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Upper Triassic Solitary Corals from the Gosaukamm and other North Alpine Regions

By

E. Roniewicz

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durch das w. M. H. Zapfe)

Summary

This paper describes 12 species of solitary corals from limestones of the Norian of the Gosaukamm, the Norian of Aussee vicinity, the Norian of Hochschwabgebiet, the Rhaetian of Hochkoenig and from the Salzburg vicinity, and a taxon from the marly Zlambach beds of Kesselwand–Rohrmoos. The fauna represents highly homeomorphic corals belonging to *Distichophyllia* (*D. maior* sp. n., *D. tabulata* sp. n.), *Cuifia* (*C. marmorea* (Frech), *C. columnaris* sp. n., *C.* sp. A), *Stylophyllopsis* (*S. polyactis* Frech, *S. lindstroemi* Frech, *Stylophyllopsis* ?. sp. A), and three new genera: *Coryphyllina* (*C. rhaetica*), *Distichopsis* (*D. vesiculoseptata* sp. n., *D. minor* sp. n.) and *Distichomorpha* (*D. robusta* sp. n.). The corals are similar in shape, size and skeletal density. The inferred habitats were situated in water of low dynamics and low sedimentation rate.

Key words: Scleractinia, Triassic, Alps, Tethys, taxonomy, paleoecology.

Introduction

This paper deals with solitary corals (Table 1) constituting a part of morphologically differentiated coral fauna of the Upper Triassic limestone facies of the Northern Calcareous Alps. The corals concerned intrigue with their conspicuous dimensions and homeomorphy.

Table 1. List of described taxa of the Scleractinia

Taxa	Regions						
	I	II	III	IV	V	VI	VII
Caryophylliina							
Genus *Cuifia* MELNIKOVA (page 13)							
1. *C. marmorea* (FRECH)	+	+	+				
2. *C. columnaris* sp.n	+			+	+		+
3. *Cuifia* sp. A	+						
Genus *Coryphyllina* gen. n. (page 24)							
4. *C. rhaetica* sp. n							+
Genus *Distichophyllia* CUIF (page 25)							
5. *D. maior* sp. n						+	+
6. *D. tabulata* sp. n	+			+	+		
Genus *Distichopsis* gen. n. (page 31)							
7. *D. vesiculoseptata* sp. n	+						
8. *D. minor* sp. n	+						
Genus *Distichomorpha* gen. n. (page 35)							
9. *D. robusta* sp. n	+						
Stylophyllina							
Genus *Stylophyllopsis* FRECH (page 36)							
10. *S. polyactis* FRECH	+						+
11. *S. lindstroemi* FRECH	+						+
12. *Stylophyllopsis*? sp. A	+						

I Gosaukamm, II Sandling, III Dachsteinplateau, IV Hochkönig, V Hochschwabgebiet, VI Adnet vicinity, VII Kesselwand-Rohrmoos and Schneckengraben

In the Northern Calcareous Alps, corals are known beginning from the Lower Norian up to the Upper Rhaetian and played a more or less prominent role among the rock-building organisms in diverse facies: Dachstein limestones, Koessen limestones, Hallstatt limestones, marly Zlambach Beds and Upper Rhaetian reef limestones.

The corals from the limestone facies are less known than those from marls of the Zlambach Beds. This is caused by technical difficulties in obtaining material for investigation as coral-bearing limestones, especially those from the Dachsteinkalk, are not easily accessible and corals can rarely be safely isolated from the rock. Some corals from the Dachsteinkalk were investigated paleontologically by FRECH (1890: Gosaukamm: Donnerkogel), some were considered by ZANKL (1969: Hohe Goell), and recently, some were illustrated by WURM (1982: Gosaukamm). Corals from Rhaetian reefs of the vicinity of Salzburg (Hallein and Hintersee reefs) were considered by SCHAEFER & SENOWBARI–DARYAN (1978), SCHAEFER (1979) and SENOWBARI–DARYAN (1980).

The present investigations focus on solitary corals from the Dachsteinkalk limestones of the Gosaukamm Range from the Lower to Upper Norian (Lower Rhaetian?) stratigraphical interval (Fig. 1, Table 2). Any precise stratigraphical location of the findings is precluded due to the fact that the material in majority was picked up from the rubble.

Complementary data have been obtained from examination of corals from the Sevatian of the Hochkoenig massive and from the Upper Norian (Lower Rhaetian?) of the Hochschwabgebiet, from Hallstatt limestones of the Norian from the Aussee vicinity, and from Rhaetian reefs of the Salzburg area. A description of an unknown taxon from the Zlambach Beds of Rohrmoos–Kesselwand completes the current knowledge of the solitary corals of the Norian–Rhaetian of the Alps.

Information on the geological situation, origin and fauna composition of Dachsteinkalk of the Gosaukamm can be found in ZAPFE (1960, 1962), FLUEGEL (1960) and WURM (1982), some information on the coral-bearing beds of the Hochschwabgebiet in HOCHENEGGER & LOBITZER (1971), and those of Hochkoenig in ZAPFE (1962). Detailed geological investigations on Upper Rhaetian reefs of the Salzburg area have been accomplished by SCHAEFER (1979) and SENOWBARI–DARYAN (1980). Development of Triassic limestone facies of the Alpine region, in detailed overview, and general aspect of formation of Triassic reef facies in the Tethys realm can be found in FLUEGEL (1981 and 1982, respectively).

SCHAUER (1983) documented with conodonts the Upper Norian and Rhaetian in the highest part of the Donnerkogel (Gosaukamm) sequence and has recently determined the stratigraphical position of the Gosaukamm faunistic sites (Fig. 1: sites and stratigraphy after M. SCHAUER (1991), unpublished, *versus* L. KRYSTYN (1994) stratigraphy, unpublished).

Microstructural Glossary

Triassic primary (aragonitic) septal microstructures of Scleractinia, discussed in structural, taxonomical, and phylogenetic aspects by RONIEWICZ (1989), RONIEWICZ & MORYCOWA (1989), RONIEWICZ & MORYCOWA (1993), are differentiated into 4 types that might be defined as follows:

– minitrabecular (named also: thin-trabecular, fine-trabecular, distichophylliid) type: septa composed of fine trabeculae (20–50μm) disposed at the midline monoclinally or fanwise; laterally to the midline, the septum is composed of fibrous stereome. The fibres are normal to the midline or organized into bunches of a structure more or less centered up

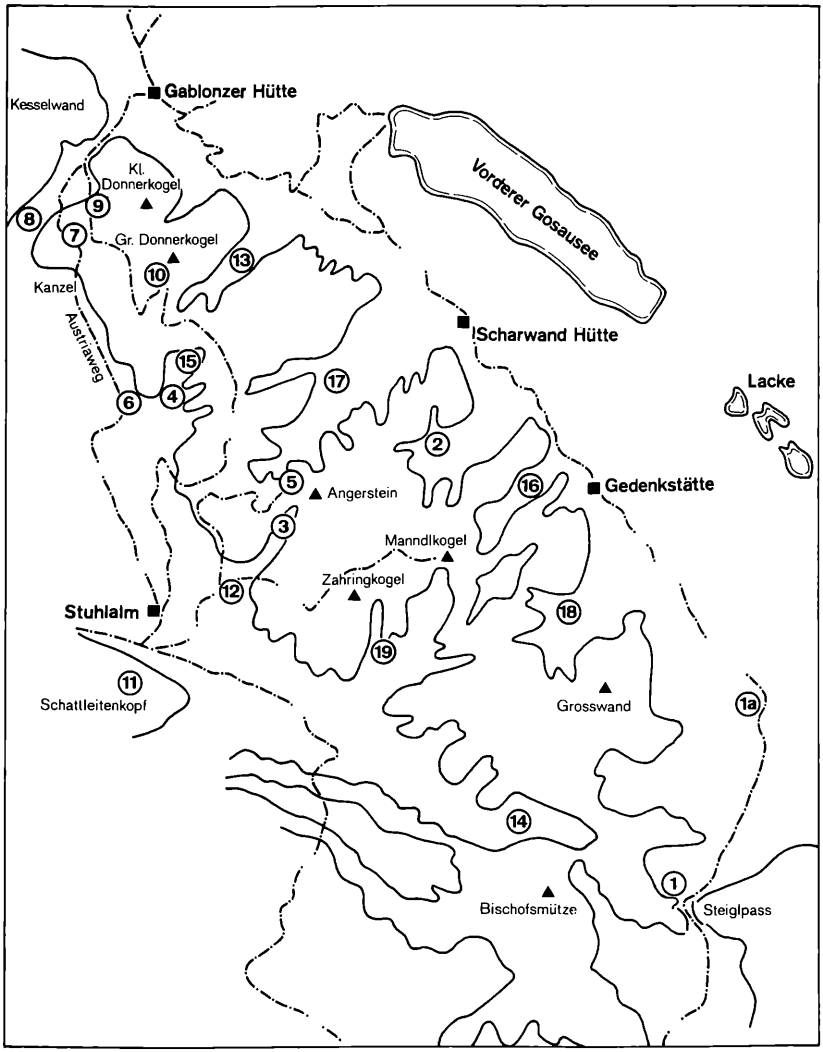


Fig. 1. Faunistic sites in the Gosaukamm (see also Table 2; location of sites and stratigraphy after M. SCHAUER 1991, unpublished; L. KRYSTYN commentary 1994 (K:). **1** Oberes Armkar, A; **1a** Eisgrube (in the Armkar), L; **2** Garmkar, Se; **3–6** Angerstein, USe-R; **7** Donnerkogel-Austriaweg, LR (K:Se); **8** Halde-Schneckengraben, USe-LR? (K:USe); **9** Halde Gr. Donnerkogel, USe-LR; **10** Point 92, ca. 50 m below Donnerkogel, LR (K:USe); **11** Schattleitenkopf, USe; **12** Schneegrube, USe; **13** Steinriese, Se-LR? (K:Se); **14** Stuhlloch, Se (A?); **15** Sulzkar, USe (LR?) (K:USe); **16** Wasserriese = Wasserkar, Se; **17** Weitschartenkar = Weitkar, Se; **18** Weitgriess, Se; **19** Weite Zahring, Se; **Go** Gosaukamm, indefinite, N. A Middle Norian; L Lower Norian; LR Lower Rhaetian; N Norian; R Rhaetian; Se Sevatian; USe Upper Sevatian; [58] site field number

Table 2. Distribution of solitary corals in the Gosaukamm sites

Taxa	Sites											
	1a	1	2	11	12	13	14	15	17	18	19	Go
1. *Cuifia marmorea*						+	+		+		+	
2. *C. columnaris*	ca +		+			+		+	+			+
3. *Cuifia* sp. A										+		
4. *Distichophyllia tabulata*	+			+		+..	+	+				
5. *Distichopsis vesiculoseptata*												[58]
6. *D. minor*	+					+						
7. *Distichomorpha robusta*	+											
8. *Stylophyllopsis polyactis*					+	+				+		
9. *S. lindstroemi*						+						
10. *Stylophyllopsis*? sp. A	+											

For explanations see Fig. 1

to formation of lateral trabeculae oriented normal to the midline. Superfamily: Reimaniphyllioidea.

– thick-trabecular (medium & thick-trabecular) type: the septa are composed of unique kinds of elements – trabeculae more than 50 µm (usually above 100 µm) in diameter, independent in origin from the wall, in monoclinal of fanwise arrangement. Superfamily: Thamnasterioidea.

– fascicular (stylophyllid) type: the septa, are formed of septal spines which, as the entire skeleton (septa, wall, dissepiments), are composed of uniform bundles of fibres and are structurally continuous with other parts of the skeleton. Suborder: Stylophyllina.

– pachythecal type: the septa are composed of a monoclinal series of trabeculae originated on the wall; centripetal fibres of the wall are organized into more or less definitely axiferous horizontal elements arranged in vertical tracts. Suborder: Pachythecaliina. Not considered in the paper.

Each of the two suprafamilial taxa considered display one of the following two types of wall structure:

– fibro-radial wall: composed of radially disposed fibres, supposedly initiated in an invagination of the distal portion of the polyp column, like epitheca of recent corals (Barnes, 1972; Stolarski, 1995). Fiber growth is centripetal. Suborder: Caryophylliina, superfamily: Reimaniphyllioidea.

– scaly wall: composed of variably oriented and variably shaped bundles of fibres accreting successively in a scaly manner to the preceding

ones (RONIEWICZ, 1989, Plates 42 and 43). The wall skeletal tissue continues into the septal tissue. Suborder: Stylophyllina.

In the corals under consideration, the microstructural types are recognizable only in traces preserved in recrystallized skeletons.

Material

Collections

The majority of the investigated specimens belong to the Naturhistorisches Museum Wien (NHMW) collections from the Gosaukamm completed mainly in the years 1959–1966 by H. ZAPFE, E. FLUEGEL, H. KOLLMAN, and in the years 1990–1991 by M. SCHAUER, and the collections from the Hochkoenig completed by H. ZAPFE, in the fifties. Corals from the Hochschwabgebiet, housed at the Geologische Bundesanstalt Wien (GBA), were collected by H. LOBITZER. A small part of the material coming from the Rhaetian reefs of Adnet was collected by the author in 1981 and belongs to the collection of the Institute of Paleobiology, Warsaw (ZPAL).

Preservation

Skeletons are completely recrystallized, nevertheless, the architectural features and indicative features of the septal microstructure are recognizable. The corallum structure was examined in thin sections. Specimens are represented by fragments of complete coralla and only a few of them can be interpreted as debris; it is worth mentioning that solitary corals are, in general, extraordinary rare among the detritus.

Pellicular walls in *Distichophyllia*, *Distichopsis*, *Distichomorpha* and thin wall in large *Stylophyllopsis* are abraded, calices and corallum sides can be affected in some degree by boring organisms. At the same time, most of coralla of *Cuifia* retain their solid walls showing advanced micritization of the surface. The damaged parts of skeletons are coated with epibionts. Elementary intraskeletal cavities (EC) in the interseptal space, from above and below limited by dissepiment skeleton, form natural voids which can be filled with cement or, rarely, with sediment. Sediment infilled EC occur rather in the surficial parts than at the middle of the corallum.

From 40 specimens investigated, 33 are from the Gosaukamm. Among over 60 thin sections examined, more than 20 allow for observation of deposit associated with corals.

Lithology and Remarks on Organisms Relationships

When observed in thin sections, the corals considered are associated with the following types of rock:

1. In the Gosaukamm and Hochkoenig, the corals occur in hard, light-grey limestone. Coral skeletons are in contact with sediments of different microfacies types:

(a) singular, dispersed or aggregated EC are filled with biomicrite or biopelmicrite containing radiolarians, ostracods, sponge spicules, peloids. From the spectrum of the microfacies presented by WURM (1982, p. 213, Plate 30: fig. 4, sequence underlying the Dachstein reef limestone) it fits into biomicrite with radiolarians of a bioclastic wacke/packestone type;

(b) the above type passes into similar biodetrital limestone completed with larger irregular grains of skeletal origin, fragmented thin brachiopod shells, sporadic small bivalve fragments, gastropod and ammonite shells and grapes, lithoclasts of biopelmicrites and other finedetrital deposits. The sediment frequently fills hollows in the surficial part of skeletons, sometimes it fills EC. Microfacies: wacke/packestone, passing into packe/grainstone;

(c) in places well sorted biodetrital packestone can be observed in intercalations;

(d) the above types can pass into boundstone with blue-green algae crusts, algae, tabulozoans, calcisponges, and incrusting corals. More or less abraded (see above) coral skeletons are in contact with the sediment mentioned or are incrusted by: corals, "bryozoans", algal crusts, serpules, and others.

2. brownish breccious limestone in the Gosaukamm: biomicritic and other lithoclasts divided by radiaxial fibrous calcite.
3. organodetrital light-grey packestone from the Dachsteinplateau.
4. dark-grey limestone in Hochschwabgebiet: lithology as 1a and 1b.
5. white limestone from Adnet (Tropfbruch): lithology as 1a and 1b.

Triassic Pattern of Solitary Coral Structure and its Ecological Implications

The present paper deals with solitary corals from limestone facies to show their taxonomical diversity hidden in homeomorphic external shape. A striking feature of the solitary coral taxonomic/microstructural spectrum is a great variability and high frequency of corals from the minitrabecular group, and a small share of the stylophyllid group (see Glossary and Table 1). So, the composition of the coral fauna considered

differentiates it from solitary coral fauna of Rhaetian marly facies (compare RONIEWICZ, 1989). In the material from the limestone facies, the minitrabecular group comprises 8 species (genera *Cuifia*, *Distichophyllia*, *Distichopsis* gen. n. and *Distichomorpha* gen. n.) while the stylophyllid group is represented by 3 species (*Stylophyllopsis*). For comparison, in the Zlambach Beds, the minitrabecular group is represented only by 4 species of a solitary growth form (*Cuifia* (originally described as *Coryphyllia*), *Coryphyllina* gen. n., and *Distichophyllia*; *Distichoflabellum* represents in reality a phaceloid growth form) while the stylophyllid group is differentiated into 9 species (*Stylophyllum*, *Stylophyllopsis*, *Gigantostylis*). Procyclolitid large solitary forms and incipient colonies, so typical of the Zlambach Beds, are rare in Norian limestones and are lacking in the examined material.

The corals considered are interesting for the following set of features: large dimensions, cylindrical shape, shallow calices, transversely wrinkled walls, high skeletal density.

Dimensions

As to the corals considered, with the exception of *Cuifia* sp. A and *Stylophyllopsis lindstroemi*, all adult coralla diameters exceed 20 mm and their heights are larger than 40 mm, so they belong to the large corals. Especially large are *Cuifia marmorea*, *Distichophyllia tabulata*, *Distichopsis robusta* and *Stylophyllopsis*? sp. A, representing the largest diameters known in cylindrical corals. In the literature, there are few Triassic corals of comparable dimensions and high number of septa known: *Montlivaltia gigas* VINASSA DE REGNY (1915, p. 98, Pl. 70: fig. 12, 13), with larger diameters equalling from 55 to 75 mm and septal apparatus of ca. 200 septa and *Montlivaltia* sp. 3 described by WILCKENS (1937, p. 176, Pl. 4: fig. 3) having ca. 100 septa at the diameter of 63 × 80 mm.

Corallum Morphology

The coralla are tall, cylindrical, often with proximal end curved; ultimate diameter is attained early in the ontogeny. The walls are transversely wrinkled, and in a majority of forms – epithecal in origin. The calices are not deep. The fossae are long.

Skeleton Density

Septal apparatus is composed of septa of 4–5(6) size orders, septa S1-S3 being subequal in length. Generally, septa are thin and densely packed, with rare exceptions (*Distichomorpha robusta*; Coral indet.). The

ornamentation of septa is delicate. The endotheca is dense, built of vesicular or tabuloid dissepiments filling up narrow interseptal spaces from the proximal corallum end up to the bottom of the shallow calices.

Discussion

The above data indicate that Triassic solitary columnar corals built heavy skeletons of very compact construction, composed of crowded septa combined with crowded endothecal elements. Such a structural type is unknown in modern solitary corals. The question of a possible symbiosis with algae remains, so we can speculate on the growth rates of those corals taking into consideration only their structure and some indications from the lithology.

Important for the interpretation of their life conditions is that the corals considered represent a large taxonomic spectrum embracing two largest Triassic coral groups: minitrabecular and stylophyllid corals. This means that coral biology and related polyp anatomy and corallum structure followed a mode typical of Mesozoic environments. Similar structural patterns reappeared in Jurassic *Montlivaltia* and *Epistreptophyllum*, corals belonging to other than Triassic microstructural groups (i.e. high-rank taxa), but known from similar lithologies.

The coralla of shallow-profile calices and a faint septal ornamentation may indicate that the polyps lacked the capability of dynamic retraction. Those large, multitentacular polyps lacked an edge zone. Their ability to form a wall of a particular type, with centripetally growing fibres, or a centripetal accretion of fibrous scales, differentiates them from recent corals. In the case of the reimaniphyllioids, such a wall, forestalling the inception of septa of a different, trabecular microstructure, was produced in the epithelial zone situated at the distalmost part of the body column. In the case of the stylophyllins, apparently, there was no epithelium zonation: the whole skeleton is in structural continuation, i.e. the entire body column ectoderm was able to produce the same sort of skeleton. Elongated fossae of solitary corals suggest an elongated shape of the mouths and a presence of flat pharynxes. The latter suggest a development of well marked sulci, in turn implying a possibility of a vigorous water flow through the coelenteron, related to the mode of feeding. The evaluation of the biological significance of such features, unfortunately, cannot be made due to the lack of an apropriate knowledge of Recent corals.

If any analogy to Recent corals is justified, polyps were not adapted to an active cleaning of the sediment from the oral disc (ef. Hubbard & Pockok, 1971). Apparently, those corals lived in an environment where a rapid sedimentation was absent.

Judging from a high skeleton density having no counterparts in the recent examples, the rates of growth of the corals discussed must be low. Moreover, the rates of sedimentation during long time spans when tall coralla developed were small as well, the rates of coral growth being balanced with the rate of sedimentation. Regular corallum shapes indicate a stable environment with an unchangeable regime of water dynamics during many decades.

Polyp and skeleton features seem to correspond to the habitat of quiet water and an unstable, limey sediment bottom. A ceratoid shape of corallum in ontogenetic early stages indicates that there was a lack of solid substrate on the bottom. In early stages corals were attached by a basal disc to small solid particles. They quickly grew in width and attained wide calices. Growing upward in a cylindrical shape, they became exposed to overturn. From the turned position corals usually started their growth normal to the bottom. Scarcity of epibionts on the natural wall surface suggests that the wall hardly was available to them, the coralla being probably plunged into the sediment. The corals, in the form of heavy cylinders sticking deeply in the sediment bottom, were well protected from any shifting from their place.

In such conditions any abiotic destruction was hardly imaginable. Thus, the abrasion of external parts of coralla might result from their being deplaced and redeposited with the bottom sediment. Thus, it is inferred that the corals could be shifted abruptly from their quiet habitats somewhere in the platform to the secondary beds outside the platform in result of any sediment deplacement. In the place of redeposition, they were overgrown by epibionts, with coating by blue-green algae at the end.

Corals grew slowly and undisturbed, and could acquire even very large dimensions. So, the causes of their destabilization and destruction must be mobilised sporadically, estimating in the scale of coral lifetime, i.e. in span of time of many tens, if not more than hundred years (e.g. *Cuifia marmorea*). The presumable causes of the destruction of their habitats were more likely rare earthquakes triggering deplacements of sediment, than storms. Contemporary storms crush the coral material and the succeeding destroying processes lead to subsequent destruction of the skeletons. In contrast to this, the corals discussed are rarely found in fragments in the sediment; their surface is not smoothed, only fragile parts are abraded. It means that in the environment of deposition, the coralla after a short period of being exposed to environmental factors were rather quickly covered with sediment: borings are not common, direct incrustings are ca. 0.5 mm thick. The finest sediment of wackestone type was trapped in EC proving that the sedimentation took place in low energy water.

Those marginal observations made on the basis of observation of a number of thin sections do not pretend to be a systematic microfacies study. Nevertheless, they signalize that we are far from having a clear idea on Triassic shallow water conditions of life and sedimentation. The image obtained, however, is in a general accordance with WURM's interpretation of the environment of Gosaukamm Dachsteinkalk sedimentation as connected with the upper slope/marginal zone of the platform (WURM 1982).

The above discussion shows that uniform skeletal shape and structure of taxonomically diversified corals resulted from some particular life conditions unlike to those in the recent coral habitats. Reciprocally, in recent oceans there are absent corals like those being under consideration. It is meaningful, from the paleoecological point of view, that such conditions, uncomparable to recent ones, existed worldwide in the Upper Triassic.

Judging from such features as the above discussed skeletal density and an epithecal type of wall formation in the most common corals, Triassic corals kept structural patterns closely analogous to those displayed by the rugose (partly also tabulate), i.e. Paleozoic corals. Thus, the environmental analogies of the Triasssic can be found rather in the Paleozoic than in the Recent.

Description of Coral Taxa

Synonymy of the species described is limited to illustated forms.

Abbreviations: *d* – corallum diameter; *el* – length of dissepiments; *eh* – height of dissepiments; *f* – length of fossa; *h* – corallum height; *sd*/mm – septal density: number of septa per millimeter at the wall, measured in cross section; *S1*, *S2* – septa of succeeding size orders (which may or may not correspond to orders of appearance); *12 S1, 12 S2* – number of septa of particular size orders; number of septa in the corallum may be expressed as a sum of septa of suceeding septal orders, e.g.: 88(12 + 12 + 24 + 40).

Suborder Caryophylliina VAUGHAN et WELLS, 1943
Superfamily Reimaniphyllioidea MELNIKOVA, 1974
Family Reimaniphylliidae MELNIKOVA, 1974
Genus *Cuifia* MELNIKOVA, 1975

Species typica: *Cuifia gigantella* MELNIKOVA, 1975

Species included: *Cuifia gigantella* MELNIKOVA, 1975, *C. elliptica* MELNIKOVA, 1975, *C. columnaris* sp. n., *Cuifia* sp. A., *Montlivaltia marmorea* FRENCH, 1890.

In addition to the forms enumerated above, two other might be included in the genus: a Carnian form, determined to be *Coryphyllia regularis* CUIF by TURNŠEK (1984, Pl. 4: fig. 1), displaying septa much

more differentiated in thickness than those in *Coryphyllia* CUIF and a coral named *Montlivaltia gigas* VINASSA DE REGNY, 1915 with large dimensions (larger diameters of 55–75 mm), thick wall and septal apparatus of ca. 200 septa.

Stratigraphical and geographical range. – Lower Norian – Rhaetian of the Tethys realm.

Remarks. – In septal microstructure and lonsdaleoid form of septa of the ultimate order, the genus resemble much *Coryphyllia* CUIF, 1975 which caused them to be considered as synonyms (RONIEWICZ 1989). However, the examination of a large body of material shows that *Cuifia* and *Coryphyllia* differ, first of all, in the structure of the wall: in *Coryphyllia* the wall is thin (Pl. 4: fig. 6) of a simple, fibro-radial structure growing centripetally, while in *Cuifia* the wall represents a particular modification of a primarily simple structure.

A modified wall is composed of triangular in cross section, uniform portions that I propose to name 'wall segments' (Pl. 4: 3, 4). In Central Asiatic *Cuifia gigantella* (MELNIKOVA 1975), wall segments, built of fibers growing centripetally (MELNIKOVA 1975, Pl. 14: fig. 2 b), are extremely thick and individualized. In the Alpine forms, there, alternatively, regular fibro-radial wall of the *Coryphyllia*-type can be observed in stress situation (e.g. healing injuries, a growth close to other objects). A wall of the modified type is characteristic of all Alpine species as well as for both known Pamirian species. The wall segments continue morphologically (but not microstructurally) within the septa S1–S4 (S5), while the rest are free when they lie opposite the septa of the ultimate order (lonsdaleoid septa S5 and S6).

Skeleton morphology in *Cuifia* shows some intrageneric variability, discussed in the following review.

(i) Septa; morphology and septal apparatus. – Septal blades are differentiated into the following portions: (1) a short peripheral portion, which in fact, is a wall segment, and (2) the septum proper. In the type species, that division of the septal blade is remarkable, as the septa S1–S3 are very thick, and the two parts are divided by a narrowing, a sort of a neck. In the species with slender septa, fusiform enlargements are variably accentuated and in the case of thin septa, their peripheral fusiform parts coalesce entirely with the wall segments.

The following pattern of the septal apparatus can be observed in all species: the septa are differentiated into 5, rarely 4 or 6 orders; septa S1 and S2 are of the same length, but differ in thickness; septa S3 are usually subequal with S1/S2 and septa S4 are from 1/2 to 5/6 the length of S1; the development of S5 and S6 depends on the species. Septa S5 can reach 1/2 S1 in length, or rest rudimentary; septa S6 are rudimentary. Septa S6

initiate in the interseptal space on the wall internal surface in the form of free triangular wall elements of a non-trabecualr nature. Rudimentary septa continue on the dissepimental surface as ridges (lonsdaleoid septa). A number of systems can hardly be considered as a specific feature: in *C. marmorea* the number of systems could proliferate to about 30, in individual coralla in *C. columnaris* it is from about 8 to 14.

(ii) Dissepiments. – Generally, the peripheral part of endotheca is homogeneous: dissepiments are equal, small, vesiculous, their dimensions being taxonomically valuable. In *C. columnaris*, however, a tendency is observed to form irregular dissepiments (compare also TURNŠEK 1987, Pl. 4: fig. 4) and a temporary, incomplete, thin marginarium.

(iii) Diameters. – The diameters of coralla are subequal throughout their adult, cylindric, tall parts. Adult coralla vary in diameters, e.g. in *C. columnaris* from ca. 25 to 50 mm.

Cuifia marmorea (FRECH, 1890)
(see Pl. 1: fig. 1–3; Pl. 2: fig. 1–3; Pl. 4: fig. 3)

v.1890. *Montlivaltia marmorea* FRECH, p. 41, Pl. 11: fig. 6, 6a
1969. "*Montlivaltia*" *marmorea* FRECH: ZANKL, p. 31, Pl. 2: 12 (non Text-fig. 21).
non 1980. *Montlivaltia marmorea* FRECH: SENOWBARI-DARYAN, p. 39, Pl. 3: fig. 4.

Holotypus: NHMW, collection FRECH; FRECH 1890, Pl. 11: fig. 6; herein Pl. 1: fig. 1

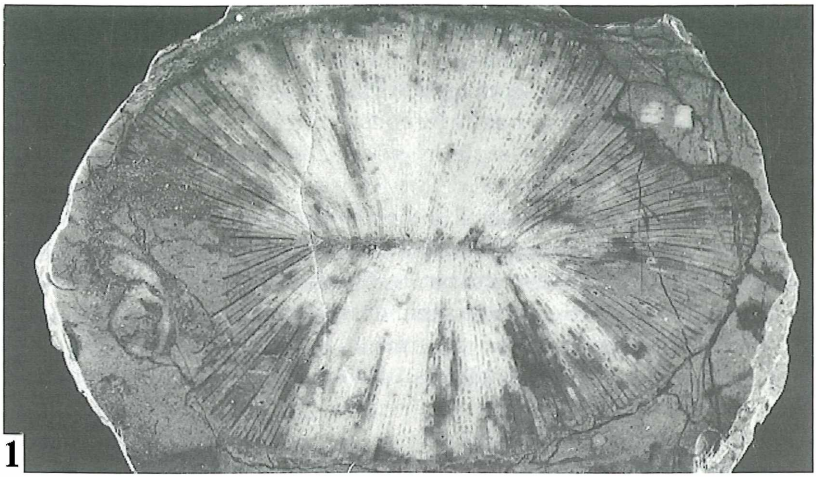
Locus typicus: Sandling near Aussee.

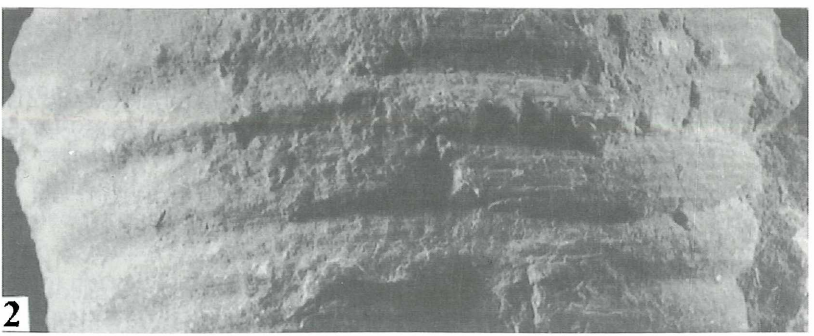
Stratum typicum: Reddish Hallstatt limestone from the Pinacoceras metternichi – Arcestes obtusegaleatus Zone (after MOJSISOVICS in FRECH 1890).

Material. – Holotype specimen from Sandling, NHMW collection FRECH. A specimen GBA 1995/2/1 from the Dachsteinplateau, N from the Feisterscharte. Four specimens from light grey organodetritic limestone from Gosaukamm: (1) a fragmentary specimen NHMW 1995/1/1 from Steinriese, site 13; (2) a fragment of corallum NHMW 1995/1/2 devoid of wall from Weitkar, site 17; (3) a specimen NHMW 1995/1/4 from Stuhllochhalde, 1783 m, site 14; (4) a specimen NHMW 1995/1/3 from Weite Zahring, site 19. 15 thin sections.

Measurements (in mm):

Specimen No.	d	s	sd/10	f	el	eh
NHMW holotype	70 × 100	230(25 + 26 + 52 + 90 + 37)	11	30	2–3	1–2
NHMW 1995/1/2	70 × 110	> 200 (ca. 24S1)	10–11	30		
NHMW 1995/1/4	50 × 65	> 150 (ca 24 S1)	10–12	15		
NHMW 1995/1/3	ca.100 × 110	> 200	10–11			





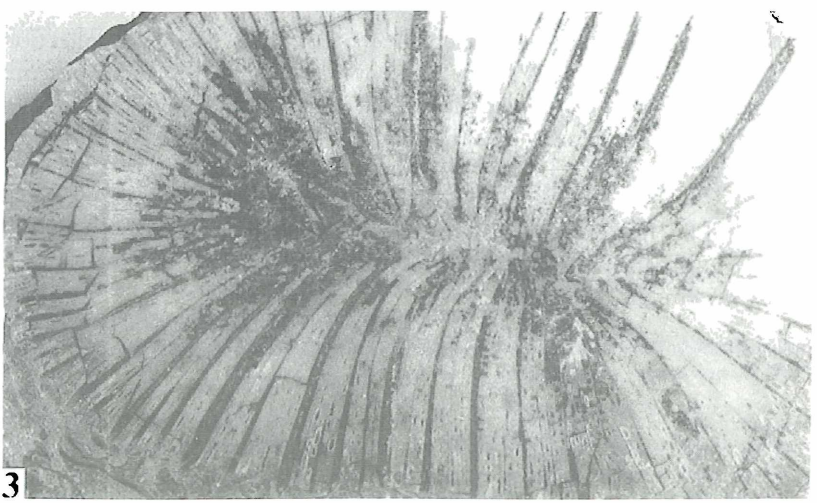
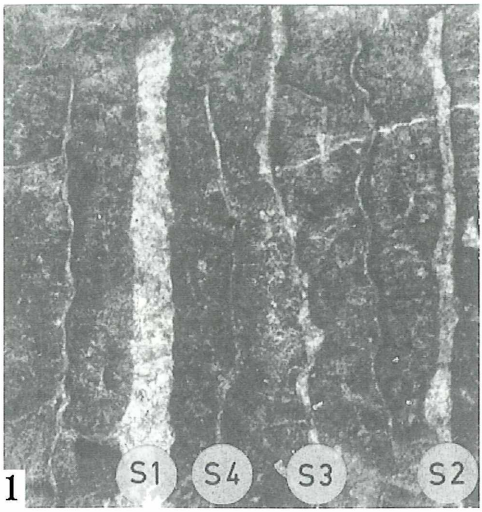


Plate 1. Figs. 1–3 (see caption text on p. 20)



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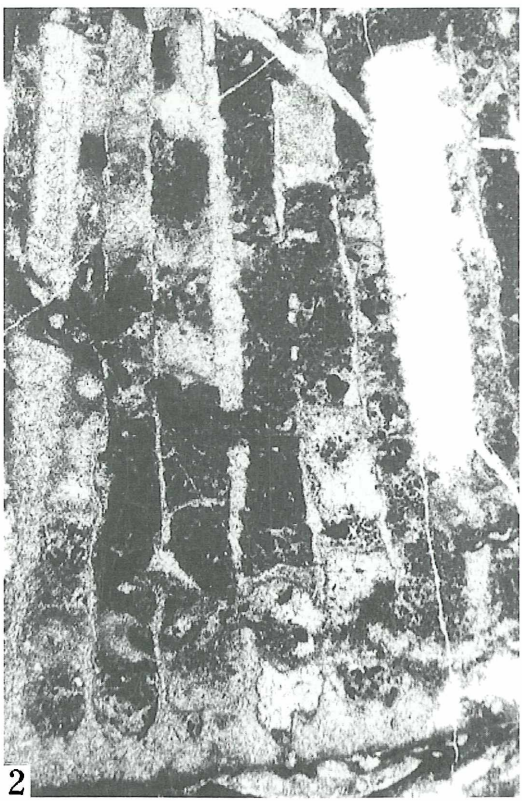

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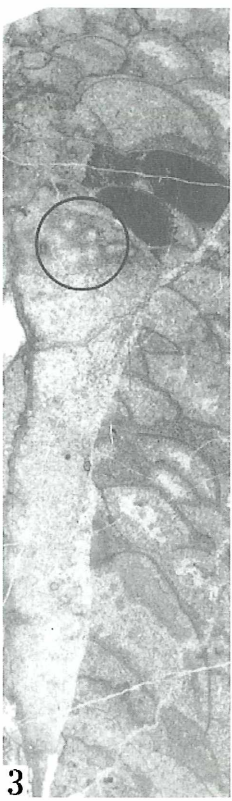

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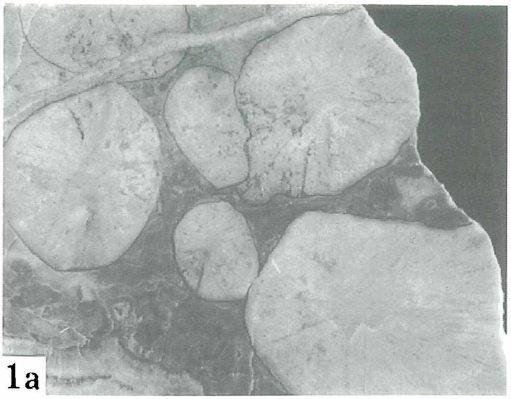
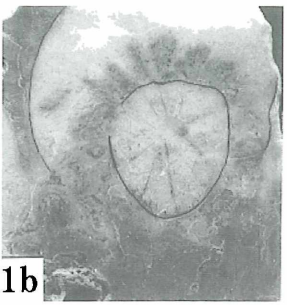
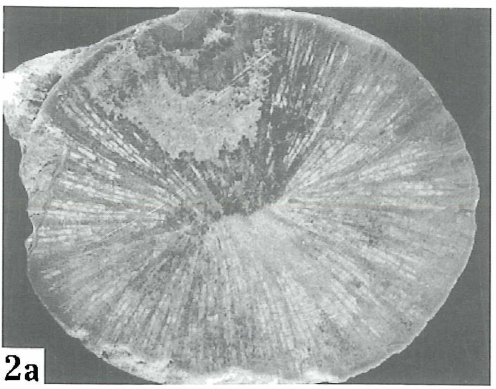
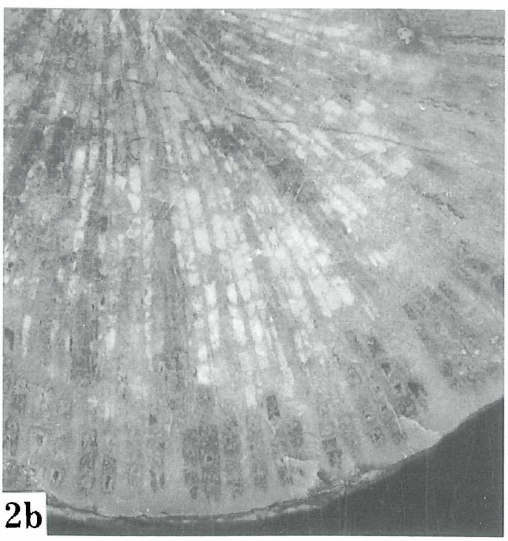
Plate 2. Figs. 1–3 (see caption text on p. 20)









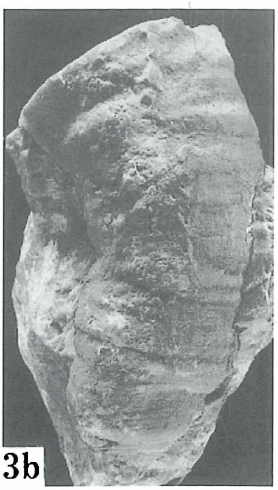
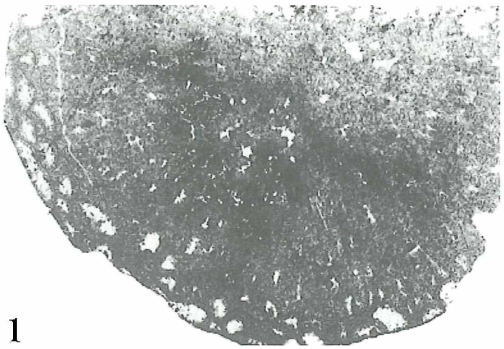
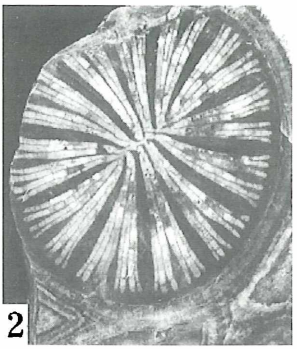
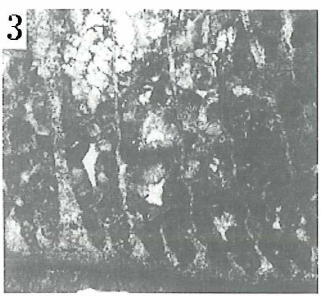
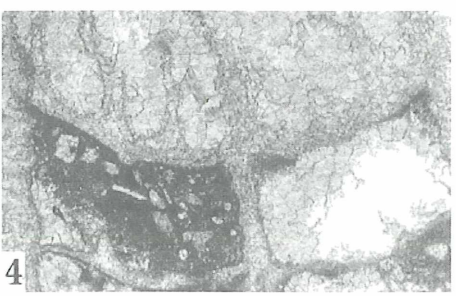


Plate 3. Figs. 1–3 (see caption text on p. 20)









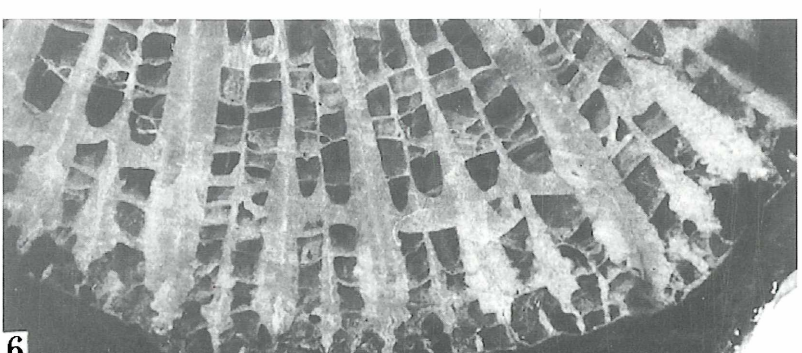


Plate 4. Figs. 1, 4, 5 (see caption text on p. 20)

Description. – Corallum in the form of a tall pillar, oval in cross section, with regular enlargements and constrictions producing bands of ca. 10 mm wide. The surface of the wall is delicately wrinkled. Septal apparatus composed of very thin, long and densely crowded septa. Septa S1 and S2 slightly thickened. Septa S4 regularly developed, S5 incomplete in number, long. The septa S4 and S5 are 30–50 µm thick. Lonsdaleoid septa S6 rare, short, ridge-like; sharp ridges of wall origin in the position of the S6 septa in the interseptal space of the internal wall surface.

In the septa S1, straight or wavy midline. Lateral septal faces ornamented with relatively well marked granulations. Wall built of wall

Plate 1. Figs. 1–3: *Cuifia marmorea* (FRECH, 1890). **1** Polished cross section of Frech's original of *Montlivaltia marmorea* FRECH, 1890; × 0.85. NHMW, Frech collection. Sandling near Aussee, Norian, Pinacoceras metternichi–Arcestes abtusegaleatus Zone. **2** Surface of the specimen NHMW 1995/1/3 displaying regular bands covered with delicate striation; × 1. Gosaukamm, Weite Zahring, Sevatian. **3** Polished cross section of the corallum NHMW 1995/1/2 showing differentiation of septa in thickness; × 1. Gosaukamm, Weitkar, Sevatian

Plate 2. Figs. 1–3: *Cuifia marmorea* (FRECH, 1890). **1** Cross section showing septa *S1–S3* extended to the calicular fossa and very thin zigzag septa *S4* ending at some distance from it; × 24. NHMW 1995/1/1. Gosaukamm, Steinriese, Sevatian (Lower Rhaetian?). **2** Cross section showing considerably thickened septa S1–S3, thin S4 and S5 and triangular segments in the wall structure; × 13.2. GBA 1995/2/1. Dachsteinplateau, N Feisterscharte, Lower Norian. **3** Longitudinal section showing vesicular dissepiments and granulations (encircled) of the septal face; × 5.5. NHMW 1995/1/2. Gosaukamm, Weitkar, Sevatian. **4** Undeterminable solitary coral. NHMW 1995/1/17. Gosaukamm, Steinriese, Sevatian (Lower Rhaetian) × 2

Plate 3. Fig. 1–3: *Cuifia columnaris* sp. n. **1a** Polished surface. Natural aggregation of coralla of a large age spectrum; × 0.9. **1b** Rejuvenescence; × 0.9. NHMW 1995/1/13. Gosaukamm, Norian. **2a** Polished surface, × 1.1. **2b** A fragment showing densely crowded septa and thin, strong wall; × 3. Holotype, NHMW 1995/1/5. Gosaukamm, Gamskar, Sevatian. **3a, b** Typically curved corallum with transversely wrinkled surface; × 0.75. NHMW 1961/406/04. Gosaukamm, Steinriese, Sevatian (Lower Rhaetian?)

Plate 4. Figs. 1, 4, 5: *Cuifia columnaris* sp. n. **1** Cross section of a recrystallized corallum. Marginal dissepimental zone well developed; × 2. NHMW 1995/1/8. Gosaukamm, Steinriese, Sevatian (Lower Rhaetian?). **4** Cross section showing dissepiments and lonsdaleoid septa of the highest orders; × 23. NHMW 1995/1/14. Hochkönig, west end of the foot of Torsaeule, Sevatian. **5** Cross section in the wall region showing peripheral dissepiments and triangular wall segments; × 14. NHMW 1995/1/13. Gosaukamm, Norian. **2** *Cuifia* sp. A. Polished surface; × 2. NHMW 1995/1/16. Gosaukamm, Weitgriess, Sevatian. **3** *Cuifia marmorea* (FRECH, 1890). Cross section showing thick triangular wall segments and thin septa; × 7. NHMW 1995/1/1. Gosaukamm, Steinriese, Sevatian (Lower Rhaetian?). **5** *Coryphyllia regularis* CUIF, 1975. Fusiform septa S1-S4 and rudimentary septa S5 at the wall; wall pellicular, epithecal; × 9. Taurus Mts, Alakir Çay valley, Lower Norian. Paratype from the Cuif collection

portions triangular in section (see above). The dissepiments are vesiculous, small, subequal, having 1–2 mm in height and 2–3 (5) mm in length.

Remarks. – The species is known for its large and high coralla. Remarkable is the fact that in that species, the number of septa of particular orders and the number of orders exceed all values known in the Reimaniphylliidae.

In the literature concerning the Norian and Rhaetian, some solitary corals are mentioned or described under the name of *M. marmorea* (e.g. VINASSA DE REGNY 1915 from Timor). However, it is hardly possible to evaluate the determinations on the basis of brief descriptions. In the case of that species, the dimensions can serve for specific identification. For the reason of far smaller diameter (ca. 30–40 mm, if one can judge from the illustration) and a phaceloid growth form (an increase by subequivalent division of the adult corallite), a coral described by ZANKL (1969, text-fig. 21) as *marmorea* has not been included in the synonymy. The coral in SENOWBARI-DARYAN (1980, Pl. 3: fig. 4) represents a large individual of *Procyclolites triadicus* with characteristic zigzag form of septa.

Distribution. – Norian (Pinacoceras-Arcestes) of the vicinity of Aussee. Sevatian (Lower Rhaetian?) of the Gosaukamm. Lower Norian of the Dachsteinplateau.

Cuifia columnaris sp. n. (Pl. 3: figs. 1–3; Pl. 4: fig. 1, 4, 5)

1979. *Montlivaltia norica* FRECH: SCHAEFER, p. 44, Pl. 10: fig. 1
1987. *Cuifia elliptica* MELNIKOVA: TURNŠEK, p. 34, Pl. 4: figs. 3, 4
1989. *Coryphyllia elliptica* (MELNIKOVA): RONIEWICZ, p. 65, Pl. 15: figs. 1ab and 2ab (not 7).

Holotypus: NHMW 1995/1/5; Pl. 3: fig. 2
Locus typicus: Gosaukamm: Gamskar
Stratum typicum: Organodetrital, light grey Sevatian limestone
Derivatio nominis: Named after its corallum shape.

Diagnosis: Calices circular, diameters of adults ranging from 25 to 50 mm. Septa 100–130 in number with a diameter of 50 mm. Radial elements differentiated into 5 orders. Dissepiments ca. 1 mm high and 2–3 mm long. Temporary marginarium can be developed.

Material. – Gosaukamm, organodetrital, light grey limestone: (1) cylindrical coral part NHMW 1995/1/5 from Gamskar, site 2; (2) proximal end NMHW 1995/1/6 from Sulzkar, site 15; (3–8) diverse fragments NHMW 1995/1/7–11 and a nearly complete coral NHMW 1961/406/04 from Steinriese, site 13; (9) cylindrical coral NHMW 1995/1/12 from Weitkar, site 17; (10) group of gregareous coralla NHMW 1995/1/13

without precise location. Specimen NHMW 1995/1/33 from light grey limestone from the foot of Grosswand, Steiglweg II, vicinity of the site 1a, Lower Norian (M. SCHAUER inf., 1991).

Hochkoenig: Cylindrical coral fragments NHMW 1995/1/14 and 15 from light grey Sevatian limestone.

Mitteralpe: Hochschwabgebiet, dark grey Upper Norian (Lower Rhaetian?) limestone: cylindrical part of corallum GBA 1995/2/2.

Over 30 thin sections.

Measurements (in mm):

Specimen No.	d	h	s	sd/10	f	el	eh
NHMW 1995/1/7	25		ca.80(12 + 12 + 24 + nS4/5)	15	4		
NHMW 1995/1/11	38	> 45	e.100(12 + 12 + 24 + 45 + e5)		8		
GBA 1995/2/2	ca.40	> 100	ca.80(12 + 12 + 24 + nS5)	16	6	2	1
NHMW 1995/1/10	40	> 110	e.113(13 + 14 + 27 + 54 + e5)	11–15	8		
NHMW 1995/1/5	45 × 55		e.127(14 + 14 + 28 + 56 + e15)	11–13	11		
NHMW 1995/1/13:							
adult	50		ca.100	10	8		
juvenile	30		> 80(9 + 9 + 18 + ca.36 + nS5)	10	4		
juvenile	10 × 13		48(12 + 12 + 24)	13	2		

Description. – Singular or gregareous. Corallum high, cylindrical, proximally ceratoid, circular in cross section. Externally smooth or regularly narrowing and enlarging its diameter resulting in rather irregular bands large ca 6 mm. Wall surface with very delicate growth lines. Constant diameter attained at the higth of about 15 mm–30 mm. Adult coral diameters variable. Calicular fossa elongated. Septa densely crowded. Septal apparatus composed of well developed septa of orders S1–4 and variably developed septa of the S5 order. Septa S1 the thickest of all. In the coralla of large diameters, the septa S4 exceed 3/4 of the length of S1, while at small corallum diameters, they vary only about half the length of S1. The septa S5 appear in a mature coral stage as lonsdaleoid structures and short lists on the wall; the latter structures originate from the wall. Septal ornamentation is granular, coarse. Wall composed of segments. Endotheca at the periphery consisting of small, vesicular dissepiments (2–3 mm long and 0.75–1 mm high) sloping axialwards, and at the corallite center formed of rather more extended dissepiments. As a rule, dissepiments traverse regularly the interseptal spaces but some of them can settle on septal blades as well. At the circumference, there can

temporarily develop large irregular dissepiments or an incomplete marginarium built of 1–2 rows of subequal, small vesiculae.

Rejuvenescence and a gregareous mode of life: In the specimen NHMW 1995/1/11, the process of rejuvenescence proceeds as follows: At the calicular circumference, eccentrically, there appeared uneven large dissepiments, septa of the highest orders disappeared, while those of the first orders thickened and lost their connection with the wall. At the same time, the skeleton developed normally in the area limited to the internal, periaxial part: all septa, S5 including, developed as well-formed blades. The boundary between the internal and peripheral corallite parts is sharp. This stage was followed by a development of a large gap between the wall and the external ends of the septa S1–S3. On the newly formed periphery of the corallum, there immediately appeared a wall of a parathecal nature, which encircled a corallite of a small diameter. The rejuvenescence is common.

In the material examined, there are three specimens suggesting a gregareous mode of life of those corals. Close to adult coralla NHMW 1995/1/10 and GBA 1995/2/2, there are present parts of other adults, while the specimen NHMW 1995/1/13 represents an aggregation composed of ca. 8 coralla of various age. The corallite diameters range from 13 mm up to 50 mm. The small individuals are fixed to the surface of the larger ones, and each of them has its own wall. The latter specimen is here interpreted as an aggregation of individuals, as no traces of their being budded from one another have been observed up to now.

Variability: Forms that have cylindrical tall coralla of a constant diameter are considered to be adult, completely developed individuals. Intraspecific variability in corallum diameter and a number of sectors in adult coralla is very large. There have been noticed the following extremes in adult forms: diameters from 25 to 55 mm and a number of sectors from 9 to 14, both having no relation to each other.

Remarks. – An abundance of material from the Sevatian enable us to discriminate the new species. The species is very close to *C. elliptica* Melnikova, 1975 but differs from the latter in subcircular shape of calice and in smaller dissepiments (2 mm high and 2–4 mm long in the latter species). In consequence, determination of Alpine Rhaetian forms (Roniewicz, 1989) as *Coryphyllia elliptica* (Melnikova) cannot be maintained, as they show features typical of the species described above.

C. columnaris is closely related to a form discriminated as *Cuifia* sp. A (see the following description).

The new species is very similar to the coral of the Late Triassic of Japan, determined as *Montlivaltia norica ominensis* (Okuda & Yamagiwa, 1978).

However, the illustration (1978, Pl. 40: fig. 2) presents an endotheca, which is built of vesicular dissepiments apparently significantly larger than those in the species considered.

Distribution. – Sevatian (Lower Rhaetian?) of the Gosaukamm. Upper Norian (Lower Rhaetian?) of the Hochschwabgebiet. Sevatian of the Hochkoenig. Rhaetian of Kesselwand-Rohrmoos, vicinity of the Gosaukamm.

Cuifia sp. A. (Pl. 4: fig. 2)

Material. – NHMW 1995/1/16, a fragment of corallum in light grey detritic limestone from Weitgriess, site 18; 2 thin sections.

Measurements (in mm):

d	h	s	sd/10	f	el	eh
20	> 40	79(12 + 12 + 24 + 31)	14	4	2(3)	1

Description. – Cylindrical, high corallum of a regular form. Wall thick. Septal apparatus regular, built of strong septa of four orders well differentiated in thickness and in length: septa S1 and S2 approaching to the fossa, but differing in thickness, S3 much shorter, S4 ca 1/3 of S1/2 in length. Dissepiments relatively large, equal, vesiculous. Wall thick.

Remarks. – A coral resembles juveniles of *C. columnaris*, but in having tall and thin corallum it apparently represents an adult form. Coralla of comparable dimensions from the intraspecific variability of *C. columnaris* from the Rhaetian (two specimens: NHMW 1982/56/39-3,4) show the following pattern of the septal apparatus arrangement:

Specimen No.	proximal d	s
NHMW 1982/56/39-4	9 × 10 mm	48(12 + 12 + 24)
NHMW 1982/56/39-3	18 mm	67(16 + 16 + 32 + 3)

The difference between adult *Cuifia* sp. A and juvenile *C. columnaris* is that the longest septa (S1) in the former are equal while in the latter are differentiated into thinner and thicker ones (i.e. the succeeding cycles are marked) and that in the former the septa S3 are conspicuously shorter, and septa S4 are present in all systems.

Distribution. – Sevatian of the Gosaukamm.

Genus *Coryphyllina* gen. n.

Species typica: *Coryphyllina rhaetica* sp. n.

Derivatio nominis: nom corresponding to *Coryphyllia* to indicate a similarity between both genera; *femin.*

Diagnosis: Microstructure of a coryphylliid type; septal apparatus formed by 4 orders of septa; septa of the ultimate order lonsdaleoid; internal border dissociated into projections; columella papillar; dissepi-

ments vesiculous; wall septothecal with addition of fibrous-radial elements. Monotypic.

Discussion. – In general, the microstructure of septa resembles that of *Coryphyllia*. It differs from the latter in clustering of trabeculae into larger units which leads to dissociation of the distal and internal edges of septa, and formation of papillar columella.

Coryphyllina rhaetica sp.n. (Pl. 5: fig. 1a–d)

Holotypus: NHMW 1995/1/31 (earlier numbered NHMW 1982/56/39-5); Pl. 5: fig. 1

Locus typicus: Gosaukamm vicinity: Kesselwand-Rohrmoos

Stratum typicum: Zlambach Beds, Rhaetian

Diagnosis: Cylindrical coral with over 100 septa of at the diameter of 40 mm.

Material. – Holotype only.

Measurements (in mm):

	h	d	s	s/3mm	f
	>30	25 × 30	e.96	5–8	3
proximally		10	48		

Description. – Cylindrical coral abruptly narrowing proximally and ending with a scar of about 5 mm. Surface with vertical striation (4.5 stries in 1 mm). Calice shallow. Septa entire with the exception of the internal edge. Septal apparatus differentiated into four size orders. Systems regular. The septa S1 and S2 approach the centrum. Their internal edges are decomposed into rare projections ca. 0.5–0.75 mm in diameter, circular in section, constituting a dense, papillar columella. Usually, single projections set off the septa S3 and S4. The septa of the ultimate order are lonsdaleoid. Septal ornamentation originally rather regularly granular, secondarily thicken with granular stereome which causes that septal surface to become coarse. Endotheca convex peripherally and markedly concave axially, composed of widely extended dissepiments ca 1.5 mm in height. Lower dissepimental layer with well marked central junction line. Upper layer of a variable thickness, constituted of stereome organized in irregular bundles of fibres and continuing on septal flanks. Wall thick, compound in structure: septothecal with the addition of a deposit of a fibrous nature. Poor state of preservation precludes its more detailed characteristics.

Distribution. – As for the holotype.

Genus *Distichophyllia* Cuif, 1975

Type species: *Montlivaltia norica* Frech, 1890

Species included: *Montlivaltia norica* Frech, 1890; *M. gosaviensis* Frech,

1890; *M. fritschi* FRECH, 1890; *Distichophyllia melnikovae* MONTANARO-GALITELLI, RUSSO et FERRARI, 1979, *D. maior* sp. n., *D. tabulata* sp. n.

In addition, there can be included forms described as *Reimaniphyllia gosaviensis* in MELNIKOVA 1975 (a form presented in Pl. 15: fig. 1 and another form–in Pl. 15: fig. 2), *Distichophyllia* cf. *norica* from the Koriak Upland (MELNIKOVA & BYCHKOV 1986, p. 65, Pl. 6: fig. 2), *Distichophyllia norica* in TURNŠEK & BUSER (1991, p. 227, Pl. 2: fig. 4, 5) and *Montlivaltia* sp. indet. in YAMAGIWA (1963, p. 84, Pl. 1: fig. 8–10), which might represent some new species.

Remarks. – The microstructure of distichophyllid coral septa is described in RONIEWICZ (1989). That type of septal structure is characterized by fine trabeculae (minitrabeculae) constituting the mid-septal part (Uhr-septum) and lateral septal stereome organized into thick and short lateral trabeculae perpendicular to the septal blade.

Septal apparatus in the genus *Distichophyllia* is composed of septa differentiated into five size orders. In the majority of forms hitherto described, the septa of the first 3 orders are subequal in length with the exception of two forms determined as *Reimaniphyllia gosaviensis* (FRECH) from the Pamirs (MELNIKOVA 1975) and Distichophyllia tabulata sp. n. The endotheca is built of either vesiculous or extended dissepiments.

Distichophyllia maior sp. n. (Pl. 6: fig. 4a, b)

1980. *Montlivaltia norica* FRECH: SENOWBARI-DARYAN, p. 88, Pl. 4: fig. 1
pars 1989. *Coryphyllia elliptica* (MELNIKOVA 1975): RONIEWICZ, Pl. 15: fig. 7

Holotypus: ZPAL zp H.V/1; Pl. 6: fig. 4

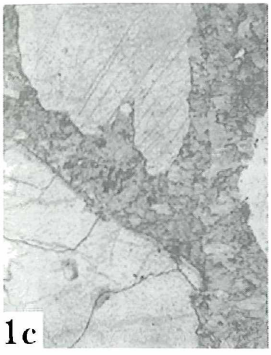
Locus typicus: Tropfbruch near Adnet, Salzburg area.

Stratum typicum: Rhaetian

Derivatio nominis: maior (Latin larger) – from corallum size, larger than observed in type species.

Paratypus: NHMW 1995/1/32 (earlier numbered NHMW 1982/56/39-2) from the Rhaetian of the Kesselwand-Rohrmoos; RONIEWICZ 1989, Pl. 15: fig. 7

Plate 5. Figs. 1a–d: *Coryphyllina rhaetica* gen. et sp. n. **1a** Polished section showing thick septa S1–S2 reaching the axis with their internal ends partly dissociated into paliform projections; × 2. **1b** Thin section displaying internal ends of the septa S3 and S4 dissociated into paliform projections; × 5. **1c** A fragment with a lonsdaleoid septum; × 28. **1d** Disrupted minitrabecular median line (arrows) of the septum S1: initiation of a decomposition of the septal blade into irregular portions; × 38. NHMW 1995/1/31. Kesselwand-Rohrmoos, Zlambach Beds, Rhaetian. Fig. 2a–c: *Distichomorpha robusta* gen. et sp. n. Corallum in cross (**2a, b**) and in longitudinal (**2c**) sections showing thick septa and tabuloid endotheca; × 2. NHMW 1995/1/27. Gosaukamm, Gamskar, Sevatian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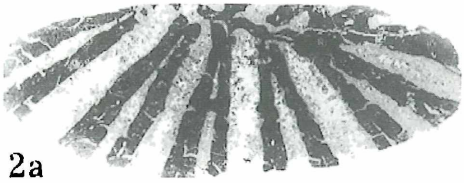
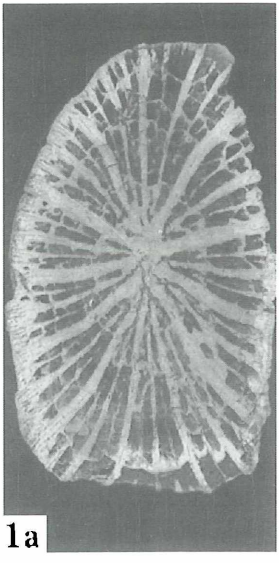

2a


2c


1b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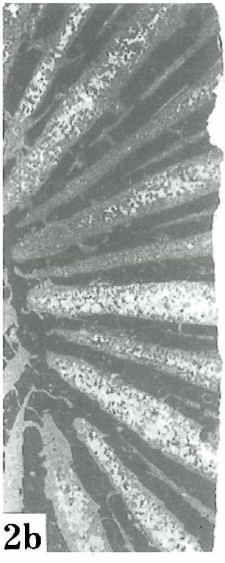
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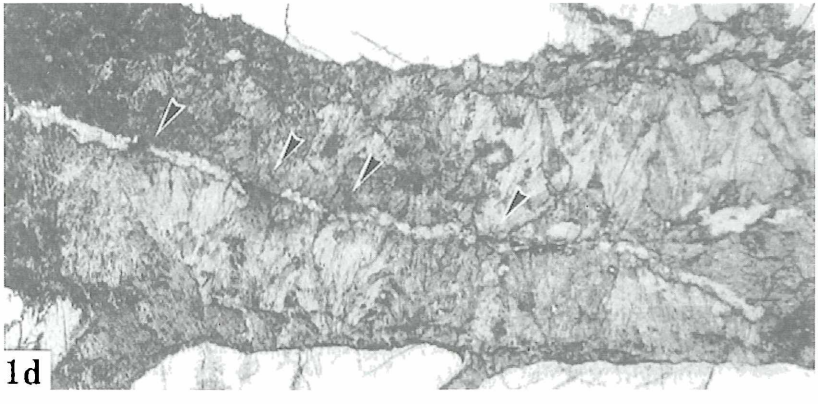

1d

Diagnosis: *Distichophyllia* having ca. 120 septa with a diameter of 40 mm, endotheca vesicular in type.

Material. – Holotype and paratype specimens have been examined; 4 thin sections. Additionally, five specimens have been noticed fitting to the diagnosis of *D. maior*, in the boxes labeled *Montlivaltia norica* FRECH in the collections from Fischerwiese, Zlambachschichten, housed at the NHMW.

Measurements (in mm):

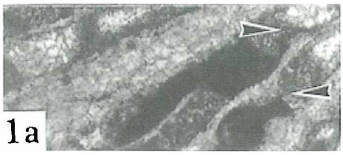
Specimen No.	h	d	s	sd/1	f	eh
ZPAL H-1981/1	> 40	35 × 42	119(12 + 12 + 24 + 48 + 23)	9–12	8	0.8–1.5
NHMW 1995/1/32	> 50	50	157(13 + 13 + 26 + 48 + 52)	10–11		
proximally		15	93(13 + 13 + 26 + 41)			

Description. – Corallum high, cylindrical, suboval in section, with distinct fossa. Septa differentiated into 5 orders: the septa S1 and S2 reach the fossa, at least some septa S3 are subequal to S1 in length, the septa S4 are longer than half the radius while the septa S5 reach one-third of the radius. The septa S1 are the thickest, their internal ends markedly thinner than the peripheral ones, other septa, with the exception of S5, are thickened peripherally. The internal halves of septa S3 and S4 and the entire septa S5 are very thin and wavy. Ornamentation in the form of faint, dense, rounded granulations. Dissepiments abundant, irregular in shape, i.e. vesiculous but often relatively largely expanding (h:w = 1:9). Endotheca concave at the central area of the corallum. Thin, pellicular wall preserved in places.

Microstructure: The paratype specimen shows a skeleton partly preserved in the form of aragonite. In the midline of the septal blade, there is a thin, wavy or zigzag line, formed by a vertical row of minitrabeculae. Lateral trabeculae well developed, emerging on the septal faces as dense granulations.

Remarks. – Although the new species resembles *D. norica*, and partly overlaps it in the measurements, the species differ from each other as follows:

Plate 6. Fig. **1a, b**: *Distichopsis minor* gen. et sp. n. Ornamentation of the septal flanks in the form of short menianes (arrows); × 12. NHMW 1995/1/25. Gosaukamm, Steinriese, Sevatian (Lower Rhaetian?). Figs. 2, 3: *Distichophyllia tabulata* sp. n. **2** Cross section with typical regularly fusiform shape of septa; × 2.5. NHMW 1995/1/19. Gosaukamm, Schattleitenkopf, Sevatian. **3** Longitudinal section showing low, extending dissepiments at the periphery (left) and vesicular ones at the axial region (right); × 2. GBA 1995/2/3. Hochschwabgebiet, Rhaetian. Fig. 4a, b: *Distichophyllia maior* sp. n. **4a** Cross section; × 2.5. **4b** Longitudinal section with homogeneous, vesicular endotheca and granulations on the septal side (encircled); × 5.3. ZPAL zp H.V/1. Salzkammergut, Adnet, Rhaetian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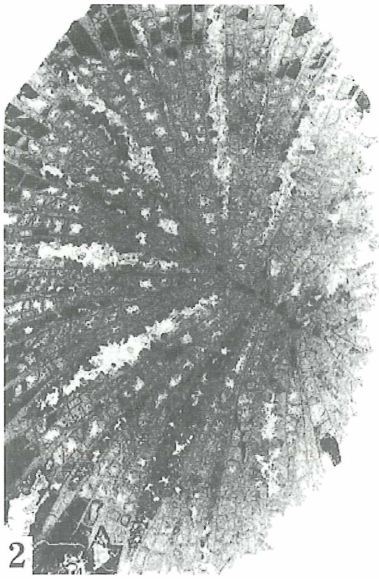
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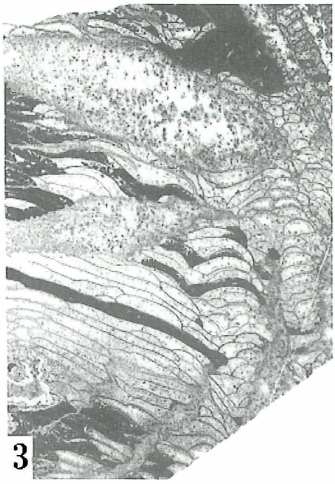
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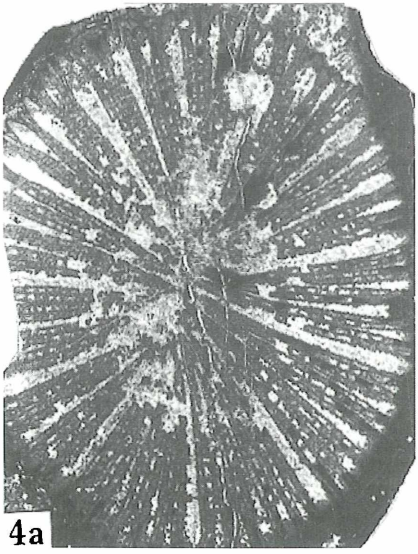
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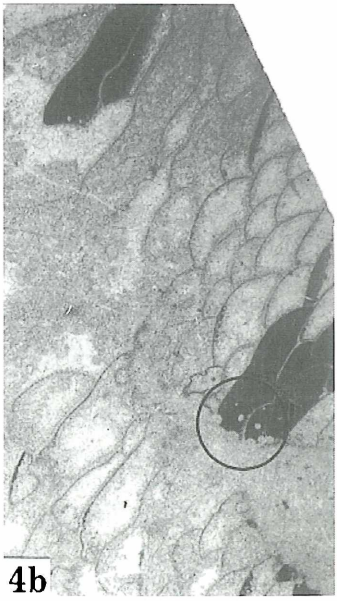

4b

(i) the density of septa is conspicuously lower than that in the type species (18/10 mm), and (ii) septa S3 are relatively longer than in *D. norica*, (iii) density of endotheca is larger than in *D. norica*.

From *D. tabulata* the species considered differs, first of all, in its vesicular structure of endotheca, and also in the shape of septa S1–2 with a maximum thickening situated at the wall.

The paratype specimen has been determined originally (see synonymy) as *Coryphyllia elliptica*. That determination based on the external features, has been corrected on the basis of thin sections.

Distribution. – Rhaetian: calcareous facies in the vicinity of Adnet and in the Gosaukamm, and marly facies (Zlambach Beds) in Fischerwiese.

Distichophyllia tabulata sp. n. (Pl. 6: fig. 2, 3)

Holotypus: NHMW 1995/1/20

Locus typicus: Gosaukamm, Stuhlloch, 1. Halde v.d. Grosswand

Stratum typicum: Sevatian (Alaunian?)

Paratypi: (1) Specimen NHMW 1995/1/19 from the Sevatian, Gosaukamm, Schattleitenkopf; Pl. 6: fig. 2. (2) Specimen GBA 1995/2/3 from the Upper Norian (Lower Rhaetian?) of the Hochschwabgebiet; Pl. 6: fig. 3.

Derivatio nominis: tabulata – from tabuloid shape of dissepiments.

Diagnosis: *Distichophyllia* with ca. 115 septa at the calicular diameter of 60 mm, with vesiculous dissepiments at the axial part, and low and extended dissepiments in the rest of the corallum.

Material. – Fragmentary specimens from light grey limestones from the Gosaukamm: (1) holotype specimen NHMW 1995/1/20, Stuhlloch (1. Halde v.d. Grosswand), site 14; (2) specimen NHMW 1995/1/21, Steinriese, site 13; (3) specimen NHMW 1995/1/19, Schattleitenkopf, Pkt 3., site 11; (4) specimen NHMW 1995/1/22, Sulzkar, Schuttkegel III, site 15. Specimen 1995/1/23, Eisgrube, Lower Norian, site 1a. Twelve thin sections.

Hochschwabgebiet: specimen GBA 1995/2/3 in dark grey limestone: Upper Norian (Lower Rhaetian?).

Measurements (in mm):

Specimen No.	d	h	s	sd/10	f	eh	max.el
GBA 1995/2/3	55 × 65	> 50	114(17 + 17 + 32 + 46)	11	15	0.5–1	15
NHMW 1995/1/22	e.40 × 50				e.8		
NHMW 1995/1/19	43		100(12 + 12 + 24 + 48 + 4)	e.9	8	0.5–1	> 15
NHMW 1995/1/20	40		ca.110(14 + 14 + 28 + ca50 + S5)	e.9	8	0.5–1	10
NHMW 1995/1/23	e.50					0.5–1	

Description. – Oval in cross section. Fossa narrow. Septal apparatus differentiated into 4 orders, but temporarily septa S5 can be observed in some systems being in course of transformation. Septa S1 and S2 subequal in length, fusiform. Septa S3 longer than half the radius and septa S4 reaching half the radius in length. Thickness of septa in GBA 1995/2/3 are as follows (measured in um): S1 900–1500, S2 450–600, S3 max. 450, S4 30 in the adaxial part and 150 at the periphery. In NHMW 1995/1/19 maximum thickness of septa S1 is 2000 mm.

Thickened parts of septa S1 are situated adaxially, while those of septa S2 are distinctly shifted to the periphery. The septa S1 and S2 taper peripherally. Ornamentation granular, observed only on septa S1–S3. At their basis, granulations are from 220 µm to ca 400 µm in diameter.

Endotheca dense, steeply sloping from the periphery toward the flat axial part. Dissepiments differentiated into vesiculous (height: width = 1:1) concentrating especially at the axial calicular part, and low and wide (h:w = 1:15 and more), subtabular in the rest of the corallum.

Microstructure: The median line is ca 30 µm thick in the septa S1–S3 and at the periphery of the septa S4. The median lines are straight or wavy in the septa S2-4 and zigzag in the septa S1. The thickness of trabeculae is estimated at < 30 µm.

Remarks. – The new species differs from the type species in larger coralla, tabuloid dissepiments and distinctly fusiform shape of septa S1–S3. In the shape of dissepiments of the peripheral part of corallum, the new species resembles much the Pamirian coral determined by MELNIKOVA (1975) as *Reimaniphyllia gosaviensis* (FRECH) (MELNIKOVA 1975, pl. 15: fig. 2, not fig. 1) which, however, shows entire endotheca of a tabular appearance. At the present state of knowledge, the taxonomical value of dissepiment shape observed in distichophyllies is rather difficult to evaluate.

Distribution. – Norian/Rhaetian of the Hochschwabgebiet. Lower – Upper Norian (Lower Rhaetian?) of the Gosaukamm.

Genus *Distichopsis* nov.

Species typica: *D. vesiculoseptata* sp. n.

Derivatio nominis: from its resemblance to the genus *Distichophyllia* CUIF, 1975; *femin.*

Diagnosis: Septa fusiform, originlly thin and widened by accretion of small dissepiments. Original septal blade is zigzag, wavy or straight in cross section. Septal apparatus composed of septa of 5 size orders. Dissepiments vesiculous, differentiated into small vesicules covering the septa and larger forming the endotheca proper.

Species included: *D. vesiculoseptata* sp. n. and *D. minor* sp. n.

Remarks. – The new genus differs from *Distichophyllia* CUIF by a

mode of thickening of the septa. Here, the formation of the ultimate structure of the septum was accomplished mainly by a mass accretion of the small dissepiments to the septal blade, while in the genus *Distichophyllia* the septa thickened exclusively by deposition of lateral stereome of a distichophylliid type, i.e. organized into lateral trabeculae. It is worth noting, that the same type of thickening of septa is known in the Norian-Rhaetian genus *Palaeastraea* Kuehn (compare RONIEWICZ 1989, p. 66).

Stratigraphical and geographical range. – Norian–Rhaetian of the Alpine region.

Distichopsis vesiculoseptata sp. n. (Pl. 7: fig. 2a–d)

Holotypus: NHMW 1995/1/24; Pl. 7: fig. 2

Locus typicus: Gosaukamm, site field number 58.

Stratum typicum: Norian light grey detritic limestone

Derivatio nominis: From the septa having dissepiments incorporated into their blades.

Diagnosis: *Distichopsis* with ca. 100 septa at the diameter of ca. 60 mm. The septa of the lower orders are strongly fusiform.

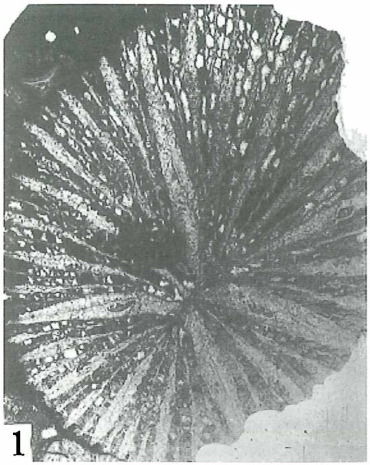
Material. – 1 specimen.

Measurements (in mm):

d	s	sd/10	f	eh
55 × 75	e.100(13 + 13 + 26 + e.50 + S5)	ca.8	10	0.8

Description. – Corallum suboval with a distinct, elongated fossa. Septa differentiated into 5 size orders, septa S1-S4 fusiform. The septa S1 are the thickest. The septa S1 and S2 can be solid, with well developed lateral stereome of a distichophylliid type, or can be thickened by dissepiments. In the septa S2 the maximum thickening develops more externally than in the septa S1 and the thickest parts of septa S3 are situated still more peripherally. The septa S3 and S4 are symmetrically fusiform. Their structure is compound: to their median part (Uhrseptum) accrete fine dissepiments; the thickest parts are built of 3–7 rows of accreting dissepiments. The septa S5 are long and filiform. Septal parts of a dis-

Plate 7. Fig. 1: *Distichopsis minor* gen. et sp. n. **1** Cross section showing unproportionally thickened septa S1 in comparison with other septa; × 2.5. NHMW 1995/1/25. Gosaukamm, Steinriese, Sevatian (Lower Rhaetian?). Fig. 2a–d: *Distichopsis vesiculoseptata* gen. et sp. n. **2a** Cross section displaying shape and arrangement of septa; × 1.2. **2b** Longitudinal section in radial plane showing vesicular dissepiments; × 6. **2c** Longitudinal section cutting septum and showing 2–3 layers of dissepiments covering original septal blade; × 20. **2d** septa magnified × 4.6. NHMW 1995/1/24. Gosaukamm, Norian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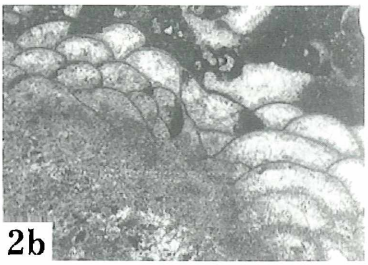
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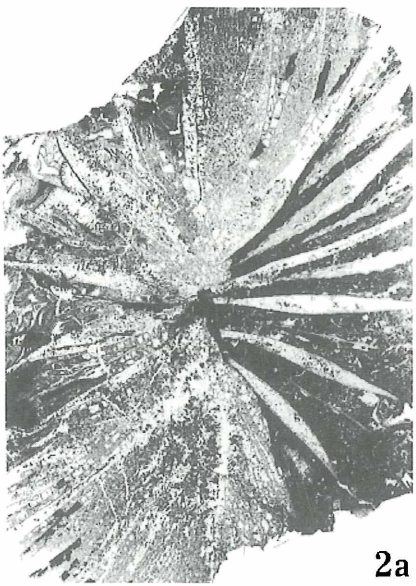
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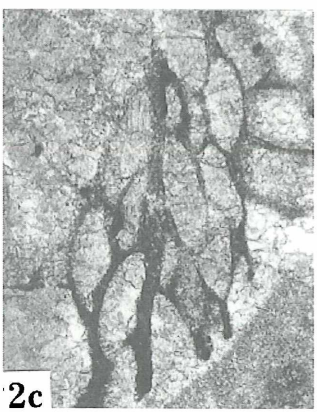
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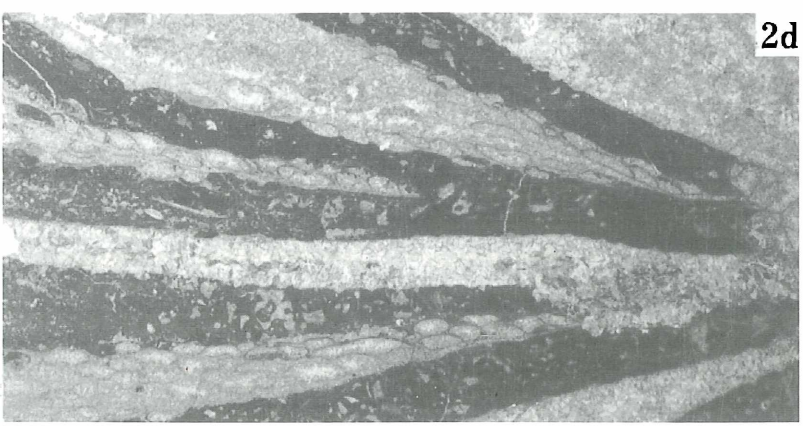

2d

sepimental origin exceed greatly that of trabecular ones. As to the trabecular part, i.e. the original septal blade, it is not thickened at all or only slightly thickened by stereome. The ratio of trabecular to dissepimental tissue in the septum can reach 1:30. The original septal blade can be situated symmetrically at the middle of the thickened septum or asymmetrically. Thickness of septa:

order	min. max.
S1	0.5–3.0 (4.0) mm;
S2	0.5–3.0;
S3	0.1–2.0;
S4	0.1–1.0;
S5	0.05 (entire)

The ornamentation of septa of a "distichophylliid" type is in the form of thick granulations.

Dissepiments sharing in the septal structure are very small and numerous. Other dissepiments, regularly intersecting the interseptal space, are distinctly larger.

Distribution. – Norian of the Gosaukamm.

Distichopsis minor sp. n. (Pl. 6: fig. 1a, b; Pl. 7: fig. 1)

Holotypus: NHMW 1995/1/25; Pl. 6: fig. 1, Pl. 7: fig. 1

Locus typicus: Steinriese, Gosaukamm

Stratum typicum: Sevatian, brownish-grey limestone

Derivatio nominis: from the dimensions smaller than in the type species.

Diagnosis: *Distichopsis* with a number of septa from ca. 80 to above 100 at the calicular diameter of 30 mm.

Material. – Gosaukamm: (1) fragmentary, abraded specimen NHMW 1995/1/25 from Steinriese, embedded in brownish-grey limestone and associated with *Margarophyllia* sp. and a reimaniphylliid indet., Sevatian, site 13; (2) abraded distal part of corallum NHMW 1995/1/26, coming from Oberes Armkar, light-grey limestone, Middle Norian, site 1.

Measurements (in mm):

Specimen No.	d	s	sd/5
NHMW 1995/1/25	e.26 × 30	> 100(8 + 8 + 16 + 32 + > 40)	8–10
NHMW 1995/1/26	e.25	ca. 80(6/6 + 12 + 24 + S5)	6

Description. – Cylindrical, high. Calice subcircular with distinctly elongated fossa. Septal apparatus differentited into 5 orders of septa. Septa S1–S2 reach the fossa. The septa S3 are about 3/4 of the length of S1.

Septa S1–S3 are fusiform, thickened in part by dissepiments. Septa S1 may be thickened by stereome and/or by accreting dissepiments. Thickening is symmetrical or asymmetrical. Septa S2 equal in thickness or thinner than S1, and stronger than septa of higher orders. Septa S3 slightly thickened by stereome in their external two thirds. Septa S4 thin, reaching at least 1/2 S1 in length and regularly developed in all systems. Septa S5 filiform and shortest of all, relatively regularly distributed (NHMW 1995/1/25) or lacking in many systems in the distal corallum part (NHMW 1995/1/26). There can be observed granular ornamentation on the septa S1 and S2, and short menianes on thin septa S3 and S4 (Pl. 6: 1a, b). In general, the ornamentation of higher order septa is distinct but scarce.

Dissepiments of two sorts: the first – intersecting interseptal space and the second – more or less regularly distributed, leaning upon the septa. All dissepiments are approximately of the same size.

Microstructure: Septa S5 and S4 very thin, built exclusively of minitrabeculae; septa S1 with well developed lateral stereome, their median line straight, wavy or zigzag.

Remarks. – The species differs from the type species in having distinctly smaller coralla.

It is possible that the form described herein represents a coral of a phaceloid growth form instead of a solitary coral, with high and cylindrical corallites. This presumption is supported by the fact that such a phaceloid coral does exist in the Middle Norian of the Pamirs (MELNIKOVA in coll.).

Distribution. – From the Alaunian to Sevatian (Lower Rhaetian?) in the Gosaukamm.

Genus *Distichomorpha* nov.

Species typica: *Distichomorpha robusta* sp. n.

Derivatio nominis: from its ressemblance to *Distichophyllia* CUIF; *femin.*

Diagnosis: Simple. Fossa long and narrow. Septa differentiated into 4 size orders. Ornamentation in the form of granulations. Median zigzag line present. Endotheca built of tabuloid, concave at the centrum, large dissepiments.

Species included: Rhaetian: *D. robusta* sp. n., *Montlivaltia frechi* HAAS, 1909; Upper Triassic: *Montlivaltia stylophylloides* VINASSA de REGNY, 1915.

Remarks. – The genus resembles *Distichophyllia* in the external shape. The wall is not preserved. It differs from the *Distichophyllia* in its septal apparatus composed of septa of only 4 orders and in its rare, tabuloid endotheca.

In the literature, corals under the name of *Montlivaltia stylophylloides* have been mentioned or illustrated. A form in OKUDA & YAMAGIVA, 1978 seems to represent another coral, different from *Distichomorpha*, with prominent septal granulations.

Stratigraphical and geographical range. – Norian and Rhaetian of the Alps; Norian of the Timor.

Distichomorpha robusta sp. n. (Pl. 5: fig. 1a–c)

Holotypus: Fragmentary specimen NHMW 1995/1/27; Pl. 5: fig. 1

Locus typicus: Gamskar, site 2

Stratum typicum: Sevatian light grey limestones

Derivatio nominis: *robustus* Latin–robust–from strong skeletal structure.

Diagnosis: Tall corallum of ca. 120 septa at the diameter of 70 mm.

Material. – Holotype specimen. The skeleton is damaged by microborings and recrystallized.

Measurements (in mm):

d	s	sd/10	f	ed/10	eh	el
ca. 70	ca. 90(12 + 12 + 24 + S4)	6	13	8–9	1–2	> 12

Description. – Tall corallum slightly elliptical in section. Fossula narrow and long. Septal apparatus composed of thick septa. The septa S1 are the thickest (3 mm) and reach the center. Their internal ends are rounded. The septa S2 are slightly thinner, with wedge-like internal ends. The septa S3 are more than half the length of the septa S1. Peripherally, they are thickened, in the thinnest parts, however, they are about 75 μm wide. The septa S4 are relatively very thin (peripherally ca. 100 μm) and reach 1/5–1/3 S1 in length. The number of septa is high as the septal systems are rather regularly developed. Septal face ornamentation is in the form of granulations with large bases, pointed tips and circular sections (max. d = 400 μm). The endotheca is built of widely expanding, large dissepiments, which are concave at the center. The wall has not been preserved.

Microstructure: The skeleton is badly recrystallized but in places, there is preserved a light, thin, zigzag line proving that the trabeculae at the midline were thin. Small trabecular diameter is confirmed by thin septa S4 and internal parts of some septa S3. Large granulations evidence that the lateral septal stereome was organized into large lateral trabeculae.

Remarks. – The form considered greatly resembles two species known in the literature: *Montlivaltia frechi* HAAS and *M. stylophylloides* VINASSA de REGNY. They have in common all morphological features excepting the larger diameter of *D. robusta*, and regular development of septa S4.

Distribution. – As the holotype.

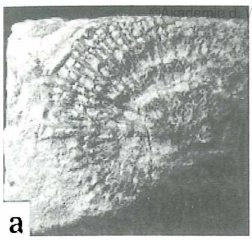
Suborder Stylophyllina BEAUVAIS, 1981

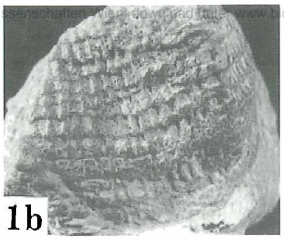
Family Stylophyllidae FRECH, 1890

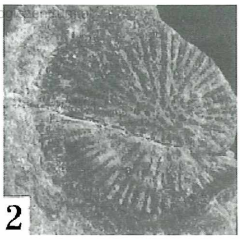
Genus *Stylophyllopsis* FRECH, 1890

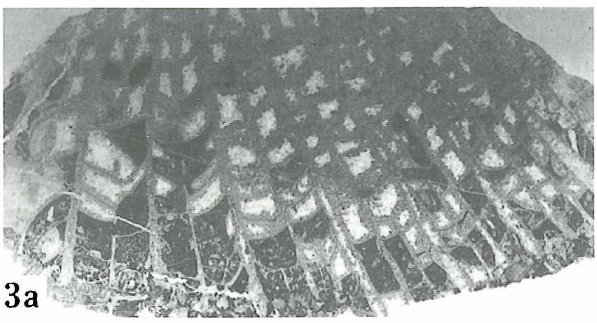
Stylophyllopsis polyactis FRECH, 1890

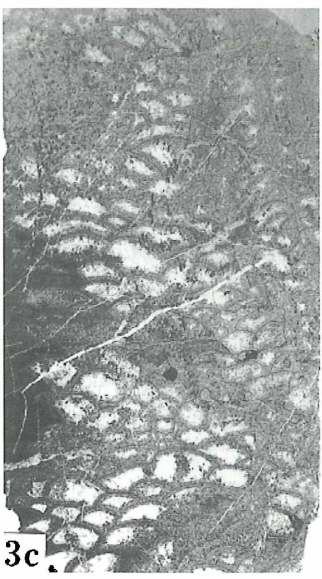
(Pl. 8: fig. 1a, b)











ate 8. Fig. 1a, b: *Stylophyllopsis polyactis* (FRECH, 1890). Weathered surface. Thin septa a) and thick tabuloid endotheca (**1b**); × 1.1. NHMW 1995/1/28. Gosaukamm, hneegrube, Sevatian. **2** *Stylophyllopsis lindstroemi* FRECH, 1890. Weathered surce; × 1.8. NHMW 1995/1/30. Gosaukamm, Steinriese, Sevatian (Lower Rhaetian?). g. 3a–c: *Stylophyllopsis*? sp. A. **3a** Cross section showing septal apparatus constituted of in septa; × 2. **3b** A fragment showing septum S3 dissociated into septal spines (arrows); 4.5. **3c** Longitudinal section with homogeneous dissepiments; × 2. NHMW 1995/1/18. Gosaukamm, Gamskar, Sevatian

1890. *Stylophyllopsis polyactis* FRECH, p. 48, text-fig. on p. 49, Pl. 12: fig. 3; Pl. 15: fig. 17–23
1989. *Stylophyllopsis polyactis* FRECH: RONIEWICZ, p. 124, Pl. 36: fig. 6, 7; Pl. 37: 1; Pl. 38: 8, 9 (here synonymy)

Material. – Three specimens from light grey limestones from the Gosaukamm: (1) 1961/406/37 from Felsriegel between Steinriesenkogel and Strickkogel, Lesesteine, height 1950 m (point 62), vicinity of the site 13; (2) NHMW 1995/1/28 from Schneegrube, site 12; (3) NHMW 1995/1/28 from Weitgriess, site 18.

Measurements (in mm):

Specimen No.	d	s	ed/10
NHMW 1995/1/29	24	70	
NHMW 1961/406/37	26	e65	
NHMW 1995/1/28	35	75	7–9

Remarks. – The specimens show characteristic, thin numerous septa of considerably large diameters and a tabuloid, dense endotheca. That form belongs to the variety characterized by a relatively fine skeleton (see RONIEWICZ 1989).

Distribution. – Sevatian (Lower Rhaetian?) in the Gosaukamm and Rhaetian (Zlambach Beds) from the vicinity of the Gosaukamm, from Fischerwiese and Halstatter Salzberg.

Stylophyllopsis lindstroemi (FRECH, 1890) (Pl. 8: fig. 2)

1890. *Stylophyllopsis lindstroemi* FRECH, p. 53, Pl. 19: fig. 15–20: Pl. 12: fig. 2
1973. *Stylophyllopsis praenuntians* (VOLZ): CUIF, p. 254, text-fig. 22a (non fig. 22b).
1989. *Stylophyllopsis lindstroemi* FRECH: RONIEWICZ, p. 128, Pl. 39: fig. 7; Pl. 40: figs. 3, 4

Material. – Gosaukamm, Steinriese: specimen NHMW 1995/1/30, site 13.

Measurements (in mm):

d	s
15	54

Remarks. – In the septa of the highest order, the specimen examied shows very thin septal spines characteristic of the species.

After having examined the holotype specimen of Carnian *Stylophyllum praenuntians* Volz, I no longer accept the CUIF (1972) proposition of including that Carnian form in the synonymy of *S. lindstroemi*, because I have concluded that they represent different species. *Stylophyllum praenuntians*, with its rare, horizontal, tabular endotheca (compare VOLZ 1896,

Pl. 11: fig. 4) essentially differs from *Stylophyllopsis lindstroemi* FRECH having endotheca built of numerous dissepiments, inclined axialward (compare RONIEWICZ 1989, Pl. 40: figs. 3, 4).

Distribution. – Sevatian (Lower Rhaetian?) of the Gosaukamm and Rhaetian of the Zlambach Beds of the vicinity of the Gosaukamm and Fischerwiese.

Stylophyllopsis? sp. A. (Pl. 8: fig. 3a–c)

Material. – Gosaukamm: distal fragment of corallum, specimen No. NHMW 1995/1/18, Gamskar, site 2; 3 thin sections

Measurements (in mm):

d	s	sd
e. 70	ca. 120	5–6/10

Description. – Septa very thin, differentiated into 4 orders. Septa S1 and S2 slightly enlarged, those of S3 enlarged peripherally. Septa S4 are well developed and long, but are missing in some interseptal spaces. Septa of the first two orders are continuous while the septa of the third and fourth orders are adaxially discontinuous. The discontinuity is of a complex nature: some fragments look like lonsdaleoid septa, other represent free septal spines. In the continuous septal portions, the septal spines are marked on the septal surfaces in the form of rounded ridges. Endotheca subhorizontal, composed of vesicular, subequal and thin-walled dissepiments. Wall thin, pellicular.

Remarks. – The coral in its thin septa resembles the thin-septal form of *S. polyactis* FRECH, type species of *Stylophyllopsis*. It differs from the latter in its vesiculous endotheca and in compact septa. The coral displays the largest diameters of all known stylophyllins.

Distribution. – Norian of the Gosaukamm.

Coral indet (Pl. 2: fig. 4)

To make the review more complete, I have presented a Sevatian undeterminable coral (NHMW 1995/1/17: d ca. 20 mm, se. 40). It displays surprisingly rare dissepiments and septa, differing in it from the majority of solitary corals considered. Generally, it resembles thin-septal *Stylophyllopsis*.

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Author's address: Dr. Ewa Roniewicz, Institute of Paleobiology, Polish Academy of Sciences, Al. Zwirki, Wigury 93, PL-02-089 Warsaw, Poland.