. 3).

The **forked** section is typical for koutaliform auriculae and appears like a "Y" both in transverse and longitudinal sections (Fig. 3).

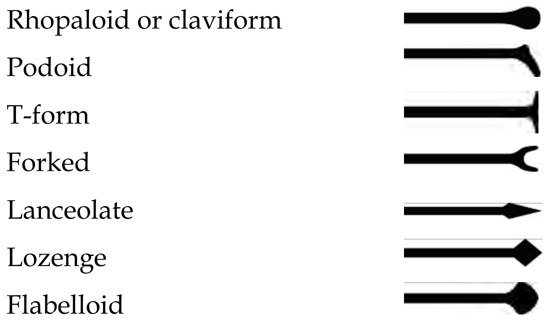

Fig. 3. Different types of transverse sections of auriculae

The **lanceolate** section could be interpreted as the section of a hastiform auricular, but it can also result from special sections of koutaliform or flabelliform auriculae (Fig. 3).

The **lozenge and flabelloid** sections are typical for flabelliform auriculae. We cannot exclude that exceptionally, koutaliform auriculae produce this type of section (Fig. 3).

As the sections are not always significant in terms of 3D microarchitecture, it is necessary to use a complete set of sections to get the best idea of the nature of auriculae.

The function (s) of auriculae is (are) still unknown. It is suggested that auriculae support some soft tissue(s) of the body, for instance mesenterial filaments.

As proposed by Gill (1977) auriculae can be used as tools to distinguish suprageneric systematic groups. Koutaliform auriculae are distinctive of a group in which we place *Heliocoenia*, *Stylina* (*sensu* Etallon) *Stylosmilia*, *Enallhelia*… Flabelliform auriculae could be a synapomorphic character of a number of genera such as *Ironella*, presently included in the family Rhipidogyridae. Hastiform auriculae occur in some *Pseudocoenia* but their systematic value still need to be explored.

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The scleractinian corals: a perspective

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During the last three decades, new research approaches have exponentially increased our knowledge of scleractinian corals. The existing paradigms have been challenged and the accumulated data are in need of new interpretation. Events like the XI International Symposium on Fossil Cnidaria and Porifera offer a rare possibility to analyze the existing knowledge and to formulate future directions of scientific research. This task is not possible for single researchers and needs the competence of the entire collegium. So, this presentation is a respectful appeal for discussion and suggestions that should find place in the Symposium resolutions. A historical review of the scleractinian research is followed by an update of the current status and issues facing scleractinain coral taxonomy and phylogeny and suggestions for some prospective directions for future studies.

The history of the scleractinian research can be divided in three periods. During the first, the Plant period (1576-1727), the scleractinians were considered plants and as such were figured by many botanists. Peyssonnel was the first to declare scleractinians to be animals and marked the start of the second, Animal period (1727-2007). The notion of the coral holobiont, the hologenome theory, the holistic species concept and integrative taxonomy marked the beginning of the third, Holistic period (2007-present). A graphical presentation of the progression of scleractinian knowledge reveals that it was not a gradual process. There are three considerable impulses, reflecting new approaches for studying the Scleractinia: first, on the boundary between the 19th and 20th centuries; second, originating in the 1950s; and third, starting in the 1980s. In the beginning, scarce material was found on the beaches or during fishing and was described typologically. Later, the entrance into the natural habitat in the end of the 19th and early 20th centuries brought to attention the exceptional coralla variability and led to usage of formae and transplantation experiments. The microstructure of the skeleton became a focus of the studies during this time. Starting in the middle of the last century, detailed studies were undertaken on multiple skeletal macro- and micromorphological characters, microstructure, and on their variability in fossil and extant material. Functional micromorphology became a new area of exploration. Scuba research *in situ* on a global scale also made a considerable contribution to the field during the second half of the last century. Beginning in the 1980s, a series of fundamental discoveries in life history and molecular biology opened new horizons for scleractinian understanding. Only less than two decades ago, the scleractinian classification was based exclusively on skeletal characters. Then in a short period of time, there were rapidly accumulated data from the new sources of knowledge, i.e. molecular biology, ecology, life history and new approaches in paleobiology. The results of molecular biology did not fit for the existing systematics. The return to the micromorphological and mictrostructural characters suggested a possible way to harmonize the skeletal information with the coming data of molecular biology.

Presently, the taxonomy is an artifact of the insufficient sampling size resulting in a lack of knowledge about morphological, geographic, bathymetric and genetic variability. There are no large recent scleractinian collections, and the old collections are not always available. Fortunately, 83% (4,980 specimens) of the largest Atlantic scuba collections made four decades ago in Cuba are well preserved and digitalized in a multimedia format. Molecular biological studies suggest that incomplete lineage sorting, hybridization and morphological convergent evolution all present challenges to a morphologically based taxonomy and phylogenetic analysis for the Scleractinia. Individual approaches, while providing interesting and new evolutionary hypotheses, are still not presenting a unified system of classification. Many molecular based studies ignore the implied taxonomic revision or relegate it to a future endeavor. Although some researchers have embraced an integrative approach to studying the Scleractinia, the area is ripe for more collaborative work across the disciplines. While the ecological interest has been predominantly focused on shallow waters, the mesophotic zone and the deep sea are still *terra incognita*.

The migration of reef species farther from the equator and the ecological shifts are indicative of ecosystem dynamics and mark trends in progress. Phenotypic differences between ecomorphs are considered in sympatry despite evidence for hybridization. There is proof that hybrid genotypes can be more fit than both parents and hybrids may occupy new econiches, as well as the products of hybridization having a paleobiological dimension with temporal and bioconstructive aspects. The first steps in immunology, allorecognition and xenorecognition, existence of chimeras, coral health and energy integration are promising for coral understanding and conservation. Today, there is no satisfactory scleractinian classification and phylogeny. There is not sufficient knowledge about part of the geological past, and sometimes data are the object of extrapolation. The actuopaleontology is contributing to the taxonomy, fossil behavior, and life strategies. There is indication for the repeated loss of coloniality and symbiosis during geological history. Data of fossil coralla help to understand the paleoclimatic conditions, e. g. they do not support permanent ENSO during Pliocene warm period. The global research collaboration on these corals is manifested by the realization of the Glossary of equivalent terms for scleractinian studies in eight languages, followed by the efforts of the Steering Group for the Revision of Treatise on Invertebrate Paleontology (TIP), by activity of the International Working Group on Scleractinian Corals and by the work on Project Corallosphere/TIP. The last is in progress, and the present meeting provides a good opportunity for discussion and suggestions.

The present, up to date knowledge of the Scleractinia and its multidisciplinary character urges efficient future scientific collaboration. The following is only a list-proposal of abridged points for focusing the future work and presents an appeal to the colleguium for discussion and steps toward research focused on the ideas in the following areas: 1) Material – expand the sample size of material collected to tap the phenotypic and genotypic diversity, the geological past, and the ecological distribution; 2) Phenotypic variation – study variability at multiple levels, exploring plasticity and intraspecific polymorphism; 3) Ontogeny – gain further insight into reproduction, septal insertion, astogeny, pathology, and senescence; 4) Functional macro- and micromorphology – "rediscover" these important aspects of morphology; 5) Paleobiology – focus research in temporal morphological diversification and "reversed" actuopaleontology, specifically data on taxon cycle concept and species reshuffle for biodiversity conservation, the importance of hybridization in the geological past, fossil behavior; 6) Molecular biology – connect new molecular findings with taxonomic revision, engage in more integrative collaborations, and begin to elucidate the molecular control of morphology; 7) Skeletogenesis – to further realize the interrelation between the animal and the skeleton; 8) Mesophotic and deep sea habitats – prompt research and evaluate their evolutionary potential; 9) Speciation – better understand hybridization, histocompatability and chimeras; 10) Coral holobiont and reef ecosystem – direct attention to their coevolution in temporal and spatial dimensions; 11) Integrative approach to harmonize the data of all sources of knowledge; 12) Preparation of specialists – workshops of the International Association for the Study of Fossil Cnidaria and Porifera, the Projects Corallosphere/TIP and the Integrative Graduate Education and Research Traineeship.

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