| Riv. It. Paleont. Strat. | v. 99 | n. 1 | pp. 3-26 | tav. 1-4 | Maggio 1993 |
|---|---|---|---|---|---|

# LATE DEVONIAN (FRASNIAN) CORALS FROM CENTRAL DOLPO, NEPAL

HELMUT W. FLUEGEL* & ANDREA TINTORI**

*Key-words*: Taxonomy, Paleobiogeography, Corals, Late Devonian, Himalaya, Nepal.

*Riassunto.* Nel corso di una spedizione geologica italiana nella regione del Dolpo centrale (Nepal), è stata raccolta una piccola fauna a Tabulata e Rugosa, che si è dimostrata di grande interesse sia per la datazione del livello fossilifero (Frasniano Inferiore), sia per le implicazioni paleobiogeografiche. Le calcareniti fossilifere, poste a circa 4900 m di quota, sono ricoperte da un livello ad ooliti e croste ferrose, messo in relazione alla trasgressione del Frasniano Superiore; viene confermata quindi la datazione paleontologica. È stato eretto un nuovo genere, *Fruehwirthia* gen.n. con specie tipo *F. heritschi* sp.n.; anche per *Scruttonia* è stato necessario istituire una nuova specie *S. rota* sp.n. La fauna comprende anche *Kuangxiastraea*, *Sinodisphyllum*, *Tabulophyllum* (?), *Thamnopora*, *Cladopora*, *Alveolites* e *Alveolitella*. Dal punto di vista paleobiogeografico questa fauna a Coralli presenta somiglianze sia con quelle dell'Europa occidentale che con quelle della Cina meridionale, fornendo evidenze circa l'esistenza di una estesa provincia faunistica lungo tutto il margine settentrionale del Gondwana. Tale provincia non comprendeva le faune rinvenute nelle rocce coeve del Karakorum, Afghanistan, Iran e Turchia.

*Abstract.* Rugosa and Tabulata from the Late Devonian of central Dolpo (Nepal) belong to the genera *Kuangxiastraea*, *Scruttonia*, *Sinodisphyllum*, *Tabulophyllum* (?), *Fruehwirthia* gen. n., *Thamnopora*, *Cladopora*, *Alveolites* and *Alveolitella*. The calcarenitic beds yielding the fossils are overlain by a prominent oolitic ironstone with thick ferruginous nodules and crusts. The age of the corals is probably Early Frasnian, thus younger than the Givetian fauna previously reported from eastern Dolpo. Biogeographic relations of the new fauna are with Western Europe and South China.

## Introduction (A.T.).

In September 1990, an Italian geological expedition visited the Dolpo region (Himalaya, Nepal) (Garzanti, Nicora & Tintori, 1992), for a project on the Tethys Himalaya concerning the entire Himalayan Range. For many years before 1990 most of that area was closed to westerners; this is the situation again. Geological knowledge

* Institut für Geologie und Palaeontologie, Heinrichstrasse 26, A-8010 Graz.

** Dipartimento di Scienze della Terra dell'Università degli Studi di Milano, Via Mangiagalli 34, I-20133 Milano.

is very poor, and entirely due to the valuable work by Fuchs (1967, 1977). We could only visit a small area of central Dolpo (Fig. 1), in particular the area surrounding the villages of Do and Tok Khyu (respectively Tarap and Atali in the geological literature). Though small, it is very interesting because it is intermediate between eastern and western Dolpo, which have different sedimentary histories.

The party was mainly interested in the Permo/Mesozoic rocks, but, as much as possible, older rocks were also investigated. A continuous sequence of Devonian to Middle Triassic units crops out at the head of the valley west of Numa La, at about 4900 m. Low tectonic deformation has allowed the fossils to be very well preserved (Nicora & Tintori, 1991; Nicora, 1992). Coral-rich blocks are rather common along the scree, so special attention was paid to the research of the fossils source-rocks. Calcarenite beds overlying a thick dolomite horizon (Garzanti, Nicora & Tintori, 1992) proved to be very rich in organic content, with predominant corals and a few brachiopods. This paper focusses on the corals; they represent a new Himalayan fauna. Only a Givetian fauna was previously known (Fluegel, 1966) from the Devonian of the Tethys Himalaya.

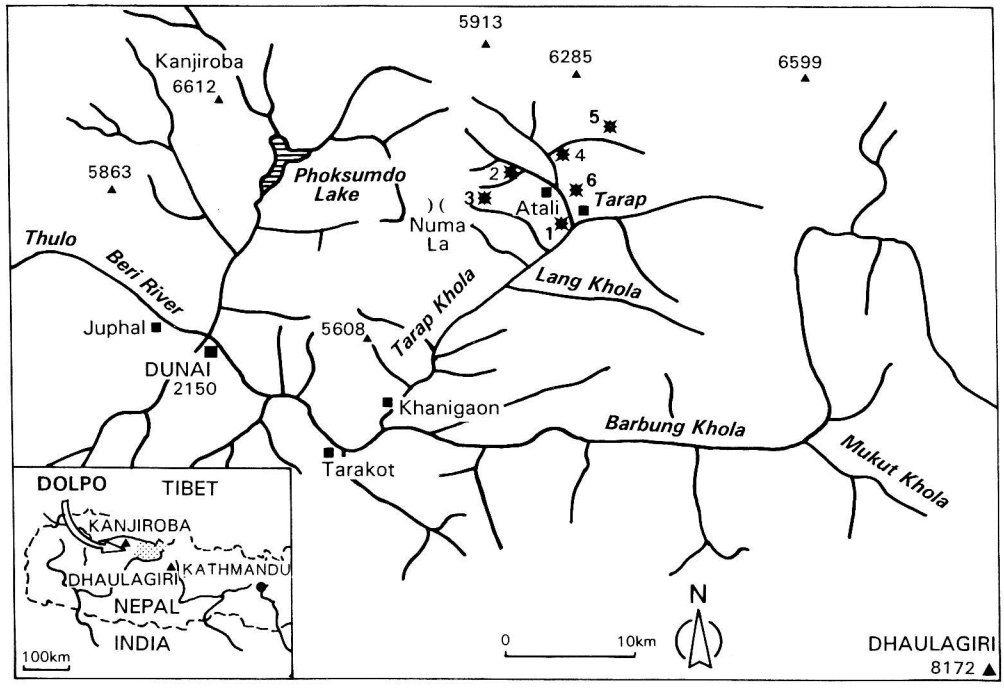



Fig. 1 - Geographic map of the Dolpo area investigated in 1990 by the Italian geological expedition. Location of studied sections is indicated as follows: 1) Tarap (Carboniferous? to Norian); 2) Atali South; 3) Atali-Numa La, yielding the fossils of the present paper; 4) Atali; 5) Atali North; 6) Tarap (Norian to Liassic).

**Geological framework and age (A.T.).**

The Middle-Late Devonian rocks in Nepal show a wide range of sedimentary environments. From east to west, we can differentiate three major areas: the Manang/Thakkhola/eastern Dolpo subsident terrigenous basin, the western Dolpo and Kumaon dolomitic platform and, in the Spiti-Zanskar Synclinorium, quartzarenitic beaches.

In the first region, the Tilicho Pass Formation consists of pelites with intercalated fine-grained sandstones and carbonates (Garzanti & Pagni Frette, 1991). A Middle Devonian age was inferred from corals and brachiopods for the lower-middle part of this unit in the Thakkhola (Bordet et al., 1967, 1971) and eastern Dolpo (Fluegel, 1966), whereas Frasnian conodonts have been found in its middle-upper part in the Manang area (Fuchs et al., 1988).

In western Dolpo, carbonates (massive dolomites) predominate over calcareous quartzites and quartzarenites (Fuchs, 1977). This unit was called the Muth Formation by Fuchs (1977). In our opinion use of this term is somewhat incorrect, because the Nepalese succession is rather different from the supermature beach quartzarenites found farther west (Muth Quarzite of Spiti and Zanskar; Stoliczka, 1866); these contain very little or no carbonate at all (Gaetani et al., 1986). In any case, the unit yielding our coral fauna cannot be ascribed either to the "Muth Formation" of Fuchs (1977) or to the Tilicho Pass Formation *s.s.*, to which it is, however, broadly related. Furthermore, the transition between the Tilicho Pass Formation and the dolomites of western Dolpo occurs in this area (Fuchs, 1977). Our knowledge of the region is still poor, so we prefer to designate these beds informally as "fossiliferous Late Devonian limestone" (Garzanti, Nicora & Tintori, 1992).

The fossiliferous beds, overlying the Middle ? Devonian dolomites, may well mark the end of a long period in which carbonate sediments were deposited in central and western Dolpo. Our area can be interpreted as the hinge between the terrigenous basin, with centre in the present Thakkhola-Manang region, and the shallow carbonate platform of western Dolpo. In central Dolpo, sedimentation ceased for a while (ironstone deposition) then started again with shales. This can be related to the late Frasnian transgression in the conodont *gigas* Zone (Talent & Yolkin, 1987). It follows that the fossiliferous limestones are probably pre-late Frasnian.

*Kuangxiastraea pengellyi* (Milne-Edwards & Haime, 1851) is presently known only from the late Givetian of England; most other species of the genus occur in the Frasnian of Eurasia. *Scruttonia* and *Tabulophyllum* (?) *implicatum* Tsien, 1977 are Frasnian. *Sinodisphyllum litvinovitshae* (Soshkina, 1949) was described from the late Givetian and early Frasnian of Russia (Ural) and S. China. The new genus *Fruehwirthia* and the tabulate corals have a less biostratigraphic value. The fauna, as a whole, is most likely of early Frasnian age.

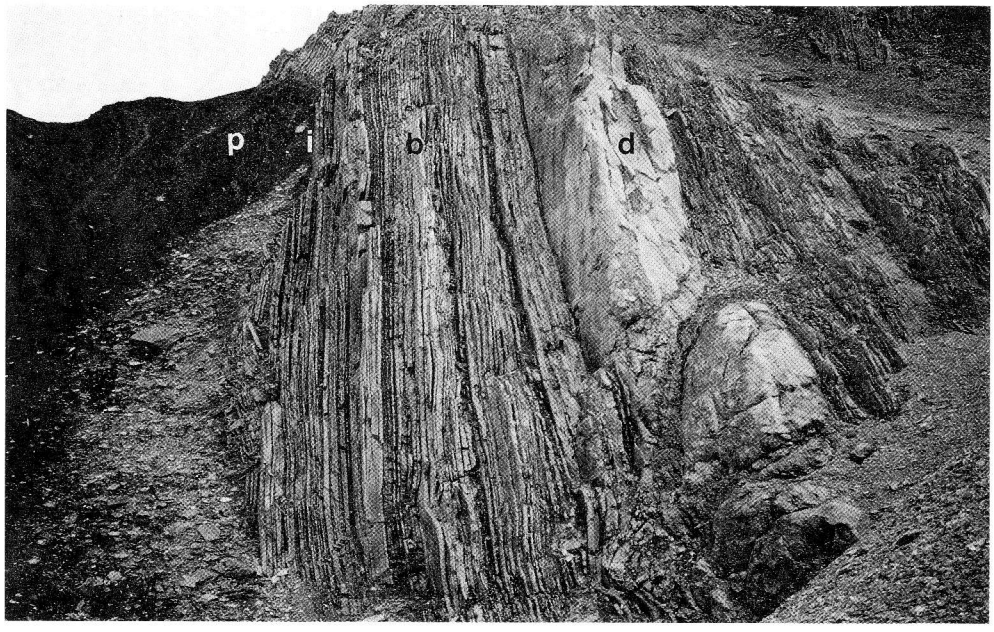



Fig. 2 - Early Late Devonian succession in the Atali-Numa La section. Thick bedded, white dolomites (d) are overlain disconformably by thin-bedded biocalcarenites (b) yielding corals and brachiopods. A condensed ironstone surface (i) follows. Dark pelites (p), of inferred Late Devonian age, hundreds of meters thick, overly the ironstone.

The fact that the two Devonian coral faunas known from Dolpo are of different ages, though from nearby areas, is in accord with great variability in paleoenvironments in the region. Conditions favorable to building of coral reefs probably recurred along the margin of the Thakkhola Basin, the locii varying with time.

**Paleobiogeography (A.T. & H.W.F.).**

The paleobiogeography of now juxtaposed regions of the Australia-Asian hemisphere (Talent, Gratsianova & Yolkin, 1986; Talent & Yolkin, 1987) was very complex during the Devonian. Several continental blocks with marginal marine facies, can be discriminated by their fossil content (mainly brachiopods), as well as by geological data. Though the Frasnian is normally considered a period of strong cosmopolitanism, Talent & Mawson (1979) pointed out that a measure of provincial heterogeneity can still be discerned. It may represent an inheritance from the marked provincialism of the Early-early Middle Devonian (Ferrari, 1968; Vai, 1991). After the late Frasnian transgression, more cosmopolitan faunas occurred, following the generalized drowning of reefs and carbonate platform (Ferrari & Vai, 1973; Vai, 1991). Faunal provincialism during early Frasnian is consistent with the existence of marine waters between the

various blocks along the northern edge of Gondwana.

As already noted above, the north-west Himalayan Devonian, consisting almost entirely of beach deposits (Muth Formation) rarely yields marine faunas. Normal marine sediments are found mainly in the eastern Himalaya, from where the two small coral faunas under discussion are known.

Devonian corals are present in Chitral (Pakistan) in a well-known sequence described by Hayden (1915) and Desio (1966). According to Talent & Mawson (1979), the corals described by Schouppé (1965) from Kuragh Spur and Shogram must be ascribed to the Frasnian rather than to the Givetian. Furthermore, the fossiliferous beds lie a few meters below a thick (5 m) oolitic ironstone, in a position similar to that of our new material from Dolpo. Since the ironstones are probably due to global changes (Garzanti, 1993), the two faunas are likely coeval. Comparison of the faunas shows no significant similarities; a few species from Chitral, however, also occur in European faunas, i.e. *Grypophyllum (Leptoinophyllum) vermiculare* (Goldfuss, 1826), *Macgeea (Macgeea) multizonata* (Reed, 1922), *Thamnopora reticulata* (de Blainville, 1830) and *T. boloniensis* (Gosselet, 1877) (see Schouppé, 1965). A few Chitral species are also widespread in Russia and Siberia, i.e. *Macgeea (Macgeea) multizonata*, *Thamnopora reticulata* and *T. boloniensis*. According to Desio (1966) the brachiopods, found together with corals in Chitral, are similar to those of West Afghanistan. Our Dolpo fauna does not resemble the coeval faunas from Afghanistan, nor those from northern Iran and southern Turkey (Brice, 1970; Fluegel, 1955; Fluegel & Fluegel, 1961; Gods, 1982; Hubmann, in press). During most of the Paleozoic, continental blocks, such as some of those of Tibet, the Karakorum, Afghanistan, Iran and Turkey, are thought to have been separate from the northern margin of Gondwana, though rather close to it (Leith, 1982; Scotese & McKerrow, 1990). Nonetheless, both brachiopods and corals are strongly provincial, apparently pointing to seas of appreciable width in between them. Also paleoecological factors could be important in separing bioprovinces, especially when long and narrow seas cut landmasses. Paleogeography of the Asian Devonian is still far from being definitively understood. For example, the late Eifelian (Middle Devonian) brachiopod fauna from Burma is astonishing similar to western European faunas raising questions about the relative position of those regions at that time (Talent, Gratsianova & Yolkin, 1986).

A tentative restoration of Frasnian coral biogeography suggests a province extending along the northern edge of Gondwana from South China to west Europe through Burma, north-western Australia, Tethys Himalaya and North Africa. Other provinces are assumed to be related to blocks isolated from the main Gondwana landmass. The Middle Devonian coral fauna from central Dolpo (Fluegel, 1966), is also characterized by western European forms, e.g. *Cyathophyllum dianthus* Goldfuss, 1826, *Neostringophyllum* aff. *N. concavum* Walther, 1928, *Stringophyllum isactisor* (Frech, 1886) and *Favosites goldfussi* d'Orbigny, 1850.

## Systematic paleontology (H.W.F.)*

Subclass **Rugosa** Milne-Edwards & Haime

Family *Disphyllidae* Hill, 1939

Subfamily *Hexagonariinae* Bulvanker, 1958

Genus *Kuanxiastraea* Yu & Kuang, 1983

Type species *Haplothecia* (*Kuanxiastraea*) *elegans* Yu & Kuang, 1983.

1983 *Haplothecia* (*Kuanxiastraea*) Yu & Kuang, p. 255.

Diagnosis. See Pedder (1986, p. 655).

Remarks. *Kuanxiastraea* was erected by Yu & Kuang as a subgenus of *Haplothecia*. Pedder (1986) regarded *Kuanxiastraea* as a genus of its own and included it within the subfamily *Hexagonariinae* Bulvanker. McLean (1989) pointed to the similarities between *Kuanxiastraea* and *Billingsastraea* (*Sichuanastraea*) (He, 1978). They thought that both genera could be synonyms. Against that idea is the morphology of the septa, which are peripherally reticulate or degenerate in *Kuanxiastraea*, and smooth and complete in *Sichuanastraea*. Species of *Kuanxiastraea* have been reported from Middle and Late Devonian strata of China, Australia, the Rudny Altai Region and Western Europe. According to Kursten (1987), the unique species of *Kuanxiastraea* of northern America, *K. julli* Pedder, 1986, belongs to *Scruttonia*.

### Kuanxiastraea pengellyi (Milne-Edwards & Haime, 1851)

Pl. 1, fig. 1, 2

1851 *Smithia pengellyi* n. sp. Milne-Edwards & Haime, p. 422.
1967 *Haplothecia pengellyi* - Scrutton, p. 274, pl. 42, fig. 1-5; pl. 43, fig. 1,2 (*cum syn.*).
1986 *Kuanxiastraea pengellyi* - Pedder, p. 655.

Material. Specimens n.6760 (ex AD30/1, 16 field numbers) and 6761 (ex AD30/5, 7 field numbers).

Description. Colonies thamnasterioid, locally aphroid, with maximum diameter 90 x 70 mm and thickness 20 mm; centres of adjacent corallites 7 to 18 mm apart; diameter of tabularia 3 to 5 mm; diameter of corallites 7 to 19 mm. Larger corallites have 18 to 21 x 2 septa, smaller corallites 12 to 15 x 2 septa. Major septa extend to the axis and could be connected. Minor septa thin and confined to the dissepimentaria. Marginal septa degenerate to a network or end in an aphroid dissepimentarium. Both orders of septa are equipped with yardarm carinae. Near the inner edge of the dissepimentaria, septa are dilated. Tabulae are complete to incomplete. Near the dissepimen-

* The systematic arrangement of higher taxa follows Hill (1981).

tarium/tabularium boundary dissepiments are smaller than in other parts of the dissepimentarium. Horseshoe dissepiments lacking.

**Remarks.** The specimens are very similar to *K. pengellyi* described by Scrutton (1967) from the Givetian of England.

## Genus *Scruttonia* Cherepnina, 1974

Type species *Smithia bowerbanki* Milne-Edwards & Haime, 1851.

1974 *Scruttonia* gen.n. Cherepnina, p. 202.
1978 *Billingsastraea* (*Sichuanastraea*) n.subgen. He, p. 134.
1987 *Scruttonia* Kuester, p. 36 (*cum syn.*).

**Diagnosis.** See Hill (1981, p. F284), Rohart (1982, p. 105), McLean (1989, p. 243).

**Discussion.** Cherepnina (1974) erected the genus for colonial corals discriminated from *Frechastraea* Scrutton only by having a thamnasterioid corallum. The taxonomic status of *Scruttonia* is debatable. Roemer (1883) and Frech (1885) included the type species in *Phillipsastrea* d'Orbigny, Soshkina (1951, 1952) in *Pachyphyllum* Milne Edwards & Haime, Pickett (1967) and Coen-Aubert (1974) in *Billingsastraea* Grabau and Scrutton (1968) and Birenheide (1978) in *Frechastraea*. Birenheide (1990) regarded *Scruttonia* as a subgenus of *Frechastraea*, whereas Coen-Aubert (1980), Rohart (1982), Cotton (1983), Pedder (1986) and McLean (1989) agreed with the conception of *Scruttonia* as a discrete genus, as Cherepnina (1974) had done. In this connection the question of the presence or absence of horseshoe dissepiments in the type species is pivotal. The original of *S. bowerbanki* is apparently lost (Scrutton, 1968, p. 254). Description and illustration of the type throws no light on this problem. Real horseshoe dissepiments are structurally very complicated. The dissepiments are sometimes not only bent, horseshoe-like, in the radial direction of the septa, but also in the normal direction. Placed one upon the other, they make up a ring- and wall-like structure within or peripheral to the dissepimentarium. They are morphogenetically older than the adjacent normal dissepiments and/or tabulae. Genera such as *Macgeea*, *Thamnophyllum*, and *Trapezophyllum*, of the family *Phillipsastreidae* are good examples of this type (Schouppé, 1958). Half or false horseshoe dissepiments also occur occasionally in genera of *Disphyllidae*. True horseshoe-ring-structures at *Scruttonia* fail, but casual false horseshoe-dissepiments exist.

### **Scruttonia bowerbanki** (Milne-Edwards & Haime, 1851)

Pl. 2, fig. 1, 2

1851 *Smithia bowerbanki* n. sp. Milne-Edwards & Haime, p. 423.
1980 *Scruttonia bowerbanki* - Coen-Aubert, p. 5, pl. 1, fig. 1-3 (*cum syn.*).
1986 *Scruttonia bowerbanki* - Pedder, p. 658.

**Material.** Specimens n. 6754 (ex AD28/9) and 6755 (ex AD28/11).

**Description.** Corallum thamnasterioid, disc-like, with a diameter of more than 100 mm, and a thickness of more than 30 mm. Diameters of the circular tabularia are 1.0 to 1.5 mm, with distances centre-to-centre between 3 and 5 mm. Number of tabularia in 100 $mm^2$ varies between 6 and 8. There are 10 x 2 septa. Within the tabularia, major septa are thin and often reach the centre of the tabularia where they are connected. Minor septa are well developed, crossing only the dissepimentaria. Both septal orders are spindle-like, dilated at the dissepimentarium/tabularium boundary, but only slightly dilated and mostly bent within the dissepimentaria. Yardarm carinae are well developed. Dissepimentaria regular, with mostly small dissepiments; horseshoe dissepiments are absent. Seven to eight tabulae occur per mm; they are horizontal or dip slightly upwards towards the axis. Fans of trabeculae are present near the dissepimentarium/tabularium boundary.

**Remarks.** The specimens display characteristic alteration of light and dark growth strips; these are visible in both transverse and longitudinal sections. The longitudinal section shows that these strips are related with small zones of dissepiments. *S. bowerbanki* is known from the Frasnian of western Europe.

### **Scruttonia rota** sp. n.

Pl. 2, fig. 3, 4

**Holotype.** N. 6749 (ex AD28/1).

**Locus typicus.** Atali-Numa La section, central Dolpo, Nepal.

**Stratum typicum.** "Fossiliferous Late Devonian Limestone" of Garzanti, Nicora & Tintori (1992), early Frasnian.

**Paratype.** Specimens n. 6750 (ex AD28/4) and 6753 (ex AD30/2).

**Derivatio nominis.** *rota* (lat.) = wheel, referring to the wheel-like appearance of the tabularia in transverse section.

**Diagnosis.** A species of *Scruttonia* with central hub-like linkage of the major septa, with diameter of tabularia to 2 mm, and with 12 x 2 septa.

**Description.** The massive, flattened, thamnasterioid colonies are up to 100 mm in diameter and 30 mm in thickness. Diameters of the tabularia 1.8 to 2.0 mm. In 100 $mm^2$ there are 5 to 8, mostly 6 tabularia. There are 10 to 12 x 2 septa. Major septa are long and thin, connected axially and, together with the stereozone, forming a wheel-like structure around the tabularium. The hub-like connecting point of the septa is seen in longitudinal section as a pillar within the tabularia. Both order of septa are spindle-like, dilated around the tabularia and, partly, wall-like, connected to a stereozone. The minor septa do not project into the tabularia. Within the dissepimentaria the septa are slightly thicked and variably carinate. The tabulae are complete, flat and average six per mm. The dissepimentaria consist of small, globose dissepiments. Horseshoe-dissepiments are lacking. Trabeculae are arranged in asymmetrical fans.

**Remarks.** The new species is characterized by the wheel-like appearance of the tabularia in transverse sections. The measurements are similar only to *S. sanctacrucensis* Rozkowska, 1953 and *S. bolonensis minor* Coen-Aubert, 1980. Both species do not, however, show the characteristic wheel-like feature.

## Family *Cyathophyllidae* Dana, 1846
## Subfamily *Zaphrentinae* Milne-Edwards & Haime, 1850
## Genus *Sinodisphyllum* Sun, 1958

Type species *Disphyllum (Sinodisphyllum) variabile* Sun, 1958.

1958 *Disphyllum (Sinodisphyllum)* gen n. Sun, p. 11.
? 1961 *Mansuyphyllum* gen. n. Fontaine, p.100.
? 1975 *Aristophyllum* n.g. Bulvanker, Spasky & Kravtsov in Ivanovsky, p. 78.

**Diagnosis.** See Liao & Birenheide, 1989, p. 88.

### **Sinodisphyllum litvinovitshae** (Soshkina, 1949)

Pl. 4, fig. 1

1949 *Campophyllum litvinovitshae* sp. n. Soshkina, p. 86, pl. 38-40, fig. 1-3.
1977 *Sinodisphyllum litvinovitshae* - Liao, p. 43, pl. 1, fig. 6-8; pl. 3, fig. 3 (*cum syn.*).
1989 *Sinodisphyllum litvinovitshae* - Liao & Birenheide, p. 88, pl. 1, fig. 1-6.

**Material.** Specimens n. 6757 (ex AD28/8) and 6758 (ex AD30/3).

**Description.** The diameter of the ceratoid corallites is 16 to 22 mm. The 28 radially arranged major septa are 4.0 to 5.5 mm long. The cardinal septum is a little withdrawn and shorter than adjacent septa.The diameter of the free axial space is 3 to 5 mm. Minor septa are about half as long as the major septa, and terminate inside the tabularium. Both orders of septa are wedge-like within the dissepimentarium and thin out in the tabularium. Minor septa, within the dissepimentarium, are a little thinner than the major septa. Eight to 10 rows of small dissepiments, occasionally of herring-bone-type, occur.

**Remarks.** The long, wedge-shaped septa, the shorter cardinal septum, the length of the minor septa, and the numerous rows of dissepiments are differences between *Mictophyllum* Lang & Smith, 1939 and *Temnophyllum* Walther, 1928. The corallite diameter and number of septa fall within the range of variation in *S. litvinovitshae.* The species is known from the Givetian and Frasnian of the Ural and South China.

## Family *Charactophyllidae* Pedder, 1972
## Genus *Fruehwirthia* gen. n.

Type species *Fruehwirthia heritschi* sp. n.

**Derivatio nominis.** The new genus is named after Josef Fruehwirth, retired laboratory assistant of the Institute of Geology and Paleontology of the University of Graz. Without his valuable help through many years my scientific work in paleontology would have been impossible.

**Diagnosis.** Corallum ceratoid with two septal orders peripherally, with intraseptal and interseptal dissepiments; tabulae incomplete and axially arched.

**Remarks.** The new genus recalls somewhat *Ceciliaphyllum* McLean, 1982 from the Frasnian of British Columbia; differences are the inverted dissepimentarium and the existence of degenerate septa in that genus. On the other hand the new genus may

be compared with *Federowskicyathus* Rozkowska, 1980, especially *F. radicensis* McLean & Pedder, 1984 from the Frasnian of Western Canada. This species is characterised by intra and interseptal dissepiments. Differences are the existence of well developed presepiments and the tendency of the septa to be twisted axially in *Federowskicyathus*. Because of the occurrence of intraseptal dissepiments, the systematic position of the new genus is obscure.

**Fruehwirthia heritschi** gen. n., sp. n.

Pl. 3, fig. 1-4; Pl. 4, fig. 2

Holotype. Specimen n. 6751 (ex AD28/6).

Locus typicus. Atali-Numa La Section, central Dolpo, Nepal.

Stratum typicum. "Fossiliferous Late Devonian Limestone" of Garzanti, Nicora & Tintori (1992), early Frasnian.

Paratype. Specimen n. 6752 (ex AD28/10).

Derivatio nominis. I dedicate the new species to my late teacher Univ. Prof. Dr. Franz Heritsch, who inspired my love for Palaeozoic corals.

Diagnosis. Diameter of the solitary corallite below the base of the calice around 20 mm, with 27-29 x 2 septa. Major septa extend into the tabularium; minor septa are half as long as major septa. Both orders of septa have intraseptate dissepiments.

Description. Ceratoid coralla about 60 mm long, with diameter 18 to 23 mm. The transverse section shows 27 to 29 x 2 septa. The development of the major septa is different: in the holotype, one septum is long and connected in the axial region with sections of tabula; other major septa are distinctly shorter. The other specimen (paratype) shows long major septa, twisted or bent in the axial region. The minor septa are half or less than half as long as the major septa. In the peripheral part of the corallite, both orders of septa are wedge-like, dilated and fork-like, split into two branches. As well as V-shaped interseptal dissepiments ("Hohlkehlen-Dissepiment" of Birenheide, 1963) there are, within these forks, intraseptal dissepiments. At the boundary of the dissepimentarium/tabularium, the dissepiments are thicked by stereom, forming a stereozone. In longitudinal section the dissepimentarium, up to 3 mm wide, consists of small, oblique, elongated dissepiments. The tabularium is formed of an axial part of table-shaped, partly incomplete tabulae and a peripheral part of great, cyst-like tabellae. The septa consist of monacanthine trabeculae.

Remarks. The two specimens differ only in development of the major septa, but both come from the same locality, have the same number of septa and the same diameter.

Genus *Tabulophyllum* Fenton & Fenton, 1924

Type species *Tabulophyllum rectum* Fenton & Fenton, 1924.

1924 *Tabulophyllum* Fenton & Fenton, p. 30.
1928 *Apolythophyllum* Walther, p. 35.

Diagnosis. See Sorauf, 1987, p. 678.

**Remarks.** The characteristics of the genus are elongate presepiments, long major and short minor septa and an axial region without septa. These morphological characteristics vary considerably (Sorauf, 1988).

### **Tabulophyllum (?) implicatum** Tsien, 1977

Pl. 4, fig. 3, 4

1977 *Tabulophyllum implicatum* sp. n. Tsien, p. 271, text-fig. 8, pl. 4, fig. 3-5.

**Material.** Specimen n. 6759 (ex AD28/2).

**Description.** The corallite is ceratoid and more than 4 cm long. At a diameter of 22 mm are 34 x 2 radially arranged septa. Major septa are long, dilated toward the periphery, thin and twisted axially, and form, with slightly domed tabulae, a loose axial structure. Cardinal septum (?) is short. Minor septa are 2 to 3 mm long. The peripheral parts of the septa are connected forming a 1.0 to 1.5 mm thick wall. The dissepimentarium is narrow and consists of one or two rows of inclined, elongate dissepiments. Presepiments lacking. Tabulae are flattened, complete or incomplete, and occasionally slightly domed axially.

**Remarks.** The characteristics of the specimens are the long major septa swirling around the axis and generating with the tabulae a loose axial structure. Short cardinal septum (?). Dissepimentarium narrow with few rows of dissepiments. Our specimens differ from the holotype of *T. implicatum* in the lack of a stereozone. The occurrence of such a zone of a stereoplasmatic coating of dissepiments is assumed to depend on growth conditions and thus primarily on ecological factors.

The generic identification of the species is uncertain (Birenheide, 1978, p. 66). Lack of presepiments, the existence of a weak axial structure and a short cardinal septum indicate clearly that "*T. implicatum*" does not belong within the genus *Tabulophyllum*.

Subclass **Tabulata** Milne-Edwards & Haime, 1850

Order **Favositida** Wedekind, 1937

Suborder **Favositina** Wedekind, 1937

Family *Pachyporidae* Gerth, 1921

Subfamily *Pachyporinae* Gerth, 1921

Genus *Thamnopora* Steininger, 1831

Type species *Alveolites cervicornis* de Blainville, 1830.

1831 *Thamnopora* gen. n. Steininger, p. 10

**Remarks.** The morphological characteristics of thamnoporoid *Tabulata* are the diameters of the branches, corallites and pores, the spacing of mural pores and tabulae, the thickness of walls, and the presence of spines. Most of these characteristics are

highly variable and their measurements depend on orientation of the section. These uncertainties are probably one of the causes why, according to Birenheide (1985) 70 to 80 species, and according to Nowinski (1976) and myself, more than 150 species of the genus have been described from the Silurian and Devonian. This great number of species makes unequivocal determination difficult, and revision of the genus necessary.

### **Thamnopora** cf. **urensis urensis** Dubatolov, 1959

Text-fig. 3

cf. 1959 *Thamnopora urensis* Dubatolov, p. 96, pl. 30, fig. 3-6.

Material. Specimens n. 6748 (ex AD30/4) and 6764 (ex AD28/5,7,14,17,18).

Description. The colonies are fascicular, with cylindrical branches of diameter 7.5 to 11 mm. In transverse section the corallites are polygonal, with round or suboval lumen. The diameter of the lumen is axially 0.3 to 0.7 mm, peripherally 1.5 to 1.7 mm. In longitudinal sections the corallites of the axial zone are vertical and, in the peripheral zone, arcuate and oblique to the growth axes of the branch. The micro-

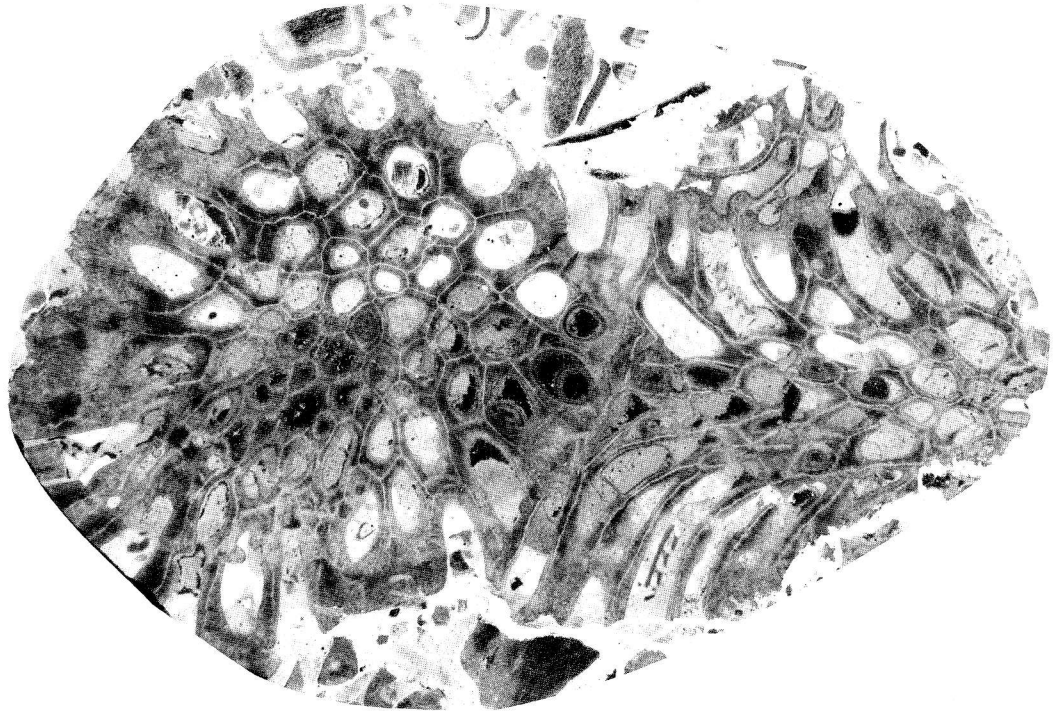


Fig. 3 - *Thamnopora* cf. *urensis urensis* Dubatolov, 1959. Specimen n. 6748 (ex AD30/4) from Atali-Numa La section (central Dolpo, Nepal); x 7.

structure of the walls is fibro-lamellar. The dark median suture is distinct. The thickness of the walls is 0.1 to 0.3 mm axially, 0.4 to 1.0 mm peripherally. The calices are deep and funnel-like. Tabulae are rare, thin and horizontal. The connecting pores are round, arranged in a single row, and of diameter 0.1 to 0.2 mm, spaced 0.4 to 1.0 mm apart. Septal spines are fairly developed. In longitudinal sections the spines could be sometimes to 0.7 mm long and squamulae-like. In deeper parts of the calices, the spines are sometimes connected, forming "toothed" septal lamellae.

**Remarks.** The existence of septal lamellae in deeper parts of the calices is not characteristic for *Thamnopora*. They recall *Parastriatopora* Sokolov, but this genus is characterised by hexagonal axial corallites and pronounced thickness of the peripheral regions of the walls.

Suborder **Alveolitina** Sokolov, 1950

Family *Alveolitidae* Dunkan, 1872

Genus *Alveolitella* Sokolov, 1952

Type species *Alveolites fecundus* Lecompte, 1939.

**Diagnosis.** See Sokolov, 1952, p. 60.

**Remarks.** Sokolov (1952) erected *Alveolitella* for ramose *Tabulata* with polygonal, thin-walled corallites in the axial zone and semi-lunar to round-triangular, thick-walled corallites towards the periphery. Iven (1980), Hill (1981), Byra (1983) and Birenheide (1985) united *Alveolitella* with *Alveolites* Lamarck. Differences between both genera are the form of the colonies, the form of the corallites and thickness of the walls. The genus is known from the Devonian of Europe, Russia and China, with about 20 species.

**Alveolitella** cf. **rarispinosa** Nowinski, 1976

Pl. 1, fig. 3

1976 *Alveolitella rarispinosa* sp.n. Nowinski, p. 63, pl. 8, fig. 2-5.

**Material.** Specimens n. 6762 (ex AD28/3,12) and 6763 (ex AD28/13).

**Description.** Colonies are ramose, up to 90 mm long, with a diameter of 8 x 15 mm. Corallites of the axial zone are polygonal to subpolygonal, with maximum diameter 0.4 mm. Towards the periphery they are slightly bent, becoming gradually alveolitid, and opening obliquely to the surface with diameter of 0.25 x 0.6 mm. Wall thickness in the axial zone is 0.1 mm and in the peripheral zone 0.3 mm. The dark median suture is distinct and semi-lunar. Connecting pores are large and round. Septal spines are rare. The tabulae are thin and slight bent.

**Remarks.** The specimens are similar to *A. rarispinosa* from the Frasnian of Poland. They differ from this species in the form of the septal spines, and in thickness of the wall at the periphery.

*Acknowledgments.*

The field work of A. Tintori received financial support from Ev-K2-CNR, the paleontological investigation by H.W. Fluegel from the "Fond zur Forderung Wissenschaftlicher Forschung Osterreich" (P. 7004-Geo., 8716 Geo.).

Thanks are due to A. Nicora and E. Garzanti for the hard, but pleasant, work done together in the Dolpo expedition, as well as to M. Gaetani for his encouragement and bureaucratic work related to the entire project. Thanks are due to C. Rossi Ronchetti, M. Gaetani, J.A. Talent and G.B. Vai for critically reading of the manuscript. Mrs. A. Krieger, Mr. J. Fruehwirth and Mr. Kober (Institute of Geology and Paleontology, University of Graz) and M.R. Torazzi Renesto provided technical assistance. The material is stored in the Paleontological Museum of the Dipartimento di Scienze della Terra (Università degli Studi di Milano).

## REFERENCES

Birenheide R. (1963) - *Cyathophyllum* und *Dohmophyllum* Arten (Rugosa) aus dem Mitteldevon der Eifel. *Senck. Leth.*, v. 44, pp. 363-458, Frankfurt/M.

Birenheide R. (1978) - Rugose Korallen des Devon. In Krommelbein K. (Ed.) - *Leitfossilien*, v. 2, VI + 265 pp., Stuttgart.

Birenheide R. (1985) - *Chaetetida* und tabulate Korallen des Devon. In Ziegler W. (Ed.) - *Leitfossilien*, v. 3, 249 pp., Stuttgart.

Birenheide R. (1990) - Untersuchungen an rugosen Korallen aus dem Bereich Schiefergebirges. *Senck. Leth.*, v. 70, n. 4/6, pp. 259-295, Frankfurt/M.

Bordet P., Colchen M., Krummenacher D., Le Fort P., Mouterde R. & Rémy M. (1971) - Recherches géologiques dans l'Himalaya du Nepal, région de la Thakkhola. *Ed. C.N.R.S.*, 279 pp., Paris.

Bordet P., Colchen M., Le Fort P., Mouterde R. & Rémy M. (1967) - Données nouvelles sur la géologie de la Thakkhola (Himalaya du Nepal). *Bull. Soc. Géol. France*, s. 7, v. 9, pp. 883-896, Paris.

Brice D. (1970) - Etude Paléontologique et Stratigraphique du Dévonien de l'Afghanistan. Contribution à la connaissance des Brachiopodes et des Polypiers Rugaux. *Notes & Mém. Moyen-Orient*, v. 11, 368 pp., Paris.

Byra H. (1983) - Revision der von Cl. Schlueter (1880-1889) beschriebenen *Chaetetida* und *Tabulata* aus dem Rheinischen Devon. *Cour. Forsch.-Inst. Senckenberg*, v. 59, 127 pp., Frankfurt/M.

Cherepnina S.K. (1974) - K sistematike podotryada *Phillipsastraeina* A. Schouppé, 1958. In Sokolov B.S., Ivanovsky A.B. & Krasnov E.V. (Eds.) - *Drevnie Cnidaria*, v. 1, pp. 198-204, Novosibirsk.

Coen-Aubert M. (1974) - Representants des genres *Phillipsastrea* d'Orbigny, A., 1849, *Billingsastraea* Grabau, A.W., 1917 et *Iowaphyllum* Stumm, E.C., 1949 du Frasnien du massif de la Vesdre et de la Bordure Orientale du Bassin de Dinant. *Bull. Inst. R. Sc. Nat. Belg.*, v. 49, n. 8, pp. 1-46, Brussel.

Coen-Aubert M. (1980) - Representants Frasniens du genre *Scruttonia* Tcherepnina, S.K., 1974 (Rugosa) en Belgique. *Bull. Inst. R. Sc. Nat. Belg.*, v. 51, n. 4, pp. 1-15, Brussel.

Cotton G. (1983) - The Rugosa coral species. V. of 278 pp., Kidderminster.

Desio A. (1966) - The Devonian sequence in Mastuj Valley (Chitral, North-West Pakistan). *Riv. It. Paleont. Strat.*, v. 72, n. 2, pp. 293-320, Milano.

Dubatolov V.N. (1959) - Tabulyaty, geliolitidy i khetetidy silura i devona Kuznetskogo basseyna. *Vses. Neft. Nauchno-issled. Geol.-Razved. Inst. (VNIGRI)*, Tr., v. 139, 293 pp., Leningrad.

Fenton C.L. & Fenton M.A. (1924) - The stratigraphy and fauna of the Hackberry Stage of the Upper Devonian. *Univ. Michigan Mus. Geol., Contrib.*, v. 1, XII + 260 pp., Michigan.

Ferrari A. (1968) - Tetracoralli delle Alpi Carniche. La fauna del Monte Zermula. *Giorn. Geol.*, s. 2, v. 34 (1966), pp. 531-592, Bologna.

Ferrari A. & Vai G.B. (1973) - Revision of the Famennian rhynchonellid genus *Plectorhynchella*. *Giorn. Geol.*, v. 39, n. 1, pp. 163-200, Bologna.

Fluegel H.W. (1955) - Zur Palaeontologie des anatolischen Palaeozoikums. II. Mitteldevonfauna von Yahyali (NO Ala Dag, Taurus). *N. Jb. Geol. Palaeont., Abh.*, v. 101, pp. 267-280, Stuttgart.

Fluegel H.W. (1966) - Palaeozoische Korallen aus der tibetischen Zone von Dolpo (Nepal). *Jahrb. Geol. Bundesanst.*, S. 12, pp. 101-120, Wien.

Fluegel E. & Fluegel H. (1961) - Stromatoporen und Korallen aus dem Mittel-Devon von Feke (Anti-Taurus). *Senck. Leth.*, v. 42, pp. 377-409, Frankfurt/M.

Fontaine H. (1961) - Les Madréporaires paléozoiques du Viet-Nam, du Laos et du Cambodge. *Arch. Géol. Viet-Nam*, v. 5, 276 pp., Saigon.

Frech F. (1885) - Die Korallenfauna des Oberdevons in Deutschland. *Deutsch. Geol. Ges., Zeitschr.*, v. 37, pp. 21-130, Berlin.

Fuchs G. (1967) - Zum Bau des Himalayas. *Osterr. Akad. Wiss. Math. Naturw.*, v. 113, 211 pp., Wien.

Fuchs G. (1977) - The geology of the Karnali and Dolpo regions, western Nepal. *Jahrb. Geol. Bundesanst.*, v. 120, pp. 165-217, Wien.

Fuchs G., Widder R.W. & Tuladhar R. (1988) - Contribution to the geology of the Annapurna Range (Manang area, Nepal). *Jahrb. Geol. Bundesanst.*, v. 131, n. 4, pp. 593-607, Wien.

Gaetani M., Casnedi R., Fois E., Garzanti E., Jadoul F., Nicora A. & Tintori A. (1986) - Stratigraphy of the Tethys Himalaya in Zanskar, Ladakh. Initial report. *Riv. It. Paleont. Strat.*, v. 91 (1985), n. 4, pp. 443-478, Milano.

Garzanti E. (1993) - Himalayan ironstones, "superplumes", and the breakup of Gondwana. *Geology*, v. 21, pp. 105-108, Boulder.

Garzanti E., Nicora A. & Tintori A. (1992) - Paleozoic to Early Mesozoic stratigraphy and sedimentary evolution of central Dolpo (Nepal Himalaya). *Riv. It. Paleont. Strat.*, v. 98, n. 3, pp. 271-298, Milano.

Garzanti E. & Pagni Frette M. (1991) - Stratigraphic succession of the Thakkhola region (Central Nepal). Comparison with the northwestern Tethys Himalaya. *Riv. It. Paleont. Strat.*, v. 97, n. 1, pp. 3-26, Milano.

Gods P. (1982) - Rugose Korallen des Givetium und Frasnium im Elburz-Gebirge (Nord-Iran). *Diss. Univ. Hamburg*, 171 pp., Hamburg.

Hayden H.H. (1915) - Notes on the geology of Chitral, Gilgit and the Pamirs. *Rec. Geol. Surv. India*, v. 45, pt. 4, pp. 271-335, Calcutta.

He Xin-Yi (1978) - Subclass Rugosa. *Atlas Fossils Southwest China, Sichuan*, v. 1 (Sinian to Devonian), pp. 555-568, Beijing.

Hill D. (1981) - Treatise on Invertebrate paleontology. Pt. F. Coelenterata. Supplement 1. Rugosa and Tabulata. 2 v. of 762 pp., Boulder.

Hubmann G. (in press) - Die Korallenfauna aus dem Devon von Feke (Antitaurus, SE-Turkei). II. Rugosa. *Mitt. Geol. Palaeont. Inst. Innsbruck*, Innsbruck.

Ivanovsky A.B. (1975) - Devonskie rugozy Taymyr-Kolymskoy provintsii. *Akad.Nauk SSSR Sibirskoeotd. Inst. Geol. Geofiz. Tr.*, v. 228, 72 pp., Moskau.

Iven C. (1980) - Alveolitiden und Heliolitiden aus dem Mittel- und Oberdevon des Bergischen Landes (Rheinisches Schiefergebirge). *Palaeontographica*, Abt. A, v. 167, pp. 121-179, Stuttgart.

Kursten P. (1987) - Nachweis von Frasnium durch *Scruttonia julli* (Pedder,1986) in den Flachwasserkalken der zentralen Karnischen Alpen. *Münster Forsch. Geol. Palaeont.*, v. 66, pp. 33-56, Münster.

Leith W. (1982) - Rock assemblages in Central Asia and the evolution of Southern Asian margin. *Tectonics*, v. 1, pp. 303-318, Washington.

Liao W-H. (1977) - On the Middle and Upper Devonian boundary by Tetracorals in Dushan District, Southern Guizhou. *Acta Palaeont. Sinica*, v. 16, pp. 37-52, Beijing.

Liao W-H. & Birenheide R. (1989) - Rugose corals from the Frasnian of Tushan - Province of Guizhou, South China. *Cour. Forsch. Inst. Senckenberg.*, v. 110, pp. 81-103, Frankfurt/M.

Lutte B-P. (1990) - Horn- und kegelfürmige rugose Korallen aus dem Mittel-Devon der Eifel. *Senck. Leth.*, v. 70, pp. 297-395, Frankfurt/M.

McLean R.A. (1982) - *Ceciliaphyllum*, a new characterophyllid coral genus from the Upper Devonian (late Frasnian) of British Columbia. In *Current Research, Pt. C, Geol. Surv. Canada*, Pap. 82-1C, pp. 95-98, Ottawa.

McLean R.A. (1989) - *Phillipsastraeidae* (Rugosa) in the Frasnian of western Canada. *Mem. Ass. Australas. Paleont.*, v. 8, pp. 239-249, Sydney.

McLean R.A. & Pedder A.E.H. (1984) - Frasnian Rugose Corals of Western Canada. Part 1: *Chonophyllidae* and *Kyphophyllidae*. *Palaeontographica*, Abt. A, v. 185, pp. 1-38, Stuttgart.

Milne-Edwards H. & Haime J. (1851) - Monographie des polypiers fossiles des terrains paléozoiques. *Mus. Hist. Nat. Paris, Arch.*, v. 5, 502 pp., Paris.

Nicora A. (1992) - Conodonts from the Lower Triassic sequence of central Dolpo, Nepal. *Riv. It. Paleont. Strat.*, v. 97 (1991), n. 3-4, pp. 239-268, Milano.

Nicora A. & Tintori A. (1991) - The Lower Triassic sequence of Central Dolpo, Nepal. *Géol. Alpine, Mém.*, H.S. n. 16, pp. 61-62, Grenoble.

Nowinski A. (1976) - *Tabulata* and *Chaetetida* from the Devonian and Carboniferous of Southern Poland. *Palaeont. Polonica*, v. 35, 125 pp., Krakow.

Pedder A.E.H. (1986) - The Devonian Tetracoral *Haplothecia* and new Australian Phacellophyllids. *Proc. Linn. Soc. N.S.W.*, v. 90, pp. 181-189.

Pickett J. (1967) - Untersuchungen zur Familie *Phillipsastreidae (Zoantharia Rugosa). Senck. Leth.*, v. 48, n. 1, pp. 1-89, Frankfurt/M.

Roemer C.F. (1883) - Lethaea geognostica. Theil 1: Lethaea palaeozoica. Lief. 2, pp. 113-544, E. Schweizerbart, Stuttgart.

Rohart J.-C. (1982) - *Phillipsastreidae (Rugosa)* du Dévonien de Ferques (Boulonnais, France). 2. *Scruttonia boloniensis* (M.E. et H., 1851). *Ann. Soc. Géol. Nord*, v. 51, pp. 105-115, Lille.

Rozkowska M. (1953) - *Pachyphyllinae* et *Phillipsastraea* du Frasnien de Pologne. *Palaeont. Polonica*, v. 5, 89 pp., Warschau.

Rozkowska M. (1980) - Contribution to the Frasnian Tetracorals from Poland. *Palaeont. Polonica*, v. 40, pp. 3-56, Krakow.

Schouppé A. von (1958) - Revision des Formenkreises um *Phillipsastraea* d'Orb., "*Pachyphyllum*" E. & H., *Macgeea* (Webst.), "*Thamnophyllum*" Pen., *Peneckiella* Soshk. und verwandter Formen. *N. Jahrb. Geol. Palaeont., Abh.*, v. 106, pp. 139-244, Stuttgart.

Schouppé A. von (1965) - Die Mittel-bis Oberdevonische Korallenfauna von Kuragh (Chitral). *Ital. Exp. Karakorum (K2) Hindu Kush, Scient. Reports* IV, v. 1, pp. 13-53, Leiden.

Schouppé A. von & Stacul P. (1963) - Bau und taxionomische Fassung des devonischen Korallen-Genus *Macgeea* Webster, 1889 und seine Beziehungen zu *Thamnophyllum* Penecke, 1894. *Senck. Leth.*, v. 44, pp. 265-299, Frankfurt/M.

Scotese C.R. & McKerrow W.S. (1990) - Revised World maps and introduction. In McKerrow W.S. & Scotese C.R. (Eds.) - Paleozoic Palaeogeography and Biogeography. *Geol. Soc. Mem.*, n. 12, pp. 1-21, London.

Scrutton C.T. (1967) - *Marisastridae (Rugosa)* from south-Devonshire, England. *Palaeontology*, v. 10, pp. 266-279, London.

Scrutton C.T. (1968) - Colonial *Phillipsastraeidae* from the Devonian of South-East Devon, England. *Bull. Brit. Mus. Natur. Hist.*, v. 15, pp. 183-281, London.

Sokolov B.S. (1952) - Tabulyaty paleozoya evropeyskoy chasti SSSR. Chast 4: Devon Russkoy platformy i zapadnogo Urala. *Vses. Neft. Nauchno-issled. Geol.-Razved. Inst. (VNIGRI), Tr.*, n.s., v. 62, 292 pp., Leningrad.

Sorauf J.E. (1987) - Upper Devonian (Frasnian) Rugose Corals from New York State. *Journ. Paleont.*, v. 61, pp. 676-689, Lawrence.

Sorauf J.E. (1988) - The Devonian Rugose genus *Tabulophyllum* Fenton & Fenton, 1924. In McMillan C. et al. (Eds.) - Devonian of the World, v. 3, pp. 397-412, Calgary.

Soshkina E.D. (1949) - Devonskie korally Rugosa Urala. *Akad. Nauk SSSR, Paleont. Inst., Tr.*, v. 15, 162 pp., Moskau.

Soshkina E.D. (1951) - Pozdnedevonskie korally Rugosa, ikh sistematika i evolyutsiya. *Akad. Nauk SSSR, Paleont. Inst., Tr.*, v. 34, 124 pp., Moskau.

Soshkina E.D. (1952) - Opredelitel devonskikh chetyrekhluchevykh korallov. *Akad. Nauk SSSR, Paleont. Inst., Tr.*, v. 39, 178 pp., Moskau.

Steininger J. (1831) - Bemerkungen über die Versteinerungen, welche in dem Uebergangs-Kalkgebirge der Eifel gefunden werden. V. of 44 pp., Trier.

Stoliczka A. (1866) - Summary of the geological observations during a visit to the provinces Rupshu Karnag, South Ladakh, Zanskar, Sumdo and Dras of western Tibet. *Mem. Geol. Surv. India.*, v. 5, pp. 337-354, Calcutta.

Strusz D.L. (1965) - *Disphyllidae* and *Phacellophyllidae* from the Devonian Garra Formation of New South Wales. *Palaeontology*, v. 8, pp. 518-571, London.

Sun Y.C. (1958) - The Upper Devonian Coral Faunas of Hunan. *Palaeont. Sinica*, s. B, v. 8, pp. 1-28, Beijing.

Talent J.A., Gratsianova R.T. & Yolkin E.A. (1986) - Prototethys: fact or phantom? Palaeobiogeography in relation to the crustal mosaic for the Asia-Australia hemisphere in Devonian-Early Carboniferous times. *Proc. Int. Symp. Shallow Tethys 2* , pp. 87-111, Wagga Wagga.

Talent J.A. & Mawson R. (1979) - Palaeozoic-Mesozoic biostratigraphy of Pakistan in relation to biogeography and the coalescence of Asia. In Farah A. & De Jong K.A. (Eds.) - Geodynamics of Pakistan, pp. 81-102, Quetta.

Talent J.A. & Yolkin E.A. (1987) - Transgression-regression patterns for the Devonian of Australia and southern West Siberia. *Cour. Forsch. Inst. Senckenberg.*, v. 92, pp. 235-249, Frankfurt/M.

Tsien H.H. (1977) - Rugosa massifs du Dévonien de la Belgique. *Mém. Inst. Géol. Univ. Louvain*, v. 29, pp. 197-222, Louvain.

Vai G.B. (1991) - Palaeozoic strike-slip rift pulses and palaeogeography in the circum-Mediterranean Tethyan realm. *Palaeogeogr., Palaeoclimat., Palaeoecol.*, v. 87, n. 1-4, pp. 153-185, Amsterdam.

Walther C. (1928) - Untersuchungen über die Mitteldevon-Oberdevongrenze. *Zeit. Deutsch. Geol. Ges.*, v. 80, pp. 97-152, Berlin.

Wrzolek T. (1981) - Rugose coral *Cyathophyllum diffusum* sp. n. from the Frasnian deposits of the Holy Cross Mts. *Acta Geol. Polonica*, v. 31, p. 169-175, Warszawa.

Yu Chang-Min & Kuang Guo-Dun (1983) - Late Middle Devonian Rugose Corals from Liujing, Heng Xian, Guangxi and their paleoecological significance. *Bull. Acad. Sinica*, pp. 241-278, Nanjing.

*Received September 23, 1992; accepted February 17, 1993*

PLATE 1

Fig. 1 - *Kuanxiastraea pengellyi* (Milne-Edwards & Haime, 1851). Transverse section. Specimen n. 6761/7; x 3.25.

Fig. 2 - *Kuanxiastraea pengellyi* (Milne-Edwards & Haime,1851) Longitudinal section. Specimen n. 6761/5; x 2.92.

Fig. 3 - *Alveolitella* cf. *rarispinosa* Nowinski, 1976. Transverse section. Specimen n. 6763; x 3.25.

All specimens from Atali-Numa La section (central Dolpo, Nepal).

PLATE 2

Fig. 1 - *Scruttonia bowerbanki* (Milne-Edwards & Haime, 1851). Transverse section. Specimen n. 6754; x 2.92.

Fig. 2 - *Scruttonia bowerbanki* (Milne-Edwards & Haime, 1851). Longitudinal section. Specimen n. 6754; x 2.92.

Fig. 3 - *Scruttonia rota* sp.n. Holotype. Transverse section. Specimen n. 6749; x 3.25.

Fig. 4 - *Scruttonia rota* sp. n. Longitudinal section. Specimen n. 6750; x 5.85.

All specimens from Atali-Numa La section (central Dolpo, Nepal).

PLATE 3

*Fruehwirthia heritschi* gen. n, sp. n.

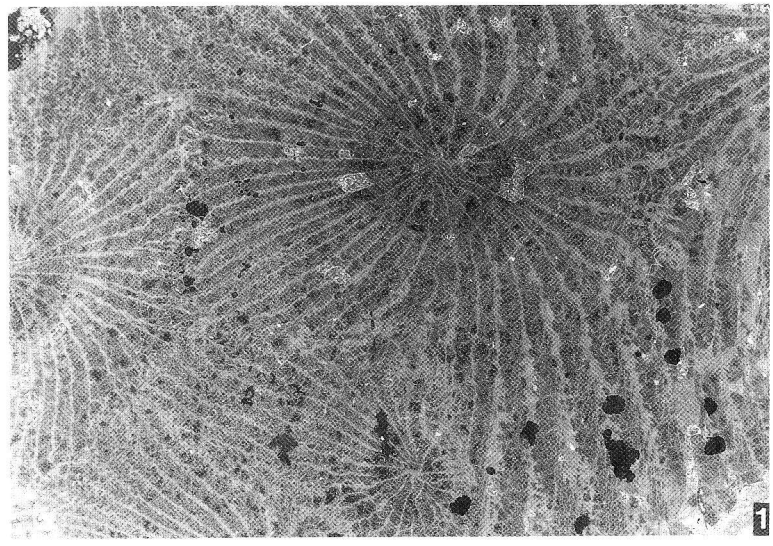
Fig. 1 - Holotype, specimen n. 6751. Transverse section; x 3.90.
Fig. 2 - Holotype, specimen n. 6751. Transverse section; x 9.10.
Fig. 3 - Holotype, specimen n. 6751. Transverse section; x 22.75.
Fig. 4 - Holotype, specimen n. 6751. Longitudinal section; x 3.90.

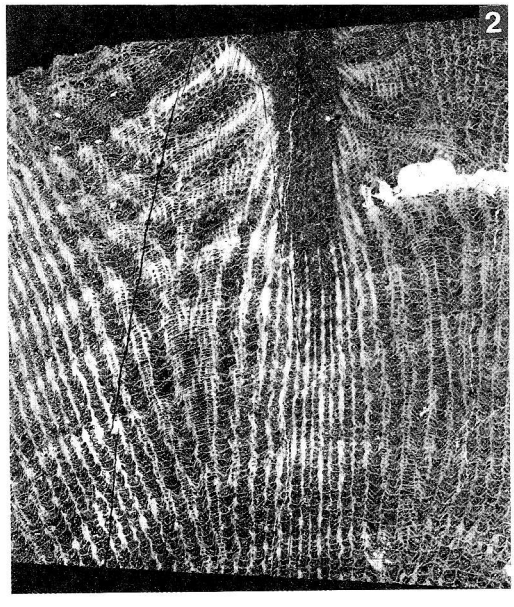
All specimens from Atali-Numa La section (central Dolpo, Nepal).

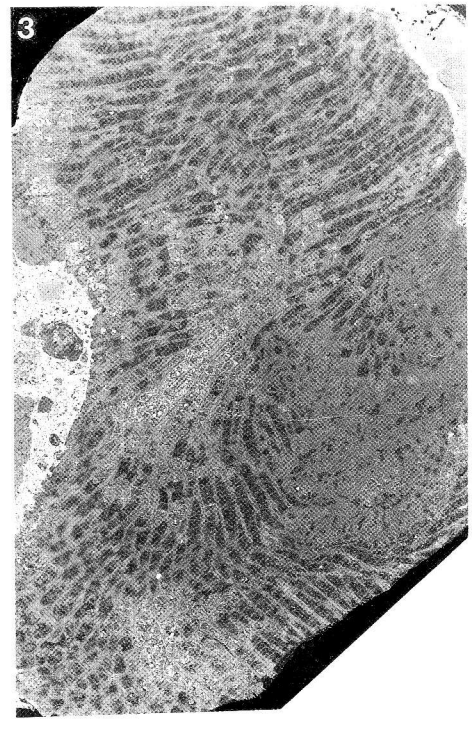
PLATE 4

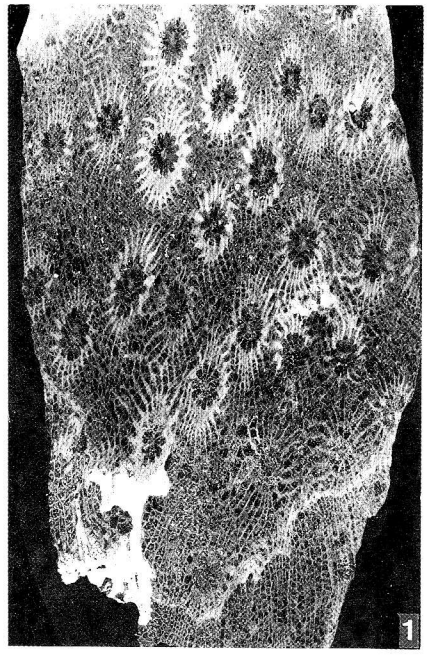
Fig. 1 - *Sinodisphyllum litvinovitshae* (Soshkina,1949). Transverse section. Specimen n. 6757; x 4.55.
Fig. 2 - *Fruehwirthia heritschi* gen. n., sp. n. Transverse section. Specimen n. 6752; x 4.55.
Fig. 3 - *Tabulophyllum*(?) *implicatum* Tsien, 1977. Longitudinal section. Specimen n. 6759; x 4.55.
Fig. 4 - *Tabulophyllum*(?) *implicatum* Tsien, 1977. Transverse section. Specimen n. 6759; x 3.57.

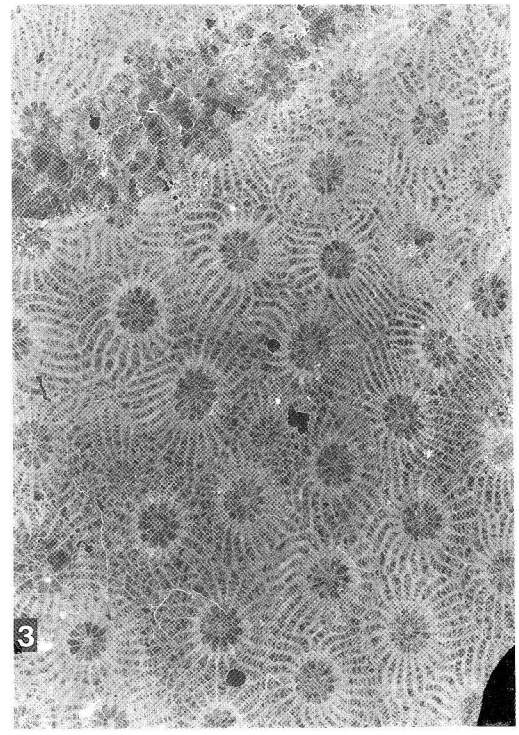
All specimens from Atali-Numa La section (central Dolpo, Nepal).

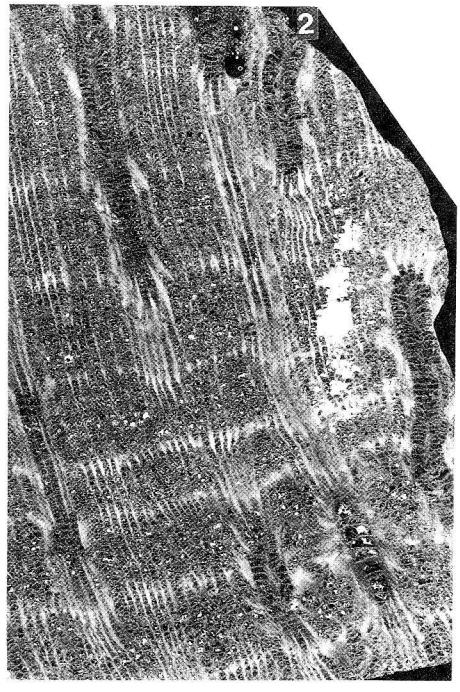

1

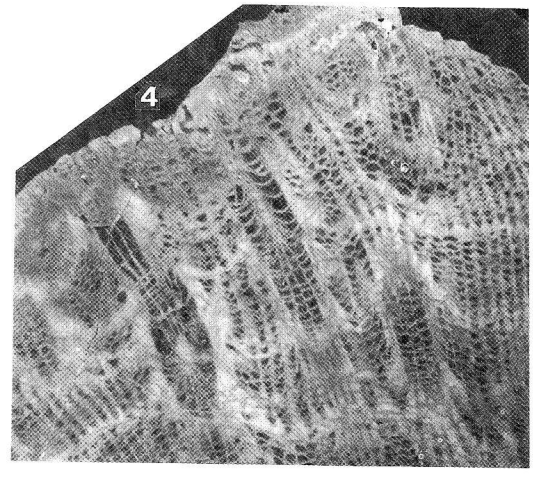

2

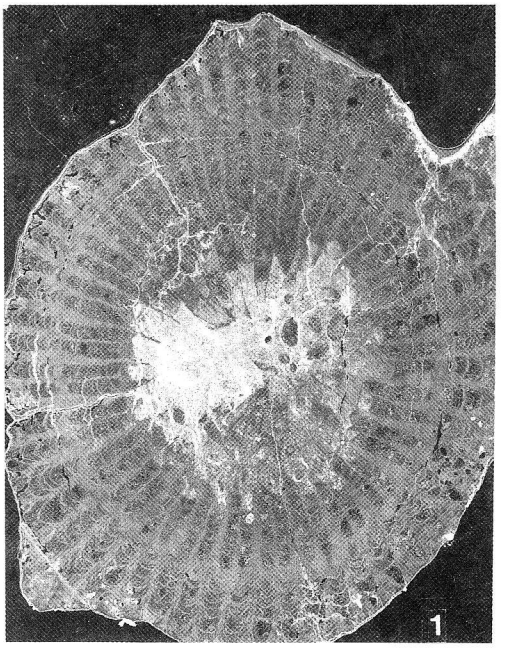

3

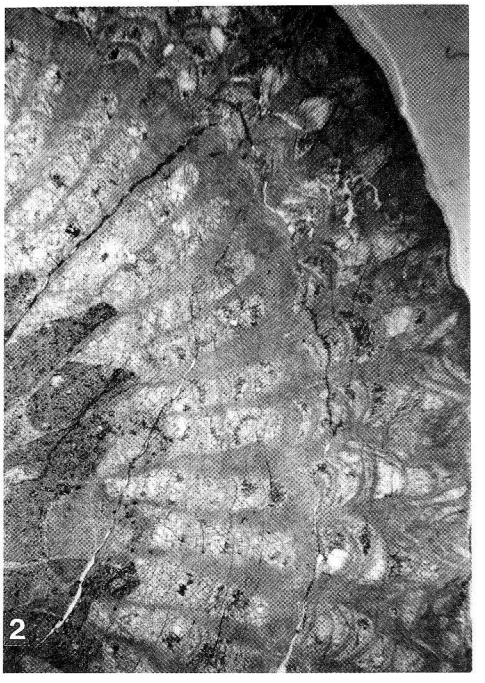

1


3

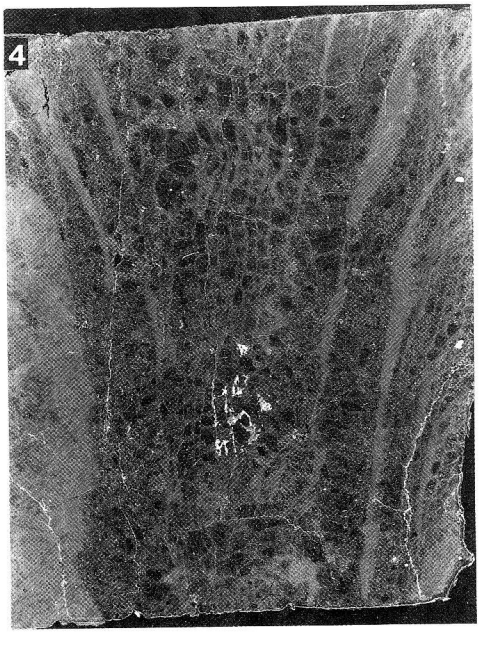

2

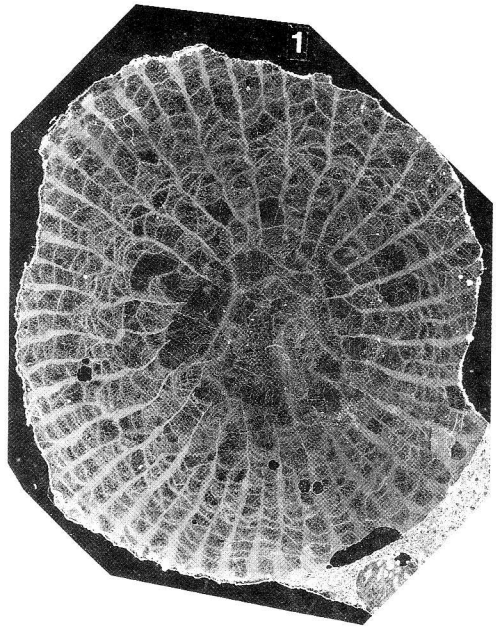

4

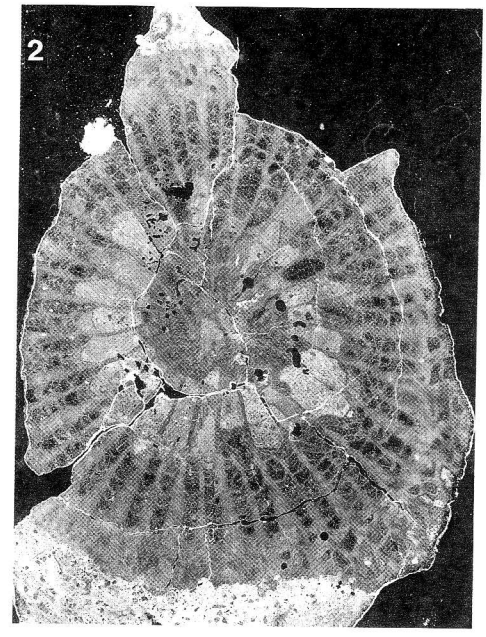

1

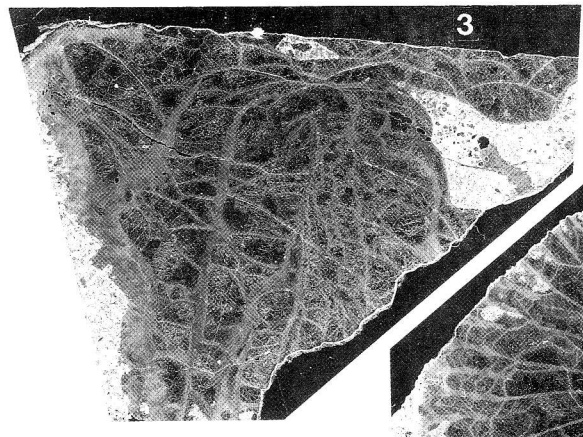

2

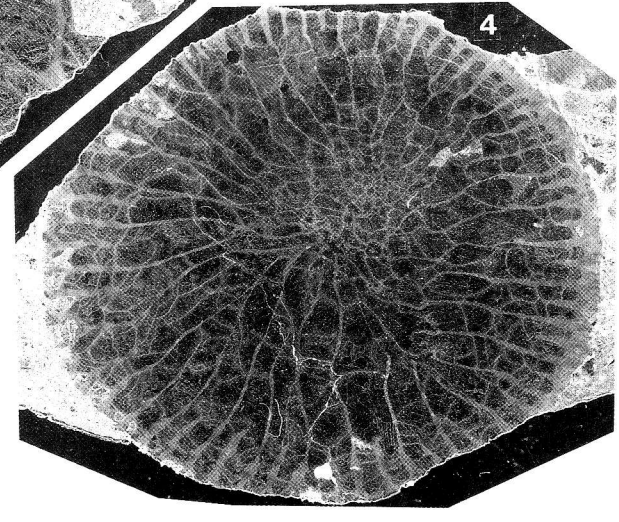

3


4


1


2


3


4