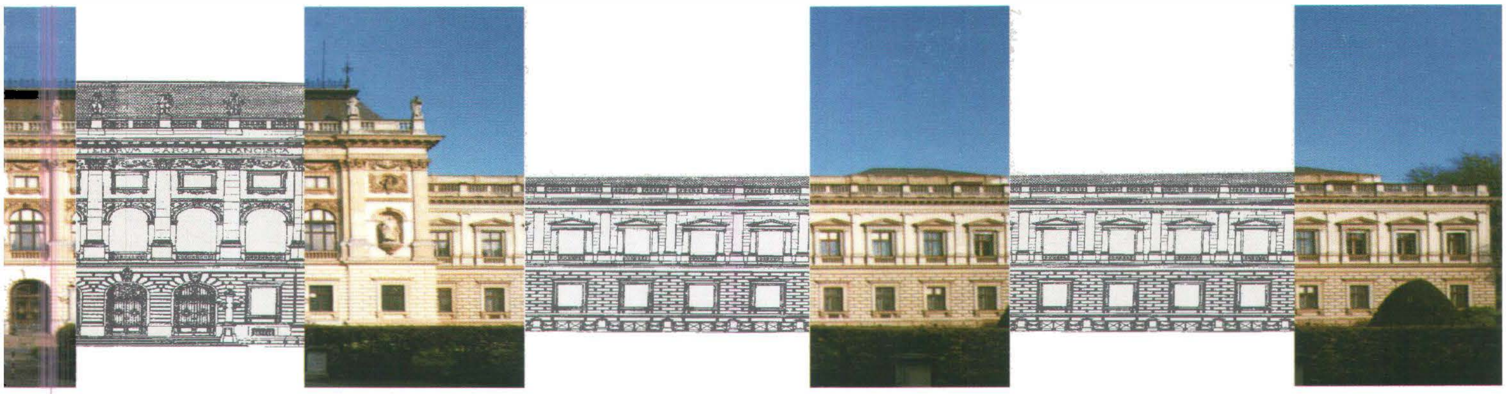

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9th International Symposium on Fossil Cnidaria and Porifera

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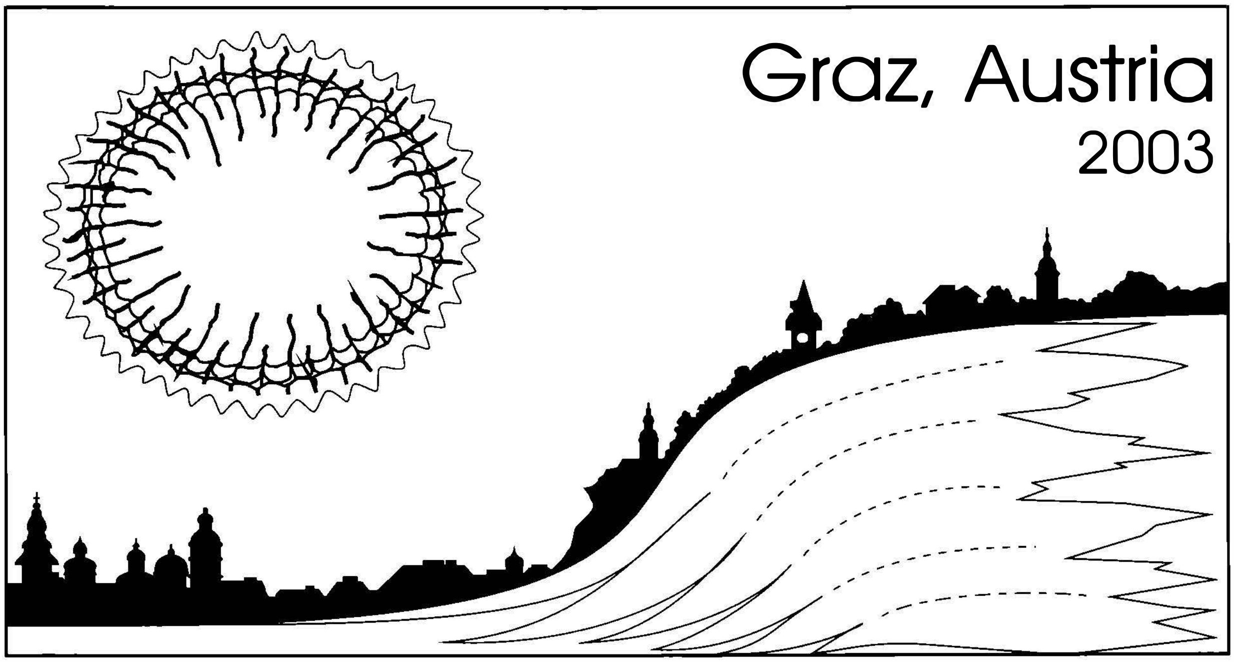

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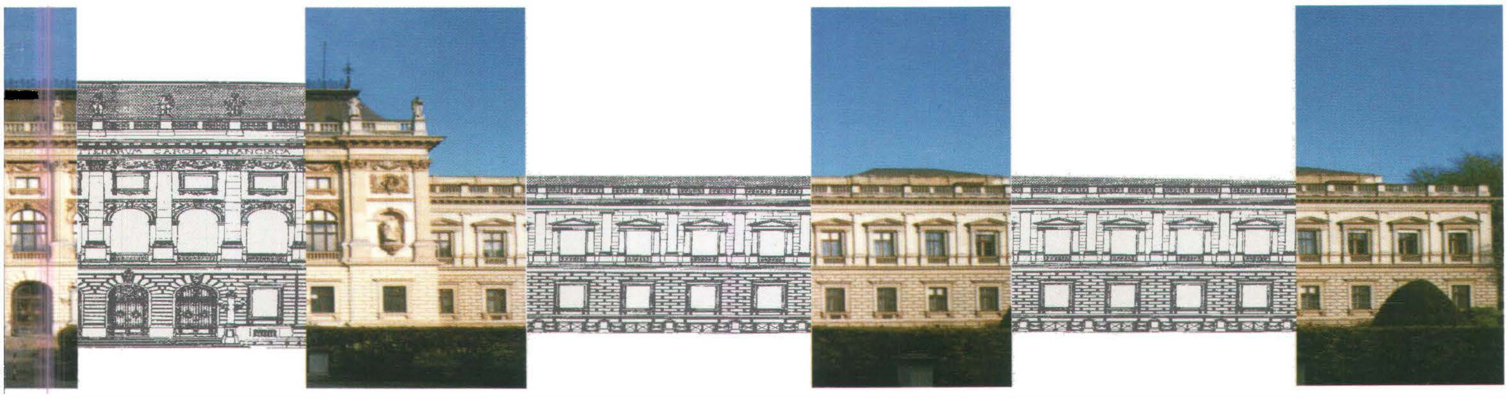

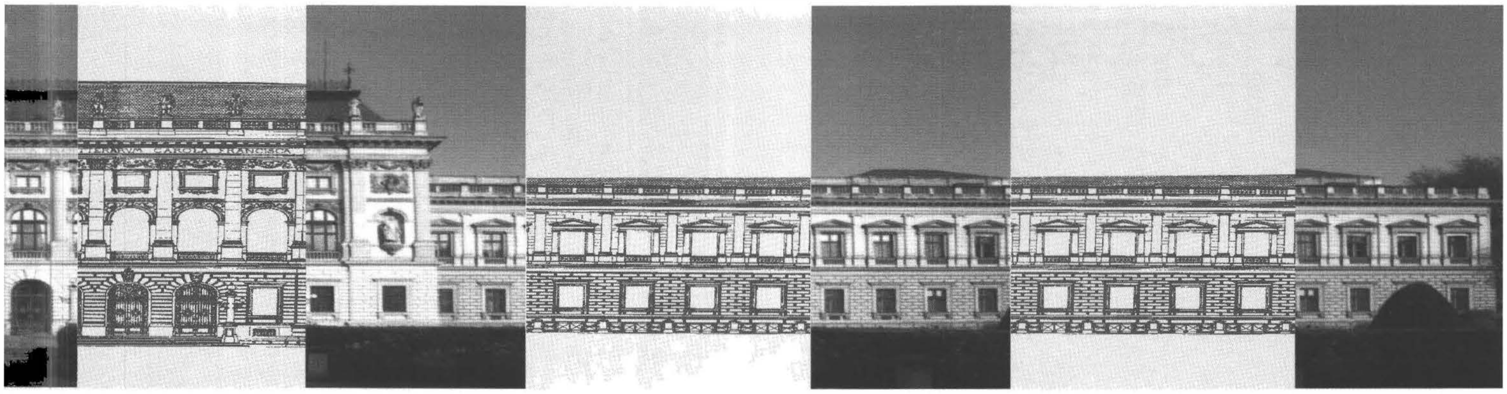

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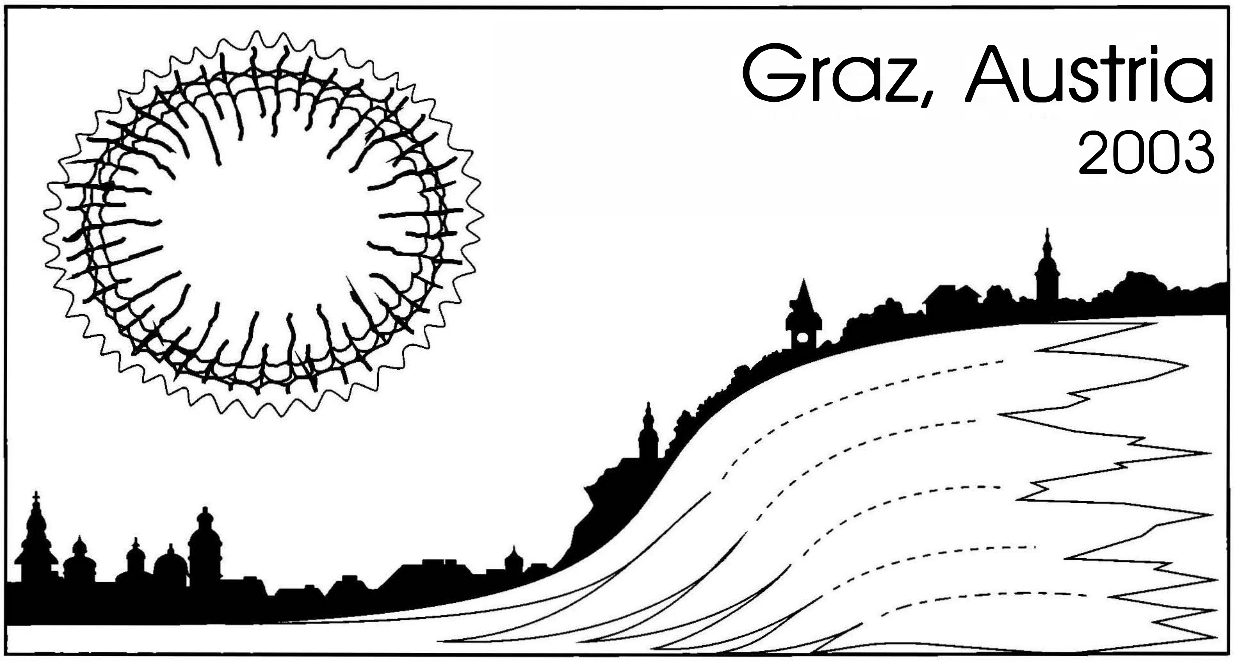

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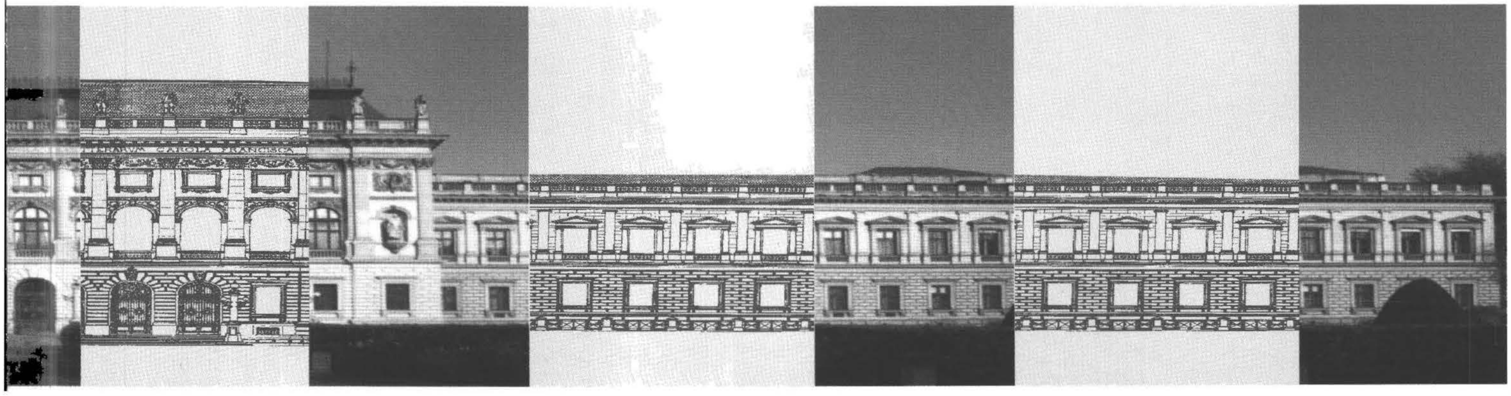

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Preface

The International Association for the Study of Fossil Cnidaria and Porifera (formerly: International Association for the Study of Fossil Cnidaria) organizes the International Symposium on Fossil Cnidaria and Porifera every four years. The initial symposium was held 1971 in Novosibirsk, the last one, number 8, was organized 1999 in Sendai (Japan). During the general assembly of the Association in Sendai the Institute for Geology and Palaeontology of the University of Graz, Austria, was selected for the organisation of the 9th Symposium. One of the reasons for this dedication may be the long tradition in studies of corals and sponges at the Institute in Graz. Well recognized scientists in this context are A. Penecke at the end of the 19th century and F. Heritsch and H. W. Flügel of the 20th century. These names are strongly connected with the Palaeozoic. Austria, however, offers also a broad range of Mesozoic and Cenozoic cnidaria and sponges which were described by famous scientists, e.g., F. Frech, E. Flügel, O. Kühn, and A. E. Reuss.

The Institute of Geology and Palaeontology of the University of Graz is proud to host the 9th Symposium on Fossil Cnidaria and Porifera from August 3 – 7, 2003. The volume 7 of the Berichte des Institutes für Geologie und Paläontologie is dedicated to the abstracts of oral presentations and posters presented in the course of the symposium. This volume clearly demonstrates the wide range of topics related to fossil cnidaria and porifera. This symposium tries to combine palaeontological and biological aspects and put it into the frame of geodynamics, thus reflecting innovative activities of the Association.

Bernhard Hubmann, Christine Latal, Werner E. Piller, Michael W. Rasser
Graz, Juli 2003

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MICROSCOPIC MICROBIALITE TEXTURES AND THEIR COMPONENTS IN THE LOWER DEVONIAN LAGOONAL FACIES OF THE FUKUJI FORMATION, CENTRAL JAPAN

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Calcimicrobes and microbialites are known to have been volumetrically significant and especially abundant in the Devonian reefs (Webb, 1996). The calcimicrobe *Girvanella* is comparatively abundant in the Devonian lagoons. However, few microbial details are known in Lower Devonian lagoonal environments. The lagoonal facies is typically developed in the Lower Devonian Fukuji Formation (Lochkovian to Emsian) and exhibits varied microbialite textures (Ezaki & Adachi, 2000).

The Fukuji Formation is restricted to the Hida „Gaien" Terrane, Central Japan. The carbonate successions contain well-preserved and diversified skeletal metazoans, such as rugose and tabulate corals, stromatoporoids and brachiopods, together with calcimicrobes (e.g., *Girvanella*, *Rothpletzella*, *Wetheredella* and *Renalcis*). Three types of microfacies are distinguished: 1) stromatoporoid-coral bindstone/bafflestone; 2) bioclastic floatstone/wackestone; and 3) bioclastic packstone/rudstone. Stromatolitic, thrombolitic and leiolitic textures are formed in each microfacies by three principle components; peloids, micrites and calcimicrobes. Skeletal components occasionally serve as substrates for encrustation of microbialites, when sheet-like to domal and oncoidal growth fabrics are produced, ranging from only a few millimeters to several centimeters thick. The relative abundance of calcimicrobes is not high (average 4%), but *Girvanella* is predominant and is closely related to the formation of varied microbialite textures. *Girvanella* occasionally exhibits stromatolitic textures by its accumulations of different sizes of filaments and densities. Additionally, *Girvanella* relates to thrombolitic textures by being partly tangled with each other, and/or leiolitic textures by being densely packed, respectively. Accumulations and partial aggregations of peloids and micrites exhibit in some cases stromatolitic and thrombolitic textures where *Girvanella* is involved. Small intraskeletal cavities (cryptic spaces) formed by tabulate corals and brachiopods, however, include rare calcimicrobes and bioclasts, and are filled with well sorted mini-peloids that show limited, thrombolitic and leiolitic textures. In such sheltered microenvironments, microbial components and textures are quite different from those of open spaces. Similar features are also known from the ancient and modern reef cavities where peloids are generated by bacterial activity (e.g., Reitner, 1993).

In the Lower Devonian lagoonal facies concerned, it is emphasized that *Girvanella* as a cyanobacterium played an important role in the generation of varied microbialite textures. However, other bacterial activities also might have contributed greatly to the formation of microbialite textures as suggested by examples in cryptic spaces. The differences in microenvironments and resultant microbialite textures have not yet been fully examined in the lagoonal environments. Further research is necessary to elucidate microbialite varieties according to differences in microenvironments and to establish precise relations between their components and textures in different lagoonal settings during Devonian time.

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GENESIS OF STROMATOLITIC TEXTURES IN THE STROMATOPOROID BINDSTONE OF THE LOWER DEVONIAN GARRA FORMATION, NEW SOUTH WALES, AUSTRALIA

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Laminar characteristics of stromatolites are generated in relation to cyclic environmental changes. Stromatolitic textures that are formed by both microbes and large skeletal organisms are developed to a remarkable degree in a biohermal limestone (*sensu* Strusz, 1966) of the Lower Devonian Garra Formation of New South Wales, Australia.

In the studied section, stromatolitic textures are found in association with stromatoporoid bindstone and consist roughly of regular alternations of both 1) laminar stromatoporoids ca. 5mm thick, whose laminae are at intervals of two to three hundreds of micrometers and 2) microbialites ca. 1-2mm thick. Tabulate corals (*Favosites*) occasionally replace laminar stromatoporoids. The skeletal organisms occupy 40-80% in area in thin sections, whereas microbialites occupy 10-15%. The remaining matrix includes sand sized clasts of tabulate corals, crinoids and gastropods, and those sediments are directly covered by stromatoporoids. Microbialites are composed of silt sized peloids, dense micrites and *Girvanella* with external diameters ranging from 10 to 15μm. Surfaces of stromatoporoids are ordinarily heavily micritized, where coccoid microbes, 30-80 μm in diameter preferentially bore into stromatoporoids in the opposite sense to the growth direction of the stromatoporoid, suggesting that the boring activities have occurred after the death of stromatoporoids, Those microbialites are present where stromatoporoids and tabulate corals are conspicuously notched laterally and/or occupy the topmost surfaces of the frameworks. Minute columnar stromatolites, ca. 1mm in height are in rare cases formed everywhere within the intraframework, in cryptic spaces whose roofs also are lined with pendant microbialites composed of peloids and *Girvanella*.

The evidence noted above suggests that the stromatolitic textures were formed as follows: 1) stromatoporoids grew and stabilized bioclastic sediments; 2) stromatoporoids were partly damaged by episodic deposition and subject to bioerosion. Microbialites were formed by microbial activity, such as by *Girvanella*; 3) surviving stromatoporoids spread laterally and vertically to cover underlying microbialites and matrix; and 4) intervening cryptic spaces produced by repeated laminar growth of stromatoporoids provided a unique environment suitable for the development of columnar stromatolites on the cavity floors and pendant microbialites on the roofs.

Laminar stromatoporoids are generally considered to grow under conditions of low sedimentation (e.g., Kershaw, 1981). Background sedimentation in this section was normally low but became intensive episodically with influx of coarse particles to damage skeletal organisms, including stromatoporoids, and allow microbes to flourish, especially on the partially killed surfaces of the organism. The stromatolitic textures noted herein were thus inferred to have been brought about by repeated partial mortality of stromatoporoids and tabulate corals due to intermittent severe sedimentation, subsequent intensive microbe activities, regeneration of skeletal organisms, and microbialite infillings of cryptic spaces.

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NEW SPECIES OF BARTONIAN (EOCENE) CORALS: JACA BASIN, PYRENEES, SPAIN

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An analysis has been made of the coralline species in the Jaca Foreland Basin (Huesca South Pyrenees- Spain). These facies correspond to the deltaic Belsué-Atares Fm, though also with Pamplona Marls and Sabiñánigo Sandstone (Puigdefàbregas, 1975). The corals are found in high frequency transgressive episodes (100.000 years) (Millán et al., 1994). the coralline facies are situated in cron 17, covering the Bartonian-Priabonian boundary (Hogan y Burbank, 1996). 64 species of corals have been identified (Álvarez-Pérez et al., 2001).

In this work five new species of fossil cnidaria, *Millepora subpirenaica* n. sp. (Hydroidomedusa, Capitata), *Stylocoenia sanctaorosiae* n. sp., *Stylophora binacuaensis* n. sp., *Leptoseris santaciliaensis* n. sp. and *Alveopora ataresensis* n. sp. (Anthozoa, Scleractinia), from the Bartonian-Priabonian (Middle/Upper Eocene) of the Belsué-Atares Formation (Jaca Basin, Huesca) are described. *Millepora subpirenaica, Stylocoenia santaorosiae* and *Leptoseris santaciliaensis* are widely distributed in the research area, while *Stylophora binacuaensis* and *Alveopora ataresensis* are more restricted.

The systematics is based on Boschma, H., 1956; Solé Sabarís Ll. 1942; Wells, J. W., 1956.

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THE CORALS OF THE ILERDIAN (PALEOCENE-EOCENE) STRATOTYPE AND PARASTRATOTYPE. PYRENEES, SPAIN

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The E-W Graus-Tremp Foreland Basin lise to the south of the Pyrenees on top of the Cretaceous Montsec Unit (Seguret 1972). Transported by the Montsec Thrust, the basin progressively divided into two, the Tremp Basin to the east and that of Graus to the west (Serra-Kiel et al. 1994).

The Ilerdian stratotype was defined by Schaub (1969) as part of the Ager Fm.. Subsequently Barbera et al. (1997) updated the stratigraphy, locating it instead in the Figols Group. It lies within in the Tremp Basin and contains an important coral record. This study has identified 21 species of corals, of which eight are cited for the first time in this area. *Turbinolia sulcata*, *Tubicora aylmeri*, *Rhizangia brauni* and *Pachygyra flexuosissima* are species which, in the South-Pyrenean Eocene Basins, only appear in the Ilerdian. The coral associations found have been studied and assigned to shallow benthic biozones (SBZ) recognised in this area (Serra-Kiel et al. 1998).

The Campo section in the Graus Basin, was considered by Schaub (1969) as the parastratotype of the Ilerdian. This study describes the corals found here and in the adjacent areas to the east. Systematic study has allowed us to identify 10 species in the Campo section and 12 more nearby. *Astreopora tecta* and *Actinacis cognata* are the most important colonial species. All the coralline species have been assigned to the biozones described by Schaub (1969), and the shallow benthic biozones recognised in this area by Serra-Kiel et al. (1998).

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PALAEOECOLOGY OF LATE DINANTIAN CORAL BIOSTROMES FROM COUNTY SLIGO, NORTHWESTERN IRELAND

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The Asbian succession of northwestern Ireland is characterised by northward retrogradation of deltaic systems and the diachronous advance of pure carbonate facies due to a gradual sea-level rise. Rugose corals are abundant in the Bricklieve Mountain Formation, and in its northern equivalents, the Glencar and Darty formations. However, only *Siphonodendron* constructs distinctive biostrome-dominated horizons, which can be traced across more than 40 kilometres through Cty. Sligo in a transect more or less perpendicular to the palaeocoast. Named according to the predominating species, these are from below: „*pauciradiale* reef", „*martini* reef" and lower, middle and upper „*junceum* reefs".

The oldest coral horizon, the „*pauciradiale* reef", is up to 50 m thick. According to its geometry and dimensions, it is a biostromal reef complex (Aretz 2002). In the southern exposures, heterogeneously distributed coral boundstones, coral debris rudstones/grainstones, and bioclastic grainstones are interbedded. Only few horizons are laterally persistent for more than a few meters; rigid coral frameworks are rare. The abundant coral debris resulted from *in situ* destructions of the colonies. Neither a cyclic development nor a succession of ecological stages could be evidenced. Sections in the transitional realm towards the siliciclastic facies in the north have strongly reduced thickness of about 16 m. Alternating shales and coral limestones form small-scale cycles, which may be autocyclic, derived from switching delta lobes, or allocyclic, derived from glacio-eustatic sea-level variations. Colonial rugosa are always transported. *Solenodendron furcatum*, a rare species in the South, predominates.

The 7 m thick „*martini* reef" is mostly homogeneous across the N-S transect. It is characterised by repeated coarsening-upward, few colonial corals in place, and an exaggerated amount of coral debris. It is a polyspecific para- to autoparabiostrome, formed by repeated tempestitic reworking, and resedimentation of more or less autochthonous coral debris.

The overlying lower, middle and upper „*junceum* reefs" are monospecific, low-height, often single-generation autobiostromes. Abundant elongated and partly branched chert nodules directly below the lower „*junceum* reef" are interpreted to be burrows of the *Thalassinoides* type, thus indicating slow sedimentation rate and hardground formation.

The different geometries, internal construction modes and thicknesses of the coral horizons indicate strong ecological control of their formation. This is stressed by the predominance of different *Siphonodendron* species, which stratigraphically co-occur during the later Asbian.

The geometry of the „*pauciradiale* biostromal reef complex" indicates position on a southward dipping ramp. Optimum water-depth for *S. pauciradiale* colonies with small, quite fragile corallites, apparently was around storm-wave base. The growth of the wedge of the biostromal reef complex resulted in formation of a shelf platform enabling growth of the tabular, „*martini* para- to autobiostrome", which is characteristically undifferentiated in thickness and facies all across the studied transect. Carbonate facies demonstrates settlement of *S. martini* with its more stout corallites above fair-weather base, i.e. in shallower water than *S. pauciradiale*. The „*junceum* autobiostromes" developed after drowning of the platform in deeper water, as seen by the predominantly upright position of the colonies with very delicate corallites. Low sediment input and hardground formation may be connected with maximum flooding phases of the Late Asbian transgression.

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THE HOLKERIAN/ASBIAN BOUNDARY (VISÉAN) AT THE LITTLE ASBY SCAR STRATOTYPE SECTION (CUMBRIA, ENGLAND): NEW EVIDENCES ON ITS CORAL FAUNA, FACIES, AND BIOSTRATIGRAPHIC ZONATION

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The division of the British Lower Carboniferous succession into substages is today widely accepted and used as a reference in other countries. However, despite their wide acceptance the exact correlations of the boundary intervals within Britain and with adjacent countries are often problematic.

New investigations at the stratotype section of the Holkerian/Asbian boundary at Little Asby Scar in Cumbria illustrate some of the problems linked to this boundary. The distribution patterns of rugose corals and microfossils, and the application of sedimentary sequences have led to a new interpretation of the boundary interval and to the first detailed correlation to age-equivalent succession in Belgium.

Five coral assemblages from the Holkerian-Asbian succession of the stratotype section at Little Asby Scar have been studied. It is clear that the stratotype section is located near a fault zone, and that the contact of the Potts Beck Limestone (earlier Asbian) and the Knipe Scar Limestones (later Asbian) is tectonically controlled.

The limestone bed which has previously been considered to represent the base of the Asbian (bed f) bears a coral assemblage which is clearly Holkerian in age. The first *Dibunophyllum*, the traditional coral genus for the Asbian-Brigantian (later Viséan), is not known until the overlying Knipe Scar Limestone. However, other coral taxa from the Knipe Scar Limestone are typical of the late Asbian. No coral assemblages of the earlier Asbian were found.

The coral bed at the base of the Potts Beck Limestone (bed f) is classified as polyspecific parabiostrome. Macrofaunal distribution patterns show vertical and horizontal shifts over its total exposed length (800 m). The main components of the biostrome are fragmented colonial rugose corals, mostly *Siphonodendron* (?due to storm events). Other locally important components are chaetetids, solitary rugose corals and tabulate corals.

A detailed comparison of the coral assemblages and foraminiferans at Little Asby Scar with standardized Belgian biozones and sedimentary sequences allows a revised correlation of this succession. The Ashfell Limestone, plus the basal unit (bed f) of the Potts Beck Limestone, is correlated to the Belgian Seilles Member, indicating that the Belgian Livian/Warnantian boundary occurs within this interval. It belongs to the highstand system tract of sequence 7. The earlier Asbian (beds g-i of the Potts Beck Limestone) forms the thin sequence 8. The Knipe Scar Limestone comprises sequence 9, and its coral distribution allows differentiation into the biozones RC7α/β. The Holkerian/Asbian boundary should be shifted to the boundary between beds f and g of the Potts Beck Limestone.

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UNDERSTANDING ENDEMIC CLADES WITHIN COSMOPOLITIAN FAMILIES: LOWER CARBONIFEROUS SYRINGOPORID CORALS FROM EASTERN AUSTRALIA

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Geographic isolation is one of the widely accepted factors controlling evolution (e.g. speciation), but taxonomic research on fossil corals commonly does not take palaeogeography adequately into account.

Syringoporid corals are clonal organisms with relatively simple structure. Few characters are taxonomically important, and the degree to which some characters reflect palaeoecological influences is still uncertain. Taking into account the simplicity of the corallites, the small number of characters, morphological variability, and long geological record of the group, homemorphy cannot be excluded, and, to the contrary, seems to be very likely. For instance, the geological record of *Multithecopora* contains a gap representing the entire Devonian.

Eastern Australian syringoporoids are significant for the systematic evaluation of the entire Early Carboniferous syringoporoid clade, because the eastern Australian subclade is most likely to have evolved in geographic isolation on the basis of co-occurring highly endemic rugose coral faunas and the isolated palaeogeographical position on the eastern end of Gondwana. Hence, character transformations that occurred in eastern Australian syringoporoids are unlikely to be homologous to those in other regions. Hence, the Australian clade can be interpreted as a simplified evolutionary lineage where particular character transformations can be observed without the complication of intermixing various clades through migration events, which may complicate syringoporoid systematics in Tethyan and Euramerican regions.

The oldest Australian syringoporid taxa occur in the lowermost Tournaisian Gudman Formation. Although an Eastern Australian Upper Devonian precursor is unknown, the taxa clearly belong to the genus *Syringopora* indicating migration into eastern Australia. Numerous septal spines are one dominant character of the Tournaisian taxa.
Throughout the Lower Carboniferous several individual evolutionary trends occurred, mostly culminating in new genera. 1) Steroplasmatic thickening of tabulae and loss of infundibular tabulae gave rise to a new genus (formerly assigned to *Multithecopora*). 2) Relative increase of thickness and length of septal spines led to *Spinuliplena.* 3) Reduction of intracolonial corallite distances resulted in Australian '*Roemeripora*' (close to *S. samsi*) and higher integration of the corallites to *Pseudoroemeripora.* 4) Simplification of the organisational pattern of septal spines and tabulae also occurred within *Syringopora.*

Some eastern Australian syringoporid taxa show superficial phenotypic similarities to taxa of other areas, but major internal differences clearly developed independently from older eastern Australian taxa. However, migration cannot be totally excluded and might include Panthalassian taxa.

MORPHOMETRICS OF *CATENIPORA* (TABULATA; UPPER ORDOVICIAN; SOUTHERN MANITOBA, CANADA)

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Multivariate analyses have been carried out to discriminate closely related species of *Catenipora* from the Selkirk Member, Red River Formation, Manitoba. Ten morphological characters measured in transverse sections of 37 colonies were tested to perform cluster analyses.

Results of frequencies, bivariate plots, simple correlation analysis, and principal component analysis indicate that five morphological characters contribute the most to species differentiation: tabularium area, length of corallite, width of corallite, tabularium length, and tabularium width.

A cluster analysis was performed on the raw data matrix coordinated with 37 colonies by the five selected variables. The variables were standardized to mean 0 and variance 1 and squared euclidean distances among the colonies were calculated. Unweighted pair-group method using arithmetic average was also employed for clustering among colonies. Four morphotypes were consequently extracted from the dendrogram, which was based on the variation of the five morphological characters.

Morphotypes A, B and D have distinctive ranges in variation of all selected morphological characters except length of corallite. Morphotype C appears to be an intermediate type, in which the ranges of variation of all five variables partially overlap those of morphotype A and/or B. Another cluster analysis, including type specimens previously reported from Manitoba, has also been performed on the data matrix coordinated with 41 colonies by the five variables. This analysis suggests that morphotypes A, B and C are comparable with *C. rubra* Sinclair and Bolton in Sinclair, 1955, *C. foerstei* Nelson, 1963 and *C. robusta* (Wilson, 1926) of Nelson, 1963, respectively. Morphotype D does not correspond with previously reported species.

The result of cluster analysis based on the selected five variables demonstrates efficiency in distinguishing closely related species of *Catenipora* from southern Manitoba. The same procedure could also be applied to other cateniform corals.

LIFE HISTORY STRATEGIES OF A SPECIES OF *CATENIPORA* (TABULATA; UPPER ORDOVICIAN; SOUTHERN MANITOBA, CANADA)

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The life history strategies (survival and growth characteristics) in response to different physical environments are determined and evaluated for colonies of *Catenipora* cf. *foerstei* Nelson, 1963 from the Selkirk Member, Red River Formation, in southern Manitoba.

The change of tabularium area of corallites within colonies is documented through serial transverse thin sections. Fluctuations of tabularium area occur in cycles over vertical intervals ranging from 3.2 to 7.8 mm. Each cycle is considered to represent annual growth.

The growth rate of colonies is higher in association with episodes of sediment influx, probably generated by storms. Commonly, partial mortality due to sediment influx was followed by specific types of axial and/or lateral increase.

In contrast, during periods of relatively low growth rate in colonies, growth was not interrupted by sediment influx and was characterized by different types of axial and/or lateral increase. The new offsets tend to be concentrated in dense cyclomorphic bands, when tabularium area of corallites is reduced.

Some colonies have extraordinarily high rates of offsetting by normal, undamaged corallites. Simultaneous formation of two offsets by lateral increases between two adjacent corallites, followed by additional lateral increases and rarely axial increase, resulted in agglutinated patches within colonies.

In conclusion, in storm-dominant environments, partial mortalities due to sediment influx occurred commonly, and offsetting usually accompanied rejuvenation and regeneration. The colony growth rate was relatively high. In stable environments, on the other hand, growth and offsetting in colonies depended primarily on the formation of new offsets by normal, undamaged corallites.

ONTOGENETICAL DEVELOPMENT IN UPPER CRETACEOUS SCLERACTINIAN CORALS

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From Upper Cretaceous strata of the Austrian 'Gosau Group' (Finstergraben, Grabenbach, Hofergraben, and Hochmoos-Russbach; marls of Grabenbach and Hochmoos beds; Santonian) the ontogenetical development in scleractinian corals were studied (Baron-Szabo, 2003):

Columactinastrea pygmaea (Felix), *C. formosa* (Goldfuss), *Agathelia asperella* Reuss, *Hydnophora styriaca* (Michelin), *Cladocora gracilis* (d'Orbigny), *Peplosmilia latona* (Felix), *Placosmilia martini* (Michelin), *P. fenestrata* (Felix), *Aulosmilia aspera* (Sowerby), *Phyllosmilia didymophila* (Felix), *Diploctenium ferrumequinum* Reuss, *Flabellosmilia bisinuatum* (Reuss), *Acrosmilia elongata* (Reuss), *Actinacis parvistella* Oppenheim, *Fungiastrea exigua* (Reuss), *Cunnolites polymorpha* (Goldfuss), and *Aspidastraea orientalis* Kühn.

In their earliest stages of ontogeny these corals have a well-defined wall and axial region. The only exception might be *Agathelia asperella* Reuss in which the early stages of ontogeny are probably characterized by unclear wall structures, consolidating during later stages of its ontogeny.

In these species the septal apparatus develops in one of three ways: The development of the septal apparatus can be in cycles in each stage of ontogeny [*Columactinastrea pygmaea* (Felix), *C. formosa* (Goldfuss), *Cladocora gracilis* (d'Orbigny), *Agathelia asperella* Reuss, *Peplosmilia latona* (Felix), *Aulosmilia aspera* (Sowerby), *Acrosmilia elongata* (Reuss), *Actinacis parvistella* Oppenheim), *Cunnolites polymorpha* (Goldfuss), *Aspidastraea orientalis* Kühn], or in cycles in the initial stage transforming to a septal arrangement in size orders in the adult stage [*Diploctenium ferrumequinum* Reuss, *Flabellosmilia bisinuatum* (Reuss)], or develops in size orders throughout the entire ontogenetical growth [*Hydnophora styriaca* (Michelin), *Placosmilia martini* (Michelin), *P. fenestrata* (Felix), *Phyllosmilia didymophila* (Felix), and *Fungiastrea exigua* (Reuss)].

In solitary forms the development of the septal apparatus is closely related to the size of the corallite diameter, but is insignificant to the height of the corallum.

Throughout the entire ontogenetical growth in the corals the same microstructural development can be observed: The microstructure which is present in the initial stage of an individual occurs in each of the following ontogenetical stages.

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ASSEMBLAGES OF SOLITARY RUGOSANS FROM THE DEVONIAN VENTING SYSTEMS OF HAMAR LAGHDAD (ANTI-ATLAS, MOROCCO)

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Unique assemblages of small, solitary, rugose corals have been discovered within the Devonian deep-sea hydrothermal venting systems of the Hamar Laghdad (Anti-Atlas, Morocco). Hamar Laghdad area is situated about 20km south of Erfoud and forms an elevated ramp-dipping south, where more than 50 conical buildups of hydrothermal origin (Belka 1998) are perfectly exhumed. Mostly, they belong to so called Kess-Kess Formation of the Emsian (Dalejan) age, but a part of them situated on the eastern side of Hamar Laghdad belong to the Givetian. Mud mound facies are composed mostly of skeletal wackestone and mudstone riddled by stromatactis cavities and packstone intercalations (Brachert et al. 1992). Biotic components of the mud mound facies consist mostly of tabulate corals (auloporids, thamonoporids and favositids), which are more or less regularly spaced. Within the main mound body rugose corals occur sporadically or even they are absent but their numerous assemblages flourished around vents nowadays mostly filled with younger sediment. They form the „coral meadows" growing around the outlets of venting channels irregularly forked within the mounds. The taxa living around vents do not differ in the general anatomy and structure of the skeleton from small undissepimented corals living in typical deep environments not touched by venting activity. But most of them are represented by new (probably endemic) genera. Although, the Emsian (monospecific) and Givetian (polyspecific) rugose assemblages differ in taxonomy they reveal a similar phenomenon concerning with growth pattern. Strikingly, most of all (78% in Emsian and 63% in Givetian mounds) individual skeletons grew within the empty calices of extinct individuals. The phenomenon called here „calice-in-calice" growth is related to selective survival of coral larvae i.e. it is postulated that the larvae, which settle within the calices of extinct individuals were more successful in their development. They probably use empty calices as shelters against the physical (hot or poisoning fluids) or biological (predators) factors. The presence of numerous ostracod carapaces within the empty calices of extinct rugosans allows reconstructing a part of trophic relation between corals and ostracods, which lived around hydrothermal vents.

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SCLERACTINIAN DISTRIBUTION IN A SILICICLASTIC INFLUENCED CARBONATE SETTING: EXAMPLES FROM THE PALEOCENE/EOCENE OF OMAN

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The most complete succession of Paleogene depositional sequences in the Middle East is exposed along the southeastern Arabian platform margin in Oman. The distribution of the coral faunas and their paleoecological environment depends on the development of the Arabian shelf. Tertiary transgression started during the late Paleocene. Later, due to a fairly generized regression of the Eastern Arabian Peninsula, the Oligocene sea was much more limited in extent.

Late Paleocene - Early Eocene (Thanetian-Ipresian): This period involved widespread subsidence and extensive transgression over the Arabian platform, aggradation of the first Paleogene carbonate platform. Slope and basin area were dominated by carbonate hemipelagic sedimentation. Some gravity flow deposits are observed in lowstand and early transgressive system tracts of 3rd order depositional sequences. The upper part of the Jafnayn Formation, representing a shallow shelf environment, consists of carbonate horizons with alveolinid foraminifera, coralline algal nodules and scleractinian corals (*Astrocoenia, Siderastrea, Pachygyra, Dendrophyllia, Polytremacis*) forming isolated colonies and coral banks. The coral development is influenced by siliciclastic influx. Extentional tectonic activity and a correlative major sea level drop were responsible for a wide emergence of the Arabian carbonate platform (RAZIN et al. 2001) at the end of the Ipresian.

Middle - Late Eocene (Lutetian-Priabonian): Regional subsidence of the Arabian plate was accompanied by extensive transgression and aggradation of the second Paleogene mixed carbonate siliciclastic carbonate platform. Thick deltaic deposits accumulated along the subsiding eastern border of the passive platform margin. The calcarenitic shallow shelf deposits in the west 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*) and form coral banks, which contain a rich benthic foraminifera microfauna.
The main extentional tectonic phase in the Oligocene is related to the opening of the Gulf of Aden, progressive uplift and emergence of the Arabian platform, further block faulting at the margin. Forced regression and shelf margin platform progradation/aggradation developed at the edge of the Arabian plate. Carbonate platform collapse and resedimentation along the margin occurred at the beginning of this stage. Than chaotic gravity flow sedimentation eroded along the bypass slope.
The Paleogene major transgressive-regressive cycles show a depositional partitioning between platform and basin that can be directly related to tectonic activity. The periods of tectonic relaxation reflected by regional subsidence are characterised by aggradation of the carbonate platforms onlapping the Arabian craton. During the Paleogene control 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.

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GEOGRAPHICAL DIFFERENTIATION OF EARLY CAMBRIAN TUMUL ARCHAEOCYATHEANS OF SIBERIA AND FAR EAST

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Determination of the Archaeocyathean migration ways in different ages of the Early Cambrian epoch gives a clue to paleogeographic reconstructions, and thus it is of great interest. Using the method of interregional correlations of the complexes of tumul Archaeocyatheans from the deposits, confined to the Siberian platform, the Altai-Sayan fold area, Transbaikal area, Priamurye, and the Far East, the author has traced at a species level the appearance, distribution, and dispersion of Archaeocyatheans in lateral and vertical ranges.

Four main stages have been distinguished.

At the first stage answering the uppers of the Tommotian age, the first appearance of tumul Archaeocyatheans is fixed within the modern Siberian platform and in the Far East.

At the second stage answering the lows of the Atdabanian age, tumulous become rather diverse, and new centers of migration, such as Altai-Sayan fold area, appear in addition to the Siberian platform.

At the third stage timed to the Late Atdabanian age, the relation of the Siberian and Altai-Sayan tumul Archaeocyatheans with those of Mongolia, Transbaikal, and Priamurye was significantly widened.

At the fourth stage related to the Botomian age, some tumul species become rather common. At the same time, in the most of listed above regions, the complexes containing endemic species appear. This testifies to both some paleoclimatic differences and existence of paleocurrents favoring a gradual migration of Archaeocyatheans from one basin to another. As a matter of fact, both flourishing and subsequent extinction of tumul in all listed above regions fall on the Botomian age.

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THE CHANGING BIOTIC COMPOSITION AND ITS CONTROL ON THE NATURE OF REEF TRACTS AND REEF SLOPES: A CASE FROM THE OLIGO-MIOCENE OF THE APULIA PLATFORM MARGIN (SOUTHERN ITALY)

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Reefs of Oligocene and Late Miocene age, both times of massive reef development in the Mediterranean region, are well developed along the eastern margin of the Apulia Platform (eastern coast of the Salento Peninsula, southern Italy). Their growth occurred in a physiographic and depositional setting which remained stable from Late Cretaceous until Late Miocene and we assume that, presumably, depth and hydrodynamic gradient along reef profile was nearly the same.

This quite unusual context provides the opportunity to focus basically on evolutionary changes that differentiate Oligocene and Late Miocene reef biota of the Apulia Platform and to illustrate how different reef communities produce different framework, growth fabrics and sediment types along reef tracts and reef slopes.

The two reef complexes, respectively represented by the lower Chattian Castro Limestone and the lower Messinian Novaglie Formation, are compared by data on reef-building components (primary and secondary reef builders) including diversity, size and growth morphologies, on growth fabrics and coral cover, associated sediments and fauna.

The Oligocene reef tract is largely dominated by a high diversity coral fauna associated with a moderate presence of coralline algae. Growth fabric is mainly represented by a dense domestone-mixstone (about 70% of coral cover). The slope is also dominated by corals but with those in growth position clearly subordinate with respect to coral debris.

In contrast, the Messinian reef tract displays a very low diversity coral fauna but an abundance of other reef-building components. *Porites* domestones and pillarstones (about 40-50% of coral cover) are associated with abundant coralline algae, strongly binding coral colonies or forming in places crustose frameworks, together with abundant encrusting foraminifera, bryozoans and micritic crusts. The nature of the reef slope is varied and shows, together with coral debris, also *Porites* sheetstones, crustose coralline frameworks, *Halimeda* bioherms and, in general, a larger amount of grain-producing biota.

The picture derived from this comparative study shows the Oligocene reef almost totally composed by a high diversity and abundant coral fauna („monotonous" reef-building biota) versus the Messinian reef, characterized by a very low coral diversity but abundant and varied secondary reef-builders (heterogeneous reef-building biota). These differences in biotic composition, mainly related to climatic changes, have important consequences on organism-environment feedback. For the Oligocene we can assume a high framebuilding capacity in the reef tract margin but low in the slope that is largely composed of gravity-dispalced debris. In contrast, for the Messinian, a relevant framebuilding capacity can be recognized also in the slope, strongly biologically stabilized and thus available for further coral settlement and encrustation.

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HETERACTINIDS AND HEXACTINELLIDS: A PALAEONTOLOGICAL VIEW OF BASAL SPONGE RELATIONSHIPS

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Relationships between the sponge classes are controversial, and current hypotheses are largely based on molecular and zoological data. The emphasis on Recent taxa has resulted in well-defined boundaries between the classes, since each represents a restricted crown group, relative to past diversity. However, it is often assumed that their distinguishing features have always existed. This has resulted in the assumption that at least Calcarea and Hexactinellida diverged prior to mineralization.

Spicules of heteractinids were shown by Mehl and Reitner (1996) to possess similar internal structure to the extant Calcarea, which suggests a very close relationship. The skeletal morphology and architecture of the Eiffelliidae are also very similar to the simplest extant Clathrinida. Both simple Clathrinida and Eiffelliidae share with protospongioid hexactinellids a body wall consisting of a single layer of spicules, with up to around seven size orders. These are arranged in a regular rhomboidal grid (or rectangular, in later hexactinellids), the spaces subdivided sequentially by successively smaller spicule size orders. The early representatives of the classes differ in spicule symmetry and composition.

An undescribed specimen of *Eiffellia globosa* Walcott has prompted re-examination of the type specimens. This has revealed the presence of a variable proportion of stauractine, and in some cases apparently hexactine, spicules incorporated into the mesh. They are usually third-order spicules or smaller, and subdivide the first-order hexaradiate mesh; their positions are elsewhere occupied by equivalent-sized hexaradiates. In some specimens, over a third of spicules are tetraradiate, although some have non-orthogonal rays.

The composition of spicules of *Eiffellia* and other early heteractinids is uncertain, although later forms are known to be calcitic; those of all heteractinids are presumed to be Mg-calcite and amorphous calcium carbonate spicules secreted by sclerocytes, and surrounded by a membrane, as in modern Calcarea. The composition of Cambrian hexactinellids is similarly uncertain, although spicules were certainly siliceous by the Ordovician, with evidence of axial filaments in many Palaeozoic taxa. Some well-preserved, apparently pyritized specimens of *Eiffellia* show evidence of a bilaminar structure to the spicules, with a possible organic layer separating inner and outer regions; these layers are sometimes differentially dissolved. We speculate that the transition between Mg-calcite and opal compositions involved opal deposition onto an external organic membrane surrounding *Eiffellia*-like calcareous spicules, independent selection of hexactinal symmetry, and resultant loss of the coincidence between spicule rays and calcite crystallographic axes. Subsequent reduction of the calcareous inner region, and growth of the opal layer, would have led to shrinking of the organic membrane to a 2D filament, onto which silica was deposited.

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THE FIRST FOSSIL *ROSSELLA* (PORIFERA, HEXACTINELLIDA) FROM THE UPPER CRETACEOUS (CONIAC) OF BORNHOLM (DENMARK) AND PROBLEMS OF CLASSIFICATION WITHIN THE FOSSIL LYSSACINOSA

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The island of Bornholm in the Baltic Sea is a horst within the Fennoscandian Border Zone, which represents the marginal area between the stable Precambrian Baltic Shield and the subsiding late Palaeozoic-Mesozoic Danish subbasin. The northern part of Bornholm consists of Precabrian basement. The southern and western parts of the island consist of Palaeozoic and Mesozoic rocks in the form of down-faulted blocks.

The lyssacinosan Hexactinellida occur only at the type locality of the Arnager Limestone Formation (Coniac), which is exposed in a small stripe on the south coast immediately West of the town Arnager.

The mainly two-dimensionally preserved sponge fauna is comprised largely of lyssacinosan Hexactinellida, which consist predominantly of Rossellidae. The preservation of these non-rigid sponges is normally very poor, because of their soft skeleton of non-fused spicules. Without a rigid skeleton the sponge disintegrates as soon as the soft parts decay, therefore normally only isolated spicules can be found. The good preservation of these non-rigid and fragile Arnager sponges is the result of 1) a fast sediment covering and 2) a bacteria-induced pyritization of the spicules, which took place already during the decay of the just covered sponges.

The new *Rossella* has a cup-shaped form with a dense skeltal lattice formed by diactine bundles and hexactines. Round to oval wall openings are arranged in staggered rows. The diactine bundles are mainly parallel or diagonal to growth direction. Hypodermalia are paratropal and orthotropal pentactines, autodermalia are hexactines. The root tuft is long and moderately dense, with spicules on average 45 mm long. Basalia include 3- and 4-rayed orthotropal anchors. The new species is assigned to the genus *Rossella* Carter, 1872 because of its combination of skeletal characters: choanosomal diactine bundles and larger hexactines, protuding hypodermal paratropal and orthotropal pentactines, autodermal hexactines and diactines, and a large untwisted root tuft consisting of long anchoring spicules (orthotropal pentactines and perhaps paratropal pentactines and diactines).

The most important tool for the identification of recent lyssacinosan (and other) Hexactinellid species are the microscleres. This type of spicules, however, is normally not preserved in the fossil record, and in the unusual case of such preservation, the microscleres are found only isolated in the sediment. Due to the general absence of microscleres, the megascleres and the external habitus that are the most important criteria for classification of fossil sponges. Therefore, the comparison of the lyssacinosan sponges from the Arnager limestone with recent representatives by analysing the skeletal architecture is attempted. This includes the occurrence, distribution, sizes and pattern of the megascleres, particularly the choanosomalia, hypodermalia, lateralia and basalia. The assessment and analysis of their general form, fixation and external wall structures (internal/external openings, small elevations) are equally important. However, the two-dimensional preservation of the Arnager sponges and the pyritization of the spicules add to the difficulties of comparison and classification.

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PALEOECOLOGIC AND TAPHONOMIC CONSIDERATIONS OF A HEXACTINELLID SPONGE FAUNA FROM THE SEPTARIENTON (RUPELIUM, OLIGOCENE) OF BAD FREIENWALDE (NE-GERMANY) AND THE FIRST FOSSIL SPECIES OF *ASCONEMA*

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Exceptionally well preserved hexactinellid sponges were found in the Septarienton (Rupelium, Oligocene) of a clay pit near Bad Freienwalde (NE Germany). The fauna is of moderate diversity, but with high individual numbers. It consists of Amphidiscophoran, as well as hexasterophoran species: *Asconema* n. sp. (Hexasterophora, Lyssacinosa), the so far first fossil representative of this genus, *Aphrocallistes* sp. (Hexasterophora, Hexactinosa) and *Hyalonema* sp. (Amphidiscophora). *Asconema* and *Aphrocallistes* show high plasticity in body form which seems to be linked with environmental parameters.

The three-dimensional, pyritic preservation suggests specific embedding and preservation conditions: First, the fast embedding is assumed to have been caused by mudflows; second, early diagenetic processes in the anoxic microenvironment are considered responsible for the pyritic preservation.

Sedimentological observations and the low diversity of the comparably small sponges indicate a slightly restricted, maybe temporarily dysoxic, environment. This was characterized by relatively low levels of sedimentation and turbulence, which is a precondition for the settlement and body-preservation of lyssacinosan hexactinellids. These environmental conditions were disturbed only by episodic mudflows.

The paleoenvironment of the sponges is reconstructed as a shallow shelf - possibly in the distal range of a delta. The occurrence of Hexactinellida in an environment shallower than it is usually the case has several reasons. First, relatively cool water offers good living conditions for hexactinellid sponges. Second, the soft sediment with only little substrate material (e.g. shells) offers good settling conditions for sponges adjusted to soft grounds. Third, the relatively low diversity of the sessile benthos caused only little ecological pressure for relatively slowly growing sponges.

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HYBRIDIZATION AND ITS IMPACT ON THE EVOLUTION OF SCLERACTINIAN SPECIES: AN EXAMPLE FROM THE PLEISTOCENE OF THE BAHAMAS

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Understanding how species boundaries form and maintain their integrity over geologic time is fundamental to understanding the high biodiversity of modern coral reef ecosystems. Recent molecular analyses suggest that many Indo-Pacific species belong to hybridizing species complexes or „syngameons"; others are believed to have experienced hybridization in the geologic past, which has affected their modern-day genetic structure. Here we examine patterns of species overlap in the fossil record of one such complex, *Montastraea annularis* s.l., to determine if hybridization in the past could be responsible for the structure of modern-day species boundaries.

Our analyses focus on the Bahamas, where unlike other Caribbean locations, two members of the complex today are not genetically distinct. We measured and collected colonies along linear transects across Pleistocene reef terraces (125 Ka) on the islands of San Salvador, Andros, and Great Inagua. Ecological analyses of transect data show that three common Pleistocene growth forms of the species complex (massive, column, organ-pipe) co-occurred. Although organ-pipes had higher abundances in patch reef environments, columnar and massive forms exhibited broad, overlapping distributions and had abundances that were not related to the environment.

Morphometric analyses of collected samples were performed using landmark data digitized on transverse thin sections, and linear measurements made on longitudinal slabs. Bookstein size and shape coordinates were calculated from landmark data, and used together with measurements in canonical discriminant analyses comparing growth forms. Although differences in corallite morphology among forms are statistically significant, columns overlap extensively with organ-pipe and massive forms.

Further analyses compared the corallite morphology of Pleistocene Bahamas forms with: (a) genetically-characterized colonies of modern species from Panama, and (b) Pleistocene growth forms from the Dominican Republic. In both comparisons, the pattern of species overlap in the Pleistocene Bahamas forms is unique. In the first comparison, the three modern species are widely separated, but the Pleistocene Bahamas species are intermediate and overlap extensively. In the second comparison, Dominican Republic growth forms comprise distinct morphologic clusters, which match modern species.

These results indicate that the structure of species boundaries within the complex varies geographically, and these geographic differences have persisted since the Pleistocene. The observed ecological and morphological overlap among species in the Bahamas Pleistocene differs from other Pleistocene and modern locations; however, it resembles that observed today in the Bahamas. Genetic data suggest that modern overlap among species may have been caused by an ancestral polymorphism resulting from past hybridization. Our data indicate that hybridization involved fusion of three distinct evolutionary lineages in a limited geographic area (the Bahamas), in association with Pleistocene sea level and temperature fluctuations. As a result, species in the area developed intermediate morphologies, which persist until today.

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MICRO-ARCHITECTURAL ASSESSMENT OF SKELETAL ELEMENTS IN *MONTASTRAEA FAVEOLATA*, LOOE KEY, FLORIDA, USA

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Core samples of *Montastraea faveolata* from Looe Key, Florida provide a valuable opportunity to study the structure and micro-architecture of a coral skeleton. Looe Key Reef is located within the Florida Keys reef tract and is approximately nine nautical miles southwest of Big Pine Key. The specimen used for this study is one of 24 coral cores taken along the fore reef and will be used for comparison to additional sites along the track and other coral reefs where environmental conditions may show growth variations in skeletal morphologies.

The primary focus of this study was to learn more about the influence of crystal structure and crystal relationships (micro-architecture) as seen on dissepiments, septal flanks and costal flanks (meso-architecture) of annual high and low density portions of the coral skeleton. Annual density banding has been previously studied in species of *Montastraea* and while the microarchitectural aspect was acknowledged, it was denounced as not being a significant player in the role of skeletal density. It is generally accepted that the thickness of exothecal dissepiments contributes to the most obvious increase in skeletal density, and we are in agreement with those results. However, the question is, how can one downplay the role of micro-architecture, while it is this fundamental framework that creates the meso-architectural elements that are said to have the most influence?

The coral core was slabbed, photographed, x-rayed and cut into smaller pieces for examination with the Scanning Electron Microscope (SEM). The x-radiographs were used to determine locations to cut the coral along high and low density bands in both longitudinal and transverse sections. These samples were heavily analyzed and photographed while in the SEM.

In this preliminary work, it was found that there are differences in micro-architectural character between high and low density bands. Although on a meso-architecture scale, the dense annual band exothecal dissepiments plainly stand out in longitudinal sections, the crystal structures and relationships on dissepiments show more contrast in transverse (plan view) section. The undersurfaces of dense band endothecal dissepiments generally exhibit a ropy texture of merged aragonite crystals while the lighter bands mainly display clear acicular (needle-like) aragonite crystals. The undersurfaces of exothecal dissepiments within light bands have similar characteristics to their endothecal counterparts, but within dense bands, the crystals seem increasingly „cemented" (increased crystallization). In contrast, the crystal arrangements and distinctions between low and high density annual bands are clearer in longitudinal section along septal and costal flanks.

This is the first in a long line of studies that will address, not only density banding as seen at a micro-architectural scale, but the affect of environmental changes and the identification of times of stress in a corals life as these factors are reflected within the fundamental framework of the coral skeleton.

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CNIDARIAN COLLECTIONS AT THE NATURAL HISTORY MUSEUM, LONDON

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The fossil Cnidaria collections consists mostly of anthozoan corals but also include medusoids and conulariids (here regarded as cnidarians), and various hydrozoan groups. The stratigraphic range of the whole collection is from the late Precambrian to the Recent ('sub-fossil') with a geographical emphasis on Britain and its former colonial countries, together with regions which have been economically connected with Britain through oil and mineral exploration (mainly Middle East).

There are over 100,000 specimens of which two thirds are registered and 4,000 of which are type specimens, and other specimens that have been figured in scientific publications. The bulk of the collections were assembled in the late nineteenth and early twentieth centuries, but they include some older and some much more modern material. The most important historical collections are those of Milne Edwards & Haime (British), Murchison (Russian Palaeozoic), Duncan (West Indies Tertiary and British post-Palaeozoic), Gregory (especially Jurassic of India) and Stanley Smith (British Palaeozoic). More recent collections include Quaternary from East Africa (Crame) and Aldabra (Kennedy). The largest collections arising from our own work include late Cretaceous corals from the United Arab Emirates, and Cenozoic material from Papua New Guinea and southern Iran. Access to the collections for research, and loans of specimens, can be arranged through Jill Darrell. Visits should be arranged a reasonable time in advance.

Additionally, there is a large and important collection of Recent Cnidaria in the Department of Zoology. All the dried anthozoans are stored at the Museum's out-station depot at Wandsworth about 45 minutes from the main site at South Kensington. Further information about the zoological collections can be obtained from Clare Valentine, Collections Leader.

Over recent years, many visiting researchers from European Member and Associated States have obtained funding from our Access Grant scheme, SYS-RESOURCE. This supports visitors to work on the Museum's collections, to use its facilities and to collaborate with staff. The Museum is currently awaiting confirmation in September that we have been successful in our bid for an extension to this scheme.

Websites

http://www.nhm.ac.uk/palaeontology/
http://www.nhm.ac.uk/science/rco/sysresource/
http://www.nhm.ac.uk/zoology/index.html

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RESPONSE OF CORAL FAUNAS TO ENVIRONMENTAL CHANGE IN THE LATE ORDOVICIAN OF LAURENTIA

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Four biogeographic divisions of corals arose in the Late Ordovician (Cincinnatian) of Laurentia (North America). These include the cratonic Red River–Stony Mountain, Richmond and Edgewood provinces, and a „continental margin" assemblage. The development of this provincialism resulted from introductions of corals to environmentally distinct regions, as overall environments changed through Late Ordovician time.

Prior to the Cincinnatian, during Mohawkian time, sand was deposited widely over western Laurentia in environments that were unfavourable for corals. In the east, corals were widespread within the carbonate facies. Beginning in the late Mohawkian, this eastern fauna was displaced westward in response to the development of a foreland basin, with turbid, cool-water, nutrient-rich conditions, related to the Taconic Orogeny along the continental margin. This set the stage for the appearance of Cincinnatian coral faunas.

A major early Cincinnatian transgression brought an epicontinental sea and predominantly carbonate deposition to western and northern Laurentia. Water temperature and salinity were typically elevated compared with the sea in the east and with the open ocean. The Red River–Stony Mountain Province originated during this event, as corals arrived from the eastern sea and the continental margin, and endemic forms appeared. The ecologic structure in this province was complex, with specialized species and distinct species-associations. Fluctuations in the dominance of taxa, and bioevents involving evolution and dispersion, were related to environmental changes during two major transgressive-regressive cycles. Late in the Cincinnatian (late Richmondian–Gamachian), sea level and temperature dropped in association with glaciation in Gondwana. Red River–Stony Mountain species became extinct and corals resembling „continental margin" forms were introduced to the continental interior.

The Richmond Province was established during Richmondian time, on a mixed carbonate-siliciclastic platform along the margin of the epicontinental sea in eastern Laurentia. Corals were introduced from the continental interior and new endemic forms appeared during transgressive events as favourable environments, such as more tropical marine conditions, returned to this region. In general, water salinity was probably somewhat lower and nutrient content somewhat higher than in the Red River–Stony Mountain Province. There were distinct species-associations and differences in species dominance in various environments, but two highly variable solitary rugosans spanned the range of conditions inhabited by corals. This province was eliminated during the major end-Richmondian regression.

The Edgewood Province originated during Gamachian time, with the arrival of immigrants and the appearance of endemic corals. This occurred during minor transgressions into the continental interior from the open ocean to the south, as sea level oscillated during the glacial maximum. Carbonate sedimentation was dominant in this small epicontinental sea. Fluctuating, elevated levels of nutrients and runoff likely contributed to overall environmental instability. There was just a single species-association, dominated by one extraordinarily variable solitary rugosan. This fauna persisted into the earliest Silurian as sea level rose during deglaciation, but it was succeeded by a new assemblage in late Rhuddanian time.

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PALEOECOLOGICAL SUCCESSIONS IN THE BADENIAN (MIDDLE MIOCENE) LEITHA LIMESTONE (RETZNEI/ROSENBERG; SOUTHERN STYRIA)

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The Styrian Basin is located at the eastern margin of the Alps and part of the Pannonian Basin System. Its internal topography is highly structured and consists of a variety of subbasins. The basin fill consists predominantly of Neogene clastic sediments with volcanic intercalations. During the Badenian (Middle Miocene) stage, however, carbonate sediments (Leitha Limestones) were deposited on topographic elevations within the basin and along basin margins. They range from coralline algal dominated limestones to coral carpets and coral bioherms.

An active quarry system in Retznei near Ehrenhausen (Lafarge-Perlmooser Zementwerke AG) offers good insight into the internal organisation of these carbonates and enables a complete cut through one of these carbonate bodies of early Badenian age. Although two major quarry areas exist, the northeastern quarry (Rosenberg) is currently under exploitation and offers better outcrop conditions. The older quarry was studied and described in detail by Friebe (1988, 1991). The particular aim of this study is to document and interpret the internal composition and paleoecological successions of this about 25 m thick and terrigenously influenced carbonate body in the Rosenberg quarry.

The carbonate development starts with a basal conglomerate on a primary, tectonically induced relief. This relief correlates with the „Styrian Unconformity" separating the Karpatian „Steirischer Schlier" from the Badenian Leitha Limestone. Within the limestones ten facies units can be distinguished according to the frequency of skeletal (rhodolites, corallinacean branches and fragments, bryozoan, foraminifera, echinoids and corals) and non-skeletal grains (mainly siliciclastics); most facies types are characterized by a marly matrix. Patch reefs, built mainly by *Montastrea* sp., *Tarbellastrea* sp. and *Porites* div. sp., developed in different stratigraphic levels and show internal zonation of coral taxa and growth-forms. Inter-reef areas are represented by carbonate sands and gravels, showing a distinct lateral zonation with a rhodolite facies next to the coral patches, followed laterally by bryozoan and larger foraminiferal (e.g., *Planostegina papyracea gigantea*) facies. This zonation in combination with sedimentary structures indicates a distinct topographic elevation of these patches above the surrounding sea-bed (superstratal). Upsection, the primary topographic relief of the patch reefs is largely levelled by algal sediments and some coral layers.

Several dark marly layers, enriched in volcanoclastics, interrupt the carbonate body and are traceable throughout the quarry area. Some of these interruptions as well as the termination of the currently outcropping carbonate development are marked by an irregular surface pointing to erosion and probable subaerial exposure. The volcanoclastic sedimentation distinctly influenced carbonate production and reef-growth.

This study is a contribution to FWF-project P-14366-Bio: „Stable Isotopes and changing Miocene paleoenvironments in the Eastern Alpine region."

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CARBONIFEROUS RUGOSA IN THE HINA LIMESTONE, AKIYOSHI TERRANE, SOUTHWEST JAPAN: FAUNA ENDEMIC TO THE PANTHALASSAN OCEAN

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Exotic limestone masses of seamount origin are sporadically present within the Akiyoshi Terrane in the Inner Zone of Southwest Japan. Rugose corals of the Akiyoshi Terrane are notable, both because of their role in reef construction and due to their highly endemic nature (Kato and Minato, 1975) that gives rise to questions as to their palaeobiogeographic variation and their origin.

Until now, little has been known about the faunal characteristics of the coral rich Hina Limestone (Early Viséan to Late Bashkirian) in the Akiyoshi Terrane. The overall trend of the rugosan succession is as follows: *Cyathaxonia* is characteristically abundant in the Early Viséan. The non-dissepimented solitary corals are replaced in the Middle to Late Viséan by such large dissepimented solitary corals as *Amygdalophyllum*, *Echigophyllum*, *Nagatophyllum*, and *Dibunophyllum.* This solitary fauna is followed by dominantly pseudopavonid corals of variable form, including the fasciculate *Hiroshimaphyllum*, cerioid *Ozakiphyllum* and thamnasterioid *Pseudopavona.* During the Late Viséan warm-water transgression, the Akiyoshi fauna contrasted markedly with Tethyan faunas (e.g., the *Kueichouphyllum* fauna), forming a characteristic Akiyoshian type.

Ozakiphyllum, *Pseudopavona*, and *Omiphyllum* suggest close phylogenetic continuity through their intergradational morphology. Only four species of *Ozakiphyllum*, three of *Pseudopavona*, and one of *Omiphyllum* were previously known elsewhere in specific Japanese terranes. However, abundant new species of these genera are recognized in the Hina Limestone, and those will clarify phylogenic relationships among them. Although *Hiroshimaphyllum* may be ancestral to this clade, its solitary species are not yet well known.

Of special interest is the presence of the Australian „*Orionastraea*" cf. „*O.*" *columellaris* that perhaps is to be separated from European *Orionastraea* (Webb, 1990). Webb (1999) also noted closely related genera in Eastern Australia and the Akiyoshi Terrane, such as „*Siphonodendron*" vs. *Akiyosiphyllum*; *Amygdalophyllum* vs. *Omiphyllum*; *Symplectophyllum* vs. *Nagatophyllum*; and *Dinostrophinx* vs. *Echigophyllum.* However, no pseudopavonid genera have yet been interpreted as exhibiting true „sister-group" relationships with any genera from regions other than the Japanese Islands. If the true „sister-group" rather than „analogous-group" relationships are recognized within pseudopavonids and non-pseudopavonids, phylogenetic problems may arise as to the monophyly of the family Pseudopavinidae. More importantly, invaluable clues for the origins of the Akiyoshi fauna can be obtained from the combination of palaeogeographic and phylogenetic analyses.

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REGULAR AND FLEXIBLE METHODS OF INCREASE IN THREE SILURIAN RUGOSE SPECIES OF *STAURIA* AND *CERIASTER*

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Colonial corals give rise to descendants by asexual reproduction, producing offsets by division of parent corallites during parricidal increase. Ezaki and Yasuhara (in press) show several features essential to division in *Stauria favosa*. Division site and mode of subsequent septal insertion (sites, order, polarity) are strictly regulated in *S. favosa*. However, there are few studies to show whether these regular modes of division are found in other species.

Modes of division were examined thoroughly in 1) a second species of *Stauria*, *S. qijiangensis* and 2) *Ceriaster guanyinqiaoensis*. In *S. qijiangensis*, site of division appears to be variable. Tripartite increase occurs in nearly half of the sample, followed in order by quadripartite, pentapartite, and bipartite increase. Tripartite increase characteristically occurs on the left and right alar planes, together with the cardinal area. Bipartite increase follows one of two patterns: 1) even division, utilizing two alar septa, or 2) uneven division, using the cardinal and one of the alar septa. In *C. guanyinqiaoensis*, quadripartite increase is overwhelmingly present, followed by tripartite, pentapartite, and bipartite, respectively. In tripartite increase, corallites are divided to include both the cardinal-counter plane and one alar septum, or else a left and right alar area with the cardinal septum. In bipartite increase, corallites are divided either on the cardinal-counter plane or at the cardinal and one of the alar septa. The frequency of occurrence is quite different in each species.

Division occurs in a regular manner in that parent corallites in most cases give rise to daughter corallites by using some of the parental protosepta. Either cardinal or alar septa or both of them are involved in division. However, there are significant variations in the sites of division and their frequency of occurrence, leading to differences in numbers of daughter corallites produced at each division.

Three species of Silurian *Stauria* (*S. favosa* and *S. qijiangensis*) and *Ceriaster* (*C. guanyinqiaoensis*) exhibit a unique cross-shaped axial structure formed by axial connection of four dilated protosepta, the loci of division, where parent corallites are ordinarily divided into daughters. Protosepta are the first established in offset corallites, maintaining polarity identical to the parental, and metasepta are subsequently inserted at four specific sites in corallites, following Kunth's rule. Each corallite thus has an inflexible mode of division in terms of polarity and septal insertion.

Each module contributes greatly to flexibility of growth mode by immediately regulating possible sites of division, directly affecting the number and diameter of daughter corallites produced in one division event. It is probable that corallites adopted strategies suitable for fluctuating environments as constituents members of colonies, by regulating sites of division, in addition to the essential modes of division, quickly and flexibly.

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TESTING THE LIMITS OF UNIFORMITY AND SIMPLICITY IN LIVING POLYNESIAN AND FOSSIL (CAPITAN LIMESTONE: PERMIAN, USA) REEF COMMUNITIES

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Environmental stress in reef rim communities involves long-term degradation primarily due to abnormal physical-chemical factors (eg. turbulence, salinity, temperature). Recovery occurs over ecological time (decades-centuries). The chief biological responses of these communities to stress are reduced species diversity and guild overlap, i.e. bafflers or binders become of such great volumetric importance that they replace constructors as the chief frame-builders. We first describe the biological responses of contemporaneous live Polynesian shallow sub-tidal reef face and inter-tidal atoll rim (spurs/grooves; algal ridge; reef flat) communities to environmental stress and then using uniformitarian/actualistic princlples we compare these responses to reef face and reef rim communities in the Upper Capitan Limestone (Middle Permian) at Whites City, New Mexico. In both the living and fossil reefs, the upward sequence of contemporaneous communities record similar biological responses to increasing stress in progressively shallower water. This interpretation is simpler than invoking a temporal succession of responses due to transgression and/or regression.

Recognition of a steep reef face in the Capitan, comparable to modern Polynesian atolls, is based on the presence of tabular inozoan sponges (*Gigantospongia discoforma*). Seawater circulated through canals in suspended *G. discoforma* sheets protruding from the reef face, analogous to suspended sheets of calcareous algae and corals that protrude from the steep faces of modern atolls and barrier reefs.

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REMARKS ON LITHOSTROTIONID PHYLOGENY IN WESTERN NORTH AMERICA AND WESTERN EUROPE

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Faunal exchange between Tournaisian-Viséan corals of western North America and Europe was limited by paleoenvironmental factors and by the great distance between those faunas, which were separated by the land-mass of Euramerica. Morphological comparison indicates that there is no direct relationship between species groups traditionally assigned to *Siphonodendron* in those areas. The immature morphology and stratigraphic distribution of the genus *Dorlodotia* suggest that it is the common ancestor for *Siphonodendron* in Europe and for *Siphonodendron*-like species in western North America. An unnamed, Ivorian species of *Dorlodotia* from western Canada initiated the phylogenetic succession that lead to the North American *Siphonodendron*-like lineage in the latest Tournaisian and subsequently to the European *Siphonodendron* lineage in the early Viséan.

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MAASTRICHTIAN SOLITARY CORALS FROM THE SIMSIMA FORMATION, GEBAL AL FAYAH SERIES, WESTERN SIDE OF THE NORTHERN OMAN MOUNTAINS, UNITED ARAB EMIRATES

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A highly fossiliferous Maastrichtian limestone known as the Simsima Formation is exposed at Gebal Al Fayah series, western side of the Northern Oman Mountains, United Arab Emirates. The section is rich in macrofossils which are represented mainly by rudistid bivalves, acteonellid gastropods and corals, besides other species of gastropods, bivalves and echinoids. Microfossils are represented by abundant occurrences of orbitoids besides other benthonic and planktonic foraminifera.

Corals are studied from the taxonomic aspect, 36 species are represented which are mainly colonial forms (25 species).

Solitary corals are represented by 12 species which belong to the genera *Cunnolites*, *Peplosmilia*, *Cyclolites*, *Epistreptophyllum*, *Ellipsosmilia*, *Diploctinium* and *Phyllosmilia.*

Cunnolitid corals are the most dominant among the solitary corals, they are characterized by discoid morphotypes that are indicative for hard substrate environment with low sedimentation rate.

QUATERNARY REEF FRAMEWORKS IN BELIZE: PATTERNS AND SIGNIFICANCE

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Based on the analysis of 220 m of Holocene reef limestone in cores, three reef facies are distinguished in the Belize barrier and atoll reef system, Central America. These include (1) the coral facies with abundant *Acropora palmata* and members of the *Montastraea annularis* group, (2) the well-cemented coral grainstone to rudstone facies with *Millepora* sp. and *Agaricia* sp. predominating, and (3) the unconsolidated sand and rubble facies.

(1) The coral facies is characterized by cm- to dm-sized coral fragments. Apart from the taxa mentioned above, *Diploria* sp., *Porites* sp., *Siderastrea siderea*, *Agaricia* sp., *Acropora cervicornis*, and the hydrocoral *Millepora* sp. occur. It is not possible to distinuguish between autochthonous and allochthonous corals in the core. Windward reef margins of the Belize Barrier Reef and the offshore atolls are dominated by *A. palmata*; leeward reefs are characterized by members of the *M. annularis* group. Accasionally, larger cavities in corals are observed to be colonized by cryptic microbialites or by an unidentified branched foraminifer. (2) The well-cemented coral grainstone facies contains cm- to dm-sized pieces of the foliacous corals *Millepora* sp. and *Agaricia* sp. as well as fragments of the other coral taxa listed above. Crustose coralline algae, encrusting foraminifera such as *Homotrema rubrum*, and chips of *Halimeda* sp. are common. Small cm-sized coralline sponges and thecideine brachiopods are also found in this facies. Acicular aragonite and microcrystalline high-magnesium calcite are the most common cement types. (3) Unconsolidated sand and rubble consists largely of fragments of coral, coralline algae, and *Halimeda* sp.

Calculated Holocene reef accumulation rates based on radiometric dates between samples are highly variable and range from 0.56-9.07 m/k.y. with an average of 3.45 m/k.y. All reefs investigated belong to the „keep-up" type.

The overall picture observed supports the contention that large parts of the reef „framework" consist of allochthonous corals and not of reef corals preserved *in situ.* The degree of reef consolidation is negatively correlated with Holocene thickness indicating that slowly growing reefs are better cemented than fast growing ones, and that the degree of submarine cementation is a function of available time.

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CNIDARIA DISTRIBUTION ON THE SILURIAN SHELF OF PODOLIA

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The huge value of Podolian Silurian sequence does not cause of doubt. Paleontologists and Geologists image it especially good. There were carry out two Silurian international symposia field trip [3]. Nevertheless, intensity of study of this unique geologic monument has fallen. In 1985 Novodniestrovsk hydroelectric station was build near Bernashivka village. As a result of this construction many exposures, including stratotypes, were submerged by water storage, others were covered by landslides, new were discovered by water abrasion.

The urgency of Silurian section analysis linked now with expansion of Geological mapping and prospecting in the Ukraine. In our country the Geological Service passes to large-scale state geological mapping project.

The Silurian formations are widespread on western slope of the Ukrainian Shield, but the exposures of this system are only in Middle Dniester River Region. On other areas of location Silurian deposits are studied on borehole material and by geophysical methods.

Complex Study of fossil and lithological attributes of rocks point on shelf nature of Podolian Sequence. The Paleogeographical schema of west part of the East Europe shows that Podolian Silurian Sea was closely connected with the Paleobaltic Sea Basin. We can see that both basins had pericontinental position [1]

The field investigation points that Cnidarians dominates above other fossils on the special intervals of the Sequence, in others part corals are rare or are absent. The fossils corals and stromatoporata are abundant in the bioherms and biostroms, on which one in Podolian Sequence paid more attention after investigation of Vera Sytova deal with Malynivtsy coral bioherms [2]. On our observations bioherms are meet only in paragenesis with rocks of a shallow-water origin. Bioherms are found into Mouksha, Konivka, Grinchouk and Troubshin deposits of Silurian Sequence in Dniester River basin. Besides, Cnidarians Buildups crossed by boreholes on Volynian region, Ternopil area and territory of Moldova.

For definition of facial affinities of Sequence subdivision and correlation we use simple facial model of Silurian Podolian Pericontinental Basin. A volcanic ash bed (benthonites) very important for correlation aims too. The necessity simplification of the model is connected with less detail regional level of operations then in Estonia for instance [1].

Shore line and facial zones migration depend on tectonic moves which were marked by deposition on the determined sediments. Transgressions and regressions of the sea leaded to complication of sedimentation. It may be seen in the sections. The cumulative picture looks rather complicated, but for separates sections and strata levels there is an opportunity to construct more or less simple schemas, which one would mirror a natural courses of processes. We made an attempt of such reconstruction for a Podolian Sequence.

In Silurian Sequence of Podolian shelf bioherms are accessible to analysis in exposures Bagovitsa, Konivka, Tsviklivtsy, Rykhta and Troubchin Suites [3]. Thus, the organogenous buildups and its cnidarians connected with Upper Silurian deposits can be more detail investigated.

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LOWER CARBONIFEROUS RUGOSE CORALS FROM MURCHISON'S RUSSIAN COLLECTION IN THE NATURAL HISTORY MUSEUM, LONDON

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Murchison's Russian coral collection housed in the Department of Palaeontology, The Natural History Museum was made by Murchison in European Russia and in the Urals during his travels in 1840 and 1841. It comprises 45 specimens, including 27 types, figured or described specimens, to 9 out of 10 rugose species described by Lonsdale (1845) from the Lower Carboniferous (Viséan and Serpukhovian) of the Moscow Basin and Urals. These species are as follows: *Lithodendron costatum* sp. nov., *L. annulatum* sp. nov., *L. fasciculatum* J. Phillips, *Diphyphyllum concinnum* gen. et sp. nov., *Stylastraea inconferta* gen. et sp. nov., *Lithostrotion emarciatum* (Fischer), *L. mammilare* (Fischer), *L. floriforme* Fleming, *Cladocora? sarmentosa* sp. nov.

The first two taxa are valid species belonging with *Siphonodendron*. *S. costatum* comes from the upper Viséan - basal Serpukhovian (upper Tula - lower Tarusa horizons) exposed on the Oka River (southern part of the Moscow Basin), and *S. annulatum* from the basal uppermost Viséan (lower Ust'ilim horizon) exposed on the Chusovaya River in its middle reaches (western flank of the central Urals). *Lithodendron fasciculatum* comes from the uppermost Viséan - lower upper Serpukhovian of the same area as the latter and is probably a junior synonym of *S. irregulare* (Phillips). *Stylastraea inconferta* belongs with *Acrocyathus* d'Orbigny and most probably comes from Upper Viséan (lower Warnantian, Ust'grekhovka horizon) limestones exposed on the Ural River (eastern flank of the southern Urals). *Lithostrotion emarciatum* and *L. floriforme* come from the top lower Serpukhovian (Steshevo horizon) exposed on the Msta River (north-western part of the Moscow Basin) and represent various aspects of variability of *Lonsdaleia (Actinocyathus) borealis* (Dobrolyubova). *Lithostrotion mammilare* comes from the topmost Viséan-lowermost Serpukhovian (Venev-Tarusa horizons) of the same area and is a junior synonym of *Lonsdaleia (Actinocyathus) crassiconus* (McCoy). *Diphyphyllum concinnum* comes from the Serpukhovian exposed on the Ural River near Ekaterinburg (eastern flank of the central Urals) and is the senior synonym of *Diphyphyllum lataseptatum* McCoy. *Cladocora? sarmentosa* is a valid species of the genus *Paralithostrotion* Gorsky; it comes from the same locality as *Diphyphyllum concinnum* and is most probably restricted to the upper Serpukhovian (upper Bogdanovich horizon).

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THE LARGEST LATE JURASSIC REEF COMPLEX FROM THE LOWER SAXONY BASIN (KORALLENOOLITH FORMATION, NORTHWESTERN GERMANY, OSTERWALD MTS.)

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Based on microfacies analysis, the sedimentary succession of the Korallenoolith Formation cropping out in the Hainholz limestone quarry in the Osterwald Mountains has been studied (Helm et al. 2003b). The 42 m thick deposits allow the subdivision into three lithological units: the section starts with (1) the Ahrensberg Member, a 26 m thick succession with an alternation of oolithic bioclastic limestones and marls at its base followed by a monotonous oolite sequence. It is separated from (2) the overlying Hainholz Member („Obere Korallenbank") by a prominent erosional unconformity. The Hainholz Member (2) represents reefal deposits 12 m in thickness. It is overlain by (3) an unit of quartz-bearing calcarenite vertically grading into oolite, and cortoid limestone up-section, the Barenburg Member.

The Hainholz Member (2) is developed as a reef complex with abundant coral-thrombolite patch reefs imbedded in and interfingering with reef rubble facies (Reuter et al. 2001). Its exposed dimensions make it the largest known reef complex from the Late Jurassic coral bearing sedimentary succession (Korallenoolith Formation) in the Lower Saxony Basin.

The patch reefs are of pillar-like shape with their maximum thickness exceeding about 12 m. Moreover, the accompanying reef rubble facies (rudstone) is characterized by three intercalated beds with (par)authochthonous coral colonies. Compared with other Late Jurassic reefs from the Lower Saxony Basin, the coral fauna of the Hainholz reef complex is highly diverse (about 40 species). Platy coral growth prevails, whereas hemispherical, bulbous and branched colonies occur subordinately. Most abundant are specimens of *Fungiastrea arachnoides*, *Thamnasteria concinna*, *Isastrea crassa*, *Meandrarea parallela* and *Microsolena agarciformis* (Helm et al. 2003a).

Microbial crusts (thrombolite) play a significant role in strengthening the framework. Within these microbial crusts, crustose elements such as serpulids, bryozoans, small sponges, and foraminifers occur in great quantities. The high content of crinoid remains is of special interest. The crinoid remains have been derived from the patch reefs and are enriched in the adjacent reef rubble facies.

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LATE JURASSIC (OXFORDIAN) CORAL REEFS OF THE *FLORIGEMMA*-BANK MEMBER AND HAINHOLZ MEMBER (KORALLENOOLITH FORMATION, LOWER SAXONY BASIN, NW GERMANY)

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Coral reefs are widespread during the Late Jurassic and occurred in varying environments. Owing to a relatively uniform climate, there are also records of Late Jurassic (Oxfordian) coral reefs in platform carbonate settings from high palaeolatitudes, e.g. in the Lower Saxony Basin.

Compared with other Late Jurassic coral reefs, those of the Lower Saxony Basin are comparably small. Moreover, they are restricted to a few horizons that can be traced in large parts of the outcropping areas of the Korallenoolith Formation.

The *florigemma*-Bank Member is the most important reef bearing horizon (=Hainholz Member in Osterwald Mts). Reefal bioconstructions of the *florigemma*-Bank Member show a high variability in their regional appearances. Five different reef types have been recognized: 1) *Thamnasteria dendroidea* thickets with high amounts of thrombolite that grew in lagoonal settings, representing calmer conditions (Süntel Mts., Helm & Schülke 1998); 2) A coral meadow composed of *Thamnasteria dendroidea* in which *Th. dendroidea* built a loose framework and scarce microbial crusts (Kleiner Deister Mts.). 3) A widespread coral biostrome (Deister Mts.); 4) *Stylosmilia* patch reefs with high amounts of thrombolite (Deister Mts., Helm & Schülke 2000); and 5) larger coral thrombolite patch reefs (up to 12m in heigth) embedded in reef debris (Osterwald Mts., Reuter et al. 2001).

The reefs are characterized by their different coral associations (Helm et al. 2003). The highest diversity (about 40 species of scleractinian corals) is developed in the coral thrombolite reefs from the Hainholz Member of the Osterwald Mts.. Apart from the above reefal setting, the reefs were not subjected to strong physical breakdown, transport and subsequent erosion of skeletal hard parts. Therefore, the reef organisms are still preserved in their life position, and extended aprons of reef debris surrounding the patch reefs are lacking. This exellent fossil record provides the basis of a comparably exact reconstruction of the different reef types.

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OLDEST CORAL BANDS IN THE TRIASSIC OF NORTH AMERICA AND THE EVOLUTION OF PHOTOSYMBIOSIS

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Scleractinian corals first appeared in Middle Triassic time. Modern zooxanthellate descendants secrete aragonitic skeletons with discrete, periodic (annual) growth bands. Alternating low-density and high-density skeletal layers comprising annual bands, have been associated with variables of light, temperature, reproduction, nutrients, and other factors affecting the energy budget of coral growth. Such annual bands provide direct records of linear growth rates and are best developed in living zooxanthellate species. Growth bands are rare in fossil corals, previously being known from the Jurassic (Insalaco 1996). Debate exists about when the symbiotic relationship between single-celled zooxanthellae and their scleractinian hosts originated and whether the earliest scleractinians that first appeared in Middle Triassic time were zooxanthellate and thus capable of reef building. We present evidence supporting the premise that the zooxanthellate photosymbiosis with corals was present during the Middle Triassic based on apparent banding analogous to annual density banding present in modern-day zooxanthellate scleractinians.

Middle Triassic biostromes from central Nevada, USA, yield corals with distinct bands interpreted to be relict images of annual density bands which were preserved in spite of diagenesis. These growth bands are present in a massive cerioid scleractinian, *Ceriostella variabilis* (Roniewicz and Stanley, 1998), which is abundant and the principal builder of these biostromes. Although phylogenically unrelated, *C. variabilis* compares quite favorably with the common Caribbean zooxanthellate coral, *Montastraea faveolata*, both in general corallum shape and corallite characteristics as well as being a common reef species. Modern *M. faveolata* samples were chosen from a site at a general latitudinal limit to reef growth which is assumed to be most consistent with the Nevada biostromes.

Colony size and shapes of *C. variabilis,* coupled with an analysis of the growth bands, reveals morphologies consistent with light-adaptations and also yield bandwidths comparable in size, variability, and coefficients of variation with those of *M. faveolata.* No significant difference was detected in variability of bandwidth between species which supports the premise that the *C. variabilis* bands were likely produced on an annual basis akin to those of *M. faveolata.* Further, the low-/high-density ratio is comparable with values obtain from Jurassic and modern zooxanthellate corals. Results suggest that Triassic *C. variabilis* was thus a photosymbiotic and zooxanthellate coral. This gives credence to the idea that the coral-zooxanthellae symbiosis was in the early stages of its evolution or already present in scleractinian corals during Middle Triassic time.

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AMPHIPORA ONTOGENY

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The Eifelian–Frasnian limestones of SE Moravia (on Brunnia) have greatly developed facies of *Amphipora*-limestone, which prevail in lower parts of several sedimentary cycles.

The relevant beds display a large variety of sedimentary fabrics from slightly washed 'in-situ' bafflestones up to grainstone/floatstone storm beds. The unbroken *Amphipora* 'straws' are mostly linear and 10–30 cm long. Undulated or branched growth-shapes are usually rare. The growth of carbonatized tissues starts typically from small chambers with gradual thickening to 'adult' diameter of the 'straws'. The *Amphipora* populations are monotonous, associated only with green algae of type-*Issinella*. Possible past habitat was lagoonal 'seagrass', alternatively, also irregular mattresses from tangle of these 'straw-like' specimens. The strikingly linear or only slightly bent shapes (and absence of holdfasts) suggest, that *Amphipora* 'straws' must be kept in vertical position by bubbles in their upper living parts.

Investigation of *Amphipora* early growth stages (Hladil, in press) was focused to species related to *Amphipora rudis*, *A. laxeperforata* a.o. Here, the first stages correspond to bottom discs (thin, irregular, with granulae or rudimentary pillars; *d*= 0.3 mm). The primary tubes (2–6 mm long), grow from these discs and, in terminal parts of these tubes, the 'adult' spongy tissues start by protuberances on their outer and inner sides. The last change is fast but fluent.

However, the imperfectly developed bottom discs of *Amphipora ramosa* are not so strictly separated from the tube. These discs are integral parts of thick, rounded and tubercular chambers (*d* = 0.2 mm). Short funnels (0.5 mm) rapidly expand and have early transitions to 'adult' spongy morphology (Fig. 1).

The new studies of *Amph-ipora* ontogeny suggests, that *A. ramosa* and *A. rudis* have unlike origin and amphiporids, in general, are rather linked to some common protozoan ancestors of archaeocyaths and cnidarians than to 'normal' stromatoporoids.

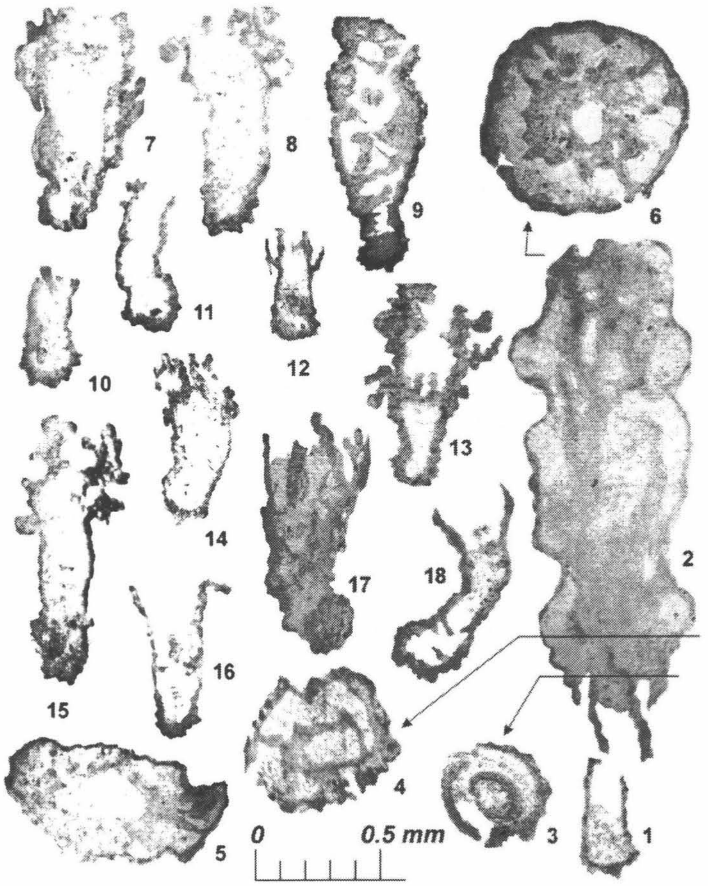

Figure 1. Young growth stages of *Amphipora ramosa*. Josefov in Moravian Karst, JOBA section, 10 m. 1 to 6 : Relationships among juxtaposed sections, illustration of early ontogenic stages. 7 to 18 : Variability of first chambers and funnels (longitudinal sections).

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Reference:
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TRANSITION ELEMENTS IN TABULATE CORAL SKELETONS: SEAWATER VS. SEDIMENT

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The Givetian scolioporids of this study originate from dense and massive micritic rocks. Marine cements, which are dull in appearance using the CL-microscopy, filled the cavities of the skeleton. Limestones were not heated over 150 °C and are practically undeformed.

The annual and intra-annual dense bands have slight brownish color hue. These zones correspond to decreased coral growth and correlate also with pore galleries. Scolioporids have quite stable although condensed structure of increments (Fig. 1). Other tabulate corals (caliaporids, a.o.) produce much more chaotic rhythms. Scolioporids are relatively euryfacial and their nutrition must be specific. These corals seem to be reliable recorders of essential changes in oceanic seawater (Hladil 2002).

The high abundance of Fe is typical for these dense bands. Concurrently are elevated also concentrations of many other transition elements (such as Ti, Co, Cu, or Mn, Ni, Y, a.o.) and these elevated TE abundances correspond to strong anomalies of K. The latter fact suggests, that this trapped and skeleton-inbuilt material can be derived from extremely fine inorganic flocculent material in seawater (~ background sedimentation). The concentrations of Sr in dense bands are x2 smaller than in light bands and cements (Fig. 2). However, the increased concentrations of V (about 30 ppm) are also in light bands. Vanadium distributions are partly disjoined from those of iron and, generally, can imply a significant organic uptake from decayed chlorophyll-bearing microalgae or cyanobacteria.

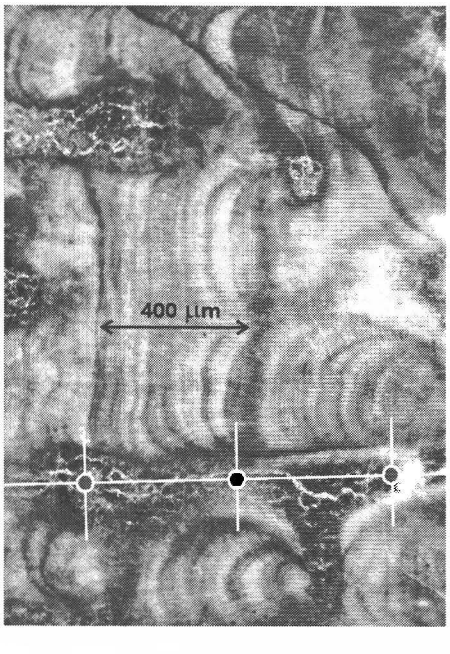

Figure 1. Thin and fine-structured annual increments of *Scoliopora denticulata* skeleton (longitudinal section) from the Slavkov-2 borehole, 1258 m.

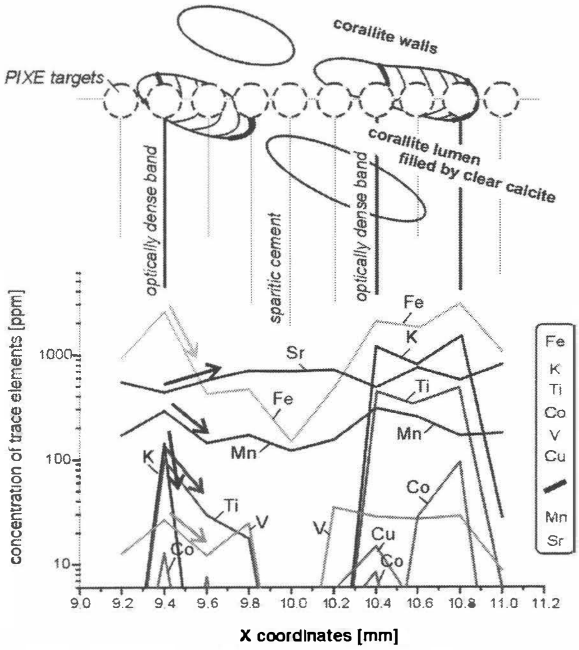

Figure 2. Variation of selected element abundances measured by PIXE in longitudinal section of *Scoliopora crassa* from the Nitkovice-2 borehole, 1702 m.

Reference: Hladil, J. (2002): Intra-annual variability in skeletal growth of the Devonian tabulate coral Scoliopora. - Geological Society of Australia Abstracts 68 (First Internat. Palaeont. Congress, Sydney, July 6-10, 2002), 77-78.

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REVIEW OF PALAEOZOIC CORALS IN AUSTRIA: STATE OF KNOWLEDGE AFTER 150 YEARS OF RESEARCH HISTORY

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In Austria the distribution of moderately metamorphic Palaeozoic successions is irregular. However two major regions of Palaeozoic developments may be distinguished, that are separated by the Periadriatic Line, the most prominent alpine fault system: the Upper Austroalpine Variscan sequences (i.e. the Greywacke Zone of Tyrol, Salzburg, Styria and Lower Austria, the Nötsch Carboniferous, the Gurktal Nappe, the Graz Palaeozoic and some isolated outcrops in South Styria and Burgenland) and the Southern Alpine sequences (i.e. the Carnic Alps and the Karawanken Alps).

Occurrences of the „*Austroalpine Coral Fauna*" (ACF) and the „*Southalpine Coral Fauna*" (SCF) are restricted to certain locations within these regions. Since all Alpine Palaeozoic units were affected by the Variscan or Alpine orogenies, - or even by both – major sections of the successions suffered deformation and alteration (tectonic fracturing, dolomitisation, recrystallisation, etc.) thereby destroying the fossil content. The recent distribution of corals obviously does not reflect the original biofacial pattern of dispersion. Especially in the Greywacke Zone and the Gurktal Nappe System corals are rare.

Within Austria's territory Lower Palaeozoic corals are frequent in the Carnic Alps and in the Graz Palaeozoic. Corals of Upper Palaeozoic age are restricted to occurrences in the eastern Greywacke Zone (Lower Carboniferous), Nötsch (Lower Carboniferous), Carnic Alps and Karawanken Mountains (Upper Carboniferous and Lower Permian).

A review of more than 200 articles, that taxonomically deal with or cite Palaeozoic corals in Austria (including coral sites near the border in Italy and Slovenia), lists 220 rugose and 113 tabulate taxa known (or even cited in the literature) from this region. Amongst these the following 10 genera were erected on the basis of Austrian specimens: *Actinopora*, *Amandophyllum*, *Carinthiaphyllum*, *Carniaphyllum*, *Geyerophyllum*, *Lonsdaloides*, *Pachycanalicula*, *Thamnophyllum*, *Torusphyllum*, *Zeliaphylum*.

A data base of Palaeozoic corals from Austria (Flügel & Hubmann 1994, Hubmann 1995, Hubmann 2002) registers 125 taxa (81 Rugosa, 33 Tabulates and 11 Heliolitids) on species level and 16 taxa on subspecies level (12 Rugosa, 4 Tabulates) which were described for the first time.

This data base is, however, limited by the need of modern revisional work for some locations, the loss of certain typoids during World War II (e.g. the Charlesworth collection), etc.. Nevertheless, the data base allows an insight into the diversity of Palaeozoic corals of the Alpine region. A synoptic view of this diversity shows a remarkable trend in both the numbers of genera and species with time.

Starting with the first occurrences of corals in the Lower Silurian up to the Middle Devonian, an increasing number of genera and species is recorded, followed by a conspicuous diversity drop in the Upper Devonian, and a renewed increase during the Lower Carboniferous to the Lower Permian.

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REEF-CORAL DIVERSITY FROM THE LATE OLIGOCENE ANTIGUA FM. AND TEMPORAL VARIATION OF LOCAL DIVERSITY ON CARIBBEAN CENOZOIC CORAL REEFS.

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New collections and continuing taxonomic revision have changed our view of the Cenozoic history of Caribbean reef-corals. Oligocene to Recent history was characterized by two episodes of apparently rapid biotic turnover. Previous work has documented in detail a Plio/Pleistocene transition with extinction of over 50 percent of a Late Pliocene fauna. An Early Miocene transition remains to be fully documented, but up to one half of the total number of reef-coral genera recovered from Late Oligocene deposits were extinct by the Late Miocene (Frost 1977, Budd 2000). Both transitions included regional extinctions and decrease in regional coral diversity, but the effects of these extinctions on local reef-coral assemblages remain unclear. I will examine the community response to these extinctions at the local scale by comparing ecological diversity of local assemblages from the Late Oligocene Antigua Fm. with the diversity of Neogene faunules from units in Costa Rica, Curacao, the Dominican Republic, Jamaica, Panama, and Trinidad.

The reef-coral fauna preserved in the Chattian (Late Oligocene) Antigua Fm. on Antigua in the Leeward Islands is one important component of the Oligocene Caribbean regional fauna (Vaughan 1919). New collections from the Antigua Formation comprise 542 colonies from 36 collections in 16 localities yielded 45 species from 25 genera including 11 species that have not been previously described. Local assemblages from the Antigua Fm. include between 10 and 30 species. However, these richness estimates are suspect because of uneven sampling among different reef units. Shannon's H and Fishers's α are two other measures of diversity that might be less subject to sampling effects because they incorporate information about the abundance distribution within each assemblage (Hayek and Buzas 1997). Both measures are not correlated with numbers of specimens recovered from the reef units considered here. Using these measures, there is no significant differences in diversity between local assemblages in the Antigua Fm. and Neogene local assemblages. Examination of rank abundance plots supports this result.

Local diversity was insensitive to the regional environmental changes responsible for the Oligocene/Miocene transition on Caribbean reefs, suggesting that there was sufficient redundancy in the regional fauna to allow functioning local communities to be built from a reduced species pool.

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ON THE CLIMATIC AND OCEANIC CONDITIONS FAVOURING RUGOSE CORAL DIVERSITY RISE IN THE BALTIC LATE ORDOVICIAN

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Corals colonized the Palaeobaltic Sea in the middle Caradoc. In the late Ordovician their diversity increased steadily, yet with some set-back. Using biodiversity as a measure, the timing of the evolutionary changes (morphological novelties) of the groups and possible influence of some ecological conditions are discussed.

The late Ordovician East Baltic Gulf was a pericratonic sea on the western margin of Baltica, with an eastward epicratonic extension reaching episodically Central Russia. Coral-bearing carbonate rocks show cyclic alternation of different limestones, marlstones and also reef-like structures at a few levels. Local climate was influenced by drifting of Baltica from mid-latitudes to a subequatorial position during the Ordovician as well as by global changes in the climate resulting in glacial conditions in the early Hirnantian. New carbon isotope studies provide evidence about the existence of several pre-Hirnantian cooler climate episodes in the middle and late Caradoc and early Ashgill.

The oldest rugose corals of the region (*Primitophyllum*, *Lambelasma*) that appeared in the earliest middle Caradoc were simple lambelasmatids with monacanthine septa and partly without tabulae. Later in the Caradoc the septa became longer and a calicular boss was formed (*Coelostylis*). Dissepiments appeared in a lambelasmatid skeleton in the Ashgill (*Neotryplasma*). The first streptelasmatids (*Streptelasma*, *Helicelasma*) that appeared in the late middle Caradoc show an advanced septal apparatus and tabularium, but a complicated axial structure became common only in the early and middle Ashgill (*Grewingkia*, *Bodophyllum*). Several morphological novelties like septofossulae (*Ullernelasma*), dissepiments (*Paliphyllum*, *Strombodes*), colonial forms (*Cyathophylloides*), etc. appeared in the Hirnantian.

Rapid radiation of lambelasmatids in the middle Caradoc caused the first diversity rise of the Baltoscandian rugose assemblage. The second notable diversification event commenced in the middle Ashgill and peaked in the Hirnantian, supported by the novelties noted above. The diversity low between these events in the early Ashgill is not a sudden event as the decrease began already in the late Caradoc. The end-Ordovician mass extinction is well expressed only on the species level.

Changes in rugose coral biodiversity are sufficiently well correlated with global warming of the late Ordovician climate. The general diversity rise was slowed down by repeated coolings in the late Caradoc and early Ashgill. Along with the development of a favourable temperature regime, changes in oceanic conditions influencing the origination and distribution of suitable habitats are of great importance. The Hirnantian glaciation, accompanied by a serious sea-level fall, brought about good conditions for coral evolution on many cratonic shelves, which helped corals survive the severe conditions of the glacial time.

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DEVONIAN RUGOSE CORALS FROM BAHRAM FORMATION, SOUTH OF OSBAK KUH (IRAN)

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Devonian corals of Bahram Formation in the Cheshme Shir area (South of Osbak-kuh) has been studied. In the studied section more than 21 species belong to 10 genus of rugose corals has been distinguished. The following genus are: *Sinodisphyllum*, *Spinophyllum*, *Glossophyllum*, *Acantophyllum*, *Temnophyllum*, *Ceratophyllum*, *Aristophyllum*, *Marisastrum*, *Hexagonaria*, *Wapitiphyllum*, which represent a Givetian-Frasnian age.

The studied corals has been compared with Mid-Upper Devonian corals of another part of the world. The Givetian-Frasnian coral assemblage of Bahram Formation show affinities with the Givetian-Frasnian corals of Rhenish mountain of Russia, China, Turkey, Afghanistan, North Africa and Central Alborz.

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SILURIAN RUGOSE CORALS FROM THE GIONYAMA FORMATION, SOUTHWEST JAPAN

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Silurian and Devonian beds known as the Gionyama Formation are exposed in Gokase-cyo, Miyazaki Prefecture, Southwest Japan. Hamada (1961) divided this formation into four members, and named them G1 to G4 in ascending order. According to him, the G2 Member referred to the upper Wenlockian because it contained *Falsicatenipora shikokuensis* Noda and Hamada, and *Coronocephalus kobayashii* Hamada. The G3 member was referred to the lower Ludlovian by him based on the presence of *Schedohalysites kitakamiensis* (Sugiyama), *Zelophyllum* sp., and *Conchidium* sp. cf. *C. knighti* Sowerby. A small land slide on the southwestern slope of Gionyama (Mt. Gion) in 1998, exposed well preserved and abundant coral specimens in mudstones and limestone conglomerates of the G2 Member. The following 18 species of rugose corals, in 12 genera, are recognized: *Tryplasma* sp. A, *T.* sp. B, *T.* sp. cf. *T. hayasakai* Sugiyama, *Cystiphyllum* sp., *Holmophyllum* sp. A, *H.* sp. B, *Labechiellata regularis* Sugiyama, *Rhizophyllum* sp. A, *R.* sp. B, *Neobrachyelasma* sp., *Amplexoides* sp., *Pseudamplexus*? sp., *Amsdenoides*? sp., *Nanshanophyllum* sp. A, *N.* sp. B, *Ptychophyllum* sp. A, *P.* sp. B, uncertain type A. Among them, *Neobrachyelasma*, *Amplexoides*, *Pseudamplexus*, *Amsdenoides Nanshanophyllum,* and *Ptychophyllum* are reported for the first time from this member.

This is the first report of *Neobrachyelasma* sp. in Japan, which is known from South China, Mongoria and Kazakhstan. *Nanshanophyllum* has been considered as an endemic coral in China (Scrutton and Deng, 2002). Additionally, ten genera including *Nanshanophyllum* and *Neobrachyelasma* are common between the Gionyama Formation and the upper Llandovery sequence in the Ningqiang – Guangyuan depression in the northeastern part of Cathaysian Land. Thus, the co-occurrence of *Nanshanophyllum* and *Neobrachyelasma* in the Gionyama Formation is important for the paleogeographical study of the Japanese Silurian faunas.

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ENCRUSTING AND INTERGROWTH SYMBIOSES BETWEEN *STYLOSMILIA CORALLINA* AND CALCIFIED SPONGES (LATE JURASSIC)

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Mesozoic macrosymbioses with corals are rarely reported in comparison with Palaeozoic and fossil Cenozoic examples, including Palaeozoic coral - calcified (coralline) sponge associations (see Darell and Taylor, 1993).

Encrusting symbiosis has been recognized in an exotic of Stramberk-type limestones (mainly formed during the Late Tithonian), Polish Flysch Carpathians. All branches (about 50) of phaceloid (pseudocolonial) scleractinian coral *Stylosmilia corallina* (suborder Stylinina) are overgrown by undetermined calcified sponge attributed to the family Milleporellidae. Encrustations, directly on corallites, attain thickness up to 3 mm (usually about 1 mm). Two corallites show minor skeletal distortions. Between coral branches some columns of Milleporellidae not associated with coral also occur.

At Bukowa (SW margin of the Holy Cross Mts., Poland) in the Lower Kimmeridgian shallow water carbonates containing coral meadows, the coral cf. *Stylosmilia corallina* intergrew with chaetetid sponges. Coral determination is uncertain, because corallites are poor preserved, mostly dissolved. Associations have been recognized in 7 of approximately 60 cut specimens. Corals have not developed typical growth form of *S. corallina*. Transverse sections through chaetetid skeletons exposed sparsely and irregularly distributed corallites (from 1 to 32 in the largest chaetetid specimen). Vertical section through compound columnar (branching) chaetetid revealed that the coral was able to form lateral branches.

It can be supposed that in the first described association, although the early stage is not known, the coral was a host. (Other corals from studied limestones are rarely encrusted by macrofauna. Microbial crusts and microencrusters were more effectively encrusters, but possibly on dead coral surfaces.) *S. corallina* was a common species during the Late Jurassic, however similar encrustations (interpreted as chaetetids) have been recognized and illustrated only by Turnšek (1975) in some specimens from the Upper Jurassic of Croatia.

In the intergrowth symbiosis from the Holy Cross Mts. chaetetids were hosts and corals their „guests". Two scenarios are possible: coral larvas settled on live chaetetid tissue or on dead surface and became overgrown by renewed growth of chaetetid. The growth of coral kept pace with upward host growth. Epizoans, except for worm-like organisms, are very rare within the studied chaetetid skeletons, suggesting that the sponges possessed defense mechanisms preventing other organisms from colonizing their surfaces. The growth form of some individuals have been modified by associated corals.

Costs and benefits of described symbioses, similarly as in many modern examples, remain unclear.

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SIMILARITIES OF PACHYTHECALIINA AND RHIPIDOGYRINA (SCLERACTINIA): PHYLOGENETIC RELATIONSHIPS OR CONVERGENCE?

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Pachythecaliina Eliašova, 1976 and Rhipidogyrina Roniewicz, 1976, two extinct scleractinian suborders are commonly believed to be phylogenetically unrelated, although some taxa from both suborders have been occasionally classified together. Some authors suggest that Pachythecaliina (Late Triassic – Maastrichtian), including amphiastreids (Roniewicz & Stolarski, 2001) and other families from the former suborders Amphiastreina and Heterocoeniina (pachythecaliinans *sensu lato* – Stolarski & Russo, 2001), are descendants of Rugosa. On the other hand, Rhipidogyrina (Late Jurassic – Maastrichtian) are usually linked with typical scleractinian groups like Stylinina or Meandriniina.

However, despite differences in microstructure and overall morphology, rhipidogyrinans share with pachythecaliinans more common features than with other suborders. The following features will be discussed to show these similarities: (i) wall that is developed prior to septa, (ii) corallite bilateral symmetry (possibly better marked in juvenile blastogenic stage of rhipidogyrinans), (iii) marginarium, (iv) lonsdaleoid and apophysal septa, (v) distal margins of septa, (vi) neorhipidicanth-like microstructure of some pachythecaliinan wall.

Recently, on account of neorhipidicanth microstructure, Aulastraeoporidae (the family morphologically close to heterocoeniids) has been placed among Rhipidogyrina (Morycowa & Kolodziej, 2001). Because of „mixed" rhipidogyrinan- pachythecaliinan characters in members of this family, it is tempting to speculate about a phylogenetic link between these suborders. More studies are necessary to support this hypothesis and exclude possibility of convergence. Attention should be focused on studies of early blastogeny of rhipidogyrinans, and especially microstructure, including relations between pachytheca and rhipidotheca. New evidences could cast light on possible evolutionary relationships of scleractinian suborders with different septal microstructure.

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LATE JURASSIC CHAETETIDS: A REVIEW AND A CASE STUDY FROM THE HOLY CROSS MTS., POLAND

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The acme of post-Palaeozoic hypercalcified sponges with chaetetid-grade skeleton occurred during the Late Jurassic-Middle Cretaceous. This review summarizes some aspects of knowledge on the Late Jurassic chaetetids and suggests future research opportunities.

About 20 species of chaetetids representing 5 genera (however there is no distinct borders between chaetetids and stromatoporoids) have been described from the Upper Jurassic. Most of them were established in the 19th or the first half of 20th century (see review by Fischer, 1970). On the basis of spicules, it was possible to establish taxonomical position within the Porifera only a few fossil chaetetids. One of the problems is the need for work on criteria used for speciation. Studies of Carboniferous chaetetids revealed that the two most commonly used characters, i.e. tubule diameter and tubule wall thickness, are not species specific (West, 1994). Carefully comparative studies of types and new collections of post-Palaeozoic specimens would casts some light on species problem. Another perspective research area is the palaeocology of post-Palaeozoic chaetetids. Results of modern studies of the biology, ecology and biocalcification processes of living coralline sponges may provide a key for understanding the ecological role of fossil forms. However, compared with Palaeozoic chaetetids and stromatoporoids, some aspects of palaeoecolgy of post-Palaeozoic fossil representatives have not been studied, either in terms of autecology or their relationships to facies and associated biota.

The Late Jurassic chaetetids are considered as part of typically Tethyan biota (nearly all localities are in Europe), however, in contrast to stromatoporoids, they are still locally abundant in the Paris Basin (N France), Lower Saxony Basin (NW Germany) and in the Holy Cross Mts. (HCM) in Central Poland.

The material studied by the author was collected mainly from the Lower Kimmeridgian carbonates from Sulejów (NW margin of the HCM), Bukowa and Ptasznik (SW margin of the HCM). Chaetetids are sparsely distributed within shallow water carbonates, along with coral meadows. Preliminary results of work on the taxonomy of chaetetids from the HCM suggest that although abundant, they are not taxonomically diverse and that intraspecimen variability of selected features is not great. Although the morphology of chaetetids can be controlled by environmental factors that could act concurrently (genotypic factors should be also considered), it is possible to speculate on the environmental significance of some general morphological features. Chaetetids from Sulejów are mostly domical forms with smooth or more rarely ragged margins. Growth interruption surfaces are not common, except borings. At Bukowa, there are more specimens with ragged domical growth form and overturned skeletons suggest turbulent episodes. Oncolites from Ptasznik contain overturned chaetetids, or chaetetids that formed the outermost layers of oncoids. Such oncoids also suggest more turbulent events.

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LATE EOCENE-OLIGOCENE CORALS FROM EVROS (THRACE BASIN, NE GREECE)

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During Tertiary, Evros region (northeastern Greece) was located in the Thrace Basin. The northward directed transgression started in this part of the basin in the Middle Eocene (Lutetian), and during the Late Eocene (Priabonian) covered all the Hellenic Rhodopes. In the Late Oligocene time increase in reef development occurred on a global scale, which is reflected also in Evros.

The studied corals come from the three time slices:

Late Eocene (Priabonian). Preliminary field studies of isolated outcrops in Lefkimi, Lagina and Likofos revealed poorly diversified coral assemblages (small massive faviids, poritiids and branching acroporiids). At Lefkimi corals are dominated by large colonies or fragments of branching acroporiids. Priabonian corals from Evros are often silicificated, locally heavely encrusted by coralline algae. Some of them occur within conglomerates covering tuffs.

Late Eocene ? – Early Oligocene. Small reef structures from Soufli contain generally similar coral assemblage as that one from Didimoteicho and Koufovouno characterized below. However, small ramose colonies of *Stylophora* are relatively abundant, and *Caulastraea* occurs subordinately.

Late Oligocene. Large reef is exposed in Didimoteicho and near located Koufovouno, the most northern localities on the studied area. Corals are abundant and diversified. The presence of large phaceloidal colonies of *Caulastraea* is characteristic feature. Other species represent massive (*Astreopora, Alveopora, Goniopora)* and branching acroporiids and poritiids, *Stylophora, Actinacis, Pavona, Cyathoseris, Diploria, Leptoria, Antiguastraea, Montastraea, ? Favia, Colpophyllia* and *?Euphyllia.*

Matrix of coral limestones from Soufli and Didimoteicho area is composed mainly by bioclastic and peloidal packstone/wackstone. Skeletal elements are dominated by foraminifers, coralline algae and bryozoans. Coralline crusts are not common; algae occur mainly as unattached branches and their detritus.

Corals from Evros display a typical Mediterranean Tethys character. The only richest coral fauna from Paleogene of Greece has been recently described from Oligocene of Doutsiko (Mesohellenic Basin, NW Greece). Interestingly, Schuster (2002) recognized there the oldest (Late Oligocene) fossil record of *Acropora*-dominated coral assemblege. The assemblage from Lefkimi with abundant branching acroporiids needs further investigation.

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RUGOSE CORALS FROM THE BOUNDARY INTERVALS WITHIN THE UPPER CARBONIFEROUS OF THE EUROPEAN PART OF RUSSIA: THE APPROACH TO THE STAGE BOUNDARY DEFINITION.

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The historically used stages of the Upper Carboniferous (the Middle and Upper Carboniferous series of Russian Stratigraphical Scale) had been proved mainly by brachiopods, fusulinids, and corals. The usage of conodont zonation as a basis for GSSP definition and the revision of the stage boundaries in a type area have resulted in approval of new stage boundaries that are more or less closely related to the former ones. The comprehensive data on the other traditionally used faunal groups are also of importance.

The Askyn (the South Urals) and Sula River sections studied contain coral faunas near the Serpukhovian/Bashkirian boundary. At the boundary the gap has been confidently recorded in Askyn section (the Southern Urals), but less well proved in northern sections (northern Timan and Novaya Zemlya). The shallow-water coral assemblage occurred at the *Pseudostaffella antigua* level is represented by fasciculate colonies both in the ramp and platform carbonate facies. This fauna includes a few genera, which need a taxonomic revision. The first species which appeared near the boundary is *Protokionophyllum vassilukae*. *„Lytvophyllum" antigua* Gorsky should be separated as a type species of the Gen. nov. 1, because of its strong difference from the type species *Lytvophyllum tchernovi* Dobrolyubova known from the Lower Permian deposits of Lytva River. The *Protodurhamina* Kozyreva, 1978 is represented by *P. toula,* and *P. karanelgense* with a complicated axial structure. There is a strong similarity of the axial structure between *Protodurhamina* and *Corwenia.* Also, the Lower Carboniferous *Heintzella rossica* (Stuckenberg, 1904) closely resembles the Lower Permian species of *Heintzella,* which are widespread in the Russian Arctic.

In the type area of the Lower Moscovian „caninomorph" corals appeared at the *ouachiensis* conodont Zone slightly above the Bashkirian/Moscovian boundary (Makhlina et al., 2001). They are represented by *Alekseeviella irinae* (Gorsky) discovered in the Moscow basin (Oka-Zna uplift), in Malaya Pokayama section (Northern Timan) and in the northern island of the Novaya Zemlya Archipelago. In the type area the uppermost Moscovian (Peski Fm.) is characterized by the disappearance of massive colonial Petalaxidae. Contemporaneous deposits of the Dalnyi Tyulkas section of the Pre-Uralian foredeep contain the deep-water „*Cyathaxonia*" fauna. Relatively abundant *Bothrophyllum* characterize the *saggitalis* conodont Zone boundary, which has been recently discussed as a possible level of GSSP at the Moscovian/Kasimovian transition. *Gshelia rouilleri* (Stuckenberg) is one of the most widespread taxa found 1.5 m above the boundary in the memorial stratotype of the Gshelian Stage, near Gshel' Village in Moscow basin. Several high correlation potential levels have been discovered within these stages. It is shown that restricted coral assemblages occur at the „traditional" stage boundaries. This could be explained by the sedimentological events which have been used for establishing the classical Russian stages as far back as the end of 19th century.

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ECOLOGICAL ASPECT OF THE UPPER CARBONIFEROUS - PERMIAN „CYATHAXONIA" FAUNA EVOLUTION (THE EASTERN EUROPEAN PLATFORM AND THE URALS)

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Isolated locations of „*Cyathaxonia*" fauna occur in different facies, but abundant and variable assemblages characterize ecologically stressed environments for the typical shelf biota of the carbonate platforms and their margins. The recurrent assemblages of the „*Cyathaxonia*" fauna appeared repeatedly during the Upper Carboniferous-Permian. A few examples of the „*Cyathaxonia*" association –from the Moscovian/Kasimovian boundary, from the Late Artinskian and some from the Kungurian -Kazanian are considered. The scarce assemblage represented by *Lophophyllidium* sp.1, *Pseudowannerophyllum* sp. 1, *Cyathaxonia* aff. *cornu* Michelin, *Kabakovichiella* sp. has been found recently in the Upper Moscovian (Myachkovian) clay layers of the Dalnyi T'ulkas section (South Urals). Large „caninomorphs", represented by *Pseudotimania* and *Siedleckia* occurin the underlying beds of the Podolskian Substage. Comparison with the assemblage from the contemporaneous deposits of the upper part of the Picos de Europa Fm. (Spain) shows a similar generic composition (Rodriguez, Kullmann, 1999). The appearance of the assemblage coincides with the deepness of the basin that resulted in the accumulation of clay, tuff, wackestone and black silica layers. The isotopic records show some increase of ^{13}C value and decrease of ^{18}O both in the Uralian and Moscow basin sections (Grossman et al., 2002) The latter is considered as a warming trend, that allows to refer the assemblage to thermophilic deep-water environment.

The Upper Artinskian assemblage is one of the most widespread and stratigraphically remarkable in the preserved Pre-Uralian foredeep. Corals have been found in seven localities in latitude 42 - 64 North. The difference between the northern and southern occurrences was expressed in the predominance of the rugosa with columnella (*Lophophyllidium, Pseudowannerophyllum*) in the northern localities. The appearance of the Mid-Artinskian „*Cyathaxonia*" fauna seems to be stimulated by an influx of cold Panthalassa ocean water. The following Kungurian weakening of cooling did not result in the re-appearance of typical shallow water colonial corals, but in the scarce distribution of non-variable assemblages. *Sochkineophyllum* and *Ufimia* were identified at two levels in the Upper Kungurian (former Ufimian). Their occurrences coinciding with transgressive impulses have been established in the siliciclastic inner-shelf deposits, which accumulated in the carbonate-starved basin. Corals represented by *Euryphyllum boreale* Fedorowski& Bamber, 2001 are known from a similar stratigraphic position in the Kapp Starostin Fm. (Svalbard) (Ezaki, Kawamura, 1992). Also one specimen of the Hapsiphyllidae has been found in the Talata Fm (Vorkuta region). The post Late Artinskian, but pre - Late Permian assemblage is distinctly impoverished. The strong Roadian (Kazanian) transgression accompanied by some increase of diversity led to the re-appearance of „*Cyathaxonia*" fauna, represented by *Calophyllum* and *Paracaninia*, which were found together with *Sverdrupites* sp. (Ammonoidea)(Esaulova, 2001).

Thus, two Permian assemblages are distinguished in the temperate zone of Panthalassa. The Late Artinskian is considered as the initial one and the Late Permian assemblage shows similarity with non-columellate genera of the Late Artinskian and *Calophyllum* could be the only typical feature.

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SEA ANEMONES (ATHENARIA) AS A KEY GROUP FOR THE CORALS EVOLUTION STUDIES

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The problem of origin and early evolution of corals is so far from final decision. The interest of zoologists and molecular biologists recently more and more focused to the study of the evolutionary history of solitary coral polyps, which has been based before almost wholly on the results of the paleontological descriptions of the skeletal structures of *Anthozoa.* Some scenario of more than one appearance of soft corals by the way of the decalcifying of their hard ancestors was suggested in USA (Buddemeier, Fautin, 1996; Stanley, Fautin, 2001). These scenarios have been connected also with the relatively fast change of atmospheric CO_2 concentration and in the same time with the reduction of calcium carbonates saturation in marine waters. By molecular data the divergence of *Scleractinia* from soft ancestors near end of Carboniferous has been discussed (Romano, Palumbi, 1996; Romano, Cairns, 2000).

The comparative morphogenetic study of modern and fossil sea anemones *Athenaria* shows this group of free-living solitary polyps as one of the primitive ancestral branch of *Anthozoa* with very variable but bilateral every time body plan (from pentamerous to decamerous). This is because they are characteristized by the very simple mesenterial arrangement. The initial anthozoan type may be a small vermiform polyp with eight or twelve macronemes, elongate, cylindrical column divisible into regions, without basilar muscles and sphincter, something like the modern *Edwardsia* and *Halcampoides.* Well-defined external ribs of *Edwardsia* are connected with mesenterial muscles activity in the process of animal migration including the burrowing of sediments. Large number shallow and deep-water (more than 2000 m) *Edwardsia* and *Halcampoides* recently inhabit from Arctic to Antarctic waters. On the basis of internal and external morphogenetic features and behavior the families *Edwardsiidae* and *Halcampoidiidae* are greater affinities with a possible actinian – grade Precambrian polyp *Inaria* (after Gelhing, 1988), Cambrian *Mackenzia* (after Walcott, 1911) and *Conostichus* (after. Chamberlain, 1971) from Carboniferous.

By the presence of eight protomesenteries polyp *Edwardsia* is similar also with polyp *Octocorallia* (including solitary *Taiaroa*) and it may be explained as the evidence of their genetic proximity and primary divergence. The ancestral anthozoan type may be understand as solitary free-living coral something like the polyp Athenaria. In older to reconstruct in detail the wais of sea anemones evolution it's necessary to analyze differences in nematocysts types together with molecular distance and morphogenetic data too.

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REMAKING OF CORALS SYMMETRY: VALUES FOR THEIR PHYLOGENY RECONSTRUCTION

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For the majority of researchers the radial and bilateral arrangement of mesenteries and skeletal septa is the invariable base for the establishment of the main subclasses of *Anthozoa.* But in the processes of individual and phylogenetic development the symmetry of corals presents as the integral population characteristic, changes of which show animal genotype transformation.

The arrangement of mesenteries and its retractors, tentacles and other morphological structures of soft body is of vital importance for the topological organization of coral polyp during their ontogeny and phylogeny (in accordance with the principle of topographical correlation). The swimming larvae have always well-defined bilateral symmetry, but at the adult animals, which are attached to substrate, the septa arrangement is radial. All corals have laterally compressed actinopharynx, which stretched in dorso-ventral plane, and another morphological structures, for example, retractors of mesenteries and siphonoglyphs of recent *Actiniaria*, are springing up in both direction from this plane and hardly bilateral.

The comparison of mesenteries and skeletal septa insertion sequence in different zones of growth of coral polyp allows to separate the morphogenetic fields, which are reflect species relationship and trends of their phylogeny. In two studied species of *Caryophyllia* (*C.clavus* and *C.cyathus*) the palingenesis field reflects the unity of septa insertion plan in the early stages of their individual development, but subsequent divergence of two plans called deviation field for middle stages. The field of anaboly (indicated by additional septa appearance) has been showed only at the final stage of *C.cyathus* development, which is evolutionary more forwarded. The change of symmetry transformation in of *Caryophylliidae* phylogeny has been traced from archallaxis and deviation at Mesozoic species to anaboly at Neogene and recent species (in accordance with A.N. Severtsov theory).

More than once the morphogenetic development of corals has been described as the way of the gradually separation of bilateral forms from its ostensibly radial ancestors (V.N. Beklemishev, A.V. Ivanov et al.). But B.S. Sokolov and M.A. Fedonkin convincingly showed that for ancient Vendian polyps concentric, spiral and bilateral symmetry are typical, but not radial. The diversity of septa symmetry types more increases in the Early Paleozoic branches of corals. Spiral-concentric symmetry even characterizes the formation of the epitecal structures of some Jurassic polyps, but in the following history this mode of development wasn't showed more.

The similar conformities of coral body plan symmetrization have been estimated by authors as a result of the ontogenetic evolution of Mesozoic *Scleractinia* and recent *Actiniaria.* Among these groups of corals frequently not only hexamerous patterns but also pentamerous, octamerous and decamerous forms happen. Their stable presence in the modern populations is an evidence of the of corals origin in ancient time. In accordance with published by S.Romano molecular data the roots of *Scleractiniamorphs* depart from Carboniferous or from the older-age time of Paleozoic. After N.N. Yakovlev's point of view we suggest to recognize sea anemone *Athenaria* as the most probable ancestors of *Anthozoa.* Octamerous pattern is typical for all *Alcyonaria* and some *Actiniaria* (*Edwardsia, Octineon, Segonzactis* et al.) in all ways of these corals development, and this possibly testifies to their parallel evolution.

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CORAL ZONATION OF AN OXFORDIAN REEF TRACT IN THE NORTHERN FRENCH JURA

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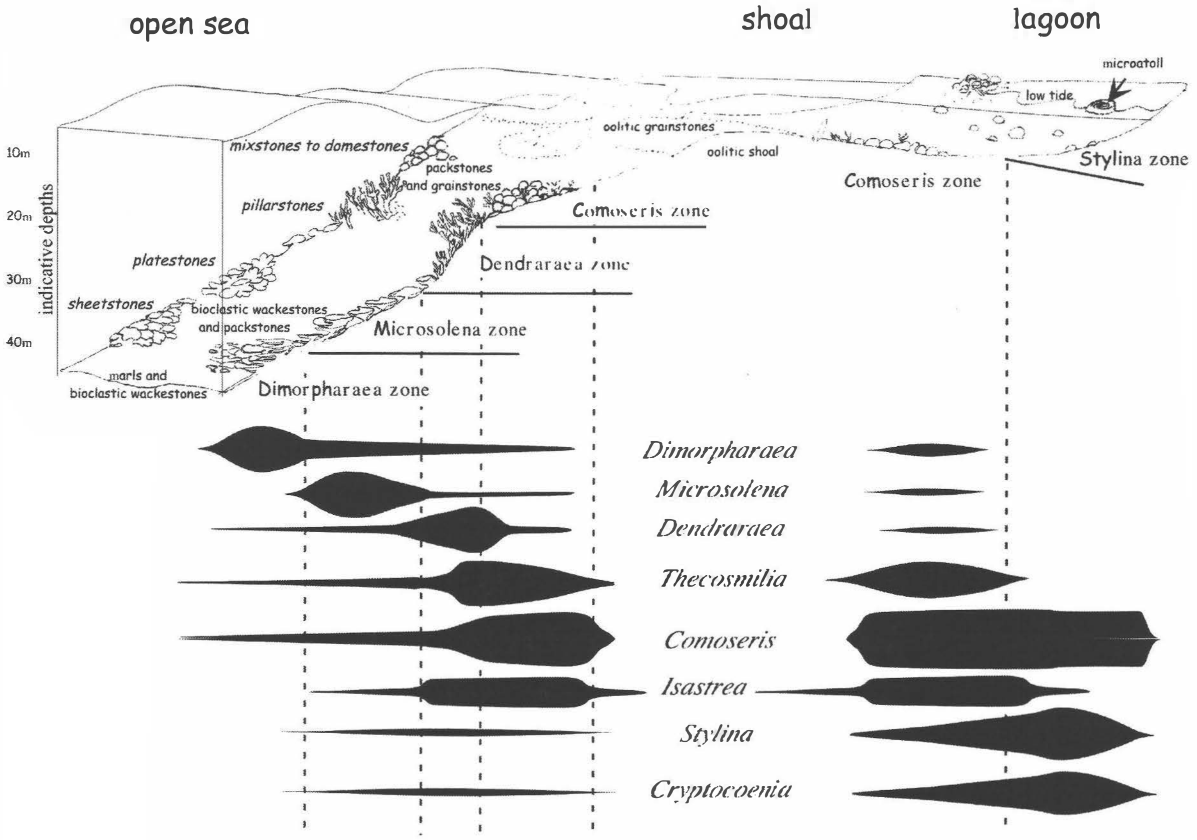
A well exposed section in the Middle Oxfordian reef complex of the Northern French Jura was studied at Bonnevaux le Prieuré. Corals were extensively sampled, (at least 30 samples per facies unit when possible). Oriented sections were determined at the generic level. A general shallowing upward trend can be deduced from many sedimentological and paleoecological criteria. The section begins with open sea ammonitic marls and ends with lagoonal facies. It is an opportunity to understand how an oxfordian coral reef tract could be zoned during oxfordian times.



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AXIAL INCREASE IN SOME EARLY TABULATE CORALS

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Various modes of increase, known from both cnidarians and poriferans, are recognized in some early tabulate corals. Among the tabulates occurring in the Late Ordovician of southern Manitoba, Canada, are *Saffordophyllum newcombae*, *Trabeculites maculatus*, *Manipora amicarum, Manipora* sp. A, and *Catenipora* spp. A, B, C and D. Lateral increase, considered to be typical of corals, appears to be a normal mode of increase in all these species. In addition, axial increase is also apparent. This mode of increase is generally considered to be characteristic of coralline sponges, but also occurs rarely in rugose corals. Four types of axial increase are recognized in these tabulate species. In the first type of axial increase, the dividing wall originates in the axial area of a normal corallite and subsequently lengthens in both directions to join the corallite wall. The parent usually divides into two, but rarely three or even four offsets separated by walls that usually divide the parent corallite radially. This form of increase occurs in all species except those of *Catenipora.* The second type of axial increase is similar to the first, but takes place in association with rejuvenation of a damaged corallite following sediment influx. The original corallite is replaced by two, or rarely three or even four corallites. This type of increase appears to be very common and is observed in all species. It often coincides with dense cyclomorphic bands in *Saffordophyllum newcombae* and all *Catenipora* species, but usually occurs in the less-dense bands in *Trabeculites maculatus*, *Manipora amicarum* and *Manipora* sp. A. The third type of axial increase involves the division of a relatively large but otherwise normal corallite into two offsets that are similar in size. The dividing wall originates from a septum on one side of the parent corallite, and lengthens to join a septum on the opposite side. This form of increase is rare, but is recognized in all species except *Catenipora* spp. A, C and D. A fourth type of axial increase is rare. It occurs in response to deposition of a foreign skeletal grain (e.g., crinoid ossicle) on the growth surface of a corallum. The corallite beneath the grain divides and grows around the object, eventually incorporating it into the corallum. This form of increase is observed in *Saffordophyllum newcombae* and *Manipora amicarum.* The various types of axial increase that are characteristic features of these early tabulate corals have not been reported from other tabulates. Certain other growth features recognized in these corals are also very different from those of typical tabulates. The similarities in modes of increase and other paleobiologic attributes in these species suggest a close phylogenetic relationship among them, despite the differences in wall microstructure and mural pores.

SYMBIONTS IN SOME LATE ORDOVICIAN TABULATE CORALS

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Three types of small, vertical tubes are recognized in certain colonial corals from the Late Ordovician of southern Manitoba, Canada. They occur in the tabulates *Saffordophyllum newcombae* and *Trabeculites maculatus* (massive, cerioid coralla), and *Manipora amicarum* and *M.* sp. A (tollinaform coralla; i.e., cateniform with some multiple ranks and aggregates of corallites). The nature of these tubes and their relation to adjacent corallites suggest that they were formed by the corals in response to soft-bodied biotic associates of unknown taxonomic affinity. These tubes differ from the various tubular structures, considered to have housed vermiform symbionts, that have been described from other corals. Type 1 tubes are circular in transverse section, relatively slender (diameter typically about 1 mm), and may exceed 14 mm in length. The only example of a Type 2 tube is circular, relatively broad (maximum diameter 3.1 mm), and more than 5.7 mm long. Type 3 tubes have a lenticular transverse section (major axis up to 3.5 mm, minor axis up to 2.4 mm) and a length that may exceed 35 mm. Formation of the tubes took place in a number of situations. A tube usually developed during recovery following termination or disruption of one or more corallites, especially in cerioid coralla (*S. newcombae* and *T. maculatus*) but in one case in *M.* sp. A. It is thought that the larva of a foreign organism developed inside a polyp, or that a more mature individual settled on the coral surface, causing injury or death while upward growth of the surrounding colony formed and maintained a tubular skeletal enclosure around the associate. Less commonly, a tube formed during the contraction of a lacuna in a tollinaform corallum (*M. amicarum*). In a few cases, a tube rises at full size from the bottom of a cerioid corallum (*T. maculatus*). The tubes are of variable length. Some extend to the top of the corallum, whereas others terminate in various ways within the corallum. Gradual expansion of surrounding corallites, resulting in contraction of a tube and its eventual termination, was very common. In a few cases, abrupt termination occurred when one or more corallites expanded into a tube. Sometimes, abrupt termination occurred when a corallite moved entirely into a tube. Commonly, a lateral offset from an adjacent corallite entered a tube and rapidly expanded, transforming it into a new corallite. The biotic associates apparently preferred certain corals, and prompted particular responses from their hosts. Type 1 tubes are predominant in *S. newcombae*; just one has been found in *T. maculatus*. A divergent growth pattern, due to rapid generation of new corallites by lateral increase, occurred around this type of tube. The only example of a Type 2 tube is known in *S. newcombae*. There was a convergent growth pattern, with a reduction in the number of corallites, around this tube. Type 3 tubes are predominant in *T. maculatus* and also occur in *M. amicarum* and *M.* sp. A. Corallites adjacent to these tubes commonly record normal upward growth, but with incidents of corallite decrease or increase.

CORALLITE INCREASE IN A LICHENARIID (TABULATA, ORDOVICIAN, TENNESSEE)

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Lichenaria is a representative of the most primitive stock of tabulate corals. Despite its phylogenetic significance, our understanding of this Ordovician genus is strikingly poor because very little work has been done on it. This study documents and assesses modes of increase in *Lichenaria globularis* Bassler, 1932 from the upper Hermitage Formation (Upper Ordovician, Mohawkian Series, Chatfieldian Stage) of the Nashville Dome, Tennessee, U.S.A.

Corallite increase in *L. globularis* is exclusively lateral, but five types are recognized. Type 1 increase is most common in this species. As is typical for tabulate corals, an offset begins as a protuberance located in a corner of the parent corallite. Within a short vertical distance (0.2 mm), the opening between the protuberance and the parent corallite closes due to the extension and fusion of walls from opposite sides, yielding an offset. Unlike „typical“ tabulates (especially favositids), however, such offsets arise not only from „adult“ corallites but often from „juveniles“ in this species. Type 2 increase is similar to Type 1, but involves the development of two lateral offsets simultaneously on opposite sides of a single parent corallite. This process has not been reported previously in tabulates. In Type 3 increase, the formation of an offset involves two corallites. Development of a protuberance in a corner of the parent corallite is followed by opening of the wall between the protuberance and an adjacent corallite. Dividing walls then form, one after the other or simultaneously, separating the offset from the two corallites. A similar process is recognized in a species of the Ordovician tabulate coral *Manipora.* Type 4 increase is essentially the same as Type 3, but it involves the development of an offset in conjunction with commonly three to rarely five adjacent corallites. This type of increase is comparable with that known in the problematic Ordovician genus *Agetolites*, which possesses characteristics of both tabulate and rugose corals. In Type 5 increase, two offsets begin simultaneously as protuberances in the corners of two facing or adjoining parent corallites. The wall between the protuberances opens, either before or after the development of walls separating the protuberances from their parents. A dividing wall then forms in the fused offset („pseudo-axial increase“), thereby separating the two individuals. This process is observed in some Ordovician tabulates (e.g., *Manipora*). In contrast with its simple morphology, *L. globularis* exhibits an unprecedented range in types of lateral increase. Some of these types are comparable with those in a few other Ordovician tabulate corals, but most are unknown from „typical“ tabulates. The coordinative process during lateral offsetting (reflected by synchronous and apparently cooperative behavior and function among polyps) is one of the characteristic features in *L. globularis*, suggesting a higher level of colony integration than originally expected.

ON CORALS FROM THE MAASTRICHTIAN TYPE AREA (UPPER CRETACEOUS, THE NETHERLANDS): *MICRABACIA* SP. AND A NEW CORAL SPECIES THAT LIVED ON THE ROOTS OF SEAGRASSES

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The corals from the Maastrichtian type area (Limburg, The Netherlands) are not only interesting for their proximity to the K/T-boundary and for their relatively northern occurrence in that time, but also for the interest that pioneer coral researchers in the eighteenth and nineteenth century showed for them. Of most of the corals only casts are preserved. Sometimes silicified specimens and specimens with recrystalized calcite are found. Umbgrove (1925) presented the most complete overview of the fauna and Leloux (1999) presented the local stratigraphical distribution of the 35 most common taxa. This lecture will present some results from the ongoing study.

One of the most common fossil corals in the Santonian to Danian sediments from Limburg, The Netherlands, is *Micrabacia.* In the Upper Campanian sands in the region a large amount of original fossils is found, while in the rest of the stratigraphic column it is present as casts. For the interpretation of these casts a statistical research on measurements of several populations in North West Europe is done. Wells (1933) did recognise evolutionary trends in *Micrabacia* species in America. He measured height, diameter and the relative length of the fifth cycle septum. The same dimensions are measured here and the hypothesis, that all specimens from the Upper Cretaceous and Danian of North West Europe do belong to the same species, is tested.

One of the more peculiar phenomena found in the Upper Maastrichtian is the presence of a probably new taxon which seems to have lived on the roots of sea grasses. Several casts and silicified fossils of these small colonial corals are found.

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COMPARISON OF THE GIVETIAN RUGOSE CORAL *ARGUTASTREA* OF DUSHAN (SOUTH CHINA) AND GRAZ (AUSTRIA)

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The genus *Argutastrea* was established by Crickmay in 1960 with its type species *Argutastrea arguta* Crickmay, 1960. Representatives of *Argutastrea* are known from Europe, Asia, West Australia, North Africa and western North America.

Formerly, many Devonian cerioid corals were attributed to *Hexagonaria* Gürich 1896. Restudies of the neotype of the type species *Hexagonaria hexagonum* (Goldfuss) from Bensberg, Germany (probably upper Givetian or lower Frasnian) resulted in the new view that the bulk of the so-called „*Hexagonaria*" in reality belong to *Argutastrea*.

Hexagonaria Gürich is mainly distinguished from *Argutastrea* Crickmay by its spindle-shaped dilatation of septa with typically carinae.

The genus *Prismatophyllum* Simpson, 1900 differs from *Argutastrea* Crickmay by its thinner septa with yardarm carinae.

We are greatly indebted to the exchange-program between the Chinese Academy of Sciences and the Austrian Academy of Sciences that supported a comparisonal study of cerioid rugosa of the Hochlantsch area north of Graz, Austria and Dushan, southern Guizhou, China in 2000 and in 2002 respectively.

Cerioid corals of the Hochlantsch area were already mentioned by Frech (1888) who determined them as *Cyathophyllum quadrigemminum*. Our recent collecting activities within the Zachenspitz Fm. (middle to upper varcus-zone) yielded individuals which are better preserved than the previous material known from here (Flügel & Schimunek 1961). However taxonomic studies confirmed Flügel & Schimuneks determination as *Argutastrea darwini* (Frech).

In 2002 we studied the Devonian section at eastern and northern suburbs of Dushan County town, southern Guizhou Province, China and collected some species of *Argutastrea* (Middle Devonian, Givetian).

Nearly two decades ago, Liao &. Birenheide (1985) published some species of *Argutastrea* from the Givetian of Dushan, Guizhou Province, South China. They are *Argutastrea dushanensis* Liao and Birenheide, 1985, *A. jiwozhaiensis* Liao and Birenheide, 1985, *A. elegans* (Kong in Kong and Huang), 1978 and *A. endeca* (Kong in Kong and Huang) 1978. Among them, *Argustrea dushanensis* is closely related to *Argutastrea darwini.*

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FOSSIL SPONGES IN THE NATURAL HISTORY MUSEUM, LONDON.

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Since 1753, when the sale of Sir Hans Sloane's Collection to the nation resulted in the foundation of the British Museum (BM), later to become the British Museum (Natural History), many important specimens and manuscripts have been donated to or purchased by what is now The Natural History Museum (NHM). Using specimens, publications and contemporary manuscripts, this poster aims to highlight some historically and taxonomically important specimens added to the fossil sponge collection over the past 250 years, and the lives and work of the early
palaeontologists who described them.

Although some fossil sponges housed in the NHM are from collections first made in the 18th Century, such as those of Thomas Pennant (1726-1798), a zoologist and antiquarian from Flintshire whose collection was donated in 1912, many more are from collections that were either purchased or donated in the 19th Century. These include sponges of historical importance, such as those collected and figured by William Smith (1769-1839, collection purchased 1816 and 1818), who was the first person to use fossils to identify strata in England and to produce a large-scale geological map. Smith's illustrations (1816-1819) include specimens figured by him as *Alcyonites.*

The earliest taxonomically important specimens are those that were figured from the 1820s onwards and which represent the first attempts at understanding the British fossil sponge fauna, especially the rich fauna of the Upper Cretaceous Chalk. Amongst those who contributed to the collection at this time were J. S. Bowerbank and G. A. Mantell. Their work along with that of Joshua Toulmin Smith, G. J. Hinde, H. A. Nicholson and R. G. S. Hudson is will be reviewed.

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CRETACEOUS CORALS AS INDEX FOSSILS ?

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Post-Paleozoic coral genera of the order Scleractinia are known to be long-lived genera. Past monographs refer only to „Jurassic“ or „Early Cretaceous“ when describing the stratigraphic distribution of a genus. A lack of knowledge of the exact stratigraphic extent limits the capacity of coral genera to assist in dating. More exact knowledge on the stratigraphic distribution of coral genera would facilitate dating sediments that contain almost exclusively corals mixed with other organisms such as gastropods or bivalves that serve as poor index fossils (except for rudist bivalves).

To estimate the stratigraphic extent of Cretaceous coral genera, a large computer database of about 5,500 Cretaceous coral specimens (1,500 type specimens) was analysed. All samples were assigned to a genus on the base of the characteristics of the (type of the) type species or traditional understanding (e.g. *Calamophylliopsis, Meandraraea, Stylina, Thamnoseris*). Not all genera could be used since for many the type specimen is lost or is too poorly preserved to allow a clear determination of the genus. Determination of which genera should be included depended on how well the genera were defined. For example, *Microsolena* is much better defined than *Placocoenia*, where the type of the type species is a mould.

All samples were assigned to a locality with more or less exact stratigraphic age. To be as exact as possible, the original stratigraphic data of the localities of the samples have been updated using the more recent literature. Still poorly dated localities (e.g., „Neocomian“, „Senonian“, „Aptian to Albian“) were discarded, as well as localities that are dated solely on the bases of the coral faunas.

The stratigraphic extent of the included genera was calculated on the bases of the samples assigned both to a genus and locality. The literature were used only when the described material was not available, but could be clearly assigned to a genus, and when the publication in question included a well-confined stratigraphy of the locality from where the material was described. Cases in which the stratigraphic extent of a genus reported in the literature clearly exceeded the assessed extent were investigated in detail. The literature was also used to try to reconstruct whether a genus originated in the Jurassic and/or reached into the Tertiary.

A total of 104 (of 610) genera (orders *Scleractinia* and *Coenothecalia*), covering 1,785 (of 3,045) Cretaceous species (sensu Löser 2000, Löser et al. 2002) are included in the analysis. This corresponds only to 17 percent of the Cretaceous genera, but to 68 percent of all indications of these genera in the literature.

The results of this study are clearly limited by the definition of genera; many of them could not be used because both their contemporary and historical nature remains unclear (e.g., *Barysmilia* and *Latomeandra*). The aim of this study is to present a highly concise list of genera, in terms of stratigraphy and taxonomy, rather than a long list of genera that are poorly described and whose inclusion is dubious.

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PALAEOBIOGEOGRAPHIC DISTRIBUTION OF LATE APTIAN TO ALBIAN „NEW WORLD" CORALS

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Today coral distribution is determined by provinces. Caribbean coral species differ from Indian Ocean coral species, and east Australian species differ from Red Sea species. In current times, oceans are arranged in north to south directions and continents form natural barriers. This was not true during the Cretaceous Period, when oceans were arranged in an east-west-direction and corals could disperse freely. Cretaceous corals were more cosmopolite with practically no existence of faunal provinces. Their distribution was likely controlled by other factors such as temperature and salinity.

To gain more insight into factors determining patterns of distribution among coral, coral distribution was observed in a small area through a short time span. The area of investigation - the Bisbee basin (northern Mexico and southern USA) and the Texas platform (USA) - is no larger than the western Mediterranean Sea. The time period investigated spans the Late Aptian to Albian (18 Ma).

The project has been carried out using exclusively samples. Some material was obtained from collections, but for the most part samples were collected anew within the past four years. The literature was not used in this study because the 70 year-old descriptions of Cretaceous corals from Texas are in need of revision and the coral record of the Bisbee Basin is not thoroughly described.

A total of 81 species were used for the analysis. Some dubious and/or rare genera were excluded. The material was analysed using methods of numerical taxonomy. The faunas were first compared interspecifically by correlating and clustering. Both complexes - Late Aptian / Early Albian corals from the Bisbee Basin and Albian corals from the Texas platform - were compared to 300 other palaeogeographic units. Correlation and clustering was carried out as well with these data.

The generic diversity for both complexes is high. The faunas are mainly composed of colonial corals of the genera *Actinastrea, Adelocoenia, Astraeofungia, Aulastraeopora, Eugyra, Felixigyra, Mesomorpha, Microsolena, Preverastraea and Thamnoseris.* The genera *Amphiastrea, Axosmilia, Brachyseris, Cladophyllia, Columactinastraea, Columnocoenia, Confusaforma, Heterocoenia, Latusastrea, Meandraraea, Pentacoenia, Polyphylloseris, Polytremacis, Pseudomyriophyllia, Pseudopistophyllum, Stylina, Thecosmilia, Tiarasmilia* are rarer.

The number of species at each of the 32 sample locations in the area of investigation area is moderate to low (with the maximum number of 18 species in a Northern Mexico fauna). The faunas differ in their composition. This difference can be explained neither by geographic distances, nor by slightly differing stratigraphy, but is explained by differing facies. It appears that the influence of local conditions was important as well.

A stratigraphic similarity between the faunas considered in this investigation and other faunas throughout the world is demonstrated: both complexes correlate with Late Aptian Tethyan faunas of the southern Pyrenees and North Africa.

PALAEOENVIRONMENTAL SIGNIFICANCE OF STROMATOPOROID SHAPES IN THE DEVONIAN OF THE HOLY CROSS MOUNTAINS, POLAND

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Stromatoporoid shapes and taphonomic attributes are widely considered to be valuable palaeoenvironmental indicators. Most of stromatoporoid external features are unrelated to taxonomy, which is based on the internal microstructure (pillae and laminae arrangement). KERSHAW & RIDING (1978) have introduced a parameterization method of stromatoporoid shapes, improved later by KERSHAW (1984), allowing a quantitative morphometric approach. This method has been applied for the Upper Devonian of the Holy Cross Mountains in Central Poland.

Stromatoporoids were measured in three localities: Karwów, Kadzielnia and Sitkówka-Kowala quarries (ŁUCZYŃSKI 1998). Quantitative analysis of the measurements demonstrated several differences interpreted in terms of ecological variations between the localities. The stromatoporoid assemblages from Karwów and Kadzielnia point to an environment with periodically accelerating deposition and water turbulence, whereas stromatoporoids from Sitkówka-Kowala indicate a calm setting with low deposition rate. The similarity of stromatoporoid assemblages from Karwów and Kadzielnia confirmed that dolomites exposed in the Karwów quarry represent the Kadzielnia-type reef mound deposits.

The Upper Devonian stromatoporoid- and coral-bearing limestones quarried in Bolechowice-Panek, located very close to Sitkówka Kowala in the Holy Cross Mountains, are widely used in Poland as decorative stones. The slabs exposed inside numerous public buildings in Warsaw provide an opportunity to observe a great number of vertical cross-cuts through stromatoporoids, allowing focusing on various biological and environmental factors that might influence stromatoporoid morphometric features (ŁUCZYŃSKI 2003). The stromatoporoid shape appeared to be strongly dependent on its size – the V/B ratio decreases along with increasing B. The relation can be well matched by a curve described by a formula: $f(x) = 5.7103x^{0.81633}$. The size of the measured specimens must be therefore taken into account in those studies of the stromatoporoid morphology, where it is concerned a palaeoenvironmental indicator. The stromatoporoids adopted several types of initial surfaces, corresponding to various growth strategies in the first phase of their growth in response to various environmental conditions, such as substrate consistency and sedimentation rate. Arrangement of latilaminae – internal growth-bands – well records the stromatoporoid growth history and therefore its studies are crucial in environmental interpretations, as the conclusions inferred from the shape alone might be very misleading.

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SILURIAN AND DEVONIAN TABULATE CORALS COMMUNITIES IN THE SUBPOLAR URALS.

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On the western slope of North Urals 90 species (representing 25 genera) of Tabulate corals have been identified in the strata of the Silurian and Lower Devonian age. Comparative analyses of taxanomical composition and distribution of faunas, and distribution of facies, resulted in recognition of several ecological association of Tabulate corals in the region.

Přidoli. 15 species (5 genera) recognized belong to *Favosites pseudoforbesi* Assemblage characteristic of which is the dominance of *Favosites*. At some levels colonies of *Favosites* (diameter up to 20-30 cm) together with several syringoporids and squameofavositoids form biomorphic beds up to 1.5 m thick.

Characteristic of the Lochkovian strata in the Subpolar Urals is the *Thamnopora faceta* Assemblage dominated by the nominal taxon. At some levels, *T. faceta* together with *Striatopora tshichatschevi* form „coral meadows". In general, Lochkovian assemblages are dominated by cylindric and branchy colonies characteristic of shallow-water environment.

Pragian. Extensive regression in this time resulted in almost complete disappearance of Tabulate corals in the region.

Emsian. Following the Emsian transgression, Tabulate corals reappear in the studied region. In the Late Emsian, the *Favosites goldfussi* Assemblage (includes 22 species of *Favosites*, *Pachyfavosites*, *Alveolites*, *Caliapora*, *Gracilopora* and *Syringopora*) was established in the Subpolar and Polar Ural region (sections on Bet'yu, Shchugor and Lek-Elets rivers).

Eifelian. In this time, considerable changes in the composition of Tabulate coral faunas occurred: *Favosites* and *Squamefavosites* disappeared; *Alveolites*, *Crassialveolites*, *Syringopora* and chaetetidae started to dominate. In the Syv'yu River region, the Eifelian strata are characterized by the *Alveolites maillieuxi* Assemblage which, together with cosmopolitan taxa, includes several endemic syringoporoids.

Givetian. In this time, the composition of the Tabulate coral faunas in the modern North Ural region changed almost completely. *Pachyfavositids* disappeared, thick-walled alveolitids started to dominate.

Summarising the data above it is evident that different stratigraphical intervals in the Silurian-Devonian sequence in the North Ural region are characterized by different assemblages of Tabulate corals. Particularly distinct changes in the Tabulate corals succession occurred at the Silurian-Devonian boundary. Although *Favosites* and *Parastriatopora*, both characteristic of the upper Silurian, occur also in Devonian the Silurian and Devonian faunas of these genera differ completely. Most characteristic of the Devonian taxa is that the corners of their corallites possess thicker walls than in Silurian.

In general, during the Early Devonian the assemblages of the Tabulate coral genera almost did not changed. At the end of the Early Devonian time *Favosites* and *Parastriatopora* disappeared, and *Squameofavosites* and *Pachyfavosites* became rare. At this time, the most common genera were *Thamnopora* and *Syringopora*. At the Early and Middle Devonian boundary the composition of the Tabulate corals changed almost completely. In the Middle Devonia time, thick-walled alveolitids became to dominate.

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SEDIMENTOLOGY OF HOLOCENE WARM TEMPERATE LIMESTONE AT MUROTO-MISAKI, SHIKOKU JAPAN

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Muroto-misaki (Cape Muroto) is a southern tip of the eastern half of Shikoku, southwestern Japan. The Nankai Trough, where the Philippine Sea Plate subducts beneath the Eurasian Plate, is located about 100 km to the southeast of this cape. Muroto-misaki and its environs have been seismically uplifted.

Sedimentological study was conducted on Holocene limestone that occurs along the coast from Muroto-misaki to Meoto-iwa located about 13 km to the north of the cape. Distribution of the limestone is limited to < 10 m in elevation. The limestone is up to 4.4 meter in mean diameter and less than 0.5 m in thickness, and consists mainly of fossilized sessile organisms such as annelids, bryozoans, corals, encrusting foraminifera, and coralline algae. Associated components include barnacles, ostracods, molluscs, echinoids, benthic foraminifera, peyssonneliacean algae, and non-calcareous clasts and grains. Cement is a minor component and found in a semi-closed space between coralline algal crusts and their substrates.

Modal composition of limestone was determined by a point counting technique. The results show that the limestone can be classified into 6 types on the basis of predominant fossilized sessile organisms. The dominant components are: corals and coralline algae in Type I; coralline algae in Type II; coralline algae, annelids and barnacles in Type III; coralline algae and annelids in Type IV; encrusting foraminifera and encrusting bryozoans in Type V; and molluscs in Type VI. Comparison of vertical distribution of the six types with those of modern sessile organisms indicates the highest elevation of Type I at a particular outcrop corresponds to mean low sea level (MLSL) when the limestone formed. Therefore the Holocene limestone is considered ideal for the analysis of relative sea-level changes. Based on the distribution of Type I limestone, we find that the elevation of paleo-MLSL decreases northwards at a rate of 10 cm/km.

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USING FRACTALS TO CHARACTERIZE THE INTERSPECIFIC VARIABILITY OF CORALS

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Introducing the notion of „fractals" by Mandelbrot (1967) was a major revolution in several branches of science such as physics (see Kaye 1989; Gouyet 1992), medicine (see Nonnenmacher 1994), microbiology (see Smith et al. 1989) and botany (to characterize leaf shape, see Vlcek and Cheung 1986). Fractal growth phenomena enable one to simulate and to explain a complex behavior such as biological growth in corals, sponges, seaweeds (e.g., Kaandorp and Sloot 2001), stromatolites (Verrecchia 1996) and plants (see Prusinkiewicz et al. 1996).

This study proposes a new method for the morphometrics, which describes and characterizes the calicular and septal morphologies of five Recent scleractinian species (*Eusmilia fastigiata, Dichocoenia stokesi, Montastraea annularis, Montastraea faveolata* and *Montastraea franksi*) and one Jurassic species (*Aplosmilia spinosa*) using only the two parameters introduced by Kaye (1989): (1) the structural fractal dimension (δs) characterizing the overall structure of the corallite and (2) the textural fractal dimension (δt) describing the texture or fine details at the septal level. In this study, the Counting-Box Method was used. It works by laying a net of various mesh (box) sizes r over the image object, then evaluating the number of boxes N, which are needed to cover completely the fractal (the image object). Repeating the measurement with different sizes of boxes, forming the net will result in a logarithmical function of the box size (log r on the x-axis) against the number of black and white boxes needed to cover the object (log N_{BW} on the y-axis). The plotting of the data on log-log scales known as a Richardson Plot yields two fractal slopes, that may be identified by an equation ($\log N(r) = \delta(\log(1/ r)) + \log k$) and by a maximal coefficient of determination r-squared. Both slope coefficients correspond to the fractal dimensions δs and δt.

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SUSPENSION-FEEDERS COMMUNITIES (SPHINCTOZOAN/SERPULID) AND AUTOMICRITES INDICATIVE OF A STRESSED ENVIRONMENT IN A NORIAN CARBONATE PLATFORM FROM NORTHERN CALABRIA (ITALY)

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The Norian-Rhaetian of the Western Tethys was dominated by widely-distributed shallow water carbonate platforms (Dolomia Principale/Hauptdolomit; Dachstein Kalk, etc.) flanking open marine basins and dissected by intra-platform troughs. These intraplatform basins were often characterized by stressed environmental conditions with dysoxic to anoxic water. The biota were very poor and characterized by microbial-serpulid mounds scattered on the slope and the outer margin of the platforms (Zamparelli et al., 1999; Flügel, 2002; Perri et al., 2003).

The studied case-history is represented by a highly-relief prograding carbonate platform, Early-Middle Norian in age, with margin and lagoon settings laterally grading into slope-basin sediments. The whole carbonate body is completely dolomitized; nevertheless, the morphology and microarchitecture of carbonate components (cements, grains and automicrite) is still clearly recognizable.

The inner platform facies association is characterized by automicrites (mainly cauliflower-columnar stromatolites) associated with detrital carbonate (intraclastic breccia, bioclastic grainstone and packstone). Skeletal metazoans (megalodontids, other bivalves, and gastropods) are rare; foraminifers, dasycladacean algae (e.g. *Gryphoporella curvata*), and subordinately porostromata also occur.

The margin facies association is dominated by automicrites (planar to low-relief stromatolites) associated with thrombolitic-fenestral boundstone. Metazoans are practically absent while a relatively rich assemblage of solenoporacean algae and porostromata flourish. Allochthonous dasycladacean thalli also occur as closely packed grainstone.

The slope facies association includes detrital carbonates (breccia/megabreccia) and automicrites (planar stromatolites and thrombolitic boundstones) mainly associated with sphinctozoan bioconstructions. Sponge patch-reefs, plurimetric in size, are larger and absolutely dominant in respect to serpulid mounds. As a rule individual bioconstructions are due to a single group of framebuilders. Sphinctozoan associations are oligotypic. Sponge skeletons are segmented and asiphonate, and many specimens can be tentatively referred to genus *Deningeria*. The low-diversity fossil association seems to indicate a stressed marine environments, probably corresponding to a restricted intraplatform dysoxic basin.

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LOWER DEVONIAN STROMATOPOROIDS IN THE SIERRA MORENA (SOUTHERN SPAIN)

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With regard to the evolution of stromatoporoids the Lower Devonian is one of the least well-known periods. In this period, between the Silurian reefs and the huge Givetian-Frasnian reefs, stromatoporoids and reefs are rather scarce. Consequently regarding Lower Devonian stromatoporoids we have two important questions:

1. Why did the Lower Devonian stromatoporoids build only very few reefs?
2. Where did the stromatoporoids of the Eastern Americas Realm reside during the Pragian stage? Stock (1994, p. 26) assumed that the Eastern Americas stromatoporoids survived in an unknown refuge in Bohemia, France, or Spain.

A detailed investigation of the Lower Devonian stromatoporoids of Bohemia by May (1999, 2002) proved, that the Prague basin could not have been the refuge postulated. On the other hand, the Sierra Morena in Southern Spain was known to contain Lower Devonian reef limestones. These stromatoporoids of the Sierra Morena however have never been investigated.

Consequently, Prof. Dr. Sergio Rodríguez (Madrid) and the author started a research project on Lower Devonian stromatoporoids of the Sierra Morena. The following represents the preliminary results.

Up to now the stromatoporoid fauna of two locations „Peñón Cortado" and „Guadámez II" in the Peñón Cortado Limestone have been investigated. It is assumed that the Peñón Cortado Limestone is of Upper Emsian age.

At location „Guadámez II" there occur *Actinostroma compactum* Ripper 1933, *Schistodictyon* n. sp. aff. *amygdaloides* (Lecompte 1951), *Clathrocoilona (Clathrocoilona)* sp., *Stromatopora polaris* (Stearn 1983), *Pseudotrupetostroma* n. sp., and *Parallelostroma sinense* Yang & Dong 1979. At „Peñón Cortado" I found only *Plectostroma salairicum* (Yavorsky 1930) and *Syringostromella zintchenkovi* (Khalfina 1960). Both fauna strongly suggest an Emsian age for the limestone.

Remarkable is the lack of branched stromatoporoids and the scarcity of encrusting stromatoporoids. It is thought that these circumstances contributed to the scarcity of reefs.

Biogeography: *Actinostroma compactum* has up to now only been found in Australia and *Parallelostroma sinense* only in China. The stromatoporoids collected hitherto in the Sierra Morena bear a strong relationship to the Emsian fauna of Victoria (Australia) and Arctic Canada, but no relation to the Eastern Americas Realm. However, further investigations are needed to confirm these results.

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FRASNIAN (UPPER DEVONIAN) RUGOSE CORAL BIOSTRATIGRAPHY IN WESTERN CANADA

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Eleven rugose coral faunal assemblages are currently recognized in the Frasnian of the Western Canada Sedimentary Basin, based on overlapping ranges of species with wide geographic distribution, but relatively short stratigraphic duration. While rugose corals are rare in this region in the early Frasnian, they increase in diversity and abundance to reach a peak in the late Frasnian, before the major extinction event near the Frasnian-Famennian boundary. They are developed best on shallow, open-marine carbonate shelves, as well as on the flanks of some of the reefal buildups. Diversity and abundance decrease in the interior of the reef complexes, and particularly in deeper water, more muddy, basinal strata. Integration of the coral faunal sequence with a succession of thirteen conodont zones (based on the zonation first developed in the Montagne Noire, France) has allowed for more precise biostratigraphic control, and provides a basis for refined correlation of the sequences of reef and basin fill.

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RHAETIAN CORALS OF CENTRAL ASIA (AFGHANISTAN, IRAN, TAJIKISTAN)

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Rhaetian corals of Afghanistan are known in the western part of the Middle Afghanistan in the ridge system of Kokhe Safed and Kokhe Pud, in the structural - -facial zone of Khaftkala. They are timed to the homonymous formation of Khaftkala whose cuts are located at the absolute elevation of 3,000 m. above sea level. Complexes of the reef-building corals, forming bands and lenses of the „biostrom" type with the capacity of 1-2 meters and the extent of 5-10 meters among sandstone and aleurolites at the total formation capacity of 100 meters, are represented by the following genera: *Afghanastraea*, *Astraeomorpha*, *Chondrocoenia*, *Distichophyllia*, *Pamiroseris*, *Retiophyllia*.

Rhaetian corals have been found in the east of Central Iran in three structural-environmental zones located along the Neiband Fault: Lut (in the east), Neiband and Darband (in the west). Profiles with the remnants of corals are known at the coal deposits of Ab-Bane, Shurabe-Naghi, Kadir, Neiband, Parvade. They are situated at the absolute elevation of 800-1,200 meters and up to 2,000 meters in the area of the Darband Mountain. Complexes of reef-building corals, forming the organogenic structures of the „bioherm" and „biostrom" types with the capacity of 1-3 m and up to 10 m. among the sand-stone, aleurolites and coal bands, are located in the House-Han and Kadir formations and are represented by the following genera: *Astraeomorpha*, *Chondrocoenia*, *Cuifastraea*, *Cuifia*, *Distichomeandra*, *Margarosmilia*, *Monstroseris*, *Pamirophyllum*, *Pamiroseris*, *Protostylophyllum*, *Retiophyllia*.

Rhaetian corals of Tajikistan are known in the South-Eastern Pamir in the profiles located at the absolute elevation above 4,200-4,700 meters. In the Axial and Transitional structural-facial zones, they formed a reef cover – Chichkautec formation with the capacity of 150 meters which fully covers the territory of both zones. Besides, in two subzones of the Axial zone – Bortepa and Djilgakochusu, rhaetian corals, timed to both bands, built among sandstone, aleurolites and argillites „bioherms" and „biostroms" with the capacity of 1.5-4 meters and the extent of 10-15 meters. In general, complexes of rhaetian corals of the Pamir are represented by the following genera: *Astraeomorpha*, *Chevalieria*, *Chondrocoenia*, *Crassistella*, *Cuifastraea*, *Cuifia*, *Curtoseries*, *Distichophyllia*, *Gillastraea*, *Margarosmilia*, *Morycastraea*, *Palaeastraea*, *Pamiroseris*, *Pamirophyllum*, *Pamirastraea*, *Paracuifia*, *Paradistichophyllum*, *Parastaromorpha*, *Procyclolites*, *Protostyphyllum*, *Retiophyllia*, *Stylophyllopsis*, *Thamnasteria*. With the exclusion of Central Asian endemics – Afghanastraea, Chevalieria, Cuifia, Curtosaries, Gillastraea, Monstroseris, Morycastraea, *Pamirastraea*, *Paracuifia*, *Paradistichophyllia*, *Thamnasteria*, all other rhaetian genera are cosmopolitans widely spread in the limits of the whole Tethys Ocean.

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STROMATOPOROIDS FROM THE LATEST REEFAL EPISODE IN THE DEVONIAN (LATE FRASNIAN) OF THE CANTABRIAN MOUNTAINS (NW SPAIN)

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In the Palaeozoic series of the Cantabrian Mountains, reefal carbonates occur first in the Devonian of the Asturian-Leonese Domain. In this period seven reefal episodes of different importance, starting from the Lower Devonian (Pragian) to the Upper Devonian (late Frasnian), were developed. The most widespread reef facies occurred at the end of the Lower Devonian (upper Emsian) and Middle Devonian (Givetian) although some reefal episodes of minor importance took place at slightly older and younger stratigraphic levels (Méndez-Bedia *et al.*, 1994). Stromatoporoids, tabulate and rugose corals were the most prominent members of the reef community.

This work focuses on the latest reefal phase which took place during the Upper Devonian (late Frasnian) within the Crémenes Limestone of the Nocedo Formation (upper Givetian-Frasnian, southern slope of the Cantabrian Mountains). Studies of the distribution of stromatoporoids in upper Frasnian rocks (Stearn, 1987; Mistiaen, 2002; among others) indicate that the diversity of the group had declined by this time. The purpose of this work is to give an example of the low diversity of stromatoporoids occurring in reefal deposits close to the Franian/Famennian boundary. Moreover, some systematic remarks and outstanding features concerning the growth morphology of the stromatoporoids from these reefal deposits are made. The large majority of species collected from the Crémenes Limestone belongs to the genera *Stictostroma* (*S. saginatum, S.* sp.), *Clathocoilona* (*C. spissa*, *C.* cf. *inconstans* and *C.* sp.) and *Stachyodes (S. australe)*. Most stromatoporoids have laminar growth forms, in some cases showing well-developed mamelons. This type of morphology is believed to be a response to environmental conditions. Stromatoporoids are associated with other reef-building organisms such as tabulate and rugose corals. Numerous encrusting and boring organisms (bryozoans, worms and algae) used hard substrates provided by stromatoporoid upper and lower surfaces. In comparison with other reefal deposits of the same age in different areas the stromatoporoid fauna recorded in the late Frasnian reefs of the Cantabrian Zone clearly shows a cosmopolitan distribution.

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SILURIAN TABULATOIDEA AND HELIOLITOIDEA OF MONGOLIA

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12 localities of Silurian corals (Tabulatoidea and Heliolitiodea) were discovered and studied in Mongolia. B.B. Chemyshev (1937) first described Silurian corals from western Mongolia. After his description many other localities and sections of Silurian corals were discovered (Geology of MPR, 1973.v.l). O.B. Bondarenko and L.M. Ulitina (1976) published an article on Mongolian Paleozoic coral taxonomy, including 28 species and 10 genera of Tabulatoidea and 13 species and 9 genera of Heliolitoidea of the Silurian. T .T. Sharkova (1981) was the first to publish a monograph on Silurian and Devonian Tabulatoidea of Mongolia and described herein 22 Silurian species belonging to 10 genera from 5 localities of Mongolia. O.B..Bondarenko (1986) first described Silurian heliolitoidea from Mongolia. Starting in 1974 Ch. Minjin had continued collecting and studying Ordovician and Silurian Tabulatoidea and Heliolitoidea. This abstract summerizes research work on Silurian Tabulatoidea and Heliolitoidea of Monogolia.

Silurian Tabulatoidea in Mongolia are divided into 3 orders, 17 families, 23 genera and 151 species; Heliolitoidea are divided into 4 orders, 9 families, 25 genera and more than 35 species. Within Tabulatoidea the genus *Favosites* (40 species), *Paleofavosites* (28), *Mesofavosites* (21), *Syringopora* (12), *Halysites* (13), *Catenipora* (8), *Multisolenia* (6) have many species, contrary *Squameofavosites* (2), *Axiolites* (3), and *Hexisma* (2) are known by only a few numbers of species. *Taxopora*, *Striatopora*, *Riphaeolites*, *Barrondolites*, *Tuvaelites*, *Thecia*, *Agnopora*, *Syringoporinus*, *Shedohalysites* and *Syringolites* are only known by one species.

Heliolitoidea represented by order Coccoseridida-3 genus (*Sytovaelites*, *Eumiklites* and *Luvsanilites*); order Propora-1 genus (*Helenolites*), order Khangailitida-9 genus (*Mcleodea*, *Hemiplasma*, *Helioplasmolites*, *Barunolites*, *Minzhinites*, *Rozmanites*, *Farabites*, *Squameolites* and *Diploepora*); order Heliolitida-11 genus (*Cryptolites*, *Cromyolites*, *Paraheliolites*, *Lidaelites*, *Cosmolithus*, *Stelliporella*, *Podolites*, *Heliolites* s.l. *Bogimbailites*, *Sibiriolites* and *Pseudoplasmopora*).

These corals reached their greatest diversity during late Llandoverian to Wenlokian age. Tabulatoidea are predominated by cosmopolitan genera and species and contrary to it, within Heliolitoidea many new genera and species are possibly endemic for this region.

The oldest known Silurian Tabulatoidea in Mongolia are early-middle Llandoverian in age, while Heliolitoidea are known from the late Llandoverian. Both taxa were distributed throughout Wenlockian, Ludlovian and Pridolian ages.

The Tabulatoidea are biostratigraphically divided into 6 Assemblage Zones. They are listed below:

1. Assemblage Zone: *Paleofavosites alveolaeris-Mesofavosites teximurinus* (early-middle Llandoverian) includes 6 genera: *Paleofavosites* (15 species), *Favosites* (7), *Mesofavosites* (6), *Subalveolites* (2) and *Catenipora* (2)
2. Assemblage Zone *Multisolenia tortousa-Catenipora exilis* (late Llandloverian) consists of 11 genera: *Favosites* (11 genus), *Mesofavosites* (11), *Paleofavosites* (10), *Multisolenia* (4), *Halysites* (6), *Catenipora* (4), *Angopora* (2), *Subalveolites* (3), *Syringopora* (2), *Syringoporinus* (1) and *Thecia* (1).
3. Assemblage Zone: *Mesofavosites diramptus-Hexisma mongolica* (early Wenlocian) is represented by 11 genera: *Favosites* (10 species), *Mesofavosites* (13), *Paleofavosites* (9),

Halysites (7), *Syringopora* (5), *Hexisma* (2), *Multisolenia* (2), *Taxopora* (1), *Thecia* (1) and *Tuvaelites* (1).

4. Assemblage Zone: *Paleofavosites asper-Syringopora gorskyi* (Late Wenlockian) is characterized by 11 genera: *Favosites* (13 species), *Syringopora* (8), *Halysites* (8), *Paleofavosites* (4), *Mesofavosites* (5), *Multisolena* (1), *Tuvealites* (1), *Barrandeolites* (1), *Subalveolites* (1), *Thecia* (1) and *Metafavosites* gen. nom. nud.
5. Assemblage Zone: *Favosites rectus* (Ludlovian) including 4 genera: *Favosites* (5 species), *Syringopora* (4), *Halysites* (2), *Taxopora* (1).
6. Assemblage Zone *Favosites multiferporata-F.muratsiensis* (Pridolian), is composed of 7 genera: *Favosites* (13 species), *Axiolites* (2), *Squameofavosites* (2), *Adaverina* (2), *Rephaeolites* (1), *Striatopora* (1) and *Syringopora* (2).

For Heliolitoidea 6 coral assemblages have been established:

1. Late Llandoverian Assemblage with more than 5 species and 5 genera: *Pseudoplasmopora*, *Rozmanites*, *Minzhinites*, *Hemiplasmopora* and *Mcleodea*.
2. Early Wenlockian Assemblage: consists of 14 species and 9 genera such as *Diploepora*, *Helioplasmolites*, *Stellipora*, *Cromyolites*, *Cryptolites*, *Cosmolithus*, *Paraheliolites*, *Helenolites* and *Farabites*.
3. Late Wenlockian Assemblage: composed by 13 species and 10 genera: *Stelliporella*, *Sytovaelites*, *Diplopota*, *Cromyolites*, *Pseudoplasmopora*, *Podollites*, *Farabites*, *Helenolites*, *Paraheliolites* and probably *Helioplasmolites*.
4. Early Ludlovian Assemblage:characterized by 6 species and 6 genera: *Lidaelites*, *Luvsanites*, *Paraheliolites*, *Cromyolites*, *Eumiklites*, Heliolitidea gen indet.
5. Ludlovian-Predolian Assemblage: includes 4 species and 3 genus: *Siberiolites*, *Barunolites* and Heliolitoidea gen.indet.
6. Pridolian Assemblage: consists 6 species and 4 genera: *Bogimbailites*? *Squameolites*, *Heliolites* s.l. and Heliolitoidea gen indet.

The majority of Mongolian occurences are known from the southern part of the country in a carbonate facies forming bioherms and reef buildings during upper Llandoverian to Wenlockian. In this region Ludlowian to Pridolian Tabulatoidea and Heliolitoidea occur in open shelf carbonate facies. In west Mongolia these corals were collected from limestone lenses and beds within terrigenic sediments. The first Silurian corals, such as Tabulatoidea probably appeared in the early-middle Llandoverian. Heliolitoidea are known from the Llandoverian. Mongolian Tabulatoidea and Heliolitoidea reached their maximum diversity and distribution during the time span of upper Llandloverian through Wenlockian to lower Ludlowian. In upper Ludlowian-Pridolian times the diversity of these corals was moderate. From the period of global regression at the Ordovician-Silurian boundary corals are not known or very rare in Mongolia. During the Silurian period the territory of Mongolia was located in a tropic and subtropic belt on the northern hemisphere. Systematical composition of Tabulatoidea and Heliolitoidea suggests that these taxa are more similar to the coral assemblages known from Altai, Tuva and Kazakhstan regions.

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AN EMSIAN STROMATOPOROID FROM THE ST-JOSEPH FORMATION, VIREUX, SOUTHERN MARGIN OF THE DINANT SYNCLINORIUM

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During a field trip in May 2003, a stromatoporoid sample was found on the left side of the Viroin River, near Vireux-Molhain city (Ardennes, France). The outcrop corresponds to the first beds of the St Joseph Formation (equivalent to the lower part of the „Assise de Bure", an old denomination, previously considered as the lowest part of Middle Devonian. This level corresponds to the beginning of the carbonate sedimentation in Ardennes. Since 1982, by Sub-commission Devonian Stratigraphy (SDS) decision, the base of the Middle Devonian corresponds to the entry of *partitus*, and the St Joseph Formation is Upper Emsian in age and corresponds to the lower part of the *patulus* Zone.

Lecompte (1951-52) didn't cite any stromatoporoid in this level but a lot (22 species) above, in the „*Assise de Couvin*" (Upper *Couvinian* = Lower Eifelian).

Later, Bultynck (1970) cited some stromatoporoids in the middle and upper part of the «*Assise de Bure*» (= Eau Noire Formation) but none in the lower part (= St Joseph Formation).

By another way, according to Bultynck *et al.*, 1991, the first Middle Devonian stromatoporoids are present in the lower part of the Couvin Formation, Lower Eifelian in age. So, the specimen here described, is apparently the oldest Devonian stromatoporoid currently reported from the Ardennes.

The stromatoporoid, with well-developed ring-pillars, typically corresponds to the genus *Stromatoporella.*

The sample corresponds to a 10 cm long, 8 large and 6 high nodule. It is broken, and we can see the stromatoporoid overlying a brachiopod shell: *Paraspirifer* sp. The stromatoporoid covers the whole brachiopod. In one place (the probable bottom?) it is only 0.6 cm thick, but in other places the thickness is generally 2 cm to 3.2 cm in the place opposite to the bottom. In the upper part of the nodule, some interlaminar spaces are pyritized, and, locally several of them form a 2.8 cm large and 0.8 cm high lenticular structure. Few external features are observable, just a weathered surface with thin meshed structure and some sectioned laminae.

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REMARKS ON MIDDLE TRIASSIC (ANISIAN) SCLERACTINIAN CORALS FROM THE NORTHERN PERI-TETHYAN REALM (CRACOW-SILESIAN REGION, POLAND)

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The occurrence of the oldest Middle Triassic scleractinian corals has been noted only in several locations, in the westernmost part of the Tethys Ocean and its northern, peripheral zone (Peri-Tethys, Central Europe) as well as in the eastern Tethyan branch from China. The oldest, stratigraphically well-documented scleractinian corals, occurring in situ, in shallow-water carbonate rocks are those from southern Poland, from the Muschelkalk of the Cracow-Silesian region (Morycowa, 1988, here the early literature; Bodzioch, 1997; Szulc, 2000). The age of the rocks in which these corals developed, assessed on the basis of conodonts, corresponds to Anisian, namely to the interval from Middle Pelsonian to Early Illyrian. Although the Peri-Tethyan (Germany, Poland), coral faunas are poor in specimens and species (about 20 species) and played a subordinate role as components of the sponge-crinoidal-coral biohermal structures, the recognition and knowledge of the oldest, skeletal Scleractinia is of great importance.

Anisian scleractinian skeletons deriving from the Peri-Tethyan, like these from the West Tethyan province, are poorly preserved, strongly recrystallized. That is why their microstructure and microarchitecture are still insufficiently known. Frequent morphological homeomorphy of coralla may lead to incorrect taxonomic identifications, and thus to erroneous conclusions concerning the comparison of these faunas to coeval and slightly younger ones from particular provinces of the Tethys and Peri-Tethys. The exceptionally well-preserved Anisian coral fauna from East Tethyan - Southern China, may, after more detailed elaboration, provide valuable information on their taxonomy, skeletal microarchitecture and palaeographic relations with faunas from West Tethyan and Peri-Tethyan (European) provinces.

One of the important Anisian coral species is *Pamiroseris silesiaca* (Beyrich) (=former *Thamnastraea Silesiaca* Beyrich), frequently occurring and widely distributed in the Peri-Tethyan subprovince (Germany, Poland), and found also in the Tethyan provinces in Southern China. West Alpine species *Thamnastraea Bolognae* Schauroth after Eck and Weissermel should perhaps also be placed in the synonymy of *Th. silesiaca.* It seems very likely that, due to free communication between the Tethys and Peri-Tethys during Anisian time, palaeogegraphic distribution of this taxon was quite wide. However, a re-examination of specimens assigned to *P. silesiaca* is needed to verify whether all of them really belong to this species, as, unfortunately, some of them are not yet satisfactorily documented. As a contribution to research on Anisian Scleractinia the authors present the relatively well-preserved skeletal microarchitecture and microstructure of some Muschelkalk taxa, i.a. *Pamiroseris silesiaca.*

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A SMALL TABULATE CORAL ASSEMBLAGE FROM THE WENLOCK OF SAAREMAA, (ESTONIA)

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Sixty-six specimens of six tabulate coral species from the shore locality „Liiva pank" on Saaremaa Island were studied in their environmental context. The corals occur in a bioherm and also in muddy layers within skeletal limestone of Jaani age, Wenlock. The dominating species is *Heliolites interstinctus,* which shows considerable intraspecific variation. The variation of *Propora tubulata* and *Halysites senior* in this locality is illustrated. *Paleofavosites* sp. A, represented by six specimens only, shows a high variation of characters, which may be caused by their different life positions in the bottom of sediment.

Rapid short-time influxes of mud interrupted the growth of coralla. Damages by boring organisms are quite often in heliolitids. Most coralla in bioherm are grown on stromatoporoids. Domal and tabular forms of coralla are dominating over bulbous ones. The environment was favourable for heliolitids which grew more rapidly than favositids and for halysitids known as mud-tolerant tabulate corals (Young and Elias 1997; Stel 1978).

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FACTORS CONTROLLING BOUNDSTONE DEPOSITION IN LATE PERMIAN CALCISPONGE REEFS IN THE SHITOUZAI SECTION, ZIYUN COUNTY, GUIZHOU PROVINCE, CHINA

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Organic reefs with calcareous sponges as main constituents were characteristic of the tropics during Middle and Late Permian time. These reefs were restricted in the Late Permian to regions such as South China. Detailed examination of constructors has been completed in the Middle Permian Capitan Reef (see Saller et al. eds., 1999 for references), but only a few such works and reports of microbial contribution in boundstones are known from Late Permian reefs. Late Permian calcisponge reefs are well develped at Shitouzai, Guizhou Province, China. Here, boundstones usually include both bindstones and framestones, the latter both as botryoidal cement-filled framestones and isopachous cement-filled framestones.

Bindstones are characterized by '*Archaeolithoporella*' forming dense crusts on calcisponges and bryozoans to make rigid frameworks. Micritic caps, consisting of peloids, filamentous microbes and dense micrites, are locally developed on skeletal organisms before the heavy coating of '*Archaeolithoporella*'. Matrix comprises lime muds and peloids that occasionally are laminated and include filamentous microbes. Remaining open spaces were filled by mosaic and isopachous cements which in part grade into '*Archaeolithoporella*'. In botryoidal cement-filled framestone, large cylindrical calcisponges themselves commonly construct framework, producing irregular cryptic spaces to various degrees. '*Archaeolithoporella*' also encrusts skeletal organisms, though thinly so here compared with bindstones. Fan-shaped, originally aragonite botryoidal cements are most characteristic within intraframework spaces, along with subordinate isopachous and infilling calcitic cements. '*Archaeolithoporella*' is sharply bounded with botryoidal cement. Matrix is composed of lime muds with faint lamination-forming peloids. Elsewhere, isopachous cement-filled framestone show irregular and thin cylindrical calcisponges and bryozoans, which are intermingled in a complex manner to form three-dimensional frameworks. These skeletal organisms are encrusted by thick micritic caps that include laminated peloids, and are further surrounded by '*Archaeolithoporella*'. '*Archaeolithoporella*' grades into isopachous cement layers where characteristic peloids with diffuse margins are frequent. Matrix here consists of bioclasts, lime muds, and peloids including filamentous microbes in interstices, whereas cements comprise only isopachous and infilling mosaic calcite.

The characteristics of boundstones are primarily determined by the nature of skeletal organisms themselves, such as calcisponges and bryozoans (composition, relative abundance and growth forms, etc.). '*Archaeolithoporella*' is a particularly important binder, which not only binds skeletal organisms together, and also covers sediments and produces peloids and cements. Botryoidal and isopachous cements are essential for infilling fenestral spaces formed and/or buffered by skeletal organisms and '*Archaeolithoporella*', according to changing environments. The nature of cements (compositions, relative abundance, and morphology) also played an important role in boundstone formation and may be strictly controlled by an age-specific, high saturation state with respect to $CaCO_3$

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DISCOVERY OF THE LOWEST CARBONIFEROUS TABULATA, *CLEISTOPORA* AND BIOSTRATIGRAPHY IN SHAHAMIRZAD, NORTH IRAN

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Carboniferous corals of Iran has been described from Talartal and northern Semnan in Elburz Mountains and correlated to the Upper Viséan because of the presence of *Kueichouphyllum* by Flügel (1963). However, the geological context and stratigraphy were not probed in detail, the fauna produced the pre-Upper Viséan corals, *Shiphonophyllia* and *Kyseringophyllum* (*Humboldtia* by Flügel, 1963) and, moreover, *Kueichouphyllum* have been described from the Upper Tournaisian in nearby Armenia by Papojan (1969) and reported from the Upper Tournaisian elsewhere (Niikawa, 1994).

Shahamirzad area, where was investigated by the author in 2001, locates in northern Semnan, SE Elburz Mountains, north Iran and can be supposed to be the same area as Flügel (1963). Among paleozoic formations, many coralline fossils occurred from the Mobarak Formation, which is divided into 10 beds from A to J in ascending order, is in disconformity contact with the Devonian old Red Sandstone and is unconformably overlay with a basal conglomerate by the Permian.

Cleistopora from this area occurred from lenticular limestone into black limy shale which is divided as Bed A of the lowermost part of the Mobarak Formation. This tabulate coral is recognized *Cleistopora* from small, discoid and holothecate corallum, short and prismatic corallite with dense walls which are pierced by sparse mural pores.

When Vaughan(1905) established biostratigraphy of the Lower Carboniferous in the Avon gorge, Bristol area, he recognized six biozones, *Modiola*, *Cleistopora*, *Caninia*, *Seminula* and *Dibunophyllum* Zones in ascending order. While *Cleistopora* Zone in this area lithologically consists of shale with subsidiary limestone (Vaughan, 1905).

Thus, the lowermost Mobarak Formation can be correlated with the lowermost Carboniferous by both paleontology and lithology.

Among other coral from the Mobarak Formation, Rugosa contain *Zaphrentites* sp. A, *Z.* sp. B, *Kueichouphyllum laosense* Fontaine, *K. sinense* Yu, *Shiphonophyllia cylindrica* Scouler in Griffith, *S.* sp. A, *S.* sp., *Cyathoclisia* sp., *Amygdalophyllum* n.sp., *Kyseringophyllum* sp., *Caninia cornucopiae* Michelin in Gervais, *C.* sp., *Campophyllum* n. sp. and Tabulata is *Syringopora* sp.

From these corals, the whole of Mobarak Formation is correlated with the Tournasian or the Courceyan to Chadian in the Dinantian.

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'SHINGLE' MICROSTRUCTURE IN SCLERACTINIAN CORALS: A POSSIBLE ANALOGUE FOR LAMELLAR AND MICROLAMELLAR MICROSTRUCTURE IN PALEOZOIC TABULATE CORALS

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Interpretations of biogenicity of skeletal microstructures in ancient organisms commonly rely on analogy with extant organisms. In the case of Tabulata and Rugosa, the organisms are extinct, but scleractinian corals can serve as appropriate analogues (Sorauf, 1996). However, lamellar and microlamellar microstructures observed in tabulate, and less commonly rugose, corals have been controversial, being interpreted as original biogenic structures (e.g., Wang, 1950; Lafuste, 1983; Rodriguez, 1989) and as possible later diagenetic features (Sorauf, 1993). One reason for the controversy is the lack of lamellar-microlamellar microstructures in scleractinian corals, which are dominated by fibrous –trabecular microstructures. However, Sorauf (1993, 1996) noted that lamellar-microlamellar microstructures might be produced by fibrous biominerals if the fibres grew roughly parallel to the surface. Possible candidates for such structures were described as 'scale-like units' in the scleractinian coral, *Acropora*, by Gautret et al. (2000). We used ultrathin sections and scanning electron microscopy to directly compare the 'shingle' microstructure of extant *Acropora* to that of *Michelinia meekana* from the Mississippian of Arkansas, which Plusquellec and Sando (1987) considered to be lamellar, and to published data from other tabulate corals.

Acropora microstructure consists of aragonite fibers arranged in typical radiating trabeculae and in bundles that are arranged in a low-relief, overlapping, shingle-like pattern. Individual bundles range from 4-20 μm in width and 2-7 μm in thickness. Length of shingles varies between 20 and 110 μm. Fibers within shingles are roughly parallel to the surface of underlying shingles and radiate laterally 6-45°. Shingle growth is directed mostly distally within corallites, and they may originate from the distal edges of trabeculae or occur on any surface with discontinuity with underlying trabecular structures. In ultra-thin sections *Acropora* shingles are similar in size and appearance to lamellae-microlamellae in Paleozoic corals, commonly having roughly crescent-shaped cross-sections. Lamellar-microlamellar microstructure in *Michelinia meekana* consists of roughly parallel scales measuring 4-50 μm in diameter and 1.5-7 μm in thickness. The scales do not appear to be fibrous. Scales in other Paleozoic tabulate corals have dimensions of 10-50 μm diameters and 2-8 μm thickness (Rodriguez, 1989). If the fibrous nature of the shingles of *Acropora* was obscured by recrystallization, but the shingles survived as recognizable units, perhaps owing to the surrounding organic matter (Gautret et al., 2000), the resulting structures would be very similar in appearance to lamellae-microlamellae. Hence, lamellar-microlamellar microstructure may have an analogue in scleractinian corals, as speculated by Sorauf (1993), thereby supporting their fundamentally biogenic nature.

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CORALS (RUGOSA AND TABULATA) AT THE TOURNAISIAN-VISÉAN BOUNDARY OF MEDIAN TIEN SHAN

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Corals from boundary Tournaisian-Viséan deposits of Madian Tien Shan have been studied (sections along the rivers Pskem, Chatcal and separate points within Almalyk-Kuramynsky ridge). Within the most full section along the streamlet Acsaray the mentioned interval has been folded by carbonanceous formation without visible gaps. It is often considered as key section in studying Central Asia; its thickness is above 900 m.

The complex paleontological studying of sections was carried out by I. Nigmadghanov („Tashkentgeology") in 1992-1989. It was he who selected the collection of corals a gave it to the author to study it. This collection in the state of slimsections is kept in the paleontological museum of Kyiv National University with number 2530.

Corals were found in the Koksuisky, Taldybulaksky, Sargadonsky and Pskemsky horizons within regional stratigraphic scheme. The following peculiarities of corals' stratigraphic range are revealed. *Uralina* cf. *megacystosa* Gorsky is found in Koksuisky horizon. The rich complex of corals *Syringopora reticulata* Goldfuss, *S. distans* (Fischer), *Kueichowpora kwangsiensis* Lin, *Pleurosiphonella crustosa* Thud., *Michelinia fasciculata* Fomichev, *Kueichouphyllum sinense* Yü, *Cyathoclisia* aff. *modavense* (Salee), *Siphonophyllia* cf. *cylindrica* (Scoul.) is revealed in bedded and bioherm limestones within the upper parts of Taldybulaksky and Sargadonsky horizons. The cast of complex is determined by *Heterostrotion vesicotabulatum* (Yü) and *Kwangsiphyllum* sp. nov.

Pskemsky horizon differs by the presence of cherts in considerable amount within limestones. Limestones contain *Syringopora gigantea* Thom., *Michelinia* aff. *rectotabulata* Vass., *Siphonophyllia spumosoformis* Anikina, *Siphonodendron junceum* (Flem.).

In comparison with the date of conodonts we see that beds with *Heterostrotion vesicotabulatum* are corresponding with the upper part of the *Gnathodus semiglaber* zone and the *Gn. pseudosemiglaber* zone, which in recent time is recognized as Tournaisian stage. It doesn't coincide with the results published from South China (Xu & Poty, 1997). There the beds with *H. vesicotabulatum* are correlated with the foraminiferal zones Cf4α2, Cf4β and the upper part of coral zone RC4 in Belgium, indicating a Viséan age.

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FACIES ANALYSIS OF TITHONIAN-BERRIASIAN LIMESTONE IN TORINOSU AREA, KOCHI PREFECTURE, JAPAN

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The Tithonian-Berriasian Torinosu Limestone crops out at Hitotsubuchi Quarry in Torinosu, Kochi Prefecture, Japan. A carbonate sequence at this quarry consists mainly of approximately 55.5 m thick of floatstone containing branching stromatoporoids, calcareous sponges (*Chaetetopsis*), micro-encrusters (*Lithocodium-Bacinella* complex) and corals, bioclastic wackestone, and arenaceous limestone. It can be divided into two sections. The lower section comprises two units; the lower unit (Unit A) consisting exclusively of arenaceous bioclastic wackestone and the upper unit (Unit B) composed of *Chaetetopsis*-branching stromatoporoid floatstone, passing laterally into wackestone. The upper section is divisible into three units (Units C, D and E). Unit C rests on Unit B with a sharp, undulated contact, indicating probable unconformity. The base of Unit C is characterized by concentration of *in-situ* branching stromatoporoids and clasts of *Chaetetopsis*, which forms a mound-like buildup (ca. 5.7 m in height). This mound passes laterally into and is overlain by floatstone and wackestone. Unit D consists of peloidal-cortoid wackestone that grades upward into mudstone. Unit E is composed of bioclastic and cortoid-peloidal wackestones with an intercalating bed of stromatoporoid floatstone. Megafossils such as stromatoporoids, *Chaetetopsis*, and much less common corals are pebble- to cobble-sized, abraded fragment and do not retain their growth positions except for *in-situ* branching stromatoporoid colonies at the base of Unit C. These megafossils are commonly found in carbonate buildups in other areas within Tethys.

Previous studies showed that a vertical facies change representing succession from initication of carbonate deposition into luxriant growth of large colonial organisms is recognized in other limestones assigned to the Torinosu Limestone. In contrast, the Torinosu Limestone at this quarry shows a cyclic facies change, which suggests that the limestone was deposited in response to two repeated sea-level rises.

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THE GENUS *ZAPHRENTIS* AND ITS RELATIVES

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Zaphrentis (as a subgenus), and five new species, including *Z. phrygia* (later selected as type species), were named by Rafinesque and Clifford, 1820, based on corals from lower Middle Devonian rocks at the Falls of the Ohio River, near Louisville, Kentucky. At nearly the same time Lesueur, 1821, described a number of American corals, one of which, *Caryophyllia cornicula* was from upper Middle Devonian rocks in lake cliffs, a few km southwest of Buffalo, New York, but „also found in Kentucky.“ Descriptions of all of these new taxa were minimal and none was illustrated. The species names were essentially unused until the 1850's when *C. cornicula* Lesueur became better known and generally accepted as the senior synonym of *Z. phrygia.* During this time, workers in New York had realized that the probable source of *C. cornicula* was a coral bed in the Lake Erie cliffs in which *Heliophyllum* was prominent and fit Lesueur's brief description. Beginning in the 1880's, the name *Heliophyllum corniculum* (Lesueur) was commonly used.

For most of the 19th Century and well into the 20th, the words *Zaphrentis* and Zaphrentidae were used very loosely for relatively simple rugosans with distinct bilateral symmetry and a cardinal fossula; dissepiments were seldom mentioned. Species of Ordovician to Permian age, from many parts of the world, were placed in the genus.

In the early 1900's, it was shown that Rafinesque and Clifford had publishing priority, reinstating *Z. phrygia* as type species. During the same decade, the first important revision of *Zaphrentis* since its initial description was published. However, it was the late 1930's before any description of *Z. phrygia* was based on specimens from the Falls of the Ohio and only then that a morphological basis for the genus was recognized. Controversy regarding the presence or absence of dissepiments continued until after World War II when the naming and sectioning of a lectotype demonstrated the presence of a narrow dissepimentarium.

At this time, I recognize only four zaphrentid genera: *Zaphrentis* (Eifelian), *Heliophyllum* (middle Emsian through Givetian), *Aemulophyllum* (middle Emsian), and *Cyathocylindrium* (Eifelian). All four seem to have originated in the Eastern Americas (eastern North America and northern South America). *Heliophyllum* is the most common, has the longest range, and is the only one known to occur outside of the area of origin.

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THE MULTIPLITY BY FOUR AS A CHARACTERISTIC OF PALAEOZOIC CORALS

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The attention is given under study of Palaeozoic corals to radial, bilateral, six-radial and twelve-radial symmetry. But the survey of measuring treats shows that such feature as multiplity by four is widely spreaded in Palaeozoic corals. It fixes in different variants in all orders – Heliolitida, Tabulata and Rugosa. For example, Heliolitida had 12 septa, 12 segments of corallite's walls or 12 fould of walls. The number of coenenchimal tubes around the corallites fluctuated from 12 to 24 (Ospanova, 1980). Maximum number of septa of Halysitina (order Tabulata) reached 12-16. The number of septa of Lichenariina divisible by four usually. 8 or 16 coarse septal edges counted in Billingsaria.The number of septa of Septentrionites reached 16. Quantity of septal edges of Lyopora were 20-24 (Sokolov, 1955, 1962; Preobrazhensky, 1965, etc.). 12 fossilized tentacle were discovered in fossil Favosites (Copper, 1985, Plusquelles,1993). Representatives of family of Tetraporellidae had quadrilateral corallites and such genera of Rugosa as Goniophyllum and Areopoma too. The laying of septa took place in Rugosa at 4 point near by 4 primary septa generally (Kunth, 1869) and number of septa divisible by four often, etc.

The recognition of this pecularity is very important because it not only supplements to general picture of relationship of Palaeozoic corals but points out the ancestor wich is probably common with the rest of Coelenterata.

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THE ORIGIN OF PALAEOZOIC CORALS BY THE WAY OF PEDOMORPHOSIS

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Tabulata, Heliolitida and Rugosa are main groups of Palaeozoic corals. They are characterized by high frequency of founding in sections, mass appearance and a long history of the coexistence. At present their studing level is sufficiently high. But there are no unity of views on the coral origin, taxonomic rank and degree of their relationship among present researchers. For example, Heliolitida consider as a part of Tabulata or independent; separate taxas of Tabulata connect with Spongia, Hydrozoa, Alcyonaria; Rugosa take out Tabulata or out relationship groups of sea anemones, etc.

The higher probability of the similarity is the higher probability of the relationship. Separate similar feature can to testify both to possibility of relationship and to possibility of casual similarity or convergence with the some probability. The relationship of Palaeozoic corals is confirmed through by the conception of the sum of common features: near related taxas of high level (subclasses, orders or superorders) must to have the sum of common features.

Some new interesting datas arise from analysis of common and specific features of Tabulata, Heliolitida and Rugosa, for example:

- development of the syringoporoid habit was modeled and new genesis of porosity of Tabulata was proposed (Ospanova, 1998);
- it was argued that Chaetetida are acromicric forms of Tabulata (Ospanova, 1994);
- the diversity of ways of beginning of coenenchime in different groups of Palaeozoic corals was established (Ospanova, 1993);
- specific features indicate about a passage by the phylum of specific stage of evolution;
- common features display in every order differently, i.e. in unadequate qualitative and quantitative expression that witness about early divergence of groups of corals and self-dependent evolution.

The analysis of the development of features forces to disclaim direct origin of Palaeozoic corals from more ancient skeletal forms or soft-body polyps and allows to draw a conclusion about origin of three main groups (order Heliolitida, order Tabulata and order Rugosa) by the way of pedomorphosis from medusoid forms.

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OVETIAN CRYPTIC ARCHAEOCYATHS, LOWER CAMBRIAN FROM LAS ERMITAS (CÓRDOBA, SPAIN)

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The record of archaeocyathan community supports the evidence that these cryptic organisms were pioneers in crevices into neoproterozoic andesites in Las Ermitas (Pedroche Formation, Ossa-Morena, Spain) during the Ovetian times. The different filling phases and the cavity-dwelling biota are described in Vennin *et al.* 2003. The archaeocyaths and calcified microbial are major components, we described the archaeocyathan taxa from the crevices and breccias. The poriferan cryptic community is composed by coelobiontic forms in life position, *Dokidocyathus avesiculoides, Nochoroicyathus* sp., *Erismacoscinus* sp., *Neoloculicyathus magnus, Protopharetra gemmata* and *Protopharetra* sp. They were attached to hard substrates, such as calcified microbial or archaeocyathan skeletons during the first phases to filling the cavities and crevices. In the last filling phases are common debris skeletons of chancelloriids, hyoliths, brachiopods, trilobites, and reworked *Okulitchicyathus andalusicus.*

The immediately overlies levels to the cavities are breccias, calcimicrobial limestones and lutites with carbonate nodules. The archaeocyathan diversity is high in these platform sediments, 41 taxa in total. We described the species from breccias too, *Okulitchicyathus andalusicus, Rotundocyathus* sp., *Leptosocyathus?* sp., *Urcyathus?* sp. and the new *Nochoroicyathus simoni.*

The Ovetian cryptic archaeocyathan community from Las Ermitas is composed by *Dokidocyathus* and *Protopharetra* which are the first occurrence as cryptic taxa in Atdabanian2. *Neoloculicyathus* is common to others cryptic communities of Atdabanian2 in the Siberian Platform, but *Okulitchicyathus* was described of Tommotian and *Erismacoscinus* of Atdabanian1, both in the Siberian Platform. Therefore this cryptic archaeocyathan assemblage is different from others described during the Atdabanian and there are not obligate cryptobionts because the same taxa appear in the platform sediments outside the cavities.

Forty species in total have been described in the reef complex from Las Ermitas. The cryptic community represents the eleven per cent, the mound community the twenty three per cent; but in other facies the archaeocyaths present high diversity, the fifty eight per cent, in the nodular and interbiohermal facies, meanwhile it is only the eight percent in the breccias.

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CORALS AND CONODONTS FROM THE MOLONG LIMESTONE (LATE SILURIAN), NEW SOUTH WALES, AUSTRALIA

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The Molong Limestone crops out in a meridional belt about 11 km long and up to 2 km in width, passing through the western part of the town of Molong, which lies in the central west of New South Wales, at 148° 52' E and 33° 6' S. No corals have ever been formally described from the Limestone, though it is the type stratum for a number of brachiopods (e.g. *Molongia*) and trilobites.

The Foys Creek section traverses the width of the outcrop about 1 km north of Molong. Here the measured thickness of the limestone is 1050 m. In outcrop the surface of the limestone is weathered, and the search for fossils is generally laborious. About 250 m from the base of the section the limestone is interrupted by a rhyolitic tuff, 10 m thick, the zircons from which have yielded an age of 414 ± 8 Ma. This Lochkovian age is in conflict with the probable pre-*ploeckensis* Zone age indicated by the conodonts.

More than 100 samples taken throughout the section were examined for conodonts. Yields were quite poor, and the only true zonal forms were recovered from near the middle of the limestone. In the lower half of the section the faunas are scant, and there are long barren intervals, particularly between the 200 m and 500 m levels. The limestone is characterised by massive stromatoporoid colonies over much of this barren interval, so the absence of conodonts my be due to a very shallow environment. *Polygnathoides siluricus* occurs between 520 m and 610 m, and in the lowest sample this species is accompanied by *Ancoradella ploeckensis*, indicating upper *ploeckensis* Zone. Thus it is possible to delineate the boundary between the *ploeckensis* and *siluricus* Zones at 530 m. In the higher levels the commonest species is *Ozarkodina inclinata*, but the forms present only broadly suggest a post-*siluricus* age. Age control on the oldest and youngest parts of the section is therefore poor. The oldest beds could be as old as late Sheinwoodian; the youngest are certainly still Silurian, but they may not extend far into the Pridolian.

Halysitids, species of *Quepora* and *Halysites* s.s., occur in the lower 200 m of the limestone, the last fragments (*Quepora* sp.) being observed at 210 m. They are accompanied by *Palaeophyllum oakdalense* McLean, which continues higher to near the 500 m level, that is, probably into the *ploeckensis* Zone.

From about the 500 m level corals become more abundant, and continue until the section is faulted at 750 m. The most varied assemblage occurs at 670 m, and includes *Favosites librata*, *Favosites* spp., *Yacutiopora* sp., *Palaeocorolites* sp. nov., *Planocoenites* sp., *Coenites pinaxoides*, *Propora conferta*, *Heliolites daintreei*, *Syringopora* sp., *Tryplasma* spp., an unidentified rugosan, stromatoporoids and algae. This fauna illustrates the typically small number of rugosans at all levels in the limestone. Above the fault corals are extremely rare, the only one found being a single specimen of *Pseudoplasmopora* cf. *distans* from 1805 m, though stromatoporoids occur just below 900 m.

The conodonts indicate that the most coral-rich part of the limestone corresponds in time to the most richly fossiliferous part of the famous Silurian section in the Yass Syncline (south-central New South Wales), but the Molong Limestone coral assemblages give practically no hint of this. The Yass assemblages from the Silverdale Formation (including the Bowspring and Hume Limestone Members) comprise at least 19 rugosan species, and probably at least as many tabulates. The Foys Creek rugosans number only 9 species in 6 genera, and are represented by generally very few individuals.

STRUCTURE AND MICROSTRUCTURE OF *PACHYPORA LAMELLICORNIS* LINDSTRÖM, 1873, TABULATE CORAL FROM THE SILURIAN OF GOTLAND, SWEDEN.

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The examination of types (specimens of Lindström, 1896) and topotypes (specimens of Lecompte, 1936 and collections by two of us in 1981 and 1998) of the type species of *Pachypora* (*Pachypora lamellicornis* Lindström, 1873), from the Upper Visby Beds, Lower Wenlock, District of Visby, Gotland, facilitates enhanced characterization of morphology, structure and microstructure of this genus.

Calices very small, rounded or crescent, sometimes spiny, in some places calices closed by operculum. Tabulae sparse, only angle mural pores present, pore plate probably lacking, lateral increase with basal pore.

Wall microstructure well preserved and studied in polished ultra thin sections : median lamina made of granules in the axial zone of the branch, small plates in its margin, lacking in the peripheral zone; main layer of sclerenchyma (very thick in the peripheral zone) composed of scutellate microlamellae (Lafuste, 1984) coated in the axial zone by a fibrous layer sometimes topped by a thin film of microlamellae. No obvious growth lamellae.

A comparison between *Pachypora* and *Platyaxum* is attempted.

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THE RECORD OF DEVONIAN REEFS OF THE CARNIC ALPS (AUSTRIA) AS DEDUCED FROM SLOPE DEPOSITS

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The carbonates of the Carnic Alps span the entire Devonian period and preserve a record of shelf, proximal and distal slope and basin facies. The narrow shelfedge appears to be missing and is presumably tectonized or buried. In this project an attempt has been made to reconstruct margin architecture through analyses of shelf and slope deposits. Analysis of the shelf deposits enables distinction between open and rimmed shelf margins and analysis of clast composition of the slope deposits gives clues to the nature of the source area.

A reefal margin has been postulated for the Carnic Alps carbonate platform based on the presence of debris sheets in slope deposits of the Cellon and Rauchkofel Nappes. However, analyses of the clast composition indicate that reef-derived clasts are rare in many units and that fine-grained wackestone and mudstone lithoclasts dominate. Reef-derived clasts intermittendly occur in debris sheets from late Emsian onward through Middle Devonian and Frasnian times and are limited to certain areas. High abundances of reef-derived lithoclasts occur at Mts. Freikofel and Findenigkofel.

These findings imply that either the source area contained reefal buildups only in some places or that the source area was not everywhere and always the shelf margin but a deeper ramp or upper slope with finer-grained sediments.

The nature of shelf- and slope deposits imply the following succession of reefal or other marginal buildups.

1. Lochkovian: The large amount of crinoidal debris in the upper Lochkovian suggests that barriers of crinoidal debris formed along the shelf/ or ramp edge where waves began interfering with bottom sediments. Mudmounds probably lined the slope in deeper water.
2. Pragian: The shelf sediments contain patch reefs with numerous stromatoporoids. Coarse crinoidal limestone with large, fibrous cement-lined cavities suggests the presence of crinoidal mounds.
3. Emsian: Only the Hohe Warte Limestone contains appreciable amounts of potential reefbuilders which did not achieve much relief above the seafloor. None of this lithology can be found in the slope deposits which are generally fine-grained with few reef-derived bioclasts. Shelf lithologies point to existence of an open margin without reef barrier.
4. Eifelian/Givetian: Clast composition of slope deposits indicates presence of stromatoporoid reefs at the shelf margin with up to 70 cm large stromatoporoid heads and *Stachyodes* fragments.
5. Frasnian: Stromatoporoid reefs are preserved on the shelf with large stromatoporoids and compound tabulate corals.
6. Famennian: No reef record but some lithologies suggest presence of mudmounds. One horizon with crinoidal debris („Strunian"?)

BIOMETRIC ANALYSIS OF CORALLITE SIZE IN THE COLONIAL RUGOSAN *CRENULITES*

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Corallite size is an important criterion for species distinction and recognition in colonial corals. Diameter has commonly been used to represent corallite size. Different values, however, may result from the varying conventions that previous workers have employed for size measurement and for the selection of corallites to be measured. Compounding this problem, the methodology used in many studies is unspecified. We agree with workers who consider corallite area to be a more constrained, reproducible parameter that better reflects the dimensions of the organism. It has become common to measure 20 corallites for adequate representation of a corallum. Recently, however, it has been suggested that 20 mature corallites (having six or more sides) in a contiguous area should be measured. It was thought that data for mature corallites could be grouped because corallites with six and more sides did not differ significantly in size. The present study evaluates and further refines methodologies for biometric analysis of corallite size, based on the cerioid rugosan *Crenulites* from the Upper Ordovician Selkirk Member, Red River Formation, at Garson, southern Manitoba, Canada. The objective is to develop a standardized technique yielding tightly constrained values for the characterization of coralla and distinction of taxa.

Six coralla were selected for detailed study. For each corallum, a block was cut parallel to the growth direction from both the central axis and peripheral margin. For each block, a transverse polished section was prepared of each well-preserved high-density and low-density cyclomorphic band. Each section was scanned to produce a digital image. Using image analysis software, the areas of 20 mature corallites were measured for each section. In addition, the number of neighbors in contact with each corallite (polygonality) was recorded.

Statistical analysis demonstrated that corallite area generally increases with increasing polygonality. Corallite frequency within each polygonality class varies among sections in a corallum, and thus, mean corallite size is also variable. Six-sided corallites are in equilibrium and are usually the most frequently represented class. In order to reduce variability among sections, data collection from this class alone is recommended. Comparison of mean areas of six-sided corallites among all sections in each block revealed values identified as anomalously low or high. In order to confine the data set to sections representing normal growth, we recommend that anomalous values be excluded from further analysis. Also, because anomalous values were commonly found in basal and top portions of coralla, these portions can be excluded to expedite data collection. Data from all remaining non-anomalous sections can be combined to yield a larger sample and an overall mean value of corallite area that is representative of each block. Comparison of these values between blocks for each corallum revealed that, where the mean areas differ significantly, the value for the peripheral-margin block was greater. Therefore, we recommend that analysis be confined to central-axis blocks.

In this study, we distinguished two species of *Crenulites* from the Selkirk Member; one characterized by large corallite size and low intraspecific variability, the other by relatively small corallites and higher variability. The refined biometric methodology permits efficient, reproducible and consistent measurement of corallite size, yielding large data sets with minimal variation for comparison of coralla and for species distinction.

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THE „AVINS EVENT": A NOTEWORTHY WORLDWIDE SPREAD OF CORALS AT THE END OF THE TOURNAISIAN (LOWER CARBONIFEROUS)

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On the shallow water shelf of the Namur-Dinant Basin (Belgium and north France), the end of the Tournaisian is marked by the development of crinoidal limestone (Flémalle Member) which are abruptly capped by oolitic limestones (Avins Member), and corresponds to the highstand system tract of the third-order sequence 4 of Hance et al. (2001). The Flémalle Member yields a coral fauna comprising *Sychnoelasma hawbankensis* and the last representatives of *Cyathoclisia,* typical for the Coral RC4□ Subzone. The Avins Member is characterized by the appearance, among others, of the genera *Palaeosmilia*, *Merlewoodia*, and *Amygdalophyllum*, which mark the base of the RC4□ Subzone, and by the last occurrence of *Keyserlingophyllum.* The Avins Member is also marked by the appearance of foraminifera such as *Biseriella bristolensis*, *Loeblichia fragilis*, *Lugtonia monilis* and primitive *Eoparastafella* (*E. rotunda*), while the brachiopod *Levitusia humerosa* is common.

It is noteworthy that the Avins level can be traced throughout Eurasia and as far as Australia on the basis of the biostratigraphy (corals, foraminifera) and the sequence stratigraphy. More, its lithology is relatively constant and usually characterized by grainstones, often oolitic, contrasting sharply with the underlying rocks, usually devoid of oids, and marking the sharp dramatic change between the „Tournaisian" and the „Viséan" depositional patterns. Among other records, in Europe, it can be correlated with the Gully Oolite of Southern England and with the top of the Mazurowe Doly Formation of southern Poland (Krakow area). In Guangxi (southern China), it corresponds to the lower part of the Penchong Member of the Liuzhou Formation, and in Japan, it corresponds to the base of the Akiyoshi Limestone Group, in which species of *Amygdalophyllum* and *Merlewoodia* are common (attributed to various genera : *Eostrotion*, *Rylstonia*, *Akiyoshiphyllum*, *Amygdalophyllum*, «*Menophyllum* », *Carcinophyllum*, etc.). In Australia, it can be correlated with the Rangari oolitic Limestone of New South Wales, which yields also the oldest *Amygdalophyllum* and *Merlewoodia*, and *Endothyranopsis* sp., a foraminifera not known lower than the top of the *anchoralis* Conodont Zone.

Such a very widespread coral assemblage is unusual for the Dinantian, during which most coral faunas are endemic, and shows that good connections between distant areas existed at the end of the Tournaisian, suggesting a very high sea level. This high stand is followed by a strong drop of the sea level which continues during the lowest Viséan and is responsible for the gap of the sequence 5 on the shallow platforms (Hance et al., 2001). During this interval, the coral fauna became isolated in different basins and gave rise by separate evolutions from the same stock of corals to highly endemic coral assemblages caracteristic of the Lower Visean.

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REVISION OF THE LOWER CARBONIFEROUS GENUS *THYSANOPHYLLUM* NICHOLSON & THOMSON, 1876 (CLISIOPHYLLIDAE, RUGOSA) IN EUROPE AND NORTH AMERICA

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A revision of the Lower Carboniferous (Viséan and Serpukhovian) genus *Thysanophyllum* Nicholson & Thomson, 1876 with the type species *T. orientale* Nicholson & Thomson, 1876 (Brigantian, Middle Valley of Scotland) results in the exclusion from it of all British and Russian species formerly attributed to it. Three fasciculate to subcerioid species from the latest Viséan and earliest Serpukhovian of central Russia and one species from the latest Viséan of Great Britain formerly attributed to *Koninckophyllum* Thomson & Nicholson, 1876 are placed in this genus. Four new species are proposed, one from the latest Viséan-earliest Serpukhovian of the Moscow Carboniferous Basin, two from the latest Viséan of Nova Scotia and one from the late Viséan of the Rocky Mountains.

The geographic distribution of *Thysanophyllum* in Scotland, England, Ireland, central Russia, Nova Scotia and the Western Rocky Mountains is confirmed, and its stratigraphic range seems to be restricted to the late Viséan-early Serpukhovian.

Thysanophyllum is distinguished by fasciculate to cerioid colonies, columella sporadically developed, tabulae complete or incomplete, commonly flat-topped, transeptal dissepiments typically developed in the middle part of dissepimentarium, and by lateral increase. The genus is considered as being close to *Koninckophyllum* and attributed to the family Aulophyllidae, subfamily Dibunophyllinae.

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IF THE SCLERACTINIAN CORALS ORIGINATED FROM RUGOSAN?

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The question is far from solution because number of Paleozoic scleractiniamorphs increase from year to years. In some cases new findings are correlated with modern data on Paleozoic divergence between Rugosa and Scleractinia. This hypothese are partly supported also by findings Permian Conophyllia Orb. in Japan and Houchangocyathus Ezaki in China.

Need to transform our previous rigid definitions and suggested «laws» for anthozoan corals septal arrangement today are more conclusive than yesterday. After comprehensive review of modern corals origin and their early evolution trends (Stanley, 2003) we need to develop new methods and models of phylogenetic relationships between main groups of Anthozoa. The heterogenity of Scleractinia which was postulated before only by paleomorphologists (Yakovlev, 1926; Wells, 1967; et al.) today are new evidences from isotopic biogeochemistry and molecular genetics.

In South Primorye the Midian complex of Rugosa are presented mostly by streptelasmatids (with solitary / colonial ratio 20:3). However, the Lower Dzhulfian coral community are ratio between solitary and colonial species is 5:23. Upper Dzhulfian complex are composed only by two species of solitary plerophyllids and one tabulate species (*Pseudofavosites kotljarae Ivan. et Krop.*). Similar picture on the last stages of Permian corals development was described in Japan (Minato, 1973). Some Tabulata and Rugosa probably survive here the end – Permian crisis in small and isolated refugia. The Middle – Late Triassic scleractiniamorphs occur Russian Far East in different combinations of solitary and colonial species and vary in relative importance through time indicating four stages: Anisian, Ladinian – Early Carnian, Carnian – Norian and Rhaetian. Bilateral septal plan are typical for several rugosomorphs and scleractiniamorphs. After Rhaetian regression only stylophyllids and conophyllids crossed the Triassic / Liassic boundary.

Stable isotops composition of Far Eastern Triassic coral skeletal parts ranged from + 0.9 ‰ to 3.1 ‰ for carbon – 13 and from – 2.2 ‰ to – 6.4 ‰ for oxygen – 18. Enrichment in carbon – 13 as a result of photosynthesis process which are not presented in non – zooxanthellae corals. The majority of the Late Triassic scleractinians from Sikhote – Alin were zooxanthellate and this is a evidence of significant role of coral – algae coevolution in reefal facies. All earliest scleractinian corals was hermatypic as last rugosan. Total combination of facts are correlated with polyphyletic model of scleractinian corals origin from different skeletized and soft-bodies ancestors.

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CORAL FRAMEWORKS: BIOHERMAL, BIOSTROMAL, RUBBLE – WHAT PALEOECOLOGICAL SIGNIFICNACE?

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A key factor in geologists' and paleontologists' interest in coral-and calcifying sponge-dominated systems is their ability to build coherent, three-dimensional structures that preserve well in the geological record. Since these structures are built by living organisms that react actively to their environment, the deposited frameworks obviously have the potential to encode environmental conditions. The modern ocean knows three types of coral frameworks: incipient frameworks, bioherms (reefs), and biostromes (coral carpets). Other common facies dominated by reef-related fauna are coral-dominated non-frameworks (coral thickets) forming rud- to floatstones and coral or framework rubble that can be re-deposited to form reef-like structures.

This presentation deals with examples from the modern ocean (Red Sea, Arabian Gulf, Caribbean, Pacific) and points out depositional and therefore ecological and environmental similarity in fossil systems. These examples come from the Miocene Paratethys in Austria, where coral biostromes and bioherms similar to those presently found in the Caribbean and Arabian Gulf occurred, the Alpine Jurassic of the Northern Calcareous Alps, where rubble accumulations somewhat similar to those presently found in the Caribbean exist, and the Austroalpine Palaeozoic, where patch reefs, incipient reefs, and coral biostromes reminiscent of those found in the modern Caribbean and Pacific were formed. Applying an actualistic approach, it is attempted to use the similarities in framework types to draw inferences about the ecological and framebuilding functioning of the ancient coral systems and their environment.

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COMPARISONS OF RUGOSE CORALS FROM THE UPPER VISÉAN OF SW SPAIN AND IRELAND: IMPLICATIONS FOR IMPROVED RESOLUTIONS IN LATE MISSISSIPPIAN CORAL BIOSTRATIGRAPHY

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Rugose corals have been used in biostratigraphic studies mainly for local zonations. Their utility as index fossils have been undervalued because of problems for identification and overemphasis on the facies control on the coral distribution. Problems of identification may be solved using only well defined and well known species and genera, and by using the species group concept. The Upper Viséan transgression created extensive shallow-water carbonate shelves producing abundance of corals and widespread distribution of main taxa. For these reasons, the Upper Viséan is a very good epoch for comparing distribution of rugose coral assemblages from different regions and assessing their value as index fossils.

This study is based on distribution analysis of Upper Viséan corals collected in SW Spain and Ireland during the last 20 years. Comparisons have been made with Upper Viséan coral faunas collected in other areas of Western Tethys and adjacent regions. Rugose corals from Ireland and Spain have been considered to the species level. In some cases we applied a pragmatic approach using species groups when two or more species are similar, have identical stratigraphic distribution and may be misidentified.

More than 50 species have been analysed, but only 35 have been considered important for the coral biostratigraphy in the Upper Viséan in terms of their broad geographical distribution, their occurrence in shallow-water platform facies and their complete distribution in the Upper Viséan. Their distribution in all regions within the western Tethys subprovince is consistent with only minor differences.

The stratigraphical distribution of rugose coral species in Southwest Spain and Ireland show similar patterns. Five coral assemblage zones can be established in Sierra Morena; Zones 1 and 2 combined could be Early Asbian in age, Zone 3 is Late Asbian and Zones 4 and 5 combined are Brigantian. The Upper Viséan In Ireland comprises four coral zones, Zone F is Early Asbian in age, Zone G is Late Asbian and Zones H-I are Brigantian. There are some small differences in the first occurrences of some markers, but both zonations are analogous. These zonations are consistent with those proposed previously in Belgium (Poty 1985), Britain (Mitchell 1989) and Russia (Hecker 2001).

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FURCATE SEPTAL INCREASE OF A TRIASSIC CORAL

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Textbook models of septal increase in Recent and fossil Scleractinia typically show simple and straight septa that appear in skeletal ontogeny as consecutive cycles. The actual spectrum of septal morphological variability is, of course, much wider. Septa can be nearly completely straight smooth and solid, or undulated porous and covered with elaborate granulations. In some corals, septa can be reduced to spines as in stylophyllids or pocilloporids. Septa may reach the corallum center or be restricted to the peripheral zone; their edges can be free or merged with other septa or columella to form an axial structure. In some corals, higher-cycle septa merge with septa of lower cycles to form characteristic deltas (e.g., *Deltocyathus*). In micrabaciids that have completely everted calices, septa grow centrifugally and increase of higher septal-cycles has been interpreted as successive bifurcations of lower-cycle septa in the peripheral zone of corallum.

Herein, we redescribe a Triassic coral with very unorthodox septal increase based on new material from Italian Dolomites. The coral, originally described as *Montlivaltia septafindens* by Volz (1896), shows in the higher part of the corallum, septa that branch repeatedly and centripetally. This results in formation of septal sets composed of 3-10 blades („septal brooms"). Such multiple branching affects at least 52 septa that originate as single blades at the calicular perimeter. Three to six much shorter non-branching septa regularly intercalate with the „septal brooms". Each „septal broom" has a unique branching pattern however, remarkably, distances between adjacent branches and septa are equal. Only some septa branch earlier in ontogeny (as observed in more proximal, preserved part of the corallum) suggesting that septal branching is late ontogeny phenomenon. There are no Triassic corals showing similar septal increase to „*M.*" *septafidens*. However, certain analogy reveal some post-Triassic fossil and Recent corals.

Cretaceous aulastreoporids (e.g., *Preverastrea*), *Trochoidomeandra*, and e.g., *Tiarasmilia* develop long protrusions on septal faces. In *Tiarasmilia*, and few other taxa these protrusions occur on faces of thick and well developed septa hence can be considered „ornamentation" instead of being equipotential septal branches as in the Triassic form. In the aulastreoporids and *Trochoidomeandra*, however, such structures transform into septa of new corallites that can develop in the original interseptal spaces. Equipontential septal branches have been observed in few specimens of Recent caryophylliid *Trochocyathus* ?*rhombocolumna* Alcock, 1902, however, only the primarily septa, which split only once dichotomously. Specimens with septal branching behaviour are extremely rare in population of *T.* ?*rhombocolumna* that may suggest teratological stimulus (however, typical traces of coral intruders have not been detected). On the other hand, in some „healthy" morphotypes of *Madrepora oculata* Linnaeus, 1758 septa in distal parts of corallite can be significantly reduced and develop several, chaotically distributed small rods.

The above examples clearly show that coral septa may differ significantly from the „orthodox" textbook models, however, none of these is fully comparable with the septal extravaganza of the Triassic „*M.*" *septafidens*. Observations that there are many „extravagant" Triassic corals (e.g., *Stylophyllum paradoxum* Frech, 1890, *Gigantostylis epigonus* Frech, 1890, etc), just at the beginning of the mass appearance of Scleractinia in the fossil record, raise questions: do they evidence very wide range of the Triassic radiation, or rather diverse skeletogenic and growth strategies inherited by Triassic corals from the Palaeozoic scleractiniomorphs?

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TRIASSIC SCLERACTINIA: HETEROGENOUS ORGANISMS WITH PALEOZOIC ROOTS

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Skeletonized anthozoans show an amazing morphological and microstructural diversity from the very beginning of their Triassic emergence i.e., about 14 MA after the Permian/Triassic crisis. Many of them developed solitary and phaceloid growth forms but a number of them developed colonies with highly integrated corallites as well. Four major microstructural groups are distinguished among Triassic corals that traditionally correspond to the higher-rank taxa: Pachythecaliina, Stylophyllina, Caryophylliina, and informal group of „thick-trabecular" corals. Several skeletal morphological characters of pachythecaliinans make them similar to some paleozoic polycoeliids with simple, non-dissepimentate, and thick-walled coralla, although different mineralogy and late-ontogenetic features of the skeleton in both groups preclude a simple ancestor-descendant evolutionary scenario. Skeletal ontogeny of the other three major groups of the Triassic corals is significantly different from rugosan, hence clearly suggesting their distinct evolutionary histories and in this presentation we will focus on the problem of their origin. Morphological and microstructural distinction between stylophylliinan (= septal spines), caryophylliinan (= „Uhr-septum") and „thick-trabecular" (= widely separated „calcification centers") corals is well established already in the Anisian, however, several other formally or informally designated taxonomic groups within each traditional suborder also developed elaborated and thus probably functionally specialized skeletal structures. Among traditional caryophylliinans (that in majority do not show particular morphological specialization) protoheterastraeids develop tabular endotheca, monoclinal septa, and form colonies via multiple septal division. Among „thick-trabecular" corals, many develop conspicuous structures on septal flanks like menianae and pennulae (e.g., *Craspedophyllia*). Though a vast majority of Triassic corals have epithecate and cup-like calices, some groups of „thick-trabecular" corals have completely everted calices (e.g., *Araiophyllum*). All these diverse and often well canalized structural specializations suggest that their attainment occurred in a longer evolutionary process. There are various lines of evidences showing that the „scleractinian" style of skeletal ontogeny, architecture and mineralogy extends deeply into the Paleozoic and is not limited to the Mesozoic. Aragonitic scleractiniomorphs have been reported in the Permian (*Numidiaphyllum* Flügel, 1976; *Houchangocyathus* Ezaki, 2000) and also in the Ordovician (two species of *Kilbuchiphyllia* Scrutton & Clarkson 1991, and disregarded in the literature *Sumsarophyllum* Lavrusevich, 1971 and *Tjanshanophyllia* Erina & Kim, 1981). Also results of recent molecular studies suggest that at least two major clades of Recent Scleractinia diverged from a common stock in the Paleozoic (Carboniferous). Remarkably, Paleozoic scleractiomorphs do not co-occur with typical rugosans in the same strata, thus possibly were overshadowed by rugosans and tabulates in most environments but due to different trophic specialization they could manage in diverse but less competitive niches. Discovery of Paleozoic scleractiniomorphs challenged the view that their skeletonization occured only in the mid-Triassic (some authors suggest multiple skeletonization events among scleractiniomorphs in the Palaeozoic and Mesozoic). It became clear that „scleractiniomorhs" have a long evolutionary history and hence a „*deus ex machina*" scenario in which major groups of the Triassic corals evolved exclusively during the Triassic adaptive radiation (monophyletic scenario) is no longer needed. Scleractiniomorph survivors of the end-Permian crisis transferred to the Triassic much of their Paleozoic heritage i.e., patterns of the ruling architectural styles and diversity of skeletal microstructures.

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PALAEONTOLOGICAL PERSPECTIVES ON THE ORIGINS OF MODERN BIOGEOGRAPHICAL PATTERNS OF INDO-PACIFIC REEF CORALS: THE EUROPEAN CONNECTION

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The richness of the living Indo-West Pacific reef coral fauna is well-known, but is still widely assumed to be related to the characteristics of the region itself, such as its numerous islands, abundant reefs and warm climatic conditions. Such explanations are commonly applied by coral palaeontologists to past distributions too. Simple comparison of the Caribbean with the Indo-West Pacific, with their very different diversities today, suggests that this actualistic, approach is insufficient on its own to explain the observed patterns. History must have also contributed, but until recently, application of historical data to questions of living reef coral biogeography, has been relatively neglected. Phylogenetic analysis, both morphological and molecular (of various reefal organisms), together with simple classical palaeontological consideration of the distribution of reef corals through time, is revealing that tectonic, eustatic, climatic and oceanographic history has also profoundly influenced modern reef coral distributions.

In this talk, I will give (1) a brief resumé of my previous recent work on large-scale patterns of Indo-Pacific reef coral distributions in space and time, and (2) mention current work on the detailed case history of the single widespread and currently ecologically important genus, *Acropora* (in both cases, in collaboration with various co-workers). Leaving aside latitudinal gradients in richness, first order reef coral patterns appear to be related to the northward movements of ex-Gondwanan continental masses in collision with Eurasia – particularly the Miocene Zagros collision of Arabia in south-western Asia and the Miocene collision of Australia in SE Asia. Many common reef coral genera occurring in the Indo-West Pacific today, however, have histories that commence much earlier than these events, and far from the present Indo-West Pacific centre of diversity - typically in the Paleogene of Europe and/or Caribbean. Moreover, surprisingly, some of the key occurrences in Europe are in 'marginal' environments. Many of the earliest records of *Acropora*, for example, are from high palaeolatitude shallow bays and shelves with little or no reefal development, in the mid to late Eocene and early Oligocene of southern England and northern France – a far remove from what most reef-workers would consider a typical *Acropora* environment today.

As a general conclusion, there is a growing need for reef and reef coral workers to abandon the common assumptions that patterns and processes of (1) evolution of reefal species, and (2) high diversity of reefal species, and (3) reef-building, are tightly linked correlatives within a single synergistic 'system'.

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UNCOVERING THE BIOGEOGRAPHICAL HISTORY OF THE COMMON SCLERACTINIAN REEF CORAL *ACROPORA*: THE ANGLO-FRENCH CONNECTION.

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Acropora (staghorn coral) occurs today throughout most of the tropical Indo-Pacific and Caribbean reef regions, and is the most abundant, widespread and species-rich reef coral genus, often in extensive mono-generic assemblages. With increasing concern about the stability, and even survival, of modern reef communities in the face of global and environmental change, it is relevant to ask how old this pattern is. The oldest known record of *Acropora* is from the late Paleocene of Somalia, but by the mid-Eocene it is known from Europe and tropical America. There are no records yet from the Indo-Pacific until the late Oligocene. Its palaeontology has been very neglected, but Wallace's recent comprehensive revision and phylogeny now provides a timely framework to begin a reassessment. Remarkably, the collections of The Natural History Museum revealed an unexpected palaeonvironmental context for the early history of *Acropora*. The best preserved, oldest specimens come from mid-Eocene non-reefal, non-tropical (ca 50°N) deposits of southern England and northern France. Although the material consists of small broken pieces, preservation of skeletal detail is surprisingly good, allowing provisional allocation of specimens to various lineages in Wallace's phylogeny. In this talk we discuss the intra-generic affinities of this fossil material and preliminary thoughts on the biogeographical history of *Acropora*.

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PRELIMINARY DATA ON THE CORAL DISTRIBUTION IN THE VISÉAN FROM ADAROUCH AREA, CENTRAL MESSETA (MOROCCO)

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The Early Carboniferous sequences of the Adarouch area (NE Central Morocco) crop out in a broad area at South from the city of El-Hajeb. They are subdivided into four lithostratigraphic units: the Oued Amhares Formation, the Tizra Formation, the Mouarhaz Formation and the Akerchi Formation, comprising Upper Viséan to Serpukhovian sediments. Rugose corals are present along most succession, but they are locally abundant only in the Tizra and Akerchi Formations. Additionally, an small locality located at East from the main outcrops called Id Marrach yielded very abundant corals.

The Tizra Formation is subdivided into three members (TZ1-3). Only the two upper members yielded abundant corals. The upper beds of TZ2 yielded an assemblage composed of *Lithostrotion, Siphononodendron* and *Palaeosmilia.* The total assemblage could be late Asbian in age. Two different assemblages were recorded in the type section of TZ3. The lowest beds yielded abundant specimens of *Lithostrotion, Siphononodendron, Siphonophyllia* and *Palaeosmilia* together with syringoporoids and michelinids.. Upper beds in the same section provided *Lithostrotion, Dibunophyllum, Arachnolasma, Koninckophyllum, Haplolasma, Clisiophyllum* and *Diphyphyllum.* A section measured southward from the previously mentioned yielded two assemblages. The lower assemblage is located in a intermediate position between the two cited in the type section and yielded *Palastraea, Siphonophyllia,* undissepimented rugose corals and michelinids indicating a Brigantian age. The upper assemblage is approximately located at the same level that the upper assemblage of the type section and yielded *Palastraea, Siphonophyllia, Diphyphyllum, Siphonodendron* and a colonial new genus.

Corals are very abundant in the lower beds of the Akerchi Formation. The assemblage is composed of *Siphonodendron, Diphyphyllum, Lithostrotion, Palastraea, Paleosmilia, Clisiophyllum, Dibunophyllum, Axophyllum, Arachnolasma* and *Koninckophyllum.* This assemblage proves that the lower beds from the Akerchi Formation are Brigantian, as stated by Berkhli and Vachard (2001).

Three main sequences have been identified in Id Marrach, all of them containing abundant corals. The assemblages of these sequences show small differences at the species level, but they are similar at the generic level; they are mainly composed of *Lithostrotion, Siphonodendron, Diphyphyllum, Palastraea, Palaeosmilia, Dibunophyllum, Arachnolasma, Clisiophyllum, Koninckophyllum, Aulophyllum, Auloclisia, Siphonophyllia, Axophyllum* and common syringoporoids. The presence of *Palastraea regia* proves that Id Marrach outcrop belongs to the Brigantian.

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REFINED SPECIES CONCEPT OF THE STROMATOPOROID *ACTINOSTROMA VERRUCOSUM* (GOLDFUSS 1826) – SYSTEMATICAL AND ECOLOGICAL IMPLICATIONS.

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Based on specimen collected in several outcrops of Lower Givetian reefal deposits in the Eifel Hills (Germany), this study provides new distinctive details of the skeleton of *Actinostroma verrucosum* (Goldfuss) improving the understanding of the systematic position of the species. Furthermore by tracing variability of individuals that thrived in different environments the response of skeletal organization evidenced that the mamelons, often times regarded as a diagnostic feature of this species, might in fact be facultatively developed under low current conditions in order to enhance passive water flow in the filter feeding system and additionally preventing an easy covering by mud.

In brief a stromatoporoid skeleton is made of horizontal and vertical elements. In general they are referred to as laminae and pillars and occur with a wide variety of properties. Nature, arrangement and morphometric data of these internal elements are essential for generic and specific assessment.

Actinostroma is characterized by reduction of laminae to rod-shaped elements, named colliculi. Typically colliculi are of similar size, laterally persistent and alligned. In tangential section they connect neighbouring pillars producing a regular polygonal network, referred to as hexactinellid pattern. The pillars are rod-shaped too, they appear to be continous through many interlaminar spaces.

In contrast skeletal elements of *Actinostroma verrucosum* (Goldfuss) are of a less simple sort. Some laminae are broadened reflecting a complex internal structure (cf. Lecompte 1951), often pillars are v-shaped and confined to only one interlaminar space. Stearn et al. (1999) address this issue underlining the complex arrangement of colliculi, collocating the species peripherical but within the genus. Though they consider the possibility to propose a new genus based on this properties.

As shown now by some very well preserved specimen, the origin of complex laminae is given by two types of colliculi. One type of normal size connecting the pillars, the other much smaller with intersections independent of the pillars. If those colliculi form an angle with the horizontal plane, defined by the first type colliculi, the result is thickening of the whole laminar structure.

The dimensions of the second type colliculi are comparable to those of the microcolliculi encountered in some genera placed in the order Actinostromatida (e.g. *Densastroma*). These Silurian forms are phylogenetical linked with *Actinostroma* (cf. Stock 1994). The occurence of microcolliculi in the typical Middle Devonian *A. verrucosum* is quite remarkable. Since similar features are displayed by *Actinostroma stellulatum* (Nicholson), it might be deduced that a possible new genus includes both species groups.

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DEVONIAN RUGOSE CORALS FROM THE KARAKORUM MOUNTAINS (NORTHERN PAKISTAN).

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The Karakorum Block is regarded as a microplate of „Gondwanan“ origin and was part of the Cimmerian continent („Mega Lhasa“) which rifted away from the northern margin of Gondwana during the Late Palaeozoic/Early Mesozoic. From the Northern Karakorum Range (Yarkhun and Karambar River Valleys) an Upper Givetian to Lower Frasnian rugose coral fauna of the Shogram Formation is described. The fauna is dominated by cosmopolitan genera such as *Hexagonaria*, *Disphyllum*, *Macgeea* and the *Temnophyllum*/*Spinophyllum* group, generally showing a geographically wide distribution, although being absent from the Eastern Amercian Realm in the Upper Givetian/Lower Frasnian. Therefore its components are of little use for biogeographical deductions at sub-realm level and in explaining the relation between the Karakorum Range and other Cimmerian crustal blocks. A remarkable exception is the first record of the genus *Pseudopexiphyllum* outside of Turkey, indicating a connection to the western part of the Cimmerides.

On species level, the coral fauna of the Shogram Formation is characterized by the development of a diverse and rather unique fauna including about 35 taxa, that differs from the faunas known from neighbouring crustal blocks. So far, faunistic links to Iran (Lut Block), Central Pamir, the Lhasa Block and Western Qiangtang are not clear, and although each of these fragments are believed to be closely connected they were obviously not in direct contact. However, the Karakorum fauna is remarkably close to the one known from the Helmand Block in Afghanistan, showing a very similar generic composition, that includes numerous morphologically closely related, although not identical species.

Accordingly, the restricted faunal exchange led to the development of new taxa. Distribution of the new species of *Spinophyllum*, *Pseudopexiphyllum* and *Pseudozaphrentis* is limited to the Karakorum Mountains. Reasons for this individual faunistic development and the missing faunal exchange are unexplained, but suggest that some kind of active faunal barrier must have existed during the Devonian, which led to the development of the specific Karakorum fauna.

With the exception of *Phillipsastrea orientalis* REED 1922, which is elsewhere only known from the Burmese Devonian, the occurrence of some other species reveal a connection to regions which are regarded as biogeographically rather unrelated. A weak relation to central European faunas is indicated by the occurrence of characteristic species of *Macgeea* and *Hexagonaria* which are known from the Ardennes and the Holy Cross Mountains. More unusual are the faunistic affinities to the Altai-Sayan region shown by the surprising occurrences of species of *Spinophyllum* and siphonophrentid corals which are morphologically very close to those known from the Altai Mtns. and Kazakhstan.

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RUGOSE CORAL ASSOCIATIONS FROM THE LATE VISÉAN OF WESTERN TETHYS: EXAMPLES FROM IRELAND, BRITAIN AND SW SPAIN

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Eight Upper Viséan rugose coral associations (RCA 1-8) have been identified, based on an integrated analysis of the faunal composition (coral taxa present, abundance and diversity) preservation and orientation of taxa, and their relationship to the host or enclosing lithofacies. This involved identification of 35 genera and 43 species or species groups, principally from Asbian-Brigantian Stages in Ireland, Britain and SW Spain. The generic composition includes 24 solitary and 11 colonial forms; 7 of the latter group are fasciculate and 4 are massive, mostly cerioid colonies.

Three of the associations: *Aulophyllum-Dibunophyllum* association (RCA 1), *Siphonodendron-Diphyphyllum-Actinocyathus/Lonsdaleia* association (RCA 4) and *Koninckophyllum-Siphonodendron-Siphonophyllia* association (RCA 6) are found mostly in rocks of Brigantian age, and four associations *Palaeosmilia-Axophyllum-Clisiophyllum* association (RCA 2), *Siphonodendron-Solenodendron* association (RCA 3), *Dibunophyllum-Axophyllum-Siphonodendron* association (RCA 5) and *Lithostrotion-Siphonodendron* association (RCA 7) are typical of the Asbian. However, RCA 8 (*Cyathaxonia-Rylstonia-Rotiphyllum* association) is not biostratigraphically important, as it contains mostly long-ranging solitary genera, known throughout the Late Viséan and extend up to the Permian.

Three of the associations (RCA 1, 7, 8) have relatively low diversity (2-4 common genera), four associations (RCA 2, 3, 5 & 6) have moderate diversity (5-7 common genera), and only RCA 4 has a high diversity (> 8 common genera). Four of the eight associations are dominated by colonial corals (RCA 3, 4, 6 & 7), but of these, only RCA 7 has abundant cerioid *Lithostrotion*. The other associations are dominated by fasciculate genera, mostly *Siphonodendron*, but occasionally *Solenodendron* and *Diphyphyllum* can be locally abundant. RCA 3 and 4 often form biostromal developments.

Six of the associations are characteristic of shallow-water shelf environments (RCA 1, 2, 4, 5, 6 & 7), as indicated by the host limestone textures, presence of dasycladacean algae, oncoids, ooids and palaeokarstic surfaces in the successions. RCA 7 however, is unusual, as it developed an *in situ* wave-resistant coral framework (bioherm) within a very shallow-water turbulent setting. RCA 3 on the other hand is a deeper water shelf assemblage, but which was affected by periodic storms and bottom currents, as suggested by the frequency of overturned fasciculate colonies in some beds. RCA 8 was a mainly deeper slope/ramp association of solitary rugosans in a basinal setting. However, the same association is recorded rarely in shallow-water, protected and restricted environments such as hypersaline lagoons.

The first five associations (RCA 1-5) are widely developed in Upper Viséan rocks of Western Tethys, but RCA 6 and 7 are rare. RCA 8 is comparatively rare, although its distribution is strongly controlled by depositional setting.

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LATE VISÉAN RUGOSE CORAL FAUNAS FROM SOUTH-EASTERN IRELAND: COMPOSITION, DEPOSITIONAL SETTING AND PALAEOECOLOGY OF *SIPHONODENDRON* BIOSTROMES

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Rich late Viséan rugose coral assemblages dominated mostly by solitary forms are recorded from late Asbian limestones (upper part of the Ballyadams Formation) in the Carlow area, southeast Ireland. More diverse assemblages are recorded in the Brigantian Clogrenan Formation with abundant fasciculate and cerioid colonial taxa. The limestones display shoaling-upward cycles developed on an extensive shallow water tidally-influenced shelf in which periodic subaerial exposures are recognised by palaeokarsts and palaeosols. *Siphonodendron* biostromes are recorded from the lower part of the Clogrenan Formation at discrete horizons which can be correlated between quarries up to 50 km apart. All of the biostromes are dominated by tabular or low bulbous colonies of *Siphonodendron pauciradiale* with pronounced peripheral growth strategies. The dimensions of fasciculate colonies are typically 20-30 cm high and 70-90 cm in width, but some reach 4.5 m across. The corallites in many colonies have the same upper growth level. The mostly upright *in situ* colonies show relatively dense packing and formed bafflestones and are thus regarded as autobiostromes, but periodic storm events formed autoparabiostromes when some of the colonies were overturned. Associated rugose corals in the biostromes are *Diphyphyllum furcatum, Lonsdaleia duplicata* and the massive cerioid species *Lithostrotion decipiens, Actinocyathus floriformis* and *Palastraea regia*, together with tabulate corals (*Syringopora)* and sponges (chaetetids*)*, but all form accessory roles in the constructions. Solitary corals are mainly sparse, except at Dunamase Quarry where several recorded taxa result in a much higher diversity biostrome. Gigantoproductid brachiopods are an important related element, commonly forming concentrations of *in situ* shells below, within or above the biostrome, but rarely formed sites for attachment for the colonies.

The Carlow *Siphonodendron* biostromes show many characteristics in common with the biostromes from the late Asbian *Siphonodendron* Limestone in SW Spain, although the dominant species there is the larger *S. martini,* not *S. pauciradiale*. Both regions have biostromes with relatively high diversity, but those in Carlow have a high diversity of colonial taxa (fasciculate and cerioid) resulting from their slightly younger (Brigantian) age, coinciding with the appearance of new colonial rugose genera.

The Carlow *Siphonodendron* biostromes are different from the '*pauciradiale* reefs' in the Bricklieve Mountains, NW Ireland, even though they contain the same dominant species. The Carlow biostromes have a much higher diversity (genera and species) and formed in a shallower water setting. Also, they show less fragmentation of colonies and a higher proportion of *in situ* colonies than those biostromes in NW Ireland, where over 50 % of the colonies are overturned and abraded, reflecting growth in a more open marine shelf, commonly affected by storms. The Belgian *Siphonodendron* biostromes are thinner and not as laterally extensive as those at Carlow. They are dominated by *S. junceum* with *S. martini,* but *S. pauciradiale* has a less important role in the constructions. They are also developed above beds with chaetetids and gigantoproductid brachiopods, although neither were involved in the biostromes, similar to those at Carlow.

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DISSEPIMENTS, PRESEPIMENTS AND MARGINARIA IN THE RUGOSA (CNIDARIA, ZOANTHARIA)

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Dissepiments are formed the same way in both Rugosa and Scleractinia, but in rugosans are restricted (by definition) to a peripheral position, in a marginarium or dissepimentarium. Dissepiments in all modern and fossil corals are formed by centripetal growth of carbonate crystals to a central junction line, with the formation of their primary layer taking only 3 or 4 days to complete. Modern Scleractinia form dissepiments by crystal growth out of the thickening layer of septa into the first-formed layer of the dissepiment. Formation of series of dissepiments may have resulted from discontinuous retraction due to tensional stretching of basal polypal flesh due to elongation of septa, as supposed by Ogilvie and by Hill, or by fluid lifting from beneath, as proposed by Wedekind and by Wells. Presepiments, formed prior to septa in many rugosan genera, and the lack of septa in cystimorph corals, support the latter, the Wedekind Hypothesis of Wells. Names have been given to dissepiments in fossil corals based on their shape, continuity, position or timing of formation; most are not pertinent to the paleobiology of the Rugosa. The marginarium provided a buffer zone between vital parts of the rugosan polyp and its physical environment, and contain normal dissepiments, lonsdaleoid presepiments or may lack dissepiments. Rugosans during times of peak diversity (*e.g.* Devonian) tend to have normal dissepiments in a broad marginarium. Rugosans lacking a dissepimentarium are small, restricted to deeper water and referred to the „*Cyathaxonia* fauna" of Hill. Following several times of crisis in the Paleozoic (Late Ordovician, Late Devonian) non-dissepimented corals provided precursors for lonsdaleoid genera with presepiments, which in turn gave way to faunas with normal dissepiments. The most common function of dissepiments in the Rugosa was to provide support for the polyp base, as in the Scleractinia. The dissepimentarium of the Rugosa on soft substrates is commonly expanded for support, while on hard substrates the dissepimentium commonly forms a pedestal and replicates hard objects or surfaces. Another function of dissepiments apparently was to provide anchoring for corallites in soft muddy sediments. Expansion and contraction of the marginarium reflects marked ecologic change, but may occur without modification of the shape or diameter of the tabularium, suggesting that the tabularium was the critical area of polyp anatomy, and that the marginal area could alter without permanent damage to polyps. Spreading of the marginarium in rugosans may have benefitted the coral by expansion of marginal ciliated ectoderm for cleansing and feeding functions, but it is not supposed that these were phototrophic or influenced by symbiont photosynthesis.

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DENSITY BANDING IN THE CORAL *MONTASTRAEA FAVEOLATA* (SCLERACTINIA) FROM LOOE KEY, FLORIDA

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SEM study of *Montastraea faveolata*, part of the *Montastraea annularis* species complex of Knowlton, et al. (1997), provides new data on annual density banding, some which reinforce earlier work and some which allow modification of a model for skeletogenesis in the genus and the variations in it which lead to recognized density banding. Ma (1934) identified density banding, showing that it is temperature-related. Studies of *Montastraea* by Macintyre and Smith (1974) and Dodge et al. (1994) indicate that this banding is best developed in exothecal areas. Ogilvie (1896) described sequential steps in skeletogenesis, most recently recognized in the model of Barnes and Lough (1993), which identifies three stages of skeleton formation in *Porites*. This model is here modified to accommodate the presence of organic matrix around and within skeletal biocrystals, as illustrated by Cuif and Dauphin (1998). Three developmental stages for skeleton are also seen in *Montastraea*, 1) extensional, 2) thickening, and 3) formation of transverse elements (dissepiments). The first-formed layer within endothecal dissepiments develops from the thickening layer of septa; growth lines indicate that formation of this primary layer is a three to four day process. The extensional and thickening processes of skeletogenesis result in density banding in *Montastraea*, although to date we cannot discriminate rate variations between the two. Differences are present in the microarchitecture of septal and costal flanks and of upper and lower surfaces of dissepiments which allow recognition of their position within light or dense bands. In dense bands, the upper surfaces of exothecal dissepiments show luxurious crystal growth, while those in light bands are less well-developed. Septa are characterized by fasciculi (crystal clusters) forming new growth at their growth edges, with flanks then infilled to be smooth. In dense bands, these flanks are overgrown by abundant aragonite infilling around septal granulations. In light bands, carbonate thickening septal flanks commonly has crystals with incomplete terminations. Similar to septa, costal flanks have luxurious overgrowths of aragonite in dense bands, while costal flanks in light bands have sparse acicular crystal growths, with inorganic cements also present at some levels within the skeleton.

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LOWER DEVONIAN RUGOSE CORAL FAUNAS FROM THE CANTABRIAN MOUNTAINS (NW SPAIN): PHASES OF DEVELOPMENT AND RESPONSE TO SEA-LEVEL FLUCTUATIONS

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The Devonian history of the Cantabrian Mountains (NW Spain), as registered in the stratigraphic series, is characterized by events of variable importance and geographic significance, which are reflected in the lithology and in the fossil content. They are called geobiologic events.

Barnes et al. (1996) mentioned more than 14 Devonian global bioevents. Three of them, the *sulcatus*, Zlichov Basal and Daleje-*Cancellata* events, have been recognized in the Lower Devonian (Rañeces-La Vid Groups, Lebanza and Abadía Formations). Another one, the Chotec-*Jugleri* event, is observed close to the Lower-Middle Devonian boundary (uppermost part of the Moniello, Santa Lucia and Polentinos Formations) of the Cantabrian Mountains.

In this paper, phases of development of the Lower Devonian rugose corals from the Cantabrian Mountains, their relation to global sea-level fluctuations and as well as lithologic and palaeontologic features are analyzed in the neritic (Asturo-Leonian) and pelagic (Palentine) Domains.

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STRUCTURE AND ENVIRONMENT OF TABULATE CORAL ASSEMBLAGES FROM THE MIDDLE DEVONIAN OF THE EIFEL HILLS (RHENISH SLATE MOUNTAINS, GERMANY)

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A comparative study of branching tabulate coral-rich successions from the Middle Devonian (lower Givetian) of the Sötenich Syncline (Eifel Hills) is presented in terms of faunal composition, facies and controlling environmental factors. The tabulate fauna comprises 12 species: *Alveolites (Alveolitella) fecundus*, *Alveolites (Alveolitella) crassus*, *Scoliopora* cf. *denticulata*, *Scoliopora* cf. *serpentina*, *Celechopora devonica*, *Pachyfavosites polymorphus*, *Pachyfavosites tumulosus*?, *Thamnopora cervicornis*, *Thamnopora reticulata*, *Thamnopora irregularis*, *Roemerolites brevis*, *Roemerolites tenuis*. Each locality (Sötenich, Rinnen, Keldenich) is characterized by a different tabulate coral assemblage/association: *Celechopora-Argutastrea* assemblage (Keldenich), *Thamnopora-Roemerolites* assemblage (Rinnen), *Thamnopora-Alveolites-Spinatrypina* association (Sötenich). The assemblages/associations, forming local reef meadows, generally reveal dominance of certain taxa, which, together with low to moderate species numbers, result in low diversity. The branching tabulate corals mainly show a medial growth strategy (sensu Scrutton 1998) corresponding to an environment with: (a) non-consolidated soft-bottom substrate, (b) (episodically) elevated background sedimentation rate, (c) notable terrigenous influx, and (d) low water energy. However, facies types and variations in faunal composition point to differences in bathymetry and sediment input. The assemblages/associations occurred along a bathymetric gradient with the *Celechopora-Argutastrea* assemblage in a shallow subtidal setting (less than 10 m water depth), affected by a relatively strong terrigenous influx, presumably in combination with reduced salinity and elevated nutrient supply. The *Thamnopora-Alveolites-Spinatrypina* association was situated in a fully marine shallow subtidal environment (less than 20 m water depth), whereas the *Thamnopora-Roemerolites* assemblage occurred in a slightly deeper subtidal setting (between 20 and 50 m water depth) with constantly elevated background sedimentation rate.

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THE EVOLUTION OF MODERN SCLERACTINIAN CORALS AND THEIR EARLY HISTORY

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Events of the Mesozoic era were most critical to the early history of scleractinian corals, ancestors of all modern species which populate shallow-water tropical to subtropical reefs. Most reef corals calcify rapidly and their success on reefs is related to a photosymbiosis with zooxanthellae. These one-celled algal symbionts live in the endodermal tissues of their coral host and are thought responsible for promoting rapid calcification. The evolutionary significance of this symbiosis is important for explaining the success of corals. Scleractinia stands out as one of the few orders of calcified metazoans that arose in Triassic time, after a greater proliferation of other calcified metazoan orders during the Paleozoic. The origin of this coral group, so important in reefs of today, has remained an unsolved problem in paleontology. The idea that Scleractinia evolved from older Paleozoic rugose corals that somehow survived the Permian mass extinction, persists among some schools of thought. However Paleozoic scleractiniamorphs also have been presented as possible Paleozoic ancestors. The paleontological record shows that the first appearance of Scleractinia was after the start of the Middle Triassic. Earliest Scleractinia reveal unexpectedly robust taxonomic diversity and high colony integration.

Results from molecular biology support a polyphyletic evolution for living Scleractinia and the molecular clock, calibrated against the fossil record, suggests that two major groups of ancestors could extend back to late Paleozoic time. The idea that Scleractinia were derived from soft-bodied, „anemone-like" ancestors that survived the Permian mass extinction is a viable hypothesis. The 14- million year Mesozoic coral gap stands as a fundamental obstacle to verification of many of these ideas. However, this obstacle is not a barrier for derivation of scleractinians from anemone-like, soft-bodied ancestors. The ephemeral „naked coral" hypothesis presents the greatest potential for solution of the enigma of the origin of scleractinians. It states that different groups of soft-bodied, unrelated „anemone-like" anthozoans gave rise to various calcified scleractinian-like corals through aragonitic biomineralization. It is suggested that this occurred during the mid-Triassic interval, following a lengthy Early Triassic post-extinction interval of marine perturbation. However, it may have occurred at least three other times prior to this interval. How important is a skeleton in classification within the order Scleractinia? Because of ephemeral characteristics, possession of a skeleton may not represent a clade of zoantharian evolution but instead represents a grade of organization. In the fossil record, skeletons may have appeared and disappeared at different times as some clades reverted to soft-bodied existence and these phenomena could account for notable gaps in the taxonomic and fossil record. A fuller understanding and possible solution to the problem of the origin of modern corals may be forthcoming. However it will require synthesis of diverse kinds of data and a integration of findings from paleobiology, stratigraphy, molecular biology, carbonate geochemistry, biochemistry and invertebrate physiology.

REEF CORAL DIVERSITY IN THE LATE MAASTRICHTIAN OF JAMAICA

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Studies of Caribbean reef coral faunal change across the Cretaceous-Tertiary transition have been hampered by the lack of well-sampled late Maastrichtian coral assemblages from the region. Recent work on Jamaican Cretaceous strata, however, indicates that these successions preserve diverse shallow water macroinvertebrate communities from the terminal Maastrichtian (66.7-65.8 mya). This provides an ideal opportunity to examine Caribbean reef coral diversity and palaeoecology immediately preceding the K-T transition and to make inferences concerning the effects of the K-T boundary event.

Jamaican Upper Cretaceous sediments include a thick succession of fossil-rich impure limestones, shales and mudstones deposited as part of an ancient volcanic island arc complex. These fossil bearing units are exposed in a series of Cretaceous Inliers across Jamaica. The fossil assemblages are dominated by abundant rudist bivalves and scleractinian corals. The present work focuses on large collections (>1000 specimens) of corals made from the Latest Maastrichtian units in the Maldon and Marchmont Inliers in western Jamaica and in the Central Inlier (including the Guinea Corn Formation) in central Jamaica. We tabulated species occurrences and relative abundances at each Late Cretaceous site in Jamaica. We then compared this Maastrichtian data set with taxonomic records from over 60 well sampled Cenozoic lithostratigraphic units from the Caribbean. We also compared diversity and taxonomic richness data from a single densely fossiliferous coral unit (the 'Main Coral Bed') in the Guinea Corn Formation with similar coral-rich horizons from the Late Oligocene Moneague Formation and Late Pleistocene Falmouth and Port Morant Formations of Jamaica.

In all three inliers, corals are significant parts of the fossil fauna. The coral assemblage is ecologically diverse containing a range of taxa with massive, circumrotary, ramose, phaceloid and plate shaped colonies, as well as fixed and free solitary growth forms. With approximately 20 genera and 38 species, taxonomic richness in the Jamaican Late Maastrichtian assemblage is higher than roughly 75% of all assemblages in the Cenozoic data set. Similarly, diversity and richness in the 'Main Coral Bed' of the Guinea Corn Formation was comparable to that of coral rich units in shallow water carbonates from the Middle to Late Cenozoic of Jamaica.

Thus, diversity in terminal Maastrichtian Jamaican coral faunas is moderate to high relative to well sampled Cenozoic assemblages. There is no evidence for a drop in taxonomic richness before the K-T boundary, neither is there evidence that corals are less abundant or noticeably more ecologically restricted at this time. This is in stark contrast to the sparse, species-poor Caribbean faunas of the Paleocene through Early Eocene.

MICROCOSM OF THE CORAL SKELETON

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Perhaps it is a bit of an exaggeration calling a subject of microscopic skeletal studies a microcosm, however, it is equally easy, as in a real cosmos, to get lost in a vast area of different interpretations and proposals concerning objects, often only few micrometers in size. The purpose of this contribution is to provide some hints on how to navigate in this tiny realm.

Interpretations of the minute structure of the coral skeleton published so far are based mostly on two-dimensional observations: single transverse sections, and exceptionally, serial and/or longitudinal sections of comparable skeletal parts. Hence, it is not surprising that many microstructural descriptions bear some of the stigma of the „Flat Earth" concept, in which one of the important dimensions is missing. Many (but methodologically limited) observations of „centers of calcification" and fibers that radiate from those centers founded the concept of the trabecula i.e., a „rod formed by fibers and provided with an axis". Since the 19th century, trabeculae have been of paramount importance in traditional scleractinian classification resulting in a „Big Bang" of studies that has significantly improved understanding of coral skeleton diversity. Only recently did the model of calcification mediated by organic-matrices challenge the widespread model of purely physicochemical control of the skeleton growth, and implied an inadequacy of the trabecular concept. The crux of this new model became „calcification centers" redefined as scaffoldings for the further „fibrous" phase of skeleton growth („two-step model"). However, most data used to characterize „calcification centers" are still drawn from transversely sectioned coralla. The third dimension of „calcification centers" remained unknown and it was implied that they are composed of homogenously distributed organic and microcrystalline components.

The 3D skeletal reconstruction proposed herein is based on differently oriented sections and techniques that stain organic components. The entire septal skeleton of corals is composed of alterations of mineral and organic-enriched phases. They form superimposed layers that may be interrupted in some directions of growth but in other directions there is a continuity between „calcification centers" and „fibers", making distinction between these two structures unclear. As an alternative to the „two-step model" I put forward the „layered model" of skeletal growth which explains the differences between „calcification centers" and „fibers" in terms of differential growth dynamics (and not necessarily different timing) between these regions. As a result, these regions show different proportions (probably also biochemical properties) of mineral-organic components; however, in both regions these components characteristically alternate. Instead of the inadequate „trabecular concept" and „calcification centers", a distinction between deposits of the Rapid Accretion Front (dRAF; which in particular cases can be organized into Centers of Rapid Accretion (CRA)) and Thickening Deposits (TD) is proposed.

Several potentially significant outcomes of this microstructural reinterpretation include the following:

1) Remarkable regularity of mineral/organic phase alterations in TD skeleton of zooxanthellate corals and lack of such regularity in azooxanthellate coralla appears to be a promising criterion to distinguish these two ecologically distinct coral groups on the skeletal basis, possible also in fossils.

2) In dRAF region nanometer-scale (ca. 50 nm in diameter) mineral components seem to match the size range of nodular structures interpreted recently as nascent $CaCO3$ crystals developed upon a fibrillar organic matrix in the sub-epithelial space.

3) dRAF deposits in some „non-trabecular" stylophyllids appear to differ only quantitatively from typical „trabecular" scleractinians. Taxonomic revision and reassessment of phylogenetic position of this, and perhaps other coral groups, is pending.

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ANATOMY OF PLIOCENE CORAL REEFS ON KITA-DAITO-JIMA

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Kita-daito-jima is a carbonate island located approximately 350 km to the east of Okinawa-jima, lying on a lithospheric bulge of the Philippine Sea Plate subducting beneath the Eurasian Plate. This island has been regarded as an elevated atoll because it is composed of a peripheral rim (up to 74 m in elevation) and an interior basin. The Daito Formation, consisting mainly of dolomitized coral reef deposits, extends over the island. The main body of the Daito Formation comprises reef-core facies that constitutes the peripheral rim and backreef facies exposed at cliffs lining the interior basin. The reef-core facies is represented by coral framestone and much less common coral bafflestone. Well-developed spur and groove systems are observed in several places and horizons at seacliffs. Nongeniculate coralline algal assemblage is dominated by *Lithophyllum prototypum*. The lower backreef facies consists mainly of rudstone and the upper backreef facies is composed of coral framestone and bafflestone with abundant *Halimeda* segments in places. Foraminiferal macroids are commonly found from the lower backreef facies. They are ellipsoidal in shape and range in mean diameter from 1 to 10 cm. They consist of encrusting foraminifer *Acervulina inhaerens* and much less common nongeniculate coralline algae. The nuclei of the macroids are mostly skeletal fragments derived from branching corals.

Paleontological and sedimentological lines of evidence indicate that topographic zonation and distribution of coral morho-groups on Pliocene Kita-daito-jima atoll are basically similar to those on the present-day atolls. But the nongeniculate coralline algal assemblage on Pliocene Kita-daito-jima atoll differs from those on modern coral reefs in overwhelming dominance of *L. prototupum* and few occurrences of *Hydrolithon* and *Neogoniolithon* species. The foraminiferal macroids formed in lagoonal environment of Pliocene Kita-daito-jima atoll, which contrasts well with that the foraminiferal macroids are distributed on a 40-m terrace in the Gulf of Aqaba, where the strong currents are running.

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SPONGE-MICROBIAL STROMATOLITES AND CORAL-SPONGE REEFS RECOVERY IN THE TRIASSIC OF THE WESTERN TETHYS AND NORTHERN PERI-TETHYS BASINS

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Very particular sponge-microbial stromatolites have been found both in the Germanic and in the Alpine Triassic. In both regions, the stromatolites formed within shallow, perilitoral zone; they occur within emerged oolitic bars or upon exposed karstified horizons and mark well the sequence boundary. The stromatolites are composed of interfingered, laminated segments of microbial origin and small (< 0.5 cm) lenticular, spongean bodies. They show variety in morphology ranging between mm-thin flat laminites to 50 cm-thick columnar horizons. As a rule, the thicker, the sponge-richer are the stromatolites. Because of the animal component, the growth of the stromatolites was independent from photo- and geotropic controls. For example, some stromatolites could envelope narrow, 1.5 m-deep, partly closed, karstic fissures penetrating oolitic shoals or grew within cracks piercing tepee-hummocks. Poor preservation of internal structures hinders unequivocal determination of the sponges but the dictyid Hexactinellidea seem to be the main constructor of the Triassic stromatolites. Moreover, the aphanitic and peloidal automicrite carbonate fabrics typical of the spongean-microbial association is recognizable.

The Triassic sponge-microbial stromatolites as Lilliputian metazoan-bacterial buildups could be recognized as a „Lazarus form" enabling survival and recovery of the sponge buildups after the Permian-Triassic extinction. In middle Triassic times (Pelsonian), the hexactinnelid sponges accompanied then by first *Scleractinian* corals gave rise to the oldest *in situ* found reefs in the Western Tethys province.

The best developed Pelsonian sponge-coral buildups occur in the western Upper Silesia where they form patches of some 2-80 meters across and several meters high.

The buildups, display vertical internal succession typical for the „catch up reefs" affected by the highstand shallowing-upward trend in the basin. Generally, the buildup construction began with prostrate colonies of hexactinellid sponges settled over subaqual bioclastic dunes and formed thin (up to 3 cm) veneers perfectly mimicking disposition of the dune surface. Contribution of the sponge component grew upsection and they started to form first biostromal fabrics and then biohermal buildups. With the further growth and relative shallowing, other organisms contributed to reef community; crinoids, brachiopods, serpulids, encrusting forams and the scleractinian branched corals (*Volzeia szulci*). The sponges and *Volzeia* corals built domes and knobs clustered together. When the reef crest reached the surf zone, the encrusting corals (*Pamiroseris silesiaca*) constructed crusts typical of highly turbulent environments.

The incipient Triassic buildups are commonly believed to inhabit deeper settings, but as indicate sedimentary context and the reef structural pattern itself, the Silesian reefs developed within storm wave zone. Early meteoric diagenetic imprints and direct replacement of the reefs by algal fabrics evidence that the reefs grew up within the photic zone. This in turn implies conclusion on a possible zooxanthellate algae-coral association, denied hitherto for the early scleractinian corals.

From the paleobiogeographical point of view, the Silesian reefs belonged rather to the circum-Tethyan reef belt than to the epicontinental Germanic basin.

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SYSTEMATICAL IMPORTANCE OF THE SKELETAL ELEMENTS OF DEVONIAN CYSTIMORPH RUGOSE

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Cystimorphs as all representatives of this subclass are characterized by two forme of the growth: «solitary» and «colonial». The fundamental type of the solitary rugose reproduction was sexual. Colonial rugose had the sexual and asexual reproduction. It is necessary to distinguish the colonial (Phyllipsastrea, Bensonastraea, Mackenziphyllum) and pseudocolonial (Microplasma, Loboplasma, Rhizophylloides, Utaratuia et al.) forms among the representatives of superorder Associata. Some solitary cystimorphs form occasionally the buds, which create the resemblance with the colony. Such formations are not real colony and we suggest to name them quasicolonies. Apparently this formations is characteristic for representatives of some genera.

Skeleton of cystimorphs has a complex structure. It consists of the vertical and horizontal elements. The first of them are the septal apparatus formed by ectoderma of mesenteries. In majority of rugose of this group the septal apparatus is represented with the spines or a number of spines of different structure (holacanth, monacanth, rabdacanth et al.), different forms, length and orientation. The development of lamellar (mainly monolamellar) septa of different structure in marked in other group of cystimorphs, widespread mainly in Devonian (*Digonophyllum, Dialithophyllum, Atelophyllum* and some others). The septal apparatus of some devonian rugose is characterized with combination the lamellar septa with arch lamellar, developed on the periphery of the corallites (*Mesophyllum, Scissoplasma*). The horizontal skeletal elements of all cystiphyllida are repressented with vesicular endothecal formations - dissepiments and also with stereoplasma crusts developed in some genera (Tsyganko, 1972).

The development of these formations testify about important functional peculiarities inherent to the polips of this group cystimorphs (Tsyganko, 1996). Apparently it is the feature of high order. Among the stereoplasma crusts we distinguished earlier the complete and incomplete crusts depending on the degree of their development (Tsyganko, 1972). Functionally complete stereoplasma crusts were connected with basal and lateral ectoderma of polyps. The formation of the incomplete stereoplasma crust is connected with the vital processes proceeding in basal (descendente crust) or in lateral (ascendente crust) ectoderma (Tsyganko, 1981, 1996). Accordingly to the character of dissepimentarium, building the internal cavity of the corallite there are the forms with differentiation of the dissepiments on the sizes, orientation and the forms with two or three distinct zones dissepiments.

It is necessary to use as the basis of the classification of cystimorphs the following features (accordingly to degree of their importance):

1) the form of existence («solitary» and «colonial»)
2) the type of the septal apparatus;
3) the presence or the absense of stereoplasma crusts;
4) the chatacter of stereoplasma crust;
5) the character of the dissepiments

The type of the septal apparatus (acanth or lamellar) is inherent to the different suborders of cystimorph rugose. True coloniality and pseudocoloniality is the features of high order. They characterize suborders or families as a last resort. The presence or the absence of stereoplasma crusts as a degree of development of dissepimentarium are characteristic for the family. It is necessary to consider the peculiarities of septa microstructure, the character of stereoplasma crusts (complete or incomplete - descendent or ascendent) and the character of dissepiments as the features of genus. Structure of septal apparatus (a number of septa and so on), frequence and thickness of the stereoplasma crusts are the features of species.

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ROLE OF THE DEVONIAN RUGOSA IN ORGANOGENIC CONSTRUCTIONS OF THE NORTH OF URALS

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In the Early and Late Devonian for the Elets structural-facial zone of the west slope of the north of Urals characteristic was the development of a chain of organogenic constructions fixing the edge of the East-European (Russian) plain. They are established on the rivers Pechora, Ilych, Lemva, B.Nadota, Lek-Elets, Niyayu, Usa, Kara, on the Bely Nos cape. The role and importance of the Rugosa corals in the organogenic constructions was diverse: from not numerous individuals in the composition of the organisms-reef-lovers to active participation in the construction of the carcass.

In the constructions of the Lochkovian (rivers Ilych, Usa, Kara, Bely Nos cape) the Rugosa are not numerous. Nevertheless, some of them played the role of reef-constructors (Pseudamplexus sp., Rhizophylloides sp., Gyaloplasma agglomerata Zhav.). From the point of view of stages of the fauna development the given complex on the generic level is inherited from the previous Late Silurian one. On the species level these differences are more essential. Most forms of Rugosa are monofacial and do not occur in shallow-water beyond-reef depositions. The Rugosa are also not numerous in the constructions of the Pragian referring mainly to biogermal massifs (six species). Their complex has no common species with the Lochkovian. The role of Rugosa in the construction of the organogenic carcasses was insufficient.

In the Emsian almost all species that continued to exist from the Pragian, experience growth and are numerous in the limestone reef massifs and pre-reef depositions. Besides, there appear about ten new species also actively participating in the formation of the reef constructions and spatially related facias. In the Late Emsian, in the Kojva and Biy time, in relation to almost complete stop of the reef-formation, the Rugosa of corresponding facias are scanty. They are represented by four species having wide geographic and stratigraphic distribution. Considerable widening of the Rugosa fauna is related to the increasing of the processes of reef-formation in the Sibiryakov and Malypatok time (the Eifelian Age), where over ten species are established in the depositions. Greater part of them is characteristic for only reef facias. Among Rugosa-reef-constructors there are representatives of Polyadelphia, Centristela, Crista genera. The species of the above genera are numerous even in the organogenic constructions of the Givetian. The Rugosa are represented here by sixteen species. New taxons are represented by Nadotia genus. In the Eifelian and Givetian time the Rugosa acted as active carcass-constructors.

The reef-formation in the Frasnian is associated to its middle part and the end. In the Middle Frasnian in relation to the prevailing role of the lime-extracting algae in the organogenic constructions the role of Rugosa is insufficient. Here only two forms of wide distribution are distinguished: Disphyllum emsti (Wdkd) and Neostringophyllum sp. The Late Frasnian organogenic construction, with Rugosa participation in its formation, is established only within the Pre-Urals edge foredeep (north of the Chernyshov ridge, River Shernyadeita). The Rugosa are represented here by five species, three of which (Scruttonia bowerbanki (E. et H.), Neostringophyllum isetense Soschk., Heliophyllum (Charactophyllum) elongatum Soshk.) are characteristic of the reef constructions and related facias. In the organogenic constructions of the Famennian the Rugosa are not established.

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A 'FAMILY TREE' OF SCLERACTINIA

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Reconstructing the evolutionary sequences of Scleractinia is a complicated process for it must encompass the fossil records over very great intervals of time, the taxonomic relationships of extant corals, and studies of coral systematics using molecular techniques. The top of the 'tree' (the families of extant corals) is well established, as is the main branches through the Cenozoic, for most of these have extant representatives. However, little is known about the Mesozoic ancestors of Scleractinia, for the majority of families are extinct and their systematic status is controversial.

CORALS: POINTING TO A DIFFERENT EVOLUTION

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Reticulate evolution, where evolutionary trees have branches which converge as well as diverge, is change without improvement. It is evolution driven by physical environment, not natural selection. It is a reconstruction in evolutionary time of what can be observed in geographic space today. It underpins neo-Darwinian evolution but operates according to different rules. It brings solutions to many deep-seated taxonomic, biogeographic and systematic problems that trouble biologists today: it must be taken into account if we are to understand how the natural world is organised and how evolution occurs.

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HOW MANY *CARYOPHYLLIA* SPECIES LIVED IN THE PLIO-PLEISTOCENE MEDITERRANEAN? SEGUENZA'S TAXONOMY REVISED

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The low biodiversity of the present-day deep-water corals from the Mediterranean is well known. It's also known that, during the Plio-Pleistocene, the deep waters of this semi-enclosed basin were inhabited by an higher number of species, most of them similar to the Recent north-eastern Atlantic ones. However, how many deep-water coral species indeed thrived in the Mediterranean? How many among them are still living?

We can't answer these questions without clarifying the taxonomy of the Mediterranean Plio-Pleistocene corals, which dates back to the 19th century. In fact, at that time the scanty data on the scleractinians intraspecific variation led scientists to „split" taxa.

According to Seguenza (1864, 1880), about 20 *Caryophyllia* species would characterize the bathyal Plio-Pleistocene deposits cropping out along the Messina Strait sides. In order to evaluate the intraspecific variation of the species Seguenza analyzed, we examined many *Caryophyllia* specimens collected in the stratigraphical layers he mentioned, and we compared them with the Recent species from the Mediterranean and the north-eastern Atlantic. Besides the conventional macroscopic skeletal characters, generally used to distinguish living species, we focused on some microscopic skeletal features and realized that the outer thecal micromorphology is important in identifying some *Caryophyllia* species.

From the comparison between the Plio-Pleistocene and Recent specimens turns out, as previously suggested by other Authors, that some species of *Caryophyllia* established by Seguenza (1864) are morphotypes of the same taxon rather than true species. But, at the same time, the early results of our revision lead us to consider some living north-Atlantic species as synonyms of some fossil taxa previously established by Seguenza (1864). In particular, according to the ICZN Priority Principle, we propose to consider the living species *C. calveri* and *C. sarsiae* respectively junior synonyms of two Plio-Pleistocene Seguenza's taxa: *C. aradasiana* and *C. coronata*.

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A MESSINIAN REEF AT THE NORTHERN LIMIT OF THE MEDITERRANEAN CORAL REEF ZONE (NORTHERN APPENNINES, ITALY)

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New investigations have been carried out in the area next to the village of Vigoleno (Piacenza, northern Appennines), where the presence of a Messinian coral reef was previously mentioned by Barrier et al., 1994.

Due to tectonic adjustments, the Vigoleno reef has been strongly fragmented and blocks and outcrops of different size are scattered within a 4 Km^2 area. However, the recent discovery of new and quite complete outcrops allowed to better describe this reef, so far the northern coral reef of the Mediterranean region during early Messinian time.

Three different facies have been recognized and described according to their biotic components (reef-building organisms, associated fauna), growth fabric and sediment types, and a depositional model is presented.

- The shelf-edge is represented by a *Porites* pillarstone and abundant coralline algae. *Porites* is largely the main reef-building coral, associated with few colonies of *Siderastraea*. In particular, columnar and rod-like *Porites* colonies characterize the upper and shallower part of this facies whereas branching morphologies, reduced in size and with thinner sticks, dominate in the lower and relatively deeper part. Coralline algal crusts are extremely abundant (*Spongites*, *Lithophyllum*) and often associated with encrusting foraminifera (*Miniacina*). These crusts strongly bind coral colonies or grow directly on the substrate forming discontinuous crustose frameworks. The associated fauna is mainly represented by benthic foraminifera, molluscs, bryozoans, echinoids, ostracods and serpulids. Intra-reef sediment consists of a packstone-wackestone.
- The proximal slope facies is characterized by a dense *Porites* sheetstone, with well developed platy colonies. Frequent but less abundant are coralline algae and encrusting foraminifera. The associated fauna is similar to the shelf-edge. The sediment mainly consists of a wakestone-packstone.
- The distal slope facies is characterized by abundant rudstone associated with a gradual but significant decrease of *Porites* colonies in growth position. Coralline algae, especially melobesioids, often form small ellipsoidal, columnar rhodoliths. The deeper part of this facies is characterized by a fine pelitic mudstone with planktic foraminifera and ostracods, including the species *Pokornyella italica*, a typical „Sahelian" marker that confirmed the early Messinian age of the Vigoleno reef.

Despite its location at the northern limit of the coral reef zone, the depositional model of the Vigoleno reef and its distinct zonation of *Porites* growth morphologies, are strictly similar to those typical of Mediterranean early Messinian reefs. Only coralline algae, very abundant with respect to other contemporaneous reef sites, suggest that the Vigoleno reef most probably developed under climatic conditions close to the critical limit for coral reef growth.

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LATE PERMIAN RUGOSE CORALS FROM A SEAMOUNT LIMESTONE BLOCK IN SOUTHWESTERN XIZANG (TIBET)

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An abundant reefal coral fauna was discovered from an exotic block at Gyanyima, Zanda County, Southwest Xizang (Tibet). The strata containing corals are mainly composed of gray, yellowish gray, and purplish gray bioclastic limestones that were probably a seamount deposit in the Paleotethyan Sea between the Gondwanan and Cathaysian continents. Preliminary study indicates the rugose fauna contains only compound taxa including six species of *Waagenophyllum*, two species of *Liangshanophyllum*, and two species of *Ipciphyllum*, which all belong to the subfamily Waagenophyllinae. These taxa are typical warm-water Tethyan elements. They are accompanied by a highly-diversified foraminiferal fauna that includes *Reichelina cribroseptata* Erk, *Reichelina changhsingensis* Sheng et Zhang, *Colaniella fusiformis* Song, *Colaniella parva* (Colani) and others. These foraminiferids indicate a Late Permian, Changhsingian age. A coral reef, with *Waagenophyllum* as the major skeletal reef builder, occurs in the uppermost part of the sequence. This is possibly one of the latest Permian rugose coral reefs in the world. Furthermore, one species of *Ipciphyllum* occurs in the upper part of the sequence. This is only known record of massive rugose corals in rocks of Changhsingian age and is the youngest Permian occurrence known to date.

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RARE EARTH ELEMENT GEOCHEMISTRY OF PALEOZOIC STROMATOPOROIDS AND EXTANT SPONGE SKELETONS

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Stromatoporoids are widely considered to be the calcified basal skeletons of sponges. However, fundamental questions regarding taxonomy, phylogeny, and even original skeletal mineralogy remain to be answered for many ancient examples. We measured concentrations of rare earth elements and yttrium (REE+Y) in several Late Devonian stromatoporoids from the Canning Basin, Western Australia and in extant sponges with calcified basal skeletons [e.g., *Spirastrella* (*Acanthochaetetes*) *wellsi*] and with calcite spicular skeletons (calcareous sponges within the Calcaronea and Calcinea). Differences in stable O and C isotope incorporation in extant calcareous sponge spicules and demosponge basal skeletons suggest important differences in biomineralization processes in the groups. Such differences in biomineralization are expected to have effects on trace element distributions, and trace element distributions are preservable to some degree even in recrystallized fossils. Rare earth elements were analysed because they have predictable behaviour in seawater leading to an easily recognizable, distinctive distribution that can be preserved in skeletal carbonates.

The shale-normalized REE+Y distribution of *Acanthochaetetes* basal skeletons has seawater-like features, including: 1) high REE concentrations (mean ΣREE = 1.36 ppm); 2) uniform light REE depletion (mean $Pr_{SN}/Yb_{SN} = 0.25$) compared to 0.21 for ambient seawater; 3) negative Ce and positive La anomalies; 4) high Y/Ho ratio (mean 49.9); and 5) positive Gd (mean Gd/Gd* = 1.14) and Er (mean Er/Er* = 1.16) anomalies. Shale-normalized REE+Y patterns of calcareous sponge spicules (Calcaronea and Calcinea) are highly variable, less coherent, and much lower in concentration (mean ΣREE = 79 ppb). The specimens have seawater-like LREE depletion ($Pr_{SN}/Yb_{SN} = 0.19$-0.33), positive La and negative Ce anomalies, and superchondritic Y/Ho ratios (Y/Ho > 39.3), but pronounced positive Nd and negative Gd anomalies are atypical of seawater. Hence, although Calcaronea and Calcinea cannot be distinguished on the basis of REE behaviour, REE geochemistry distinguishes them from *Acanthochaetetes*. We hypothesize that *Acanthochaetetes* skeletons take up cations in equilibrium with ambient seawater, with no active Ca^{2+} transport by the sponge. On the contrary, the REEs in the spicules of Calcarea indicate that biomineralization is partially isolated from ambient seawater, which is consistent with intercellular formation in a sheath, and that sclerocytes play some role in providing Ca^{2+} ions to the site of mineralization. The transport mechanism in the Calcarea discriminates against REE in a non-uniform way.

Shale-normalized REE+Y distributions of clean, non-dolomitized tabular Devonian reefal stromatoporoids are seawater-like and, hence, are comparable to those of extant *Acanthochaetetes*. The patterns are characterised by 1) high REE concentrations (mean ΣREE = 4.18 ppm); 2) light REE depletion (mean $Pr_{SN}/Yb_{SN} = 0.74$); 3) negative Ce and positive La anomalies; 4) high Y/Ho ratio (mean 40.5); and 5) positive Gd (mean Gd/Gd* = 1.17) and Er (mean Er/Er* = 1.12) anomalies. The relatively poor LREE depletion results from secondary diagenetic HREE loss. Data are consistent with tested stromatoporoids being calcite basal skeletons of calcified demosponges. REE+Y patterns of branching stromatoporoids differ somewhat, suggesting that trace element geochemistry may help delineate different taxonomic groups within the extinct sponges.

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ARE PERMIAN REEF FRAMEWORKS RECORDERS OF CLIMATE CHANGE – FACT OR FICTION?

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The Permian period is characterized by the global change of climate from icehouse to greenhouse, associated variations in paleoceanographic circulation patterns, and changes in the reef framework composition and preservation. Thus, the fundamental question arises, whether climate change did influence reef development directly or indirectly.

After rigorously testing the Phanerozoic reef record, Kiessling (2001) showed that neither the total reef paleolatitude nor the width of the tropical reef zone is correlated with paleotemperature changes. Thus, the distributional patterns of reefs on global scale seem to be unaffected by climate change. Recent advantages in carbonate sedimentology have shed more light on significant depositional differences between photozoan (sensu James 1997) and heterozoan (sensu James 1997) carbonate-secreting communities. Photozoan assoziations occur in tropical depositional systems and often, but not exclusively, build up rimmed platforms, while heterozoan associations flourish in cool- to cold-water mixed-carbonate siliciclastic deposits and accumulate on high-energy ramps. Focusing on Permian reef frameworks, four carbonate factories can be recognized. Dominated by the photozoan association are the carbonate factories of (1) the tropical Tethys and of (2) tropical epeiric basins. Heterozoan associations prevail on cool-water shelves and, probably, in nutrient-rich tropical settings. Finally, the carbonate factory of isolated Panthalassan platforms is not well constrained because of a lack of data due to subduction of seamounts. The integration of outcrop, slab and thin-section data from representative reefs of these carbonate factories shows different ratios of constructive and destructive processes and, thus, variations in the preservation of the reef framework. After detailed (micro)facies analysis, I speculate that framework composition and preservation of Permian reefs was partly controlled by climate.

Therefore, the potential of Permian reefs as climate archives is two-fold: (i) large scale distributional patterns are insensitive and (ii) small-scale compositional changes of the reef framework indeed provide proxy data for the interpretation of climate change.

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DEEP OR SHALLOW – A REAPPRAISAL OF THE PALEOBATHYMETRY OF THE CAPITAN REEF (MIDDLE PERMIAN, SOUTHWESTERN USA) IN A GREENHOUSE WORLD

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The Capitan Reef has suffered minimal structural deformation and, thus, can be studied by the investigation of its superb outcrops. By the way, most researchers have meanwhile accepted the dynamic evolution from a ramp to a rimmed platform. Nonetheless, intense and controversial debates center around the fundamental question of the platform architecture during distinct time slices, especially for the Upper-Capitan massive during late Yates and Tansill times (Middle Permian, Guadalupian). Existing endmembers of depositional models comprise a seaward dipping outer shelf and reef as syndepositional shelf topography or a postdepositional compaction-induced subsidence of a prograding platform. Consequences of the interpretation are fare-reaching for paleobathymetric interpretations and significantly influence estimates of the absolute water depth of the reef crest. Paleoecology and sedimentology may be useful to overcome the problem.

We test both depositional hypothesis by using paleontological, sedimentological, and geochemical proxy data, which form the synthesis of own new observations (by Al Fagerstrom) and the new body of data published in SEPM Spec. Publ. 65. Our most important reference locality is the famous outer shelf-reef transect at mouth of Bat Cave Draw, additional data derive from Dark Canyon and Hackberry Draw.

Depending on the different interpretation of the depositional profile, water depth of the reef crest varies between 15 and 35 meters. In addition, we confirm the model that the reef crest was never subject to subaerial exposure during the investigated time slice. Within a complex network of control mechanisms, we present evidence that the long-term transition from Early Permian icehouse to Middle Permian greenhouse climate with low-amplitude sea-level changes was a critical factor for the evolution of the Capitan Reef.

PRESENT DAY AND FUTURE OF FOSSIL CORALS RESEARCH

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Responses to enquiry „where we are?" (Wrzołek 2002b), sent by about 50 students of fossil cnidarians and sponges, reflect pessimistic opinions of our community on future of our research area. The respondents generally express low expectations of improved funding, but still worse is the fact, they confirm generally low or null number of our scientific successors. This is sad: we are a very small community, and as paleontologists we know that small populations are prone for extinctions. Are there any chances of recovery?

In my opinion our best hope is not so much in what we can get from the society and from the politicians, but in establishing and implementing some improved standards of our scientific activities. At the core of this question is the protection and accessibility of our collections. So many times in the past we witnessed destruction, either malicious or accidental, of valuable material, so many times the material we are looking for happens to be „misplaced or lost". This occurred in the past, this will certainly happen in the future, we like it or not, but now we have a chance to give extra protection to our collections by carefully illustrating all the material studied and by sharing it in digitalized version. We may easily immortalize our fragile thin sections by using a scanner of high resolution, with device for transmitted light (nota bene scanners can also be used for obtaining fairly good photographs of fossils exteriors). Archivisation and sharing of data thus obtained may be the main factor of survival (or future revival) of paleontology. Therefore let us accept the idea: no new papers without attached library of good illustrations!

Moreover, I think we can easily agree upon standards of digitalization of our data, so we can collectively create the new „supertreatise" with as much data and as high resolution – in any aspect: taxonomy, geography, stratigraphy, ecology - as we only want to have (Wrzołek 2002a). This task will only benefit if we will be able to upgrade our past papers to these new standards.

Another question worth considering might be digitalization of older paleontological literature. Logical consequence of such a step would be revision of these papers and review of historical collections, with good chance for recovery of some „misplaced or lost" specimens.

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MASSIVE PHILLIPSASTREIDAE IN THE HOLY CROSS DEVONIAN

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The massive Phillipsastreidae are recorded at two distinct horizons in the Holy Cross Mts, central Poland. The first occurrence is in the Lower to Middle Givetian interval, with two species: *Phillipsastrea hennahii* and *Ph. sobolewi*. The Upper Givetian to Lower Frasnian interval is with solitary and dendroid phillipsastreid species only. Middle and, above all, the Upper Frasnian is with the massive species the most diversified. First comes the assemblage with dominating species of the *Phillipsastrea ananas* group (*Ph. ananas, Ph. macrommata, Ph. limitata*) in more open-marine settings, and with various subspecies of *Smithicyathus lacunosus* in lagoonal environments. The subsequent topmost Frasnian assemblage is with numerous species of *Frechastraea* (mostly *F. pentagona* and *F. goldfussi*), common is also *Medusaephyllum progressum.*

The material studied contains over 400 colonies, classified into five genera and over 20 species; it was collected in about 30 outcrops. The main data on these species and the sampling locations are summarized in a table below, with numbers representing measured colonies obtained at each point, or of each of the most common massive (and phaceloid) phillipsastreid species of the Holy Cross Devonian. The abbreviated genera are:

Ph. - Phillipsastrea, F. - Frechastraea, Sm. – Smithicyathus and *M. – Medusaephyllum.*

geography	main species		main outcrops			
			location		ecology	age
CENTER Kielce 221	*Ph. ananas*	19				
	F. goldfussi	20	Grabina	75	forereef	U Fra
	Sm. lacu. lacunosus	39	Panek	53	lagoon	U Fra
	Sm. lacu. smithi	29	Psie Górki	40	E: forereef	M Fra
	Ph. limitata	14			F,G: deeper for.	U Fra
	Ph. macrommata	22	Wietrznia	21	forereef+deeper	M+U Fra
	F. pentagona	15	Zgórsko	16	lagoon	U Fra
	F. sanctacrucensis	13				
NORTH Skały 40	*Ph. hennahii*	17	Laskowa	17	deeper forereef	M Giv
	M. progressum	12	Skały-Włochy	7	deeper forereef	L Giv
	Ph. sobolewi	7	Śluchowice	8	deeper forereef	U Fra
SOUTH Kowala 149	*Ph. ananas*	31				
	F. goldfussi	13	Jaźwica P, R	19	P: forereef	U Fra
	Ph. „intermedia"	14			R: deeper forer.	
	Sm. lacu. lacunosus	12	Kowala G	91	forereef	U Fra
	Ph. limitata	13	Kowala road cut.	29	deeper forereef	U Fra
	Ph. macrommata	25				
EAST Janczyce 23	*Ph. dybowskii*	11	Sobiekurów	12	deeper forereef	U Fra (?)

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TABULATE CORALS FROM THE TOURNAISIAN OF THE CRACOW AREA, POLAND

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Tabulate corals from the Tournaisian of the Cracow area are very rare and due to this they have been poorly recognised. There are only two papers about Tournaisian tabulate faunas.

The investigated material (10 incomplete coralla) comes from exposures located ca. 30 km northwest from Cracow, in the vicinity of Krzeszowice. Carbonate platform deposits occur there; most of them represent intertidal environments. Only one unit – the spiculitic limestone (Upper Tournaisian, *G. cuneiformis* Zone) represents intra-shelf deposits. This lithosome contains numerous fossils, including bryozoans, brachiopods, chetetids and corals (rugose and tabulate). A small assemblage of Tabulata has been recognised in these beds, including three taxa representing the Favositida: *Michelinia tenuisepta* (Philips), *Roemeripora nowinskii* Zapalski and *Roemeripora* sp., and two species representing the Syringoporida: *Verolites polonicus* Nowiński & Zapalski and *Pleurosiphonella* cf. *virginica* (Nelson).

The investigated fauna reveals some similarities with the fauna from Belgium and Transcaucasia described previously, it also contains, however, endemic elements.

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THE SCLERACTINIAN SPECIES CONUNDRUM

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The widely recognized difficulty in defining the scleractinian species may be attributed to two factors: the objective nature of these elusive organisms, and the subjective impact of us as researchers. Shifts in three paradigms—nomenclature (N), ethics (E) and taxonomy (T)—can reduce our negative impact on the problem. This focus on NET results requires introspection on the personal, inter-colleague and international associations levels. The International Code of Zoological Nomenclature offers a tool for regulating nomenclature procedures, but it has been troublingly ignored recently. Ethical issues require appeals to our conscience, recognition of the necessity of publishing following peer review by specialists and use of quality tests. Taxonomy can be facilitated by constantly updated species notions and approaches. Present-day knowledge on fossil and extant Scleractinia suggests an eleven-dimensional species model. Together with the three dimensions of physical space, this model incorporates the following dimensions: time, variability, long generation times and propagation through fragmentation, synchronous multispecific spawning, hybridization, ocean currents, symbiosis and life in aquaria. The model is open to future development. The cohesion species concept is helpful for better taxonomic resolution. Reverse actualism has a synergistic effect on identification and systematic. Suggestions for future strategies in scleractinian species taxonomy are offered.

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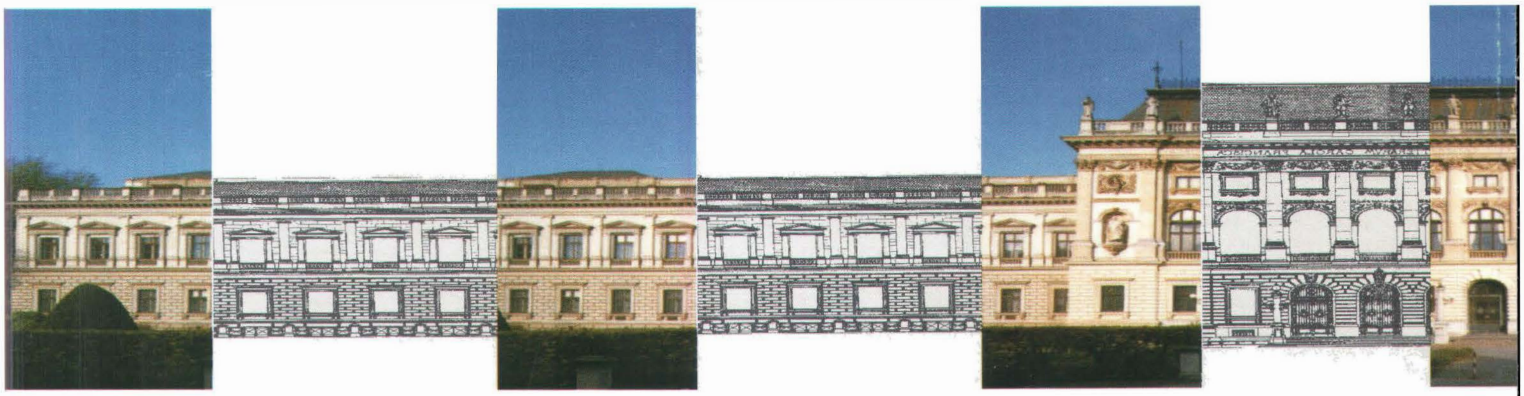

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