Société Géologique du Nord

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SOCIÉTÉ GÉOLOGIQUE DU NORD
59655 VILLENEUVE D'ASCQ CEDEX

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PALAEOZOIC RUGOSE CORALS FROM CENTRAL AND EASTERN IRAN (A. F. DE LAPPARENT AND M. ZAHEDI COLLECTIONS)

Coraux rugueux paléozoïques de l'Iran central et oriental (collections A. F. de Lapparent et M. Zahedi)

by Jean-Claude ROHART (*)

(Plates VI, VII, VIII, IX and X)

Abstract. — From collections made in the seventies, coming from different localities in eastern Iran (Tabas and Kerman regions , de Lapparent collection) and central Iran (Soh region, Zahedi collection), fourteen species are described. From Silurian, one species is attributed to *Araeopoma* (first citation outside the type-area : Gotland) and one to *Axolasma*. Ten are Devonian and have been yielded by the same stratigraphic level which is Lower to Middle Frasnian in age (Brachiopod Zone 6 of Brice 1977). They are : two *Disphyllum* species (one is *Disphyllum caespitosum tricyclicum* von Schouppé, 1965); two *Hexagonaria* species also found in Afghanistan; one species of *Cystihexagonaria* with, where septal thickening is noticeable, large monacanths of *Hexagonaria*-type; two *Macgeea* species; *Temnophyllum lapparenti* nov. sp.; *Sinodisphyllum* sp. and *Peneckiella ?* cf *cylindricum* (Yoh, 1937). From Carboniferous, *Siphonophyllia cylindrica* and from Permian *Polythecalis* cf *denticulatus* are also included. Affinities of the Devonian corals are with those of Afghanistan and Chitral.

Résumé. — *Quatorze espèces sont décrites provenant de collections faites dans les années 70 dans différentes localités de l'Iran oriental (régions de Tabas et de Kerman, collection de Lapparent) et de l'Iran central. Une espèce silurienne est attribuée à* Araeopoma *(dont c'est la première citation en dehors de la région-type, l'île de Gotland) et une autre à* Axolasma. *Dix espèces sont dévoniennes et proviennent d'un même niveau stratigraphique d'âge Frasnien inférieur à Frasnien moyen (Zone 6 à Brachiopodes de Brice 1977). Ce sont: deux espèces de* Disphyllum *(l'une est* Disphyllum caespitosum tricyclicum *von Schouppé, 1965); deux espèces de* Hexagonaria *trouvées aussi en Afghanistan; une espèce de* Cystihexagonaria *avec, là où les septes sont épaissis, de grosses trabécules monacanthes du type* Hexagonaria; *deux espèces de* Macgeea; Temnophyllum lapparenti *nov. sp.;* Sinodisphyllum *sp. and* Peneckiella ? *cf* cylindricum *(Yoh, 1937). Sont aussi comprises* Siphonophyllia cylindrica *du Carbonifère et* Polythecalis *cf* denticulatus *du Permien. Les coraux dévoniens ont des affinités avec ceux d'Afghanistan et de Chitral.*

I. — INTRODUCTION

This paper is based on fossils collected during the years 1970 by A. F. de Lapparent from the Tabas and Kerman regions, Eastern Iran and by M. Zahedi from the Soh region, Central Iran. The catholic Faculty of Sciences at Lille was entrusted with the care and the study of them. The rugose corals come from Silurian, Devonian, Carboniferous and Permian strata. Most of them are Devonian, the others are here treated mainly for their stratigraphic interest.

During this first phase of the work, Devonian Iranian corals are compared with Devonian corals from the Axial Zone and from the Central Mountains in Afghanistan. Material from these areas was collected by de Lapparent, Brice and Mistiaen and partly published (Brice, 1971) or just determined (Rohart *in* Mistiaen, 1985). Brachiopods are abundant and were identified by Brice. Brachiopod biozones defined by Brice 1977 and Brice 1985 have been successfully applied. They gave a good biostratigraphic frame for coralligenous beds (**).

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(**) Collections: The material is housed in the collections of the Laboratory of stratigraphic Paleontology of the Catholic University of Lille under numbers GFCL 3915 to 3945 for the figured specimens. The collection comprises 83 specimens with 160 thin sections and peels.
Conventions: Dimensions given are at first the common range then, between parentheses, the total range. The following abbreviations are used:
d = corallum diameter for solitary and fasciculate corals
dc = distance between adjacent corallites centers, for massive corals (preferably to the " diameter ", unappropriate for polygonal corallites)
dl = diameter of the central area free of septa
dm = diameter of the inner wall
dt = tabularium diameter, or the smaller diameter of the ellipse when the thin section is oblique
h = corallum height
SM = number of major septa
Sm = number of minor septa (usually not mentioned since Sm is equal to SM)
t5 = number of tabulae along a height of 5 mm

II. — SYSTEMATICS

Order *CYSTIPHYLLIDA* Nicholson, 1889

Family *CALCEOLIDAE* King, 1846

Weyer (1996) recently recalled that the family name Calceolidae was created by King in 1846 for *Calceola* Lamarck 1799, then supposed to be a brachiopod, not a coral. Consequently, the commonly accepted name Goniophyllidae Dybowski 1873 is a junior synonym.

Subfamily *ARAEOPOMATINAE* Lindström, 1883

Genus *ARAEOPOMA* LINDSTRÖM, 1883

1995 – *Araeopoma* Lindström, 1882 ; Johannessen, p. 33 (with synonymy).
Type-species: *Cystiphyllum prismaticum* Lindström, 1868, p. 421; Visby Formation, Silurian, Gotland (Sweden). Lectotype chosen by Johannessen, 1995,p. 33.

Diagnosis

" Corallite quadrangular or subquadrangular, with clearly obtuse corners, and with four triangular or similarly shaped opercula attached on the calicular side margins. Attachment structures developed on the basal part of the counter side. Septa rhabdacanthine, of two orders, of which major ones are long. In late stage of ontogeny peripheral and axial series of dissepiments and tabellae normally are distinguished " (Johannessen, 1995,p. 33).

Distribution

Lower Silurian, Gotland (Sweden); Silurian, Wenlock ?, central Iran (this work).

Araeopoma nov. sp.

(fig. 1 ; Pl. VI, fig. 1)

cf 1995 - *Araeopoma elongatum* Lindström, 1882 - Johannessen, p. 37, fig. 4A-N, 5A-K, 6A-H, 7A-R
Material: Loc. 6 - Dohaneh Kolut valley (Tabas area, Khorasan Province, eastern Iran) : 1 specimen I-Ch6/3 (7 thin sections and peels), middle Silurian (?Wenlock), Niur Formation.
Dimensions (mm) : height = 15 minimum (no tip); d = 15 minimum (no calice); dt = 0.5 d; SM + Sm = 36.

Description

The unique specimen is a small ceratoid solitary coral, without tip, calice or opercula, partly eroded but partly covered by the rock so that the outer shape is there preserved .

Corallite loosely quadrangular in transverse section, with very rounded angles. The fourth side is abraded but the three others are easily recognized, with their external wall preserved : lamellar, thick of 0.2 mm.

As usual for this genus (see Johannessen 1995), the two orders of septa are difficult to distinguish: same discontinuous nature, same thickness, almost same length as far as we can judge, since the unequal length of two adjacent septa may be due just to their discontinuous structure. Although septa are said to be long by coral workers familiar with this group, they are limited to the dissepimentarium. A layer of lamellar stereoplasm covers trabeculae and dissepiments between two adjacent septa. Trabeculae are large, circular or more often elliptical in section, based on the wall, or resting on the inner series of dissepiments. They look like large holacanths. But some branched structures are present in a few of them so that they may be regarded as partly recrystallized rhabdacanths (fig. 1 ; Pl. VI, fig. 1e).

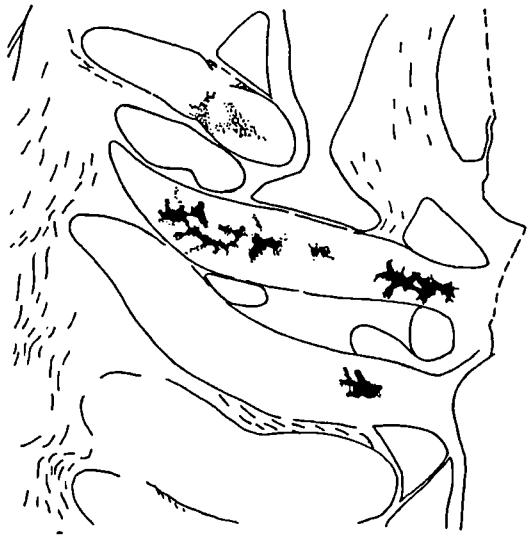

Fig. 1. — *Araeopoma* nov. sp., GFCL 3915, loc. 6 ; longitudinal section L1 (x30), also figured on pl. VI, fig. 1, showing the rhabdacanthine structure at the base of both trabeculae and at the top of the upper one (x30);

Fig. 1. — Lame longitudinale L1 (x30), également illustrée sur la pl. VI, fig. 1, montrant la structure rhabdacanthinée à la base des deux trabécules et en haut de la trabécule supérieure (x30).

Dissepimentarium narrow (2 mm width) with 2 – 3 series of large dissepiments, steeply inclined, which, in transverse section, pass across the septal discontinuities from one septal loculus to the adjacent one. Tabularium comparatively wide (diameter 6-8 mm) with lengthened, steeply inwardly inclined,vesicular periaxial tabulae and larger, more convex axial tabulae.

The lower transverse section (d = 8 mm) shows more abundant stereoplasm and more discontinuous septa.

Discussion

I refer this unique specimen to *Araeopoma* Lindström, 1882 for the loosely quadrangular shape, the very rounded angles, the acanthine septa. There are however two uncertainties: the four triangular operculae, typical for the genus, are missing, which is not surprising for such an incomplete specimen; and septa are here holacanthine instead of rhabdacanthine (Johannessen 1995, p. 33) but it is commonly admitted that rhabdacanths easily recrystallise in holacanths. I am not able to distinguish the two orders of septa but it is the case usually in transverse section (Hill 1981, p. F 109 about Goniophyllidae; Johannessen 1995, p. 34, 40) although they are seen inside

the calice of well preserved corallites (*cf* Johannessen 1995, p. 37 about *A. elongatum* Lindström, 1882; Birenheide 1974, pl. 4, figs. 11-15).

According to Johannessen 1995, p. 33, the genus is represented by two silurian species from Silurian of Gotland island (Sweden). The first one is *A. prismaticum* Lindström, 1882 (Visby Formation, Ygne Member - formerly Lower Visby Marls -, Late Llandovery = Telychian. I quote the species name as Johannessen writes it but the usual form is *A. prismaticum* (Lindström, 1868) since the first published name is *Cystiphyllum prismaticum* in Lindström, 1868). The second species is *A. elongatum* Lindström, 1882 (Visby Formation, Rövar Lilja Member - formerly Upper Visby Marls - and Högklint Formation, Irevik Member, both Early Wenlock = Sheinwoodian). These two species have more septa (30-50 of each order for 10-25 mm in diameter) than the Iranian form (36 septa of the two orders altogether for 12 mm in diameter). This one looks more like *A. elongatum* with its well defined septa, its thick trabeculae and the clear distinction between dissepimentarium and tabularium in transverse section. A new species could be defined if more than one specimen was available.

Our coral locality is in the vicinity of - or very probably inside - the reference section of the Niur Formation at Shirgesht from which Saleh in Flügel & Saleh 1970 described *Tryplasma* sp. This species is not figured but, according to the short description given, has 2x25 septa, short (2 mm) major septa and complete, flat, distant tabulae. So, clearly, it is a different form.

Distribution

Silurian, middle Silurian (?Wenlock), Niur Formation, Dohaneh Kolut section, Shirgesht area (eastern Iran).

Order *STAURIIDA* Verrill, 1865

Suborder *STREPTEMASMATINA*, Wedekind, 1927

Family *STREPTELASMATIDAE* Nicholson *in* Nicholson & Lydekker, 1889

Genus *AXOLASMA* IVANOVSKY, 1963

1963 - *Axolasma*; Ivanovsky, p. 33.
1963 - *Protosyringaxon*; Ivanovsky, p. 37.
e. p. 1965 - *Densiphyllum* Dybowski, 1873; Ivanovsky, p. 60.
e. p. 1965 - *Orthopaterophyllum* Nikolaieva *in* Bulvanker, 1952; Ivanovsky, p. 60.
1965 - *Axolasma*, Ivanovsky; Strelnikov, p. 33 (fide Cotton 1983, p. 25).
e. p. 1970 - *Enterolasma* Simpson, 1900; Ivanovsky, (fide McLean 1976, p.182).
1970 – *Axolasma* Ivanovskij 1963 ; Flügel, p. 30.
1973 – *Axolasma* Ivanovskii, 1963 ; Cotton, p. 30.
1973 - *Axolasma*; Weyer, p. 702, footnote 5.
1974 - *Axolasma* Ivanovsky, 1963; Weyer, p. 158.
e. p. 1975 - *Densiphyllum* Dybowski, 1873 ; Ivanovsky, p. 43.
1976 – *Axolasma* Ivanovsky, 1963 ; Ivanovsky, p. 26.
1981 – *Axolasma* Ivanovskiy, 1963 ; Hill, p. F150.
1983 – *Axolasma* Ivanovskii, 1963 ; Cotton, p. 23.

Type-species of *Axolasma*, by original designation: *A. flexuosum* Ivanovsky, 1963, p. 34 ; Moyero River, Siberian platform; Silurian, Llandovery; the holotype is figured in Ivanovsky 1963, pl. 7, fig. 1 ; also in Ivanovsky 1976, pl. 7, fig. 4 and in Hill 1981 fig. 83, 2b (transverse thin section only); the same specimen has been illustrated under the name *Densiphyllum* ex. gr. *thomsoni* Dyb. *in* Ivanovsky 1965, pl. 1, fig. 5a-b (transverse and longitudinal thin sections) with a more precise stratigraphic position: " base of upper Llandovery ".

Type-species of *Protosyringaxon*, by original designation: *P. primitivum* Ivanovsky 1963, p. 38, pl. 6, fig. 3 (external view); transverse and longitudinal thin sections of the holotype figured in Ivanovsky 1976, pl. 15, fig. 2 and in Hill 1981, fig. 83, 2a, 2c; Moyero River, Siberian platform; Silurian, Llandovery.

Diagnosis, completed

" Solitary: septa thickened to contiguity in narrow peripheral stereozone with short, not contratingent minor septa; weak axial structure formed of conjoined and lobed axial ends of major septa, curved in same sense around small calical depression, but free laterally in outer part of tabularium in adult stages; fossula somewhat expanded towards, but not into, axis and with long, rather thin cardinal septum; tabulae sparse; dissepiments absent " (Hill 1981, p. F150). I add " major septa thickened in young stages " - following the diagnosis of *Axolasma* in Ivanovsky 1963, p. 33, repeated in Ivanovsky 1976, p. 26 which I translate here - and " tabulae highly convex with a central part flat or slightly depressed ".

Discussion

Axolasma was placed into the family Streptelasmatidae by its author and *Protosyringaxon* into the family Laccophyllidae due to " first order septa, reaching not the axis, united by their inner edge [building] just an indication of a central tube " (part of the diagnosis of Ivanovsky 1963, translated). Ivanovsky soon considered both genera as synonyms: *Axolasma* of *Densiphyllum*, *Protosyringaxon* of *Orthopaterophyllum*, later of *Enterolasma*. Moreover, thin sections were completely figured after a long delay. This confused situation explains probably why these genera were not used, except by Strelnikov 1965. However, Weyer (1973, p. 702, footnote 5) pointed out the identity of the two type-species and considered later that *Axolasma* could be a member of the family Densiphyllidae Dybowski, 1873 if its ontogeny would be clearly established (Weyer 1974, p. 158) . Hill (1981, p. F150) followed this opinion and retained the genus *Axolasma* in the subfamily Streptelasmatinae, a synonym for her of Densiphyllinae.

The subjective synonymy of *Axolasma* with *Protosyringaxon* seems beyond any doubt if based on the published sections of the type-material. *Axolasma* has priority of page.

Densiphyllum Dybowski, 1873 is imperfectly known but has straight major septa, not twisted in the center, long minor septa and a comparatively wide peripheral stereozone whereas *Axolasma* has a thin stereozone and an axial vortex-like structure. *Orthopaterophyllum* Nikolaieva *in* Bulvanker, 1952 is considered by Ivanovsky 1965, Kullmann 1965, Weyer 1974, Dubatolov and Spassky 1971 as a synonym of *Enterolasma* Simpson, 1900. *Enterolasma* itself is believed to be a junior synonym of *Palaeocyathus* Foerste, 1888 by McLean (1976, p. 181). For him, these two last genera have " irregular carinae or tubercules on the septal sides " and " axial edges of major septa lobed, forming irregular, open-meshed axial structure having appearance of twisted rods ". *Axolasma* lacks such features.

Axolasma looks like *Helicelasma* Neuman, 1969 because they have in common a peripheral stereozone, short minor septa, long major ones which are thickened in young stages and rather thin in adult ones. But *Axolasma*

has a cardinal fossula with a long cardinal septum, more septal lobes and an axial structure like an incomplete vortex. Moreover, major septa have not the same shape of thickening: in *Axolasma*, they are thicker in the central tabularium than in the outer tabularium while, in *Helicelasma*, they are tapering more or less regularly towards the center. A species of *Helicelasma* approaching *Axolasma* is *H. selectum* (Billings, 1865) as figured in Elias (1983, p. 934, fig. 6A-X, 7).

Salvadorea Nelson 1981 has the features of *Helicelasma* with, in addition, a marked fossula with a shortened cardinal septum and an axial vermiform and proeminent structure. *Axolasma* lacks this structure.

Crassilasma Ivanovskyi, 1962 looks like *Axolasma* by its twisted major septa but they remain thick in adult stage and become thin to the center, without building an axial structure. The stereozone and the minor septa are very rudimentary. Cardinal fossula is not apparent in the lost holotype (Ivanovskiy 1965, pl. II, fig. 2a-b; Hill 1981, fig. 91, 3a-d) but seems more developed in the neotype (Ivanovskiy 1976, pl. XI, fig. 3a-b).

I conclude that *Axolasma* is a valid genus which shows the following features together: cardinal fossula with a long cardinal septum, narrow stereozone, short minor septa, long major septa thick in the young, thinner in the adult, thicker towards the center, axial structure made of septal lobes and thick septal ends twisted and united by sclerenchyme.

Axolasma nov. sp.

(Pl. VI, fig. 2-4)

cf 1970 - *Streptelasma ruttneri* Saleh n. sp. ; Flügel & Saleh, p. 728 (misprint for 287), pl. 1, fig. 6, text-fig. 1.

Material: Loc. 6 - Dohaneh Kolut valley (Tabas area, Khorasan Province, eastern Iran) : 12 specimens I-Ch 8/1 to 12 (27 thin sections and peels), Niur Formation, Silurian, probably lower " faunal-zone " of Flügel & Saleh (1970, p. 295).

Dimensions (mm) : height = 45 max., often 25; d = 18-20 (12-27); SM = 38-40 (36-45).

Diagnosis

Axolasma with 36-45 major septa of unequal length, thick in young stages and a narrow stereozone. Cardinal fossula clear, with a long cardinal septum. Axial vortex irregularly developed.

Description

Corallum solitary, ceratoid, rapidly widening, commonly curved, of medium size, with the tip often preserved. Very deep calice (32 mm in one specimen whose length is 52 mm, 18 mm in another of 30 mm height). On the convex side, fossula with a long, slightly shortened cardinal septum.

External wall 1 mm thick, constituted by septal bases and interseptal tissue.

Major and minor septa of the same thickness at the periphery. Minor septa very short and limited to the stereozone. Open fossula present since the youngest observed stage with a cardinal septum shorter than its long neighbouring major septa. Indeed, the fossula is a siphonofossula, judging from its appearance in the sections made just below the last tabula: the matrix fills the fossula as it fills the outer, depressed part of the tabularium. Counter septum is less apparent but usually somewhat longer than counter-lateral septa. Major septa are long, arranged in four quadrants, and join the axis or near, but their length is very unequal because those which are in the same quadrant rely on each other. In two specimens, they are short enough to leave a room free of septa with a width of a third of the diameter. In the sections cut just under the bottom of the calice, they are moderatly thick, tapering only slightly toward the axis and separated by interseptal loculi. The major septa have their axial end often thicker, twisted and united by sclerenchyme in an irregular vortex-like structure. In septa of both orders, the axial edge is sometimes cut in septal lamellae.

No dissepiments. Very wide tabularium. Few tabulae bearing septal fragments, convex with a very wide and slightly depressed central part and a narrow extremely steep, gutter-shaped peripheral part. They are seen in transverse sections as plates joining major septa, convex to the axis.

Ontogeny

The youngest stage observed (Pl. VI, fig. 3c) , at a diameter of 7 mm, shows 30 rather thin major septa, a little sinuous, of irregular length and joining the axis. On one side, minor septa are already developped. Later, the thickness of the major septa increases and shows a characteristic pattern: in the outer tabularium, septa are moderatly thick; but in its central part, they are thinner and become rhopaloid, twisted, usually thick enough to touch their neighbours. Sometimes they are united by some intercalated stereoplasm.

Discussion

Axolasma flexuosum Ivanovskyi 1963 (=*Protosyringaxon primitivum* Ivanovskyi 1963; see Weyer 1973, p. 702, footnote 5) from upper Llandovery of the Siberian platform is smaller and has fewer major septa and longer minor septa but looks like this form by its axial structure.

Flügel & Saleh 1970 described *Streptelasma ruttneri* Saleh n. sp. from the reference section of the Niur Formation at E Dahan-e-Kolut, Shirgesht. The species was later transferred to *Helicelasma* Neuman, 1969 by McLean (1974, p. 40). Dimensions are similar but *H. ruttneri* has straight major septa, no vortex and numerous, vesicular tabellae. Variation is not known since the unique specimen figured is the holotype. It comes from the base of the Formation.

The form here described seems new but more detailed work must be achieved and comparisons made before a formal definition. The locality is the same as the Flügel & Saleh one but the beds which have yielded de Lapparent corals cannot be determined with a great precision from his field notes (see under List of localities).

Distribution

Silurian, Niur Formation, Dohaneh Kolut section, Shirgesht area (eastern Iran). Probably lower " faunal-zone " of Flügel & Saleh (1970, p. 295).

Suborder *COLUMNARIINA* Soshkina, 1941

Family *DISPHYLLIDAE* Hill, 1939

Genus *DISPHYLLUM* DE FROMENTEL, 1861

Disphyllum sp 1
(Pl. VI, fig. 5-9)

cf 1971 - *Disphyllum lemaitreae* nov. sp.; Brice, p. 271, pl. 15, figs. 9-13.

Material: Loc. 2 - Bidu River S (Bidu area, Kerman Province, eastern Iran) : 23 specimens I-BR 1c/1 to 4, I-BR 1d/2, 3, 11 to 19, I-BR 2-71/15 to 17, I-BR 2/8 to 14 (17 thin sections and peels), Bahram Formation, Lower to Middle Frasnian.

Loc. 4 - Band-e Anar section (Ravar area, Kerman Province, eastern Iran) : 2 specimens I-RP/1, 2 (4 thin sections and peels), Lower to Middle Frasnian.

Loc. 5 - Howz-e-Dorah section (Tabas area, Khorasan Province, eastern Iran) : 2 specimens I-Ta Fr/8, I-Ta5/4 (3 thin sections and peels), Shishtu Formation, Lower to Middle Frasnian.

Dimensions (mm) : height = 70 max.; d = 6-8 (5-11); dt = 5.5-7; dl = 2-4; SM = 21-24; t5 = 8-13.

Description

Numerous cylindrical fragments and two pieces of phaceloid coralla, showing narrow closely packed corallites, often in contact with their neighbours (Pl. VI, fig. 9). Epitheca often partly preserved but several fragments are encrusted by auloporid tabulate corals which settled on the dead, abraded corallite. The two preserved calices have a rounded distal edge, vertical sides and a flat bottom. Lateral, non parricidal increase with one to four buds originating at the same level on the same side, first with an angle of 45°, then becoming vertical and parallel to the others.

External wall 0.2 mm thick, very moderatly grooved in front of each septa.

Major septa as long as 0.25 d more or less, thickened in the dissepimentarium and tapering in the tabularium. Minor septa very short, limited to the dissepimentarium and as thick as the major ones. The dilatation is usually uniform in the dissepimentarium. In some corallites, septa are thinner except near each series of dissepiments where trabeculae are widened, so septa are carinated. Stout trabeculae (0.25 mm in longitudinal section) directed upwards and inwards at 45° peripherally then axially tilted.

Dissepimentarium narrow with often one series of large and globose dissepiments. Eventually, one or two inner series of smaller vesicles in addition, more steeply inclined axially. Stereozone usually well developped at the limit dissepimentarium-tabularium owing to a deposit of stereoplasm on the inner series of dissepiments.

Tabularium wide, with a convex profile and numerous tabulae. Where major septa are long, there are highly domed axial plates and convex periaxial plates. Where major septa are short, tabulae are more complete with a less high, flat axial part and convex edges (Pl. VI, fig. 7b).

Variation

Stereozone and septal thickening are well developped in Bidu River colonies, contrary to what is seen in Band-e Anar locality

Discussion

Among the numerous *Disphyllum* species is a group with short septa and a medium diameter: in Europe, *D. wirbelauense* and several subspecies, *D. virgatum* (Hinde, 1890) sensu Le Maître 1937, *D. virgatum* (Hinde, 1890) sensu Tsien, 1970 and Coen-Aubert 1989; in Australia, *D. virgatum* (Hinde, 1890), *D. curtum* Hill, 1954; in Afghanistan, *D. lemaitreae* Brice, 1971.

D. virgatum (Hinde, 1890) from the Sadler Limestone and the Pillara Limestone, Frasnian, Caning Basin, Western Australia, was revised by Hill and Jell (1971, p. 41, pl. 9, fig. 1-8). It has a diameter often greater than 10 mm and, especially, a higher number of major septa (min. 24, max. 31) which are longer (from " two-thirds of the way to the axis " to " only slightly withdrawn from the axis). For these reasons, I separate the Iranian forms here described from this species. I also exclude from *D. virgatum* the Belgian form (uppermost Givetian, upper *dengleri* Zone, Ardenne) as well as the French one (Givetian, Vendée, France).

D. wirbelauense Pickett (1967, p. 47, t.-fig. 12, pl. 6, fig. 25) from the Iberg Limestone, Lower Frasnian, Lahn syncline, Germany, has similar size and septal number with even shorter septa. Its tabulae are complete, mesa-shaped and grouped by bundles. Several subspecies have been described from Upper Givetian-?Frasnian in Poland (Rozkowska & Fedorowski 1972; Wrzolek, 1992) and from Frasnian, Moravian karst,Czech Republic (Galle 1984,) where *D. w. regulare* is eponym of a biozone.

D. karolinae Galle (1985, p. 243, pl. 1, fig. 3-6, pl. 2, fig. 3), from the Frasnian carbonates, Moravian karst, Czech Republic, differs from *D. wirbelauense* by its reduced dimensions, its shorter septa and its less pronounced marginarium.

D. curtum Hill, 1954 from the Sadler Limestone and the Pillara Limestone, Upper Devonian, Caning Basin, Western Australia, was also revised by Hill and Jell 1971 (p. 42, pl. 7, fig. 11, pl. 8, fig. 3). It looks very similar to the species we are dealing with by its diameter, number and shortness of septa, globose dissepiments. But its tabulae are mostly complete and sagging.

D. lemaitreae Brice, 1971 (p. 271, pl. 15, fig. 9-13) from the Frasnian biostromal limestone outcropping at Ghoudjerak-Chaghna pass, Dacht-e Nawar, Afghanistan, has greater dimensions than the Iranian material. However the figured transverse section of the holotype (pl. 15, fig. 9) is the largest corallite of the collection (d = 11.5 mm, SM = 27) whereas the usual data, measured on the original slides, are d = 7.5-9.5 mm, SM = 22-23, which is not significantly different from *D.* sp 1. *D. lemaitreae* has also very regular tabulae, more complete and packed. A more complete study of the variation of this species is required.

All these species should be placed in *Pantophyllum* Lakhov 1982 as well as in *Paracolumnaria* Yü & Kuang, 1984 if we consider as essential their short septa. The type-species of *Pantophyllum* Lakhov, 1982 is *D. geinitzi* Lang & Smith, 1935 (" Übergangskalk " = Upper Givetian following Birenheide (1969, p. 40); " Bensberg " = Bergisch Gladbach, Paffrath syncline, Germany). It has very short, thin septa, small dissepiments in one incomplete series and distant complete tabulae. These

differences are sufficient to distinguish our Iranian species from *D. geinitzi*. Moreover, *D. geinitzi* is presently too poorly known in its type-area to enable one to decide upon the generic value of *Pantophyllum* and the genus position among Disphyllidae, Columnariidae or even among Endophyllidae since some authors have referred to *Smithiphyllum* forms resembling to *D. geinitzi*. *Paracolumnaria* Yü & Kuang 1984 has also short septa and, in addition, the peripheral septal ends are fused in a narrow stereozone.

Some of these species with a compact stereozone may as well be referred to *Alaiophyllum* Goryanov, 1961. Since their trabeculae are horizontal, they can also be attributed to Charactophyllidae !

Indeed, presently, all the above cited genera are in need of evaluation, most of them being based on unsufficient known type species.

Disphyllum caespitosum tricyclicum
von Schouppé, 1965

(fig. 2 ; Pl. VII, fig. 1-4)

? 1922 - *Cyathophyllum (Thamnophyllum?)* sp. ; Reed, p. 14, pl. 2 fig. 12, pl. 3 fig. 1-2.
? 1922 - *Cyathophyllum (Phacellophyllum) caespitosum* ?. ; Reed, p. 15, pl. 3 fig. 3-5.
1939 - *Pseudostringophyllum caespitosum* sp. nov. ; Soshkina, p. 36, pl.10 fig. 81-82, pl.12 fig. 97-98.
1951 - *Megaphyllum caespitosum* ; Soshkina, p. 110, pl.20 fig. 5, fig. 40.
1952 - *Megaphyllum caespitosum* ; Soshkina, p. 105, pl.46 fig. 158.
1958 - *Megaphyllum caespitosum* ; Bulvanker, p. 189, pl.57 fig. 2, pl. 58 fig. 1a.
1965 - *Disphyllum caespitosum tricyclicum* n. sp.; von Schouppé, p. 22, pl.1 fig. 5-6, t- fig. 2-4.

Holotype: by original designation, specimen 1752/1 a-d, Kuragh (Chitral), Givetian? or Frasnian?.

A nomenclaturial question. The name was apparently proposed as a replacement for Soshkina's name *Pseudostringophyllum caespitosum* Soshkina 1939. Since von Schouppé rightly transferred the species to *Disphyllum*, it appeared necessary to rename Soshkina's species, to prevent synonymy with *Cyathophyllum caespitosum* Goldfuss, 1826, type-species of the genus, keeping the original type as it is the case for a *nomen novum*. But was it necessary ? Indeed, *Cyathophyllum caespitosum* Goldfuss, 1826 was already renamed as *D. goldfussi* (Geinitz, 1846). Now, for the stability of the nomenclature, the best is to continue the established use: *D. caespitosum* (Goldfuss, 1826) instead of *D. goldfussi* (Geinitz, 1846) and *D. caespitosum tricyclicum* von Schouppé, 1965 instead of *D. caespitosum* (Soshkina, 1939).

Material: Loc. 5 - Howz-e-Dorah section (Tabas area, Khorasan Province, eastern Iran) : 7 specimens I-Ta5/1, 2, 5 to 9 (19 thin sections and peels), Shishtu Formation, Lower to Middle Frasnian.

Dimensions (mm) : height = 50 maximum observed; d = 10-15 (11-13); dt = 8 (7.5-9); dl = 3-4 (0-5); SM = 24 (23-30).

Description

Cylindrical fragments (h = 15-35 mm). The calice is 8 mm deep and has a narrow platform, steep sides and a flat bottom (Pl. VII, fig. 1b).

External wall 0.2 mm thick. In two specimens I-Ta5/7 and I-Ta5/8, between each minor septum and the adjacent major septum, the external wall is crossed by a narrow plate, lighter or darker than the surrounding tissue and slightly projected into the dissepimentarium: this last feature prevents one from considering these plates as an accident of fossilization (fig. 2a-c ; Pl. VII, fig. 2c,3a, 3c). I think they represent the von Schouppé's third cycle of septa. Usually, the wall is, instead, homogeneous or diagenetically modified and no third order septum is seen.

Septa not touching, usually notably thickened in the dissepimentarium, more in the inner part where the thickening may be spindle-shaped. Major septa taper in the outer tabularium and continue, long, very thin and somewhat wavy, to the axis which they do not attain, leaving a room free of septa of a third of the diameter. Minor septa of same general appearance but neatly thinner and shorter. Trabeculae thick (0.25-0.30 mm in longitudinal section) directed upwards and inwards at 45° peripherally, more tilted axially.

Dissepimentarium of one to four series of dissepiments larger and less globose at the periphery (almost peneckielloid vesicles), smaller and steeply inclined innermost. Tabularium floors of large axial slightly convex plates and periaxial vesicles. Stereozone sometimes developed at the limit dissepimentarium-tabularium with stereoplasm coating the inner series of dissepiments.

Variation

I include tentatively in this species a completely preserved colony cone-shaped (80x85 mm, h= 50 mm), with a rather convex distal surface, showing closely packed corallites, some of them are straight-sided. The external wall 0.2 mm thick, is moderatly grooved in front of each septa, so that it remains wavy even where corallites are in contact. No sign of third order septa.

Discussion

The large diameter, the high number of septa, the outer peneckielloid dissepiments, the biseriate look of the tabularium compare this species with *Disphyllum caespitosum tricyclicum* von Schouppé, 1965. Highly characteristic is the trace of the third order septa. The suggestive specific name was established for *Pseudostringophyllum caespitosum* Soshkina 1939, non *Disphyllum caespitosum* (Goldfuss, 1826). While revising the Soshkina collections, Ivanovskiy & Shurygina 1980 merged the Russian species with *Disphyllum pashiense* (Soshkina, 1939). So did Tsyganko 1981, p. 69. This species from the Pashia beds, Frasnian, Central Oural has thin, rather short septa arranged in two orders and is here considered different from *Disphyllum caespitosum tricyclicum* von Schouppé, 1965.

The " third cycle of septa " is not easily seen and seems irregularly developed even in different parts of the same specimen. Von Schouppé defined the subspecies by " the more or less clearly apparent stages of development of a third cycle of septa " (p. 23) and " a hint of development of a third cycle of septa " (p. 24), stressing this irregularity. He illustrated it with a sketch of the holotype. The photograph on the pl. 1, fig. 5 is too little enlarged to show this detail clearly. Accordingly, he included in the species two forms illustrated by Reed of the same area where this peculiarity is not seen as well as in the holotype of *Pseudostringophyllum caespitosum* Soshkina 1939, where it is obvious. In Iranian collection, I also put together specimens with and specimens without any trace of " third cycle of septa ".

The " third cycle of septa " is perhaps, may I suggest, the equivalent of the hyposepta of Weyer (1980, p. 61,

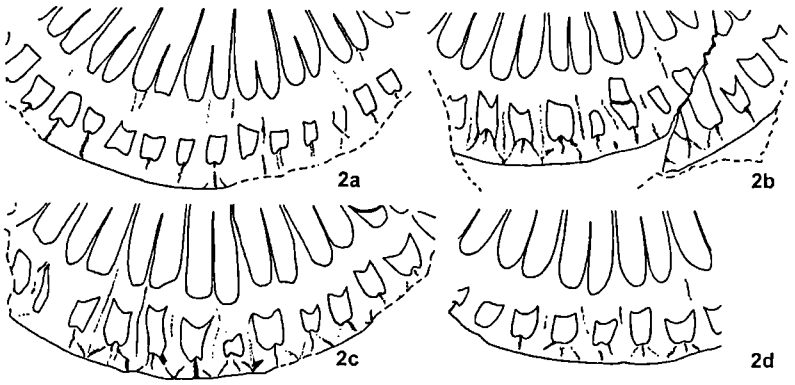

Fig. 2. — *Disphyllum caespitosum tricyclicum* von Schouppé, 1965. Details showing third order septa(x10);
2a: GFCL 3925, loc. 5; transverse section T4, also figured on pl. VII, fig. 2c;
2b-d: GFCL 3926, loc. 5; 2b transverse section T2, also figured on pl. VII, fig. 3c ; 2c transverse section T3 ;
2d transverse section T1, also figured on pl. VII, fig. 3b;

Fig. 2. — Détails montrant les septes de troisième ordre (x10).
Lame transversale T4, également illustrée sur la pl. VII, fig. 2c;
2b lame transversale T2, également illustrée sur la pl. VII, fig. 3c ; 2c lame transversale T3 ; 2d lame transversale T1, également illustrée sur la pl. VII, fig. 3b.

1997, p. 39) or of the minisepta of Hill (1981, p. 19). In this second work on the " third order septa ", Weyer reserved his interpretation of *D. caespitosum tricyclicum* von Schouppé, 1965, pending revision of the material. For him, the hyposepta are developed in the uppermost calice and then are covered with stereoplasm where they are finally included. If applied to *D. caespitosum tricyclicum,* this explanation would more or less justify the irregular presence of these structures since the farther the " third order septa " are from the calice, the less likely they are to remain conspicuous.

Pseudostringophyllum caespitosum Soshkina 1939 is the type-species of *Pseudostringophyllum*. Nothing in the species deserves a generic distinction from *Disphyllum,* the third order of septa being considered of minor importance. Consequently, *Pseudostringophyllum* has no longer been kept by subsequent workers.

Distribution

Givetian, Armenia; Givetian? or Frasnian?, Chitral (Pakistan); Frasnian, Urals; Frasnian, Kuznetsk Basin; Lower Frasnian, 6th Brachiopod Zone of Brice 1977, Tabas area, Howz-e-Dorah section (eastern Iran).

Genus *HEXAGONARIA* GÜRICH, 1896

Hexagonaria cf *magna* (FENTON & FENTON, 1924), *sensu* BRICE, 1971

(Pl. VII, fig. 5-6)

non 1998 - *Hexagonaria bassleri magna* (Webster & Fenton, *in* Fenton et Fenton, 1924); Sorauf, p. 67, pl. 32,fig. 2-5; pl. 33, fig. 1.
1971 - *Hexagonaria* cf *magna* (Fenton & Fenton, 1924); Brice, p. 283, pl. 16, figs. 4-6, pl. 19, fig. 8.
Material: Loc. 2 - Bidu River S (Bidu area, Kerman Province, eastern Iran) : 8 specimens I-BR 3a 71/5 to 12 (4 thin sections and peels), Bahram Formation, Lower to Middle Frasnian;
Loc. 8 - Soh area (Esfahan Province, central Iran) : 2 specimens I-Z 173/1, 2 (4 thin sections and peels).
Dimensions (mm) : height = 130 max.; dc = 10-12 (8-14); dm = 6-8; dt = 4-5; dl = 1-4; SM = 18-20; t5 = 8-16.

Description

Coralla ball-shaped, even laterally flattened so that they are taller than wide. One of them (I-BR 3a-71/8) began by covering the substrate, then grew vertically. Calices separated by a polygonal, slightly thick wall. Peripheral platform narrow, horizontal, with an internal wall slightly salient. Calicular pit wide compared to the corallite diameter, shallow (1-1,5 mm), with vertical sides and flat bottom. Sometimes, an axial ring, which corresponds with the twisted axial ends of major septa.

Intercorallite wall continuous, tri-layered, thin, with a zig-zag or, more often, straight path. Septa in two orders, usually thin, with a variously strong but always moderate thickening. In the dissepimentarium, major septa are smooth where they are thin, carinated where thicker, tapering very progressively into the tabularium, leaving a rather large axial space free of septa. Minor septa, short to almost reduced, much thinner than major ones.

Microstructure of septa, in transverse section, variable in the same corallite, according to their thickening. When they are very thin, a median black line may be present or not, but no sign of trabecular structure. When they are thicker, two trabeculae per millimeter are visible, whose center is swollen across the septum, like a bar with a dark axis or like a pearl with a dark center, while between these centers the septum remains thin, clear and apparently structureless. In even thicker septa, trabeculae - as above, two per mm - are more swollen transversely but also axially, so that a trabecula touches its neighbour by a wide plane; the lateral faces of the septa then have a dented appearance. Finally, a true fusiform thickening happens when trabeculae are dilated axially enough to suppress the above dented appearance. This kind of septal thickening is usual in *Hexagonaria* and the pattern here described in the Iranian species looks absolutely like the one illustrated by Sorauf 1994 pl. 3F for *H. oweni* (Frasnian, Iowa) for instance.

Dissepimentarium of 3-4 rows of vesicles, large and horizontally based at the periphery, smaller but almost vertical near the tabularium, so that the limit dissepimentarium-tabularium is very sharp in longitudinal section. It is also the case in transverse section since the innermost dissepiments are closely packed and often inosculate in transverse section, due to the reduction of minor septa.

Wide tabularium, made of complete and tightly packed tabulae. Where major septa are short, tabulae are mesa-shaped in the central tabularium and their periaxial edges are bent downward. Where major septa are longer, additional plates appear, in the axial tabularium as bundles of flat plates and periaxially as convex plates which look like inner dissepiments in transverse section.

Variation

The width of the calicinal platform increases with the age and, consequently, the dissepimentarium profile and the proportions dissepimentarium-tabularium. The same thing happens when corallum is flattened.

Vertical growth is markedly periodic. Where growth is slow, dissepiments are smaller, tabulae more packed and higher, major septa longer, trabeculae thicker, platform narrower and calice sides steeper.

Discussion

This form looks like *Hexagonaria* cf *magna* (Fenton et Fenton, 1924) *in* Brice (1971, p. 283) in the rather large corallites size, the simplicity of the tabularium, the shape of the septal thickening which bears carinae in the dissepimentarium and which is long and progressively tapering in the tabularium. But here, dissepimentarium is narrower, less exsert.

Hexagonaria magna (Fenton C. L. et Fenton, M. A, 1924) has been redescribed from Frasnian of Iowa (USA), the type-area, by Sorauf 1998. It has more numerous and longer septa.

Distribution

Lower or middle Frasnian, Afghanistan, Central Mountains, Dacht-e-Nawar: Chaghna section (Brice 1971, section 10) and Ghoudjerak pass section (Brice 1971, section 3, level 9 *pars*); these beds are alloted to the Dewal reefal limestones Formation (B. Mistiaen,1985) and have yielded index forms of the 6th Brachiopod Zone with *Cyphoterorhynchus khoragensis* (Reed, 1922).

Lower or middle Frasnian, Afghanistan, Central Mountains, Unaï pass: Badragha section, sample 775; 6th Brachiopod Zone.

Lower to middle Frasnian, Kerman area, Bidu River section (east Iran); same age, Soh area (central Iran).

Hexagonaria cf *taurensis* (HUBMANN, 1992)

(Pl. VIII, fig. 1-2)

cf 1903 - *Cyathophyllum sedgwicki* Milne-Edwards & Haime ; Penecke, A., p. 147, pl. 5, fig. 3a-c.
cf 1992 - *Argutastrea taurensis* n. sp. ; Hubmann, B., p. 154, pl. 1, fig. 3-5, text-fig. 2-6;
cf 1992 - *Hexagonaria* sp. ; Hubmann, B., p. 157, pl. 1, fig. 6-7, text-fig. 6.

Material: Loc. 2 - Bidu River S (Bidu area, Kerman Province, eastern Iran) : 4 specimens I-BR 3a-71/1 to 3, 9 (7 thin sections and peels), Bahram Formation, Lower to Middle Frasnian;

Loc. 4 - Band-e Anar section (Ravar area, Kerman Province, eastern Iran) : 1 specimens I-RP/8 (2 thin sections and peels), Lower to Middle Frasnian.

Dimensions (mm) : height = 90 max.; dc = 12 (8-16); dm = 7-8; dt = 5-6; dl = 1; SM = 20 (19-24); t5 = 14

Description

Three complete coralla preserved, one is flat (60x45, h=25 mm), one is taller (110x80 mm, h = 70 mm) and the third is laterally compressed (45x50 mm, h=90 mm). Calices limited by a thin, zig-zag wall. Wide platform, with a narrow depressed ring near the wall and a wide but low inner wall. Calicular pit, from longitudinal section, relatively narrow, 3-4 mm deep, steep sides and axial flat-domed boss.

In thin section, wall thin, tri-layered in adult. Where it limits a bud, it is thicker and has the same structure, apparently trabecular, as the septa of the bud. Septa in two orders, complete, with a fusiform thickening building an inner wall of 2 mm wide, usually strong but not compact since septa do not touch. In the outer dissepimentarium, major septa are smooth, thin and sometimes sinuous. In the thickening region, trabeculae are swollen. Outwardly, they give a carinated appearance to the lateral faces of the septa while, inwardly, they are more uniformly wide so that septa have smooth sides. Septa continue in the tabularium, very thin and long, almost to the axis. Minor septa very similar to major ones but thinner and shorter, not penetrating in the tabularium. In longitudinal section, monacanths well delimited, large, with fibers diverging widely from the axis. In the outer dissepimentarium, they form a 30° angle and, inwardly, keep an attitude perpendicular to the dissepimentarial layers: that is to say they diverge widely in the inner wall, tilting to the horizontal near the tabularium. A " fan ", sectioned on a sufficient length, shows that, in the fusiform thickening, the trabeculae upwards become wider then divide into two narrower lathes. On the inner side, trabeculae remain narrower than on the outer side : so, their dimension depends upon the width of the septal thickening in the radial plane as well as in the tangential plane.

Dissepimentarium wide, of 6-10 rows of vesicles, very variable : large and almost flat at the periphery, smaller and more convex in the inner wall but always small and steep for the 3-4 innermost rows which are the most constant of all. Sometimes stereome covers the inner row of dissepiments.

Tabularium triseriate, consisting of flat-topped axial tabellae and periaxial convex, flat or concave plates.

Variation

I include in the species a colony with smaller corallites and lighter tissue from Ravar section (Pl. VIII, fig. 2)

Discussion

Argutastrea taurensis is a typical *Hexagonaria* (spindle-shaped septal thickening, exsert dissepimentarium, strong trabeculae and carinae in the outer dissepimentarium) and

there is no reason to compare it to *Argutastrea*. I see no difference between *Argutastrea taurensis* and *Hexagonaria* sp. illustrated by Hubmann, except, in the last specimen, a better developed inner wall due to more swollen trabeculae in the outer dissepimentarium.

The Iranian form is usually larger.

This species differs from *Hexagonaria* cf *magna* sensu Brice 1971, above described, by the more regularly developed septal thickening, the wider dissepimentarium and the longer major septa.

Distribution.

Upper Devonian (Frasnian, in my opinion, owing to the aspect of rugose fauna), Turkey, Antitaurus, Feke area.

Lower to middle Frasnian, Kerman area, Bidu River section and Ravar area, Band-e Anar section (eastern Iran); 6th Brachiopod Zone.

Genus *CYSTIHEXAGONARIA* ROHART, 1988

1988 - *Cystihexagonaria* nov. gen. ; Rohart, p. 273. Erroneously spelt *Cystohexagonaria* p. 231.

Type species (by original designation) : *Cystihexagonaria defecta* Rohart, p. 274, pl. 31, fig. 13-14; pl. 34, fig. 1-3. Boulonnais (North of France), Ferques (Pas-de-Calais), Parisienne quarry and adjacent quarries; Ferques Formation, Parisienne Member, e-f terms; upper Devonian, Frasnian, equivalent to the summit of the Upper *asymmetricus* Zone.

Diagnosis

Cerioid [Disphyllid] with a thin outer wall, a peripheral platform and an inner wall. Septa spindle-shaped in the inner wall, slightly carinated, separated from the outer wall by dissepiments. Minor septa reduced or absent. Dissepimentarium wide, convex, of small dissepiments, the inner ones more or less interfingered. Tabularium floors convex in the center and depressed as a gutter at the periphery. [Where they are thickened enough, septa are made of coarse, well delimited trabeculae,with diverging fibers] *(original diagnosis, completed with the parts enclosed inside [] and translated)*

Discussion

The genus has received little attention since it was founded. Most workers have overlooked it or cited it as a synonym of *Wapitiphyllum* McLean & Pedder, 1984, without any discussion (for instance Schröder 1997) . In the following comparison, *Wapitiphyllum* will be restricted to *W. vallatum* McLean & Pedder, 1984 and to *W. facetum* McLean & Pedder, 1984, the third species *W. exiguum* McLean & Pedder, 1984 seeming to me not generically different from *Parasmithiphyllum kakisianum*.

The resemblance between those genera exists in the reduced state of septa, mainly the minor ones, and the variable development of presepiments. However, *Wapitiphyllum* has a completely different septal microstructure: very fine trabeculae which appear clearly where septa are thickened in transverse section (*W. vallatum* McLean & Pedder, the type species, 1984, pl. 7, fig. 6) and in longitudinal section (id., pl. 7, fig. 3). This kind of trabeculae does not participate in the building of broad carinae of the type seen in *Hexagonaria* and observed, although weakly developed, in *Cystihexagonaria*. Trabeculae in both last genera are coarse, well delimited, with diverging fibers (for *Cystihexagonaria defecta*, see for instance Rohart 1988, pl. 34 fig. 1b for the aspect in longitudinal section). They are swollen and contiguous in the fusiform septal thickening inside the inner wall and narrow in the dissepimentarium except where, periodically, they are enlarged in cross-bar carinae. Of course, the true septal structure is apparent only if septa are thickened enough, so that analysis remains difficult in species with thin septa. But, even in this case, some areas of the corallum show septal thickening, for instance in the skeleton built during period of slow growth. The opportunity is taken here to illustrate such a case for the Iranian species described below.

Other features separate *Wapitiphyllum* of *Cystihexagonaria* which have already been listed and are here repeated: 1- outer wall is thickened in *Wapitiphyllum* by festoons (arc of a circle in shape) representing the enlarged, perhaps multitrabecular, base of the two orders of septa; in *Cystihexagonaria*, septal bases are triangular and weak; 2- lateral dissepiments are frequent in *Wapitiphyllum*, absent in *Cystihexagonaria*; 3- very large dissepiments in *Wapitiphyllum*, smaller ones in *Cystihexagonaria* even in zones where rapid growth produces lighter tissue; 4- simpler tabularium in *Wapitiphyllum* with tabulae mostly complete and flat, instead of convex tabularial floors in *Cystihexagonaria*, with flat domed axial plates and convex periaxial tabellae, at least in species with major septa long enough.

From the above discussion, I conclude that *Wapitiphyllum* is a good genus with features typical of Kyphophyllidae while *Cystihexagonaria* is a Disphyllidae. Resemblance between the two genera is homeomorphic and not phylogenetic.

Cystihexagonaria ex. gr. *hexagona* (GOLDFUSS, 1826) *sensu* BRICE, 1971

(fig. 3 ; Pl. VIII, fig. 3)

v 1971 - *Hexagonaria* ex. gr. *hexagona* (Goldfuss, 1826); Brice, p. 276, pl. 17, fig. 4 a-b.

Material: Loc. 2 - Bidu River S (Bidu area, Kerman Province, eastern Iran) : 2 specimens I-BR 1d/1, I-BR 3a-71/4 (6 thin sections and peels), Bahram Formation, Lower to Middle Frasnian.

Loc. 1 - Hutk section (Bidu area, Kerman Province, eastern Iran) : 1 specimen I-H73-6/1 (2 thin sections and peels), Middle Frasnian.

Dimensions (mm) : dc = 7-10; dm = 4-5; dt = 4; dl = 1.5-2; SM = 16-18; t5 = 7-16.

Description

Calices narrow, very deep (5 mm), without platform, steep-sided.

Intercorallite wall continuous, tri-layered, thin, with a zig-zag path. Septa in two orders, thin, almost without thickening. In the outer dissepimentarium, major septa are often interrupted by large dissepiments and continue into the tabularium, leaving a rather large axial space free of septa. Minor septa reduced to a crest near the wall or to a triangular wedge. Microstructure of septa usually indistinguishable due to their thinness but in one place, large contiguous monacanths made a fusiform thickness. They are of the usual kind in *Hexagonaria*: large, well

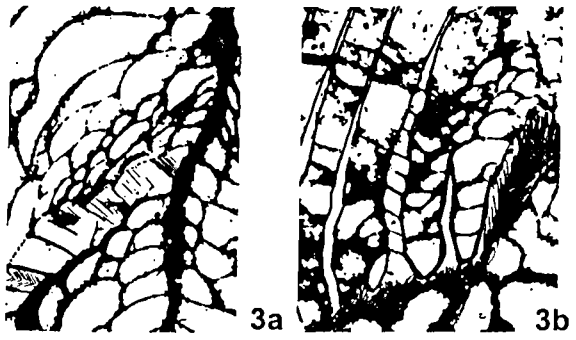

Fig. 3. — *Cystihexagonaria* ex. gr. *hexagona* (Goldfuss, 1826) *sensu* Brice, 1971, GFCL 3932, loc. 2.
a : detail of the longitudinal section L4 (x10) showing large trabeculae with fibers diverging from the axis;
b : detail of the same section (x10), also figured on pl. VIII, fig. 3d, with trabeculae well delineated in a thick major septum which is transversely cut;

Fig. 3. — Cystihexagonaria *ex. gr.* hexagona *(Goldfuss, 1826)* sensu *Brice, 1971, GFCL 3932, loc. 2.*
a : détail de la lame longitudinale L4 (x10) montrant les grosses trabécules avec des fibres divergeant de l'axe;
b : détail de la même lame (x10), également illustrée sur la pl. VIII, fig. 3d, avec des trabécules bien délimitées dans un septe majeur coupé transversalement.

delimited, with fibers strongly diverging from the axis (fig. 3a-b ; Pl. VIII, fig. 3c-e). So, I have no doubt about the relationship with Disphyllidae rather than with Kyphophyllidae where such strong trabeculae are not known.

Tabularium relatively broad, showing two main aspects which alternate in the same corallite: distant, concave, complete tabulae, or elsewhere, closely packed, flat or flat-domed plates supplemented with inclined periaxial vesicles. Dissepimentarium of 3-5 rows of dissepiments, also with periodic growth: here, narrow with small dissepiments in very steeply rows, there wider with large, horizontal peripheral vesicles and smaller, vertical inner ones.

Variation

The Hutk specimen has narrower corallites than the one of Bidu River.

Discussion

The species has the same aspect as *Hexagonaria* ex. gr. *hexagona* described by Brice 1971. A striking feature is the narrowness of the dissepimentarium linked to the steepness of the layers of the dissepiments.

Hexagonaria parallaxa masjidense Brice, is more regular and smaller, with septa shorter and more complete in the dissepimentarium.

Distribution

Lower or middle Frasnian, Afghanistan, Axial Zone, Ghouk section, Zard Sang section and Hadjigak section; 6th Brachiopod Zone with *Cyphoterorhynchus khoragensis* (Reed, 1922).

Lower to middle Frasnian, Kerman area, Bidu River section and Hutk section (eastern Iran); 6th Brachiopod Zone.

Family *CHARACTOPHYLLIDAE* Pedder, 1972

Genus *TEMNOPHYLLUM* Walther, 1928

1978 - *Temnophyllum* ; Birenheide, p. 86;
1985 - *Temnophyllum* ; Birenheide & Liao, p. 242;
1993 - *Temnophyllum* ; McLean, p. 110.
Type-species: *Temnophyllum latum* Walther, 1928, p. 123; Givetian, Germany.

Temnophyllum lapparenti nov. sp.

(fig. 4 ; Pl. VIII, fig. 4-5 ; Pl. IX, fig. 1-2)

Holotype: GFCL 3933, figured pl. 3, fig. 4a-d.
Paratype A: GFCL 3934, figured pl. 3, fig. 5a-b.
Paratype B: GFCL 3935, figured pl. 4, fig. 1a-b.
Paratype C: GFCL 3936, figured fig. 4a-b ; pl. 4, fig. 2a-b .
Locus typicus: Loc. 2 - Bidu River S (Bidu area, Kerman Province, eastern Iran).
Stratum typicum: Bahram Formation, Lower to Middle Frasnian.
Derivatio nominis: in the memory of Albert Félix de Lapparent (1905-1975) who, tirelessly, contributed to the geological knowledge of Middle East and collected most of the here described collection.
Material: Loc. 2 - Bidu River S (Bidu area, Kerman Province, eastern Iran) : 4 specimens I-BR2 71/4 to 7 (17 thin sections and peels), Bahram Formation, Lower to Middle Frasnian.
Dimensions (mm) : height = 30 max.; d = 20 max.; dt = 8-11; dl = 6-7; SM = 22-26.

Diagnosis

Temnophyllum of medium size, ceratoid to cylindrical, strong stereozone in the narrow dissepimentarium, short septa and rather simple and broad tabularium.

Description

Solitary, medium-sized, first ceratoid then cylindrical corallite. The apical end may be curved. Two specimens show a distal rejuvenescence marked by a strong constriction. Calice 15 mm deep, with a sharp edge, steep sides and a calicular pit with a flat bottom of 8 mm diameter. Epitheca with very fine growth ridges.

Peripheral stereozone, compact, 1.5 mm wide, made of thickened outer part of septa and, where neighbouring septa are not in contact, of lamellar stereoplasm.

Septa radially arranged in two orders, very thick in the dissepimentarium. Very rarely, they do not touch, so that stereozone is porous: there septa have a triangular shape and are united adaxially by a thick layer of lamellar stereoplasm laid down on the dissepiments. Major septa continue in the tabularium as a thinner, straight or slightly sinuous part which is based on a tabula and leaves a free axial zone usually wide. Minor septa are just a little thinner than the major ones in the stereozone and they project in the tabularium only 0.5-1.5 mm. Microstructure of the septa is well seen where they are thickened in transverse section: from the axis which is clear and apparently structureless, diverge, almost perpendicularly, long fibers not clustered in trabeculae (Pl. IX, fig. 2b). Indeed,

trabeculae do exist and are thick but horizontal or slightly inwardly inclined in the stereozone: that is why in transverse section, trabecular organization is unapparent. Near periphery and in the tabularium, trabeculae are tilted upwards with a 30° angle (Pl. IX, fig. 1c). This shape characterizes the charactophylloid trabeculae.

Dissepiments are usually obscured by the septal thickening. Where stereozone is porous, one row of rather large dissepiments is seen.

Tabularium wide, made of complete, flat-domed, distant tabulae, associated in the outer tabularium with vesiculous tabellae.

Variation

Rejuvenescence is frequent. It causes a constriction near the base of the calice and a great irregularity in the axial part of major septa, longer, thicker and wavier than usual. Also, the stereozone is narrower and less compact.

Discussion

This species may be compared with three genera, in addition to *Temnophyllum*: namely *Alaiophyllum* Goryanov, 1961, *Chostophyllum* Pedder, 1982 and *Kunthia* Schlüter, 1885.

The species seems to belong to *Alaiophyllum* Goryanov, 1961 with its short septa, its very strong stereozone, its complete tabulae, its charactophylloid trabeculae and the undifferenciated cardinal septum. Concerning the juvenile stages of this genus, no illustration was given. Pedder 1982, p. 566 suggested that the fig. 3g, pl. 8 of Goryanov could represent a longitudinal section of the tip and, consequently, indicate the absence of stereoplasm in the young stages. This figure may represent as well, in my opinion, a section which is rather oblique or cut in a corallum curved so that, in the bottom of the figure, the stereozone is crossed again: in this case, the beginning of the corallum is not visible in the original illustration. However the genus was defined originally as phaceloid, which is not the case of the form described here.

The genus *Chostophyllum* Pedder, 1982 was compared with *Alaiophyllum* by its author but it is solitary, has long septa, which are thickened and contiguous during the young stages. Furthermore, the short cardinal septum is well apparent during ontogenese, even in the adults of some species. Except the growth form, all these features prevent one from attributing the Iranian species to *Chostophyllum*.

The genus *Kunthia* Schlüter, 1885 has been better known since Schröder 1997 collected four specimens from the type-area (Eifel, Dollendorf syncline; Freilingen Formation, Eilenberg Member; upper Eifelian. Following the longitudinal section pl. 2 fig.16 b and the text-fig. 2, the tip contains vesicular tabulae, which means that septa do not fill the central chamber. However, the calice is extremely deep and major septa are long judging from the original Schlüter's figure: two important differences from our species. Concerning the microstructure of septa, judging from fig. 16b, pl. 2 of Schröder, trabeculae are not coarse and horizontal in the stereozone. In my opinion, *Kunthia* is not a charactophyllid.

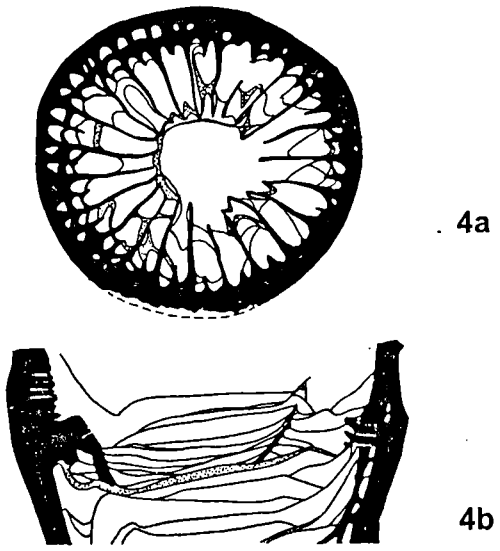

Fig. 4. — *Temnophyllum lapparenti* nov . sp., GFCL 3936, loc. 2, PARATYPE C, also figured on pl. IX, fig. 2a-b;
a : transverse peel t1(x3) ;
b : longitudinal section L1(x3);

Fig. 4. — Temnophyllum lapparenti nov. sp., *GFCL 3936, loc. 2, PARATYPE C, également illustré sur la pl. IX, fig. 2a-b;*
a : empreinte transversale t1(x3) ;
b : lame longitudinale L1(x3).

There are few comparable species. In Germany, there is *Pexiphyllum altum* Walther 1928, from the limit Givetian-Frasnian of North Sauerland. Birenheide & Liao 1985, p. 240, fig. 39, pl.7 figured, under the name *Alaiophyllum altum*, the holotype and unique known specimen: septa are more numerous for a lesser diameter. They are longer and the tabularium is much more complicated. However, the young stage shown on fig. 39b looks like the new species. From the Viersen borehole (15 km SW of Krefeld, Germany), in beds referred to " Fromelennium " that is to say upper Givetian, Birenheide 1998, p. 175, pl. 5, fig. 1 reported *Temnophyllum (Alaiophyllum)* cf *altum* with the same characteristics except a less complete stereozone.

Temnophyllum incomptum Hill & Jell 1970, p.61-62, pl. 16 fig. 1-4, from the Pillara Limestone (Upper Devonian) of the Caning Basin (western Australia) is a solitary? species with short and thick septa and a simple tabularium with large horizontal tabellae. Its authors compared it with *Alaiophyllum jarushevski*, the type species of *Alaiophyllum*, from Givetian of South Fergana, central Asia. However, it is distinguished from our form by its smaller size (9.5 mm, 2x20-23 septa) and its cylindrical shape.

Distribution.

Lower to middle Frasnian, Kerman area, Bidu River section, Bahram Formation (eastern Iran); 6th Brachiopod Zone.

Genus *SINODISPHYLLUM* SUN, 1958

1958 - *Disphyllum (Sinodisphyllum)* ; Sun, p. 11.
? 1961 - *Mansuyphyllum* ; Fontaine, p. 100.

1993 - *Sinodisphyllum* ; McLean, p. 111.
Type-species: *Sinodisphyllum* variabile Sun, 1958, Frasnian, Hunan.

Sinodisphyllum sp.

(Pl. IX, fig. 3-4 ; Pl. X, fig. 5)

Material : Loc. 5 - Howz-e-Dorah section (Tabas area, Khorasan Province, eastern Iran) : 4 specimens I-Ta Fr/ 5, 6, 9, 10 (14 thin sections and peels), Shishtu Formation, Lower to Middle Frasnian.
Loc. 9 - Soh area (Esfahan Province, central Iran) : 1 specimen I-Z 176/1 (2 thin sections and peels).
Dimensions (mm) : height = 80 max.; d = 25-35 (16-40); dt = 12-15; dl = 2-5; SM = 32-42.

Description

Solitary, large-sized, first ceratoid then cylindrical corallite. One, the largest in diameter, is trochoid. The apical end may be curved. Tip most often missing. Calice 15 mm deep, with a thick edge and a calicular pit with a flat bottom of 12 mm diameter. The tallest specimen has several buds in the calice, apparently parricidal. Epitheca with fine growth ridges and septal grooves.

Thin wall, 0.1 mm. Septa numerous, radially arranged in two orders, straight and moderatly thickened in the dissepimentarium, not touching. In a peripheral zone, 3-4 mm wide, septa are thin, waved and bear thick carinae, sometimes thin and yard-arm, sometimes stronger, asymmetrical, projected on one side and staggered from the others. Inwards, the septal thickness increases abruptly, diminishing then regularly till the axial edge of the septum. In this part of septa, septal flanks are usually smooth or just embossed. Major septa continue in the tabularium, more or less wavy, to the axis or very near where they are twisted in a vortex. Minor septa are three times thinner than the major ones and twice as short. Microstructure of the septa is well seen where they are thickened in transverse section: from the axis diverge, almost perpendicularly, long fibers clustered in trabeculae (Pl. X, fig. 5). Strong trabeculae (in longitudinal section, 2 for each mm in the thickest part of major septa, 3 for each mm in the thickest part of minor septa) directed upwards and inwards at 30° peripherally, tilted axially almost horizontally (Pl. IX, fig. 3c).

Tabularium relatively broad, made of wide, flat or flat-domed, crowded axial plates supplemented with inclined periaxial vesicles. Wide dissepimentarium (0.25 d) of two parts corresponding to the two zones of septal thickening: 2-3 rows of larger, horizontally based dissepiments in the outer dissepimentarium and 12-15 steeply inclined rows of small vesicles in the inner dissepimentarium, the innermost series quasi vertical.

No stereoplasm laid down on the dissepiments or on septa. No stereozone in adult.

Variation

The most variable feature is the transition between the two zones of septal thickening. When septa are thin in the outer zone and thick in the inner one, the transition is sharp and the opposition between them striking: thin, yard-arm carinated septa against stout, smooth-sided and gently tapering septa (Pl. IX, fig. 4b). This case is met in smaller corallites. Usually, however, transition between the two zones is progressive since septa in the outer zone are just a little less thick than in the inner zone (Pl. IX, fig. 3a).

Ontogeny

The smallest section (Pl. IX, fig. 4d) has 10 mm in diameter and shows a plane of attachment on a coenosteum of stromatoproid. On this side, which is supposed to be the lower one, dissepimentarium is absent and minor septa are hardly indicated as short spines on the wall. On the other side, dissepimentarium and minor septa are normally developed. Major septa, 28 in number, thin but, in the most developed ones, with a triangular zone of septal thickening. Axial part of major septa very wavy and long. No clear symmetry. A thin layer of stereoplasm on the series of dissepiments separating the outer from the inner zone.

Further, the growth continues thanks to the widening of dissepimentarium and the insertion of new septa. Indeed, this addition is moderate since, when diameter increases from 10 to 25x28 mm, the number of major septa increases from 28 to only 34.

These observations confirm those made on the lectotype of *Sinodisphyllum variabile*, that is to say septa are first thin and then become thicker, not touching and not forming a compact stereozone even in young stages.

Discussion

This large species has affinities with *Sinodisphyllum variabile* Sun, 1958 (based on the lectotype only) : large size, numerous septa but its major septa are longer and twisted in a vortex at the axis.

A similar species is *Neostringophyllum* aff. *modicum* (Smith, 1945) *in* Brice 1971, p.295, pl. 19, figs. 9-11 from Frasnian of Kadjao (Afghanistan), distinct from the Iranian form by the smaller diameter and the narrower dissepimentarium. Since these characteristics depend upon the size and age of corallite, a specific identity is possible but may be established only by a study of the variation on more abundant material. *Neostringophyllum* Walther, 1928 is a ptenophyllid (see Pedder, 1973, p. 101-102 for discussion).

Distribution

Lower or middle Frasnian, Afghanistan, Central Mountains, Unaï Pass: Badragha section, sample 775; 6th Brachiopod Zone.

Lower to middle Frasnian, Kerman area, Bidu River section (eastern Iran), 6th Brachiopod Zone; same age, Soh area (central Iran).

Family *PHILLIPSASTREIDAE* Hill, 1954

1989 - Phillipsastreidae ; McLean, p. 239 for recent literature.

Genus *MACGEEA* WEBSTER, 1889

1998 - *Macgeea* ; Sorauf, p. 85 (revision of the type-species in its type-area).

Type-species: *Pachyphyllum solitarium* Hall & Whitfield, 1873, p. 232; Frasnian, Iowa.

Macgeea multizonata (REED, 1922)

(Pl. IX, fig. 5)

1922 - *Cyathophyllum (Thamnophyllum) multizonatum* sp. nov. ; Reed, p. 12, pl. 1 fig. 7-12, pl.2 fig. 1-7.
1965 - *Macgeea (Macgeea) multizonata* (Reed, 1922) ; von Schouppé, p. 26, pl. 2 fig. 1-10, text-fig. 5 (with synonymy).
1971 - *Macgeea multizonata* (Reed F.R.C., 1922) ; Brice, p. 288, pl. 15, fig. 4-5.
1982 - *Macgeea multizonata* (Reed, F.R.C., 1922) ; Coen-Aubert, p. 15, pl. 1, fig. 1-3.

Material : Loc. 5 - Howz-e-Dorah section (Tabas area, Khorasan Province, eastern Iran) : 2 specimens I-Ta Fr/3, 4 (6 thin sections), Shishtu Formation, Lower to Middle Frasnian.

Loc. 7 - Soh area (Esfahan Province, central Iran) : 1 specimen I-Z 111/1 (2 thin sections).

Dimensions (mm) : height = 40 max.; d = 16-21; dt = 11-13; dl = 3-4; SM = 31-37.

Description

Fragments of cylindrical corallites. Epitheca worn out. Calice not preserved. One specimen with a distal rejuvenescence, another one with a small peripheral bud. Major and minor septa look like costae.

Septa radially arranged. All are thin in the outer dissepimentarium, have a uniform and smooth thickening in the horseshoe dissepiments zone, which continues inwards for a third or a half of the radius. The inner wall is not compact and the crown of horseshoe dissepiments is always easily seen. Minor septa cross 2-3 series of inner dissepiments. Major septa become attenuate and flexuous in the tabularium and are more or less withdrawn from the axis, leaving an axial space. Trabeculae stout (0.25 mm in longitudinal section).

Tabularium wide (0.6 d) of large, flat plates with concave edges, often interrupted by the axial part of septa when those are long or wavy. Triserial dissepimentarium typical for the species: a zone of large outer flat dissepiments, indeed often convex, locally with more than one series; a pipe of horseshoe very irregularly sized so that the very large ones may include a lower smaller dissepiment; and an inner zone of 2-3 very steep rows of normal, convex vesicles. The specimen with the bud has the flat outer dissepiments replaced by several series of normal ones, as usual in *Macgeea*.

Discussion

The Iranian specimens are similar in dimensions to those figured by Reed 1922 and von Schouppé 1965, p. 27 from Chitral. They differ by having longer and less undulous major septa. From the Middle Devonian of Robat-e Paï (Eastern Afghanistan), Brice 1971 reported corals with a narrower diameter, a lower septa number, a shorter septal thickening and smaller horseshoe dissepiments. These differences are here considered as a normal variation of the species.

The species is also cited from numerous Frasnian localities in the former U. S. S. R., Poland and Algeria. Among the Russian corals, von Schouppé 1965 has placed *M. multizonata* of Soshkina 1954, Bulvanker 1958 and Spassky 1960 in his new species *M. desioi* . Ivanovskiy & Shurygina 1980 transferred *M. multizonata* of Soshkina 1951 into *M. berdensis* Soshkina, 1939. The other occurences are not discussed here (see for instance Coen-Aubert 1982) .

Distribution

Givétien? or Frasnian?: Chitral (Pakistan); Middle Devonian ? (ill defined age: see Brice 1971, p. 289, 324) Robat-e Paï, (central Afghanistan); Lower Frasnian, 6th Brachiopod Zone of Brice 1977: Tabas area, Howz-e-Dorah section (east-central Iran) and Soh area (central Iran).

Macgeea desioi VON SCHOUPPÉ, 1965

(Pl. IX, fig. 6-7)

1965 - *Macgeea (Macgeea) desioi* n.sp. ; von Schouppé, p. 32, pl. 1 fig. 7-13, text-fig. 13 (with synonymy except the following reference).
e. p. ? 1922 - *Cyathophyllum (Thamnophyllum) trigeminum* Quenstedt - Reed, p. 13, pl. 2 fig. 8-9 (see under *Peneckiella ?* cf *cylindrica* (Yoh S.-S., 1937).

Material : Loc. 5 - Howz-e-Dorah section (Tabas area, Khorasan Province, eastern Iran) : 2 specimens I-Ta 5/3, I-Ta Fr/7 (4 thin sections), Shishtu Formation, Lower to Middle Frasnian.

Dimensions (mm) : height = 30 min.; d = 12-14; dt = 9; dl = 9-10; SM = 26-28.

Description

Two cylindrical fragments, one (I-Ta Fr/7) with a bud.

Calice not exposed but, from a longitudinal section (Pl. IX, fig. 6b), 5 mm deep, with a thick rounded edge, vertical sides and flat bottom.

Two orders of septa arranged with a slight bilateral symmetry, a few thickened (on 3 mm for the major septa, 2 mm for minor ones) in the stereozone which is centered on the crown of horseshoe dissepiments. Major septa continue in the tabularium, thin and flexuous, leaving a moderatly large axial space. Symmetrical trabecular fans. In transverse section, secondary trabeculae of the rhipidacanths are very oblique to the medium plane of the septa.

Tabularium wide, of almost complete plates, slightly convex or slightly concave, and of some convex periaxial vesicles.

Dissepimentarium narrow, biseriate: flat and large outer dissepiments, with some additional convex ones; a pipe of horseshoe dissepiments rather regular in size and superposition, thickened on each side. No inner dissepiments.

Discussion

Von Schouppé erected this species for forms smaller and simpler than *M. multizonata* with short septa and, usually, without inner dissepiments. Although the quantitative data pointed out by von Schouppé overlap here with those of *M. multizonata*, the qualitative characteristics are still observed: for the same diameter, specimens referred to *M. multizonata* have long septa and inner dissepiments, those referred to *M. desioi* have short septa and no inner dissepiments. Consequently, I retain the species, though both occur in the same beds.

Distribution

Givetian? or Frasnian?: Chitral (Pakistan); Frasnian: Russia;

Lower Frasnian, 6th Brachiopod Zone of Brice 1977: Tabas area, Howz-e-Dorah section (eastern Iran).

Genus *PENECKIELLA* SOSHKINA, 1939

Peneckiella ? cf *cylindrica* (YOH, 1937)

(Pl. X, fig. 1-2)

e. p. ? 1922 - *Cyathophyllum (Thamnophyllum) trigeminum* Quenstedt ; Reed, p. 13, pl. 2, fig. 8-9.
cf 1937 - *Campophyllum cylindricum* n. sp. ; Yoh, p. 59, pl. 7, fig. 4a-b.
cf 1971 - *Phacellophyllum* sp. B ; Hill & Jell, p. 29, pl. 5, fig. 2-3.

Material : Loc. 2 - Bidu River S (Bidu area, Kerman Province, eastern Iran) : 2 specimens I-BR1 d/18, I-BR2 71/3 (5 thin sections), Bahram Formation, Lower to Middle Frasnian.

Dimensions (mm) : min. height observed = 20 ; d = 10-11; dt = 6.5-7.5; dl = 2-3; SM = 23-24.

Description

Two cylindrical fragments. In the first one, the calice is preserved with the rounded distal edge of the septa slightly standing out above the upper rim of the wall. Low protuberances irregularly swollen the stem.

The second one has the outer wall locally preserved, very thin and finely striated. Three buds are seen, perpendicular to the parent corallite, arising on the same side from three neighbouring points just below the distal edge of the stalk (which is not the calice). Although they are less than 2 mm high, they attain 6-7 mm in diameter, which is almost the full size of the adult (Pl. X, fig. 1b, 1d). Their outline is elliptical rather than circular. Their calices exhibit the slightly exsert platform already mentioned on the first corallite.

It is impossible to decide if the species is fasciculate or solitary since no successful increase may be proved. Considering the cylindrical habitus, the small diameter and the presence of buds almost as large as their parent, if not as tall, I am inclined to a phaceloid growth form.

Septa radially arranged in two orders, with smooth lateral faces. The inner wall is 1.5-2 wide and 8-9 mm diameter and is centered on the crown of horseshoe-like dissepiments. Inside, septa are strongly thickened, spindle shaped, not touching. Inwardly, major septa become suddenly attenuate, straight, leaving a free axial space. Minor septa less dilated and shorter, projecting just a little inside the inner dissepimentarium. Fans of rhipidacanths, 0.2-0.25 mm thick, centered on the summit of dissepimentarial floors.

Tabularium as wide as two-thirds of the diameter, consisting of more or less high axial plates and convex periaxial vesicles.

Dissepimentarium narrow, highly convex. Axially, horseshoe dissepiments rare, not in a continuous pipe. Instead, most vesicles are very high, resting on two different inferior plates. Very large and very small dissepiments are juxtaposed without apparent regularity. On each side of the axial row, two or three additional rows of vesicles, the more distant ones are less convex but more inclined, the innermost almost vertical and coated with stereoplasm. No flat dissepiments near the outer wall. The unusual structure of the dissepimentarium here described is not dependent on the increase since it happens on the specimen without buds (Pl. X, fig. 2a, 2d) and, identically, on the other one, above the three buds as well as at the same level but on the opposite side (Pl. X, fig. 1).

Discussion

The rhipidacantine nature of trabeculae allows one to allot the species to Phillipsastraeidae. In addition to the uncertainty about the mode of increase (solitary or fasciculate ?), the original dissepimentarium makes this form difficult to ascribe to a known genus. All the genera with a continuous pipe of horseshoe dissepiments are excluded, those without normal dissepiments outside the pipe (*Macgeea* Webster, 1889, solitary; *Thamnophyllum* Penecke, 1894, fasciculate) as well as those with such dissepiments (*Pexiphyllum* Walther, 1928, solitary; *Pseudopexiphyllum* Hubmann, 1992, fasciculate). This last feature may deserve a full generic value when it is continuously developed in the corallite. Exceptional occurrences of normal dissepiments are well known in *Macgeea* (Brice & Rohart 1974, t-fig. 5 and pl. 9, fig. 8; Coen-Aubert 1982, pl. 1, fig. 2 & 8) , *Thamnophyllum* (Hill & Jell 1970, *Phacellophyllum* sp. B, p. 29, pl. 5, fig. 2-3).

In some genera, the absence of a continuous pipe of horseshoe dissepiments may be interpreted as a consequence of the widening of the base of horseshoe dissepiments, so that their outer edge leans on a different vesicle than their inner edge. This kind of disorganization is also occasionally observed, among others, in *Macgeea* (Brice & Rohart 1974, pl. 9, fig. 9). I consider *Debnikiella* Rozkowska, 1980 as derived by this way from *Macgeea*. This genus has large solitary corals with a wide exsert dissepimentarium and wide trabecular fans: the Iranian form cannot be alloted to it. *Debnikiella* is not accepted by Coen-Aubert & Wrzolek 1991, p. 12, mainly because they prefer to use the better known *Rozkowskaella* which exhibits the progressive replacement during ontogenese of horseshoes by normal dissepiments.

A similar evolution may be observed in *Peneckiella*. *Peneckiella* is phaceloid. Its most striking feature is the very narrow dissepimentarium consisting of a row of very high vesicles, which look like horseshoe dissepiments. They may widen with an outer less convex edge (see Rozkowska 1960, fig. 22) and disintegrate into normal convex outer vesicles (id. fig. 27-28; Pickett 1967, fig. 14). If this trend continues, more exsert and wider dissepimentarium than in typical *Peneckiella* may occur (for instance, *P. fascicularis* in Rohart 1988, pl. 35, fig. 10-13). I consider the Iranian form as an extreme case of this trend, where dissepimentarium remains strongly exsert and wide but without specialised dissepiments.

Specifically, this form is compared with *Campophyllum cylindricum* Yoh, 1937, from Givetian of Guangxi (formerly Kwangsi) for its characteristic dissepimentarium and the spindle-shaped septal thickening. The Chinese form is somewhat smaller and is said to be solitary. Trabeculae are not visible on the figure

of Yoh but on the left side of his fig. 4b, septal fibers apparently slope from the summit of the dissepimentarium to, inwardly, the axis of the corallite and to, outwardly, the periphery.

Reed (1922, p. 13) figured under the name *Cyathophyllum (Thamnophyllum) trigeminum* Quenstedt a specimen (pl. 2 fig. 8-9) with a similar complex dissepimentarium. It is larger, has more septa which are shorter than the Iranian forms. Later, von Schouppé 1965, p. 32. included it in the synonymy of *Macgeea desioi* n. sp., which has however a simpler structure.

Distribution.

?South China, Guangxi: Givetian;

Chitral, loc. K 18748 of Reed 1922, from which the fossils were obtained " from a scree at the foot of the Devonian range " (p. 125). In the list of fossils is cited *Uncinulus (Uncinulina) koraghensis*, the brachiopod characteristic of the Biozone 6. " Frasnian " for Reed; for me, ? lower Frasnian, 6th Brachiopod Zone of Brice 1977 if the above cited brachiopod comes from the same bed as the coral.

Lower Frasnian, 6th Brachiopod Zone of Brice 1977: Tabas area, Howz-e-Dorah section (eastern Iran).

Family *CYATHOPSIDAE* Dybowski, 1873

Genus *SIPHONOPHYLLIA* SCOULER *in* MCCOY, 1844

Siphonophyllia cylindrica cylindrica MCCOY, 1844

(Pl. X, fig. 3)

1844 - *Siphonophyllia cylindrica* Scouler (ms) ; McCoy, p. 187, pl. 27, fig. 5.
1963 - *Siphonophyllia cylindrica cylindrica* McCoy ; Flügel, p. 387.
1991 - *Siphonophyllia cylindrica cylindrica* McCoy ; Flügel, p. 677, pl. 2, fig.2.
Material : Loc. 5 - Howz-e-Dorah section (Tabas area, Khorasan Province, eastern Iran) : 1 specimen I-Ta 11/1(4 thin sections and peels), Shishtu Formation, bed 11, lower? Tournaisian (the resemblance with *S. cylindrica hasteriensis* favours a lower Tournaisian age for this bed).
Dimensions (mm) : height = 45 min.; d = 50 min.; dt = 25; dl = 5-8; SM = 47

Description

Fragment of a large solitary coral, almost cylindrical, without tip or calice (upper diameter : 45 x 50 mm ; lower diameter 30 x 36 mm ; length : 45 mm, probably higher than 60 mm for the whole corallum). Epitheca with very fine growth rings.

Major septa, very thin in the dissepimentarium, strongly thickened in the tabularium for those situated in the cardinal quadrants so that they are in contact, except their axial part which is again very thin. Shortened cardinal septum in a closed cardinal siphonofossula. Dissepimentarium narrow (3 – 6 mm width), in two zones: near the tabularium, concentric presepiments of second order regularly bearing septal crests and, near periphery, mainly in the distal part, first order presepiments, not very large, with rare septal crests. In longitudinal section, all vesicles are elongated and steeply inclined. Tabularium very large (25 – 30 mm) with complete tabulae, often piled in bundles and bent down near the periphery of tabularium.

In the lowest transverse section (d = 35-40 mm) are 47 major septa, very thickened in cardinal sectors. Dissepimentarium very narrow (2-3 mm wide) with concentric presepiments of second order regularly bearing septal crests.

Discussion

The strong thickening of the major septa in cardinal quadrants is similar to the one characteristic of *Siphonophyllia cylindrica hasteriensis* (Salée 1913) as revised by Poty & Boland 1996, p. 208 and by Boland 1997, p. 74 (Hastarian, lower Tournaisian, Belgium). But this subspecies has more septa (55-65 for d = 50 mm) and very large peripheral presepiments. The number of 47 major septa, here observed, is rather weak even for the nominal subspecies. These differences may be explained if the specimen was not in the adult stage : *Siphonophyllia cylindrica cylindrica* may reach 80 mm in diameter and *Siphonophyllia cylindrica hasteriensis* 74 mm. Except for the diameter and for the septal number, I consider the Howz-e-Dorah specimen as identical to the one figured, from a neighbouring section, by Flügel 1991, p. 677, pl. 2, fig. 2. He also described from the same bed *Siphonophyllia* sp. without figuration for forms with relatively few septa and without presepiments, attributed to juvenile stages.

A possible identification with *Siphonophyllia cylindrica hasteriensis* (Salée 1913) would require more material than the unique specimen available and could lead to the conclusion that this bed is lower Tournaisian.

Distribution (in Iran)

Member II, Shistu Formation, Ozbak-Kuh Group, Upper Viséan; Ozbak-Kuh Mountains, central Iran. ;

Talartal, central Elbourz; *Kueichouphyllum* zone, Viséan

Suborder *LONSDALEIINA* Spasskiy, 1974

Family *WAAGENOPHYLLIDAE* Wang, 1950

Dr. Pedder informed me that " Xu Shouyong *et al.* (*in* Lin B. et *al.* 1995, p. 590) erected Polythecaliidae Fam. nov. ". Since this book is not available to me, I have nothing else to add and mention the new family to draw the attention of more documented workers.

Genus *POLYTHECALIS* YABE & HAYASAKA, 1916

Polythecalis cf *denticulatus* (HUANG, 1932)

(Pl. X, fig. 4)

cf 1932 - *Stylidophyllum denticulatum* n. sp. ; Huang, p. 73, pl. 1, fig. 1a-c.
e. p. 1964 - *Polythecalis (Polythecalis) denticulatus* (Huang 1932) ; Flügel, p. 415, pl. 19, fig. 4 (exclusively).
Material : Loc. 10 - Soh area (Esfahan Province, central Iran) : 1 specimen I-Z 114A/1 (5 thin sections and peels); middle Permian.
Dimensions (mm) : dc = 6 (6-7); dt = 2; SM = 12-14; t5 = 35-40.

Description

The unique corallum is embedded in matrix, has the shape of a thick (18 mm in height) disc with a flat upper surface and measures 45x30 mm for the preserved part.

Calices, judging from longitudinal sections, with a broad, flat platform, a steep-sided pit less than 2 mm deep and a prominent columella, 1 mm in height. Colony partly cerioid where thick and denticulated septal wall exists and partly aphroid elsewhere. Wall very variable in thickness, from very thin to 0.5 mm wide, with a characteristic comb-like appearance, made of opposite, not alternating, bases of the three orders of septa, without median black line. Major and minor septa very similar, slightly curved and represented by septal crests in the outer lonsdaleoid dissepimentarium but laminar and with a fusiform thickening in an inner zone of 6 mm in diameter. Septa of both orders continue in the tabularium where they are somewhat sinuous and bear irregular spines and nodules. Minor septa are just somewhat shorter and thinner than major ones; they are also locally reduced to a line of septal fragments. The columella is 1x1.5 mm in diameter but the section is slightly oblique to the growth direction. It consists of a spindle-shaped median plate, a tenth of septal lamellae, irregular in length and usually not connected with the major septa.

Dissepimentarium very large, in two zones. Peripheral platform with 10 or more rows of flat dissepiments, the most inflated being circular in transverse section. Dissepiments of the two innermost rows are very steep and elongated. Lateral dissepiments exist. Tabularium and columella proportions : 1/2/1. Clinotabulae and transverse tabulae very crowded. Columella made of small axial tabellae, almost vertical, in 2-3 rows on each side of the median plate and of distally discontinuous septal lamellae.

Variation

Periodic growth very apparent. Over a height of 12 mm 5 cycles are visible, each consisting of a band of dense tissue followed by a band of looser skeleton. The tabularium and the columella seem less affected by periodic growth than other parts of corallum. During rapid growth periods, dissepiments are larger and bear less septal crests, the wall between corallites is more discontinuous: this aspect corresponds with more aphroid phases of the corallum form.

The available transverse section, although not very large, shows three buds which all arise in the lonsdaleoid phase. This observation in *Polythecalis* confirms the opinion that periods of rapid growth are also those of increase (see for instance Ezaki & Kato 1989 in *Wentzelella*, Wang 1993 in *Kepingophyllum*).

Discussion

This form has several characteristics: corallites of small size, septa rather numerous, minor septa almost as long and as thick as major ones in the septarium, septal crests in the dissepimentarium usually developed and rudimentary third order septa.

Polythecalis sp. cf. *P. japonica* Yabe & Minato of Hudson 1958, p. 187 (North Irak, *Wentzelella* limestones) has less numerous (SM = 10) septa for the same size. Minor septa are much shorter. Dissepimentarium is narrower with large peripheral vesicles. Columella is very small.

Polythecalis rosiformis Huang, 1932 is known in Iran (Flügel 1963 p.397, Central Elburz, *Pseudoschwagerina* limestone, lower Permian ?; Flügel 1964 p. 420, Central Elburz, Ruteh Limestone, Middle Permian; Gräf 1964 p. 391, Eastern Elburz, age given on p. 383 and tab. 1 as base of Upper Permian = Basleo ?). It is different with its larger size, its wide aseptate zone in the dissepimentarium, the minor and major septa being developed only in the inner dissepimentarium and in the tabularium. It seems widespread: China, Laos, Sumatra (Fontaine 1983).

Polythecalis dupliformis Huang, 1932 was reported from an unknown horizon at Julfa by Ezaki 1991 p. 114. It looks like the present form with its major and minor septa protruding in the tabularium but has larger corallites (dc = 8-10 mm) and a wider tabularium (dt = 4 mm instead of 2 mm for the Soh form).

The nearest form is *Polythecalis (P.) denticulatus* ? Huang, 1932 described by Flügel 1964 from the Ruteh Limestone, Middle Permian of Central Elburz (specimen (62) IA-383a exclusively, pl. 29, fig. 4). It differs from the more typical specimens also described in that paper by the smaller size, the narrower tabularium (dt = 2.2-2.5 mm instead of 3-4 mm; the Chinese specimens have a still wider tabularium), the less numerous septa and the longer minor septa. These features are common with the specimen dealt with here and are perhaps distinctive of a new species.

Distribution.

China, Chihsia limestone, Middle Permian;

Northern Iran, Central Elburz, Ruteh Limestone, Middle Permian;

Central Iran, Soh area, Middle Permian.

III. — CONCLUSIONS

Main conclusions are given in a former joint paper with D.Brice and B. Mistiaen. The Devonian species here described typify a unique level, which is very near or similar to the one cited by Reed 1922 and later by von Schouppé 1965 from Koragh in Chitral. In Afghanistan, the same fauna exists also.

Biostratigraphic conclusions about the sections concerned which have yielded rugose corals are in the following list of localities with the relevant stratigraphic data.

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BIBLIOGRAPHY

BIRENHEIDE R. (1969). — Typen mittel- und oberdevonischer Rugosa aus der Sammlung GOLDFUSS. *Senckenbergiana lethaea* , 50 (1), pp. 37-55, 5 pls., Frankfurt am Main.

BIRENHEIDE R. (1978). — *Rugose Korallen des Devon.* Leitfossilien, K. Krommelbein éd., Vol. 2, VI+265 p., 119 figs., 2 tabl., 21 pls. Borntträger, Berlin-Stuttgart.

BIRENHEIDE R. (1998). — Rugose und tabulate Korallen aus der Bohrung Viersen 1001. *Fortschritte in der Geologie von Rheinland und Westfalen* , 37, pp. 161-213, 1 tabl., 10 pls., Krefeld.

BIRENHEIDE R. & W.-H. LIAO (1985). — Rugose Korallen aus dem Givetium von Tushan, Provinz Guizhou, S-China. 3: Einzelkorallen und einige Koloniebildner. *Senckenbergiana lethaea* , 66 (3-5), pp. 217-267, 1 tabl., 7 pls., Frankfurt am Main.

BOLAND K. (1997). — Caninoid Rugose Corals of the Lower Tournaisian (Hastarian) of Belgium: systematics and evolution. *In* A. Perejón & M. J. Comas-Rengifo, éds., Proceedings of the VII International Symposium on Fossil Cnidaria and Porifera held in Madrid, Spain, 1995. Volume I, pp. 73-84, 5 figs., 2 pls., *Boletín de la Real Sociedad Española de Historia Natural (Sección Geológica)*, 91, Madrid.

BRICE D. (1971). — *Etude paléontologique et stratigraphique du Dévonien de l'Afghanistan.* Notes et mémoires sur le Moyen-Orient, L. Dubertret éd., Vol. 11, 1 vol., 364 p., 19 pls., 64 figs. Museum national d'Histoire Naturelle, Paris.

BRICE D. (1985). — Annexe I Tableau de répartition des principaux genres et espèces de Brachiopodes cités dans le texte. *In* B. Mistiaen, éd., Phénomènes récifaux dans le Dévonien d'Afghanistan (Montagnes Centrales). Analyse et systématique des stromatopores, pp. 333-336, *Société Géologique du Nord, Publication 11*, 1, Lille.

BRICE D., MISTIAEN B. & J.-C. ROHART (1999). — New data on distribution of brachiopods, rugose corals and stromatoporoids in Upper Devonian from central and eastern Iran. Paleobiogeographical implications. *Annales de la Société géologique du Nord* , 7 (2^{e} ser.) (1), pp. 21-33, Lille.

BRICE D. & J.-C. ROHART (1974). — Les Phillipsastraeidae (Rugosa) du Dévonien de Ferques (Boulonnais, France). Première note. Le genre Macgeea Webster, 1889. Nouvelles observations. *Annales de la Société géologique du Nord* , 94 (1), pp. 47-62, 5 figs., 3 tabl., pls. 7-9, Lille.

BULVANKER E. Z. (1958). — Devonskie chetyrechluchevye korally okrain Kuznetskogo basseina. *Vsesoyuznyy Nauchno-Issledovatel'skiy Geologicheskiy Institut (VSEGEI)* , pp. 1-212, 93 pls., Leningrad.

COEN-AUBERT M. (1982). — Rugueux solitaires du Frasnien de la Belgique. *Bulletin de l'Institut royal des sciences naturelles de Belgique, Sciences de la Terre* , 54 (6), pp. 1-65, 3 figs., 1 fig. h.-t, 12 pls., Bruxelles.

COEN-AUBERT M. & T. WRZOLEK (1991). — Redescription of the rugose coral *Macgeea (Rozkowskaella) sandaliformis* (Rozkowska, 1980) from the Upper Frasnian of the Holy Cross Mountains. *Bulletin de l'Institut royal des sciences naturelles de Belgique* , 61, pp. 5-19, 2 figs., 1 tabl., 2 pls., Bruxelles.

COTTON G. (1973). — *The rugose coral genera.* 358 p. Elsevier, Amsterdam.

COTTON G. (1983). — *The rugose coral species.* 278 p. G. Cotton, Blakedown, Kidderminster, United Kingdom.

DUBATOLOV V. N. & N. Y. SPASSKIY (1971). — *Devonskie korally Dzhungaro-Balkhaskhoy provintsiy devona.* Trudy Instituta Geologii i Geofiziki, Sibirskoe Otdelenie, Akademiya Nauk SSSR, Vol. 74, 132 p., 41 pls., Moskva.

ELIAS R. J. (1983). — Late Ordovician solitary rugose corals of the Stony Mountain Formation, southern Manitoba, and its equivalents. *Journal of Paleontology* , 57 (5), pp. 924-956, 19 figs., Tulsa.

EZAKI Y. (1991). — Permian corals from Abadeh and Julfa, Iran, West Tethys. *Journal of the Faculty of Science, Hokkaido University, Series IV: Geology and Mineralogy* , 23 (1), pp. 53-146, 5 text-figs., 27 pls., Sapporo.

EZAKI Y. & M. KATO (1989). — Growth bands in a Permian coral. *In* P. A. Jell & J. W. Pickett, éds., Fossil Cnidaria 5. Proceedings of the Fifth International Symposium on Fossil Cnidaria including Archaeocyatha and Spongiomorphs held in Brisbane, Queensland, Australia, 25-29 July 1988, pp. 83-90, 3 figs., *Memoir of the Association of Australasian Palaeontologists*, 8, Brisbane.

FENTON C. L. & M. A. FENTON (1924). — *The stratigraphy and fauna of the Hackberry Stage of the Upper Devonian.* Contributions from the Museum of Geology, University of Michigan, Vol. 1, XII+260 p., 45 pls., Michigan.

FLÜGEL H. W. (1963). — Korallen aus der oberen Visé-Stufe (*Kueichouphyllum* Zone) Nord-Irans. *Jahrbuch der Geologischen Bundesanstalt* , 106, pp. 365-404, 2 figs., 2 pls., 5 pls. in the text, Wien.

FLÜGEL H. W. (1964). — The Geology of the Upper Djadjerud and Lar Valleys (N-Iran). II. Paleontology. Permian corals from Ruteh Limestone. *Rivista Italiana di Paleontologia* , 70 (3), pp. 403-444, 2 figs., pls. 28-34, Milano.

FLÜGEL H. W. (1970). — *Bibliographie der paläozoischen Anthozoa (Rugosa, Heterocorallia, Tabulata, Heliolitida, Trachypsammiacea).* Vol. I-Bibliographie, 262 p. Österreichischen Akademie der Wissenschaften, Wien.

FLÜGEL H. W. (1970). — *Bibliographie der paläozoischen Anthozoa (Rugosa, Heterocorallia, Tabulata, Heliolitida, Trachypsammiacea).* Vol. II-Index zur Bibliographie, 323 p. Österreichischen Akademie der Wissenschaften, Wien.

FLÜGEL H. W. (1991). — Rugosa aus dem Karbon der Ozbak-Kuh-Gruppe Ost-Irans (Teil 1). *Jahrbuch der Geologischen Bundesanstalt* , 134 (4), pp. 657-688, 35 figs., 6 tabl., 2 pls., Wien.

FLÜGEL H. W. & H. SALEH (1970). — Die paläozoischen Korallenfauna Ost-Irans. 1. Rugose Korallen der Niur-Formation (Silur). *Jahrbuch der Geologisch Bundesanstalt* , 113, pp. 267-302, 5 figs., 4 pls., Wien.

FONTAINE H. (1961). — Les Madréporaires paléozoïques du Viet-Nam, du Laos et du Cambodge. *Archives géologiques du Viet-Nam* , 5, pp. 1-276, 10 figs., 35 pls., Saigon.

FONTAINE H. (1983). — Some Permian corals from the Highland of Padang, Sumatra, Indonesia. *Geological Research and Development Centre, Paleontology Series* , 4, pp. 1-31, 2 figs., 10 pls.

GALLE A. (1984). — Rugosni Korali a biostratigrafie paleozoika ve vrtu Ostravice jizne od Ostravy. *Acta Universitatis Carolinae-Geologica* , 3, pp. 237-249, 1 fig., 1 tabl., 4 pls., Praha.

GALLE A. (1985). — On some Moravian Devonian Rugosa. *Vestnik Ustredniho ustavu geologického* , 60 (4), pp. 241-244, 2 pls., Praha.

GORYANOV V. B. (1961). — Novyy rod rugoz iz srednedevonskich otlozheniy yuzhnoy Fergany. *Paleontologicheskiy Zhurnal* , 1961 (1), pp. 70-74, pl. 8, Moskva.

GRÄF W. (1964). — Permische Korallen aus dem Zagros-Gebirge, dem Elburz und aus Azerbeidjan, Iran. *Senckenbergiana lethaea* , 45 (5), pp. 381-432, 5 figs., 2 tabl., pls. 34-41, Frankfurt am Main.

HALL J. & R. P. Whitfield (1973). — Descriptions of new species of fossils from the Devonian rocks of Iowa, 23rd Annual Report, New York State Cabinet of Natural History, pp. 223-239, pls. 9-12, Weed, Parsons & Co., Albany (N.-Y.).

HILL D. (1981). — *Rugosa and Tabulata.* Treatise on Invertebrate Paleontology, C. Teichert éd., Vol. Part F, Supplement 1, 2 vol., 762 p. The Geological Society of America and The University of Kansas, Lawrence (Kansas).

HILL D. & J. S. JELL (1971 (1970)). — Devonian corals from the Canning Basin, Western Australia. *Geological Survey of Western Australia, Bulletin* , 121, pp. 1-158, t.-figs. 1-4, pls. 1-20.

HUANG T. K. (1932). — Permian Corals of Southern China. *Palaeontologica Sinica, Series B* , 8 (2), pp. 1-163, 11 figs., 16 pls., Peiping (Peking).

HUBMANN B. (1992). — Die Korallenfauna aus dem Devon von Feke (AntiTaurus, SE-Türkei). II. Rugosa. *Geol. Paläont. Mitt. Innsbruck* , 18, pp. 151-169, 9 fig. 5 tabl. 2 pl., Innsbruck.

HUDSON R. G. S. (1958). — Permian corals from northern Iraq. *Palaeontology* , 1 (3), pp. 174-192, 4 text-figs., pls. 32-35, London.

IVANOVSKIY A. B. (1962). — Dva novykh roda siluriyskikh rugoz. *Sibirskogo Nauchno-issled. Inst. Geol. Geofiz. Mineral. Syrya (SNIIGGIMS), Tr.* , 23, pp. 126-130, pl. 1-2, Moskva.

IVANOVSKIY A. B. (1963). — *Rugozy ordovika i silura Sibirskoi platformy.* Trudy Instituta Geologii i Geofiziki, Sibirskoe Otdelenie, Akademiya Nauk SSSR, 158 p., 35 text-figs., 33 pls. Nauka, Moskva.

IVANOVSKIY A. B. (1965). — *Drevneyshie rugozy.* Trudy Instituta Geologii i Geofiziki, Sibirskoe Otdelenie, Akademiya Nauk SSSR, 152 p., 77 figs., 39 pls. Nauka, Moskva.

IVANOVSKIY A. B. (1970). — Stratigraficheskie i paleogeograficheskie compleksi rugoz na Sibirskoy Platforme. *Geol. & Geofiz.* , 1970 (7), pp. 12-18.

IVANOVSKIY A. B. (1975). — *Rugozy.* Trudy Instituta Geologii i Geofiziki, Sibirskoe Otdelenie, Akademiya Nauk SSSR, Vol. 242, 123 p., 85 figs., 9 tabl. Nauka, Moskva.

IVANOVSKIY A. B. (1976). — *Ukazatel' rodov rugoz.* Trudy Instituta Geologii i Geofiziki, Sibirskoe Otdelenie, Akademiya Nauk SSSR, Vol. 217, 255 p., 26 pls. Nauka, Moskva.

IVANOVSKIY A. B. & M. V. SHURYGINA (1980). — Reviziya devonskich Rugoz Urala. *Trudy Paleontologicheskogo Instituta, Akademiya Nauk SSSR* , 186, pp. 1-64, 4 tabl., 10 pls., Moscow.

JOHANNESSEN W. H. (1995). — Species of the Silurian operculate rugose coral genera *Araeopoma* and *Rhytidophyllum*. *Geologiska Föreningens i Stockholm Förhandlingar* , 117 (1 (March)), pp. 31-41, 8 figs., Stockholm.

KULLMANN J. (1965). — Rugose Korallen der Cephalopodenfazies und ihre Verbreitung im Devon des südöstlichen Kantabrischen Gebirges (Nordspanien). *Abhandlungen, Akademie der Wissenschaften und der Literatur in Mainz, mathematisch-naturwissenschaftliche Klasse* , 2, pp. 1-168, figs. 1-21, 7 pls., Mainz.

LE MAÎTRE D. (1938 (1937)). — Etude de la faune corallienne des calcaires givétiens de la Ville-Dé-D'Ardin (Deux-Sèvres). *Bulletin de la Société géologique de France* , 7 (5° sér.), pp. 105-128, pls. 7-10, Paris.

LIN B., S. XU, H. JIA, S. GUO, X. OUYANG, Z. WANG, X. CAO, Y. YAN & H. CHEN (1995). — *Monograph of Palaeozoic Corals - Rugosa and Heterocorallia.* , 778 p., 924 text-figs., 8 pls. Geological Publishing House, Beijing (not seen).

LINDSTRÖM G. (1868). — Om tvennenya öfversilurska koraller från Gotland. *Öfversigt af Kongliga Svenska Vetenskapsakademiens förhandlingar* , 25, (8), pp. 419-428, pl. 6, Stockholm (not seen).

MCCOY F. (1844). — *A synopsis of the characters of the Carboniferous limestone fossils of Ireland.* , I-VIII + 5-207 pp., 29 pls. University Press, Dublin (not seen).

MCLEAN R. A. (1974 (1973)). — The rugose coral genera *Streptelasma* Hall, *Grewingkia* Dybowski and *Calostylis* Lindström from the Lower Silurian of New South Wales. *Proceedings of the Linnean Society of New South Wales* , 99 (Part 1), pp. 36-53, 4 figs., 2 pls., Sydney.

MCLEAN R. A. (1976). — Aspects of the Silurian rugose coral fauna of the Yass region, New South Wales. *Proceedings of the Linnean Society of New South Wales* , 100 (Part 3), pp. 179-194, 6 figs., pl. 18-21, Sydney.

MCLEAN R. A. (1989). — Phillipsastreidae (Rugosa) in the Frasnian of western Canada. *In* P. A. Jell & J. W. Pickett, éds., Fossil Cnidaria 5. Proceedings of the Fifth International Symposium on Fossil Cnidaria including Archaeocyatha and Spongiomorphs held in Brisbane, Queensland, Australia, 25-29 July 1988, pp. 239-249, 2 figs., *Memoir of the Association of Australasian Palaeontologists*, 8, Brisbane.

MCLEAN R. A. (1993). — The Devonian rugose coral family Charactophyllidae PEDDER. *In* P. Oekentorp-Küster, éd., Proceedings of the VI. International Symposium on Fossil Cnidaria and Porifera held in Münster, Germany 9 - 14 September 1991, pp. 109-118, 2 fig., *Courier Forschungsinstitut Senckenberg*, 164, Frankfurt am Main.

MCLEAN R. A. & A. E. H. PEDDER (1984). — Frasnian rugose corals of western Canada. Part 1: Chonophyllidae and Kyphophyllidae. *Palaeontographica. Abt. A* , 185 (1-3), pp. 1-38, 13 pls., 10 text-figs., Stuttgart.

MISTIAEN B. (1985). — *Phénomènes récifaux dans le Dévonien d'Afghanistan (Montagnes Centrales). Analyse et systématique des stromatopores.* Société Géologique du Nord, Publication, Vol. 11, vol. 1, 381 p., 137 figs., 5 pls., 5 annexes, Lille.

NELSON S. J. (1981). — Solitary streptelasmatid corals, Ordovician of northern Hudson Bay Lowland, Manitoba, Canada. *Palaeontographica. Abt. A* , 172 (1-3), pp. 1-71, 48 figs., 3 tabl., 8 pls., Stuttgart.

NEUMAN B. E. E. (1969). — Upper Ordovician streptelasmatid corals from Scandinavia. *Bulletin of the Geological Institutions of the University of Uppsala, new series* , 1, pp. 1-73, 59 figs., 3 pls., Uppsala.

PEDDER A. E. H. (1973). — Description and biostratigraphical significance of the Devonian coral genera *Alaiophyllum* and *Grypophyllum*. *Geological Survey of Canada, Bulletin* , 202, pp. 93-127, text-figs. 31-58, pls. 11-15, Ottawa.

PEDDER A. E. H. (1982). — *Chostophyllum*, a new genus of charactophyllid corals from the Middle Devonian of western Canada. *Journal of Paleontology* , 56 (3), pp. 559-582, 7 fig., 4 pl., Tulsa.

PENECKE K. A. (1904). — Das Sammelergebnis Dr. Franz Schaffer's aus dem Oberdevon von Hadschin in Antitaurus. *Jahrbuch der kaiserlich-königlichen geologischen Reichsanstalt*, pp. 141-152, pls. 4-7, Wien.

PICKETT J. W. (1967). — Untersuchungen zu Familie Phillipsastreidae (Zoantharia rugosa). *Senckenbergiana lethaea* , 48 (1), pp. 1-89, 1 tabl., 19 figs., 7 pls., Frankfurt am Main.

POTY E. & K. BOLAND (1996 (1994)). — Révision des Tétracoralliaires caninomorphes de l'Hastarien (Tournaisien) belge. *Annales de la Société géologique de Belgique* , 117 (1), pp. 201-225, 4 figs., 5 pls.

REED F. R. C. (1922). — Devonian fossils from the Chitral and the Pamirs. *Palaeontologica Indica (n. s.)* , 6 (2), pp. 1-134, 16 pls., Calcutta.

ROHART J.-C. (1988). — Rugueux givétiens et frasniens de Ferques (Boulonnais-France). *In* D. Brice, éd., Le Dévonien de Ferques, Bas-Boulonnais (N. France), pp. 231-296, 1 fig., 2 tabl., pls. 28-36, *Biostratigraphie du Paléozoïque* (P. R. Racheboeuf, édit.), 7, Université de Bretagne Occidentale, Brest.

ROZKOWSKA M. (1960). — Blastogeny and individual variation in tetracoral colonies from the Devonian of Poland. *Acta Palaeontologica Polonica* , 5 (1), pp. 3-55, 43 figs., Warszawa.

ROZKOWSKA M. (1980 (1979)). — Contributions to the Frasnian Tetracorals from Poland. *Palaeontologia Polonica* , 40, pp. 3-56, 12 figs., 1 tabl., pls. 1-10, Warszawa-Krakow.

ROZKOWSKA M. & J. FEDOROWSKI (1972). — Genus *Disphyllum* de Fromentel (Rugosa) in the Devonian of Poland and its distribution. *Acta Palaeontologica Polonica* , 17 (3), pp. 265-340, 28 figs., 11 pls., Warszawa.

SALÉE A. (1913). — Formes nouvelles du genre "*Caninia*". *Bulletin de la Société belge de géologie, de paléontologie et d'hydrologie*, 26(1912), pp. 41-49, pls. A-D, Bruxelles.

SCHOUPPÉ A. V. (1965). — Die Mittel- bis Oberdevonische Korallenfauna von Kuragh (Chitral). *In* A. Amuot, R. Ciry, N. Fantini Sestini, I. Premoli Silva, C. Rossi Ronchetti, P. Sartenaer, A. Vandercammen, A. v. Schouppé & C. Z. Buri, éds., Fossils of the Karakorum and Chitral.- Italian Expeditions to the Karakorum (K2) and Hindu Kush. Prof. A. Desio leader, Scientific Reports IV- Paleontology- Zoology- Botany, pp. 13-53, 6 figs., 3 pls., 1, Leiden.

SCHRÖDER S. (1997). — Die Rugosen-Fauna des Eilenbergium der Dollendorfer Mulde (Mittel-Devon/Ober-Eifelium; Rheinisches Schiefergebirge/Eifel). *Geologica et Palæontologica* , 31, pp. 1-36, 7 figs., 2 tabl., pls. 1-3, Marburg.

SCHRÖDER S. (1997). — Zur Kenntnis der Gattung *Wapitiphyllum* McLEAN & PEDDER 1984 aus dem Devon der Bergisch Gladbach-Paffrather Mulde (Rheinisches Schiefergebirge/Bergisches Land). *Geologisches Institut der Universität zu Köln* , 114 (Festschrift Eugen K. Kempf), pp. 409-425, pls. 1-3, Köln.

SORAUF J. E. (1994). — *Hexagonaria* and the Hexagonariinae (Disphyllidae, Rugosa): Devonian colonial corals. *In* E. Landing, éd., Studies in Stratigraphy and Paleontology in Honor of Donald W. Fisher, pp. 323-338, pls. 1-5, 481, New York State Museum Bulletin, New York.

SORAUF J. E. (1998). — Frasnian (Upper Devonian) rugose corals from the Lime Creek and Shell Rock Formations of Iowa. *Bulletin of American Paleontology* , 113 (355), pp. 7-159, 48 text-figs., pls. 1-56, Ithaca, New York.

SOSHKINA E. D. (1939). — Verchnedevonskie Rugosa Urala. *Trudy Paleontologicheskogo Instituta, Akademiya Nauk SSSR* , 9 (2), pp. 1-88, 14 pls., Moscou-Leningrad.

SOSHKINA E. D. (1951). — *Podznedevonskie korally rugosa, ich sistematika i evolutija.* Trudy Paleontologicheskogo Instituta, Akademiya Nauk SSSR, Vol. 34, 121 p., 42 figs., 24 pls., Moskva-Leningrad.

SOSHKINA E. D. (1952). — *Opredelitel devonskich chetyrechluchevych korallov.* Trudy Paleontologicheskogo Instituta, Akademiya Nauk SSSR, Vol. 39, 178 p., 122 figs., 49 pls. Nauka, Moskva.

STÖCKLIN J., J. EFTEKHAR-NEZHAD & A. HOUSHMAND-ZADEH (1965). — *Geology of the Shotori Range (Tabas area, East Iran).* Geological Survey of Iran Report, Vol. 3, 69 p., 33 figs., Tehran.

STRELNIKOV S. I. (1965). — Ordovikskie i siluriyskie rugozy ostrovov Vaygach i Dolgogo. *Uchenye Zapiski nauchno-issledovatel'skiy Institut geologii Arktiki (Paleontologiya i Biostratigrafiya)* , 8, pp. 24-56, 2 tabl., 7 pls., Leningrad.

SUN Y. C. (1958). — The Upper Devonian coral faunas of Hunan. *Palaeontologica Sinica* , 144 (n. s. B, 8), pp. 1-28, pls. 1-12.

TOURNEUR F., C. BABIN, F. BIGEY, F. BOULVAIN, D. BRICE, M. COEN-AUBERT, R. DREESEN, M. DUSAR, M. LOBOZIAK, W. LOY & M. STREEL (1989 (1988)). — Le Dévonien du sondage de Nieuwkerke (Flandre Occidentale, Belgique - extrémité occidentale du Synclinorium de Namur). *Annales de la Société géologique du Nord* , 108, pp. 85-112, 7 figs., 2 tabl., pls. 1-5, Lille.

TSIEN H. H. (1970). — Espèces du genre *Disphyllum* (Rugosa) dans le Dévonien moyen et le Frasnien de la Belgique. *Annales de la Société géologique de Belgique* , 93 (2), pp. 159-182, figs. 1-25, Liège.

TSYGANKO V. S. (1981). — Devonskie rugozy Severa Urala. *A. N. S.S.S.R., Komi Filial, Institut Geologii* , pp. 1-166, 2 figs., 1 tabl., 58 pls., Leningrad.

WALTHER C. (1928). — Untersuchungen über die Mitteldevon-Oberdevongrenze. *Zeitschrift der deutschen geologischen Gesellschaft* , 80 (2), pp. 97-152, 34 figs., Berlin.

WANG X.-D. (1993). — On internal growth lines in rugose corals -with an example of *Kepingophyllum aksuense* Wu et Zhou from early Permian in Xinjiang. *Acta Palaeontologica Sinica* , 32 (3), pp. 346-354, 5 figs., 3 pls., Nanjing.

WEYER D. (1973). — Über *Protozaphrentis* YÜ, 1957 (Anthozoa Rugosa, Karbon). *Paläontologische Abhandlungen. Abteilung A* , 4 (4), pp. 695-706, 6 figs., Berlin.

WEYER D. (1974). — Zur Kenntnis von *Rhegmaphyllum* WEDEKIND, 1927 (Anthozoa, Rugosa; baltoskandisches Silur). *Zeitschrift für geologische Wissenschaften* , 2 (2), pp. 157-183, 1 fig., 7 pls., Berlin.

WEYER D. (1996). — Calceolidae versus Goniophyllidae (Anthozoa, Rugosa; Silur-Devon). *Abhandlungen und Berichte für Naturkunde* , 19, pp. 69-71, Magdeburg.

WEYER D. (1997). — Hyposepta and diplosepta in the septal apparatus of Rugosa. *In* A. Perejón & M. J. Comas-Rengifo, éds., Proceedings of the VII International Symposium on Fossil Cnidaria and Porifera held in Madrid, Spain, 1995. Volume I, pp. 37-52, 4 figs., 2 tabl., 2 pls., *Boletín de la Real Sociedad Española de Historia Natural (Sección Geológica)*, 91, Madrid.

WRZOLEK T. (1992). — Rugose corals from the Devonian Kowala Formation of the Holy Cross Mountains. *Acta Palaeontologica Polonica* , 37 (2-4), pp. 217-254, 23 figs., 2 tabl., Warszawa.

YOH S.-S. (1937). — Die Korallenfauna des Mitteldevons aus der Provinz Kwangsi, Südchina. *Palaeontographica Abt. A* , 87 (1-2), pp. 45-76, pls. 4-9, Stuttgart.

EXPLANATION OF THE PLATES VI TO X

PLATE VI

Fig. 1. — *Araeopoma* nov. sp. GFCL 3915, loc. 6.

1a : upper transverse section T3 with two sides preserved in the matrix, on the left and the bottom of the figure (x5);

1b : lower transverse section T2, taken 8 mm below T3 (x5);

1c : longitudinal section L1 (x5);

1d : longitudinal section L2 (x5) ;

1e : longitudinal section L1 (x30), also figured on text-fig. 1, showing the rhabdacanthine structure at the base of both trabeculae and at the top of the upper one.

1a : lame transversale supérieure T3 avec deux côtés conservés dans la matrice, à gauche et en bas de la figure (x5) ;

1b : lame transversale inférieure T2, prise 8 mm sous T3 (x5) ;

1c : lame longitudinale L1 (x5);

1d : lame longitudinale L2 (x5) ;

1e : lame longitudinale L1 (x30), aussi illustrée sur la text-fig. 1, montrant la structure rhabdacanthinée à la base des deux trabécules et en haut de la trabécule supérieure.

Fig. 2-4 - *Axolasma* nov. sp. GFCL 3916, loc. 6 (fig. 2a, 2b) ; GFCL 3917, loc. 6 (fig. 3a, 3b) ; GFCL 3918, loc. 6 (fig. 4).

2a : transverse section T1 through the base of the calice, with the depressed fossula filled by sediment as is the peripheral part of the last tabula and the twisted axial

ends of major septa (x3) ; 2b : transverse section T2 five mm lower than 2a (x3) ;

3a : transverse section T1 through the base of the calice, taken 18 mm above T4 (x3) ;

3b : transverse section T3, taken 12 mm above T4 (x3) ;

3c : transverse section T4 (x3) ;

Longitudinal section through the edge of the calice with septal formations laying on the tabulae, including the last one (x3);

2a : lame transversale T1 à travers la base du calice, avec la fossule déprimée remplie de sédiment de même que la partie périphérique du dernier plancher et avec les extrémités tordues des septes majeurs (x3) ;

2b : lame transversale T2 prise 5 mm sous 2a (x3) ;

3a : lame transversale T1 à travers la base du calice, prise 18 mm au-dessus de T4 (x3) ;

3b : lame transversale T3, prise 12 mm au-dessus de T4 (x3);

3c : lame transversale T4 (x3) ;

Lame longitudinale à travers la base du calice avec les formations septales reposant sur les planchers, y compris le dernier (x3).

Fig. 5-9. — *Disphyllum* sp. 1. : GFCL 3919, loc. 2 (fig. 5) ; GFCL 3920, loc. 5 (fig. 6) ; GFCL 3921, loc. 2 (fig. 7) ; GFCL 3922, loc. 2 (fig. 8) ; GFCL 3923, loc. 4 (fig. 9).

5 : transverse section (x3) ;

6 : transverse section (x3) through a corallite with thin septa and another of the same colony with the partly developed stereozone ;

7a : transverse section through a typical specimen with short septa and a ring of stereoplasm between dissepimentarium and tabularium (x3) ;

7b : longitudinal section with the very regular tabularium (x3) ;

8a : transverse section (x3) ;

8b : longitudinal section (x3) ;

8c : detail of the longitudinal section (x9) ;

8d :detail of the transverse section (x9) ;

9 : transverse section through a well preserved colony (x3);

5 : lame transversale (x3) ;

6 : lame transversale (x3) dans un corallite aux septes minces et à travers un autre de la même colonie avec la stéréozone partiellement développée;

7a : lame transversale dans un specimen typique avec les septes courts et un anneau de stéréoplasme entre le dissepimentarium et le tabularium (x3) ,

7b : lame longitudinale avec le tabularium très régulier (x3) ;

8a : lame transversale (x3) ;

8b : lame longitudinale (x3) ;

8c : détail de la lame longitudinale (x9) ;

8d : détail de la lame transversale (x9) ;

9 : lame transversale dans une colonie bien conservée (x3).

PLATE VII

Fig. 1-4. — *Disphyllum caespitosum tricyclicum* von Schouppé, 1965. GFCL 3924, loc. 5 (fig. 1) ; GFCL 3925, loc. 5 (fig. 2) ; GFCL 3926, loc. 5 (fig. 3) ; GFCL 3927, loc. 5 (fig.4).

1a : transverse section through a specimen looking like *D. lazutkini* Bulvanker (x3) ;

1b : longitudinal section (x3) ;

2a : transverse section T1 (x3) ;

2b : longitudinal section (x3) ;

2c : transverse section T4, also figured in text-fig. 2a, with the dual aspect of the septa of third order : low eminences on the inner edge of the wall or plates with just a black median line (x11) ;

3a : transverse section T4 (x3) ;

3b : a detail of the transverse section T1, also figured in text-fig. 2d (x9);

3c : a detail of the transverse section T2, also figured in text-fig. 2b (x11) ;

4a : transverse section (x3) ;

4b : longitudinal section (x3) ;

1a : lame transversale dans un specimen qui ressemble à D. lazutkini *Bulvanker (x3) ;*

1b : lame longitudinale (x3) ;

2a : lame transversale T1 (x3) ;

2b : lame longitudinale (x3) ;

2c : lame transversale T4, aussi illustrée sur la text-fig. 2a, avec le double aspect des septes de troisième ordre : saillies modestes sur le bord interne de la muraille ou plaques avec seulement une ligne noire médiane (x11) ;

3a : lame transversale T4 (x3) ;

3b : détail de la lame transversale T1, aussi illustrée sur la text-fig. 2d (x9);

3c : détail de la lame transversale T2, aussi illustrée sur la text-fig. 2b (x11) ;

4a : lame transversale(x3) ;

4b : lame longitudinale (x3).

Fig. 5-6 - *Hexagonaria* cf *magna* (Fenton & Fenton, 1924), *sensu* Brice, 1971. GFCL 3928, loc. 8 (fig. 5); GFCL 3929, loc. 2 (fig. 6) ;

5a : transverse section (x3) ;

5b : longitudinal section (x3) ;

6a : transverse section (x3) ;

6b : longitudinal section (x3) ;

5a : lame transversale(x3) ;

5b : lame longitudinale(x3) ;

6a : lame transversale(x3) ;

6b : lame longitudinale(x3).

PLATE VIII

Fig. 1-2. — *Hexagonaria* cf *taurensis* (Hubmann, 1992). GFCL 3930, loc. 2 (fig. 1) ; GFCL 3931, loc. 4 (fig. 2);
1a : transverse section through a typical colony (x3) ;
1b : longitudinal section L2 (x3) ;
1c : longitudinal section L1 (x3) ;
2a : transverse section through a colony with smaller corallites (x3) ;
2b : longitudinal section (x3) ;

1a : lame transversale dans une colonie typique (x3) ;
1b : lame longitudinale L2 (x3) ;
1c : lame longitudinale L1 (x3) ;
2a : lame transversale dans une colonie à corallites plus petits (x3) ;
2b : lame longitudinale (x3).

Fig. 3. — *Cystihexagonaria* ex. gr. *hexagona* (Goldfuss, 1826) *sensu* Brice, 1971. GFCL 3932, loc. 2;
3a : transverse section T1 (x3) ;
3b : longitudinal section L2 (x3) ;
3c : detail in the same section L2 with thick septa showing strong trabeculae of the type usually seen in *Hexagonaria* (x9) ;
3d : detail in the longitudinal section L4 (x9), also figured in text-fig. 3b;
3e : detail in the longitudinal section L5 (x9);
3a : lame transversale T1 (x3) ;
3b : lame longitudinale L2 (x3) ;
3c : détail de la même lame L2 avec des septes épais montrant des fortes trabécules du type habituellement rencontré chez Hexagonaria (x9) ;
3d : détail dans la lame longitudinale L4 (x9), également illustrée sur la text-fig. 3b;
3e : détail de la lame longitudinale L5 (x9).

Fig. 4-5. — *Temnophyllum lapparenti* nov. sp. GFCL 3933, loc. 2 (fig. 4) ; GFCL 3934, loc. 2 (fig. 5) ;
HOLOTYPE ; 4a : transverse section T3 cut 5 mm below the calice (x3) ;
4b : transverse section T2 cut 9 mm below the calice (x3) ;
4c : transverse section T1 cut 11 mm below the calice with long and thin major septa united together in the center (x3) ;
4d : longitudinal section with a rejuvenescence (x3);
PARATYPE A; 5a : transverse section T2 (x3);
5b : transverse section T1 (x3);

HOLOTYPE ; 4a : lame transversale T3 prise 5 mm sous le calice (x3) ;
4b : lame transversale T2 prise 9 mm sous le calice (x3) ;
4c : lame transversale T1 prise 11 mm sous le calice avec les septes majeurs longs et réunis au centre (x3) ;
4d : lame longitudinale avec un rajeunissement (x3).
PARATYPE A; 5a : lame transversale T2 (x3);
5b : lame transversale T1 (x3).

PLATE IX

Fig. 1-2. — *Temnophyllum lapparenti* nov. sp. GFCL 3935, loc. 2 (fig. 1) ; GFCL 3936, loc. 2 (fig. 2) ;
PARATYPE B; 1a : transverse section (x3) ;
1b : longitudinal section (x3) ;
1c : detail in the same section (x9) showing the charactophylloid trabeculae at the edge of the calice;
PARATYPE C, also figured on text-fig. 4a-b;
2a : transverse section (x3) ;
2b : detail in the same section (x9) showing the fine structure of septa with their clear axial plane and their long fibers;

PARATYPE B; 1a : lame transversale (x3) ;
1b : lame longitudinale (x3) ;
1c : détail de la même lame (x9) montrant les trabécules charactophylloïdes au bord du calice;
PARATYPE C, également illustré sur la text-fig. 4a-b;
2a : lame transversale (x3) ;
2b : détail de la même lame (x9) montrant la structure fine des septes avec leur plan axial clair et leurs longues fibres.

Fig. 3-4. — *Sinodisphyllum* sp. GFCL 3937, loc. 5 (fig. 3); GFCL 3938, loc. 5 (fig. 4) ;
3a : transverse section (x2), detail is figured on pl. X, fig. 5;
3b : longitudinal section (x2) ;
3c : detail of the same section (x9) showing strong trabeculae with very divergent fibers and , in the bottom of the figure, periodic growth which results in successive dark bundles;
4a : transverse section T2 taken 30 mm above T5 (x3) ;
4b : transverse section T3 taken 22 mm above T5 (x3) ;
4c : transverse section T4 taken 8 mm above T5 (x3) ;
4d : transverse section T5 through the juvenile stage laid on a stromatoporoid (x3);

3a : lame transversale (x2), dont un détail est figuré sur la pl. X, fig. 5 ;
3b : lame longitudinale (x2) ;
3c : détail de la même lame (x9) montrant les fortes trabécules aux fibres très divergentes et, en bas de la figure, les bouquets sombres superposés qui résultent de la croissance périodique;
4a : lame transversale T2 prise 30 mm au-dessus de T5 (x3) ;
4b : lame transversale T3 prise 22 mm au-dessus de T5 (x3) ;
4c : lame transversale T4 prise 8 mm au-dessus de T5 (x3) ;
4d : lame transversale T5 à travers un stade jeune qui repose sur un stromatopore (x3).

Fig. 5. — *Macgeea multizonata* (Reed, 1922). GFCL 3939, loc. 5;
5a : transverse section (x3) ;

5b : longitudinal section (x3) ;

5a : lame transversale (x3) ;
5b : lame longitudinale (x3).

Fig. 6-7. — *Macgeea desioi* von Schouppé, 1965. GFCL 3940, loc. 5 (fig. 6) ; GFCL 3941, loc. 5 (fig. 7) ;

6a : transverse section (x3) ;

6b : longitudinal section (x3) ;

7a : transverse section (x3) ;

7b : longitudinal section through the calice (x3) ;

6a : lame transversale (x3) ;
6b : lame longitudinale (x3) ;
7a : lame transversale (x3) ;
7b : lame longitudinale dans le calice (x3).

PLATE X

Fig. 1-2. — *Peneckiella?* cf *cylindrica* (Yoh S-S., 1937). GFCL 3942, loc. 2 (fig. 1) ; GFCL 3943, loc. 2 (fig. 2) ;

1a : transverse section taken above a bud (x3) ;

1b : longitudinal section L1 (x3);

1c : detail of the same section (x9) showing various types of dissepiments and two complete fans of rhipidacanths;

1d : longitudinal section L2 (counterpart of L1) with the still incomplete dividing wall between the bud and the parent corallite (x3); the complex dissepimentarium is visible well above the bud and also on the opposite side;

2a : longitudinal section partly eroded in the middle of the left side (x3);

2b : transverse section (x3) ;

2c : detail of the same section through a widened part of the dissepimentarium (x9);

2d : detail of the longitudinal section, through a partly eroded dissepimentarium on the left and through a complete part of it on the right side (x9);

1a : lame transversale prise au-dessus d'un bourgeon (x3) ;

1b : lame longitudinale L1 (x3);

1c : détail de la même lame (x9) montrant divers types de dissépiments et deux éventails complets de rhipidacanthes ;

1d : lame longitudinale L2 (contrepartie de L1) avec la muraille de division encore incomplète entre le bourgeon et le corallite parent (x3); le dissépimentarium complexe est visible bien au-dessus du bourgeon et aussi de l'autre côté;

2a : lame longitudinale partiellement érodée au milieu du côté gauche (x3);

2b : lame transversale (x3) ;

2c : détail de la même lame dans une région élargie du dissépimentarium (x9);

2d : détail de la lame longitudinale dans laquelle le dissépimentarium est partiellement érodé à gauche mais il est complet à droite (x9).

Fig. 3. — *Siphonophyllia cylindrica cylindrica* McCoy, 1844. GFCL 3944, loc. 5;

3a : transverse section (x1.5) ;

3b : longitudinal section following the C-K plane, cardinal side on the left (x1.5);

3a : lame transversale (x1.5) ;

3b : lame longitudinale selon le plan C-K, le côté cardinal est à gauche (x1.5).

Fig. 4. — *Polythecalis* cf *denticulatus* (Huang, 1932). GFCL 3945, loc. 10 ;

4a : transverse section (x3) ;

4b : longitudinal section L2 (x3);

4c : detail of the transverse section (x9);

4d : longitudinal section L1 with the columella in an obliquely cut corallite (x3);

4a : lame transversale (x3) ;

4b : lame longitudinale L2 (x3);

4c : détail de la lame transversale (x9);

4d : lame longitudinale L1 avec la columelle dans un corallite coupé obliquement (x3).

Fig. 5. — *Sinodisphyllum* sp. GFCL 3937, loc. 5;

Detail of the transverse section T3 (x9), also figured on pl. IX, fig. 3a, with strong trabeculae which have clear centers and are larger in the stereozone and the major septa;

Détail de la lame transversale T3 (x9), également illustrée sur la pl. IX, fig. 3a, avec des fortes trabécules qui ont des centres clairs et qui sont plus grandes dans la stéréozone et dans les septes majeurs.

ANNEXE

LIST OF RUGOSE CORALS LOCALITIES

The materiel studied in this paper includes the three following collections:

* 1 - faunas collected by de Lapparent at the beginning of the seventies and never published, proceeding from **Bidu** area (Kerman Province)

* 2 - and from **Tabas** area (Khorasan Province), same date and collector;

* 3 - faunas collected by M. Zahedi from section and outcrops situated in **Soh** area (Esfahan Province).

Loc. 1 - Hutk section, 25 km NNW of Kerman, (Bidu area, Kerman Province, eastern Iran). Collection de Lapparent 1972 and 1973

- " 6- limestones, sandstones and marls " (sample I-H73-6). Brachiopod biozone 8, with *Ripidiorhynchus elburzensis* (Gaetani, 1965), Middle? Frasnian.

Cystihexagonaria ex. gr. *hexagona* (Goldfuss, 1826) *sensu* Brice, 1971

Loc. 2 - Bidu River S: this section is situated about 60 km North of Kerman, in the vicinity of Bidu village (Bidu area, Kerman Province, eastern Iran). Collection A. F. de Lapparent 1972 and 1973.

- coralligenous marls and limestones (samples I-BR). Bahram Formation. Brachiopod biozone 6, with *Cyphoterorhynchus khoragensis* (Reed, 1922), Lower to Middle Frasnian.

Disphyllum sp 1

Peneckiella? cf *cylindrica* (Yoh, 1937)

Temnophyllum lapparenti n. sp.

Hexagonaria cf *magna* (Fenton & Fenton,1924) *sensu* Brice, 1971

Cystihexagonaria ex. gr. *hexagona* (Goldfuss, 1826) *sensu* Brice, 1971

Hexagonaria cf *taurensis* (Hubmann, 1992)

Loc. 3 - Ab-Bid North section, about 70 km N of Kerman, and about 10 km N of Bidu village (Bidu area, Kerman Province, eastern Iran). Collection de Lapparent 1973.

- reefal level with corals and numerous stromatoporoids near the bottom, (samples I-AB.BR 1 ; I-AB.BR 1s). Brachiopod biozone 6, with *Cyphoterorhynchus khoragensis* (Reed, 1922), Lower to Middle Frasnian.

Hexagonaria undetermined

Loc. 4 - Band-e Anar section, approximatively 10 km W of Ravar (Ravar area, Kerman Province, eastern Iran). Collection de Lapparent 1973.

- level with fish, (sample I-RP). The age is here deduced from the coral fauna which, in other localities, is in the Brachiopod biozone 6, with *Cyphoterorhynchus khoragensis* (Reed, 1922), Lower to Middle Frasnian.

Disphyllum sp 1

Hexagonaria cf *taurensis* (Hubmann, 1992)

Loc. 5 - Howz-e-Dorah section, about 35 km SE of Tabas, (Tabas area, Khorasan Province, eastern Iran). Collection de Lapparent 1969.

- " 5 - limestones and marls (one quartzite bed) with spiriferid, rhynchonellid (" *Rhynchonella* " *cuboides* ?), brachiopods and numerous coral samples " (samples I-Ta 5 = I-Ta Fr). Shishtu Formation. Brachiopod biozone 6, with *Cyphoterorhynchus khoragensis* (Reed, 1922) and *Uchtospirifer multiplicatus* Brice, 1971, Lower to Middle Frasnian.

Disphyllum caespitosum tricyclicum von Schouppé, 1965

Macgeea desioi von Schouppé, 1965

Macgeea multizonata (Reed, 1922)

Sinodisphyllum sp.

- " 11 - marly limestones with productid, spiriferid and rhynchonellid brachiopods " (sample I-Ta 11). Shishtu Formation.

Siphonophyllia cylindrica cylindrica McCoy, 1844

This bed is may be the same as or, more probably, inferior to the one from which Flügel got a rugose coral identified later (Flügel 1991, p. 677) as *Siphonophyllia cylindrica cylindrica*. No certitude exists since the correspondance between the fossil numbers of Flügel and the bed numbers of Stöcklin *et al.* 1965, p. 11 is not published and since the correspondance between the bed numbers of Stöcklin and those of de Lapparent has only been partly established. The bed n° 11 of de Lapparent is situated inside the interval 27-32 of Stöcklin, above the " cephalopods beds " and under the well-bedded limestones (n° 12 of de Lapparent = n° 33 of Stöcklin). The most probable correspondance is with the beds 30 and 32 of Stöcklin owing to the abundance of Brachiopods and corals noticed by both observers.

Loc. 6 - Dohaneh Kolut valley, north of Shirgesht (alternative spellings: Dahanet Kolut, Dahan-e Kolut, Chirgecht); Derenjal Mountains (Tabas area, Khorasan Province, eastern Iran). Collection de Lapparent 1969. Niur Formation.

-" 6 - level with *Spirifer irbitensis* " (sample I-Ch 6). De Lapparent gave the following indication (unpublished field-notes) : " black limestones and marls and with small Spiriferids, small Productellids, corals; make a lens only on the western bank [of the valley] ". Brachiopods were examined by D. Brice who writes: " there are numerous small Spiriferids attributed to *Howellella* aff *sarytchumyshensis* Zinchenko, 1960, similar to, although smaller than those present at Khanuk (Kerman Province, eastern Iran) in beds attributed to middle Silurian (Wenlock ?) " (personal communication).

Araeopoma sp. nov.

-" 8 - upper Bryozoa horizon " (sample I-Ch 8b). De Lapparent gave the following indication (unpublished field-notes) : " sandstones, marls and limestones with corals: *Zaphrentis*, colonial corals, Bryozoa, Brachiopods ". *Zaphrentis* was here just employed as a morphological term for curved solitary coral. In the available collection, there is no rugose colonial coral but a Favositid and a Michelinid?. Following to Brice, " Brachiopod fauna is different from the above cited one. They are not abundant : two smooth Spiriferids, one Rhynchonellid (cf *Stegerhynchus* ex. gr. *praecursor*). The Silurian age is certain. " (personal communication)

Axolasma sp. nov.

The section of Dahan-e Kolut is the reference section of the Niur Formation at Shirgesht, not the type section which is northernmost, at Niur, in the Ozbakh-Kuh (= Ozbak Mountains). De Lapparent gave no indication on which bank of the valley he gathered the corals,but his sketch of the section represents the western bank of the valley. Moreover, on this sketch, no mention is made of tectonics so that a precise stratigraphic position of these two corals levels is not possible.

From this section, Flügel & Saleh 1970 described the rugose fauna and found two different assemblages: a lower " faunal-zone " with *Streptelasma, Grewingkia, Schlotheimophyllum, Tenuiphyllum, Paliphyllum* and an upper " faunal-zone " with *Microconoplasma, Cystiphyllum (Holmophyllum),Gyalophyllum (Gyalophyllum), Gyalophyllum (Coronoruga), Loyolophyllum, Strombodes (Kyphophyllum), Spongophylloides (Spongophylloides), Phaulactis* and *Holacanthia*. Obviously, the sample I-Ch 8 represents part of the lower fauna since *Axolasma* looks like *Streptelasma*.

Loc. 7 to 10 - Soh area (Esfahan Province, central Iran). Collection Zahedi. Localities are dispersed in a small region in the neighbourhood of the main section described by Zahedi.

Loc. 7 - Soh area (Esfahan Province, central Iran). Collection Zahedi

I-Z111: *Macgeea multizonata* (Reed, 1922). Brachiopods of the Brachiopod biozone 6 are poorly represented in this collection.

Loc. 8 - Soh area (Esfahan Province, central Iran). Collection Zahedi

I-Z 173: *Hexagonaria* cf *magna* (Fenton & Fenton,1924) *sensu* Brice, 1971

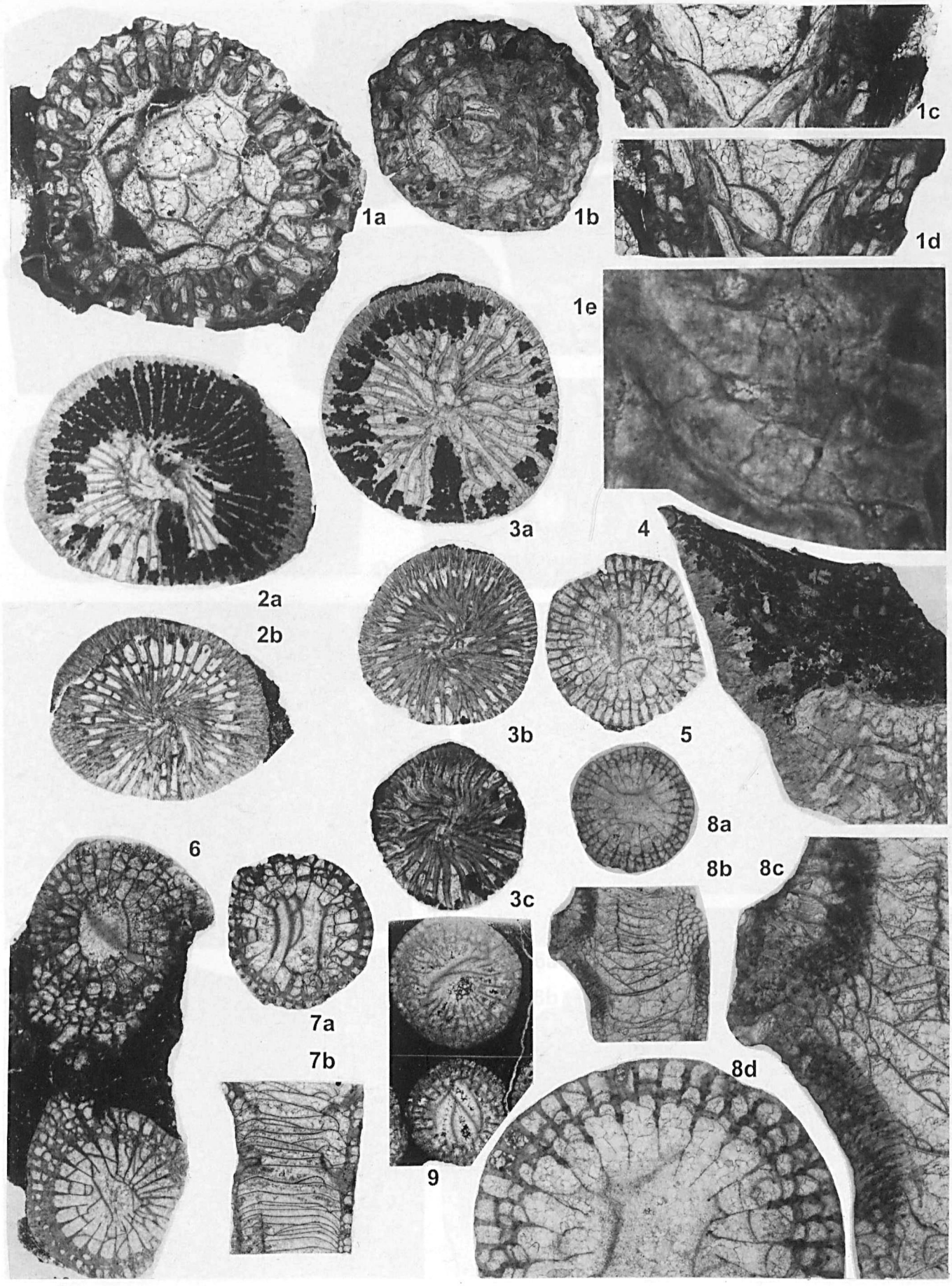
Loc. 9 - Soh area (Esfahan Province, central Iran). Collection Zahedi

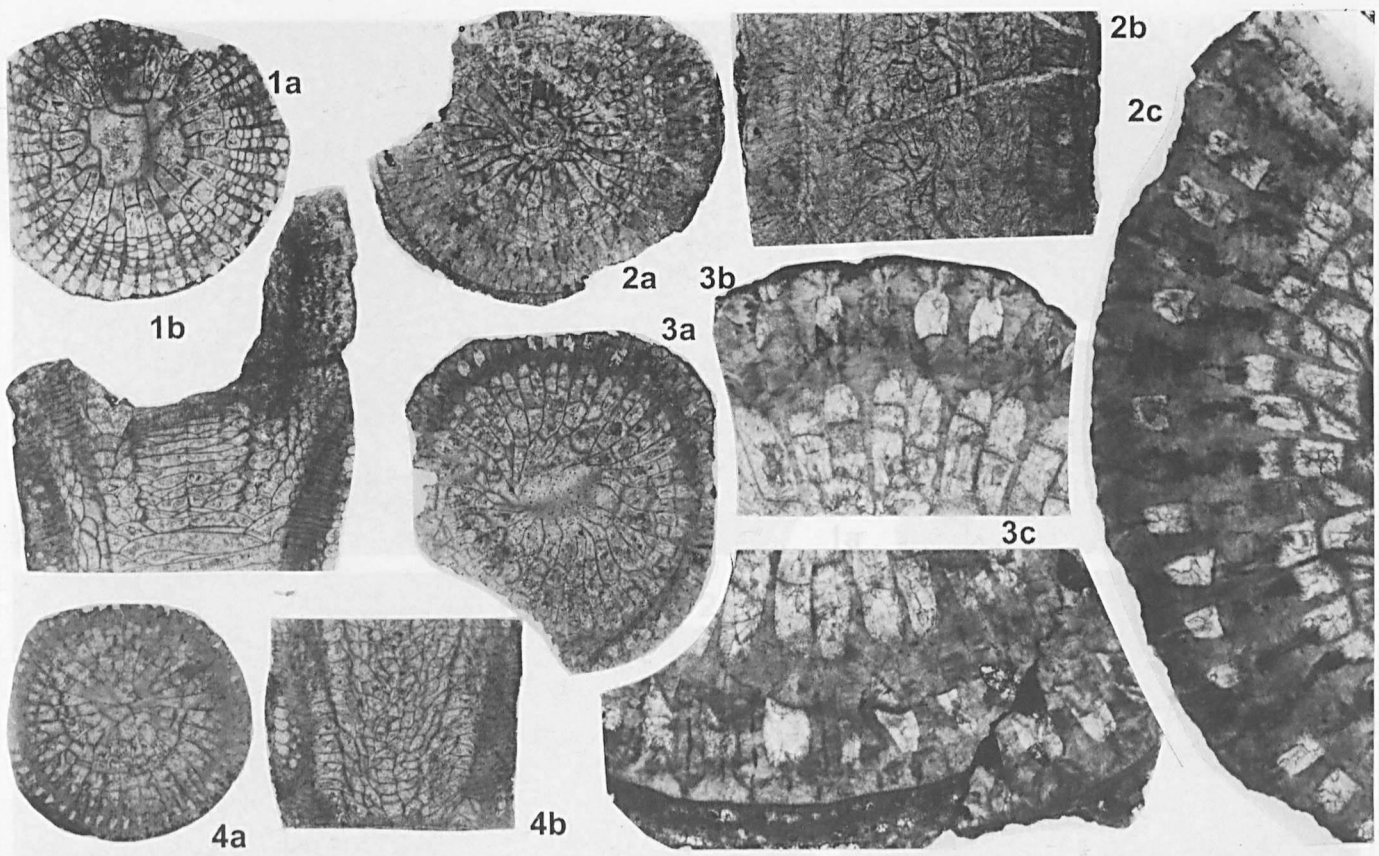
I-Z 176: *Sinodisphyllum* sp.

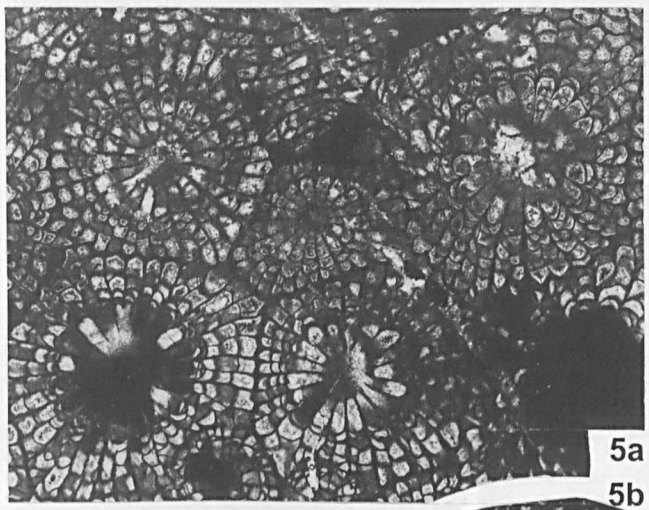
These corals are usually associated with the Brachiopod biozone 6, with *Cyphoterorhynchus khoragensis* (Reed, 1922) and *Uchtospirifer multiplicatus* Brice, 1971, Lower to Middle Frasnian.

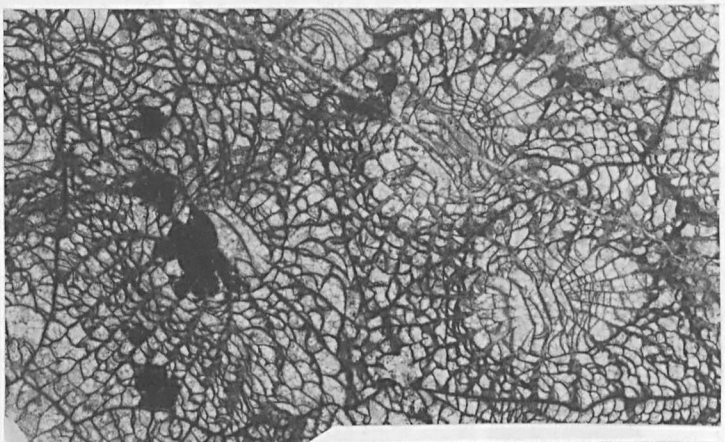
Loc. 10 - Soh area (Esfahan Province, central Iran). Collection Zahedi

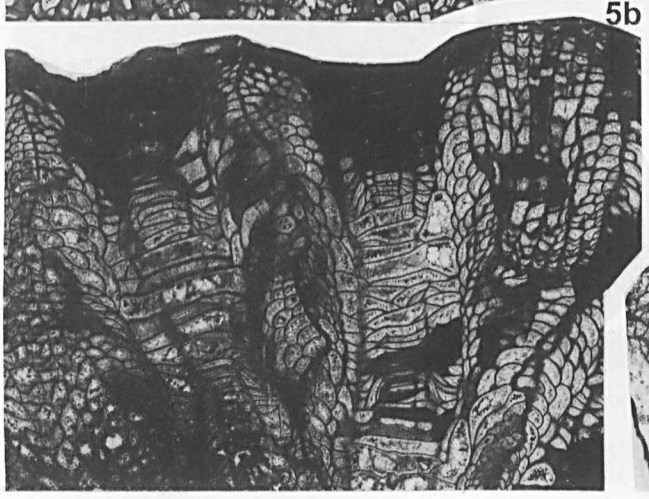
I-Z114A: *Polythecalis* cf *denticulatus* (Huang, 1932). This coral and, in the same block, a brachiopod of the characteristic suborder Oldhaminidina indicates a middle Permian age.

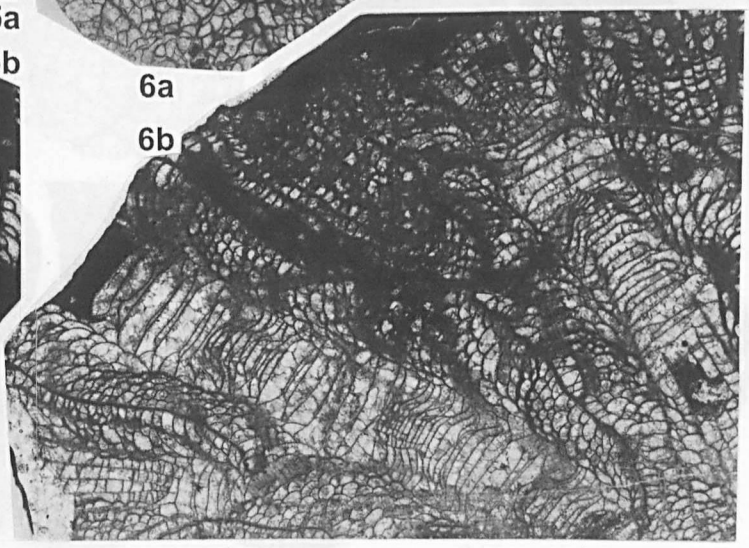


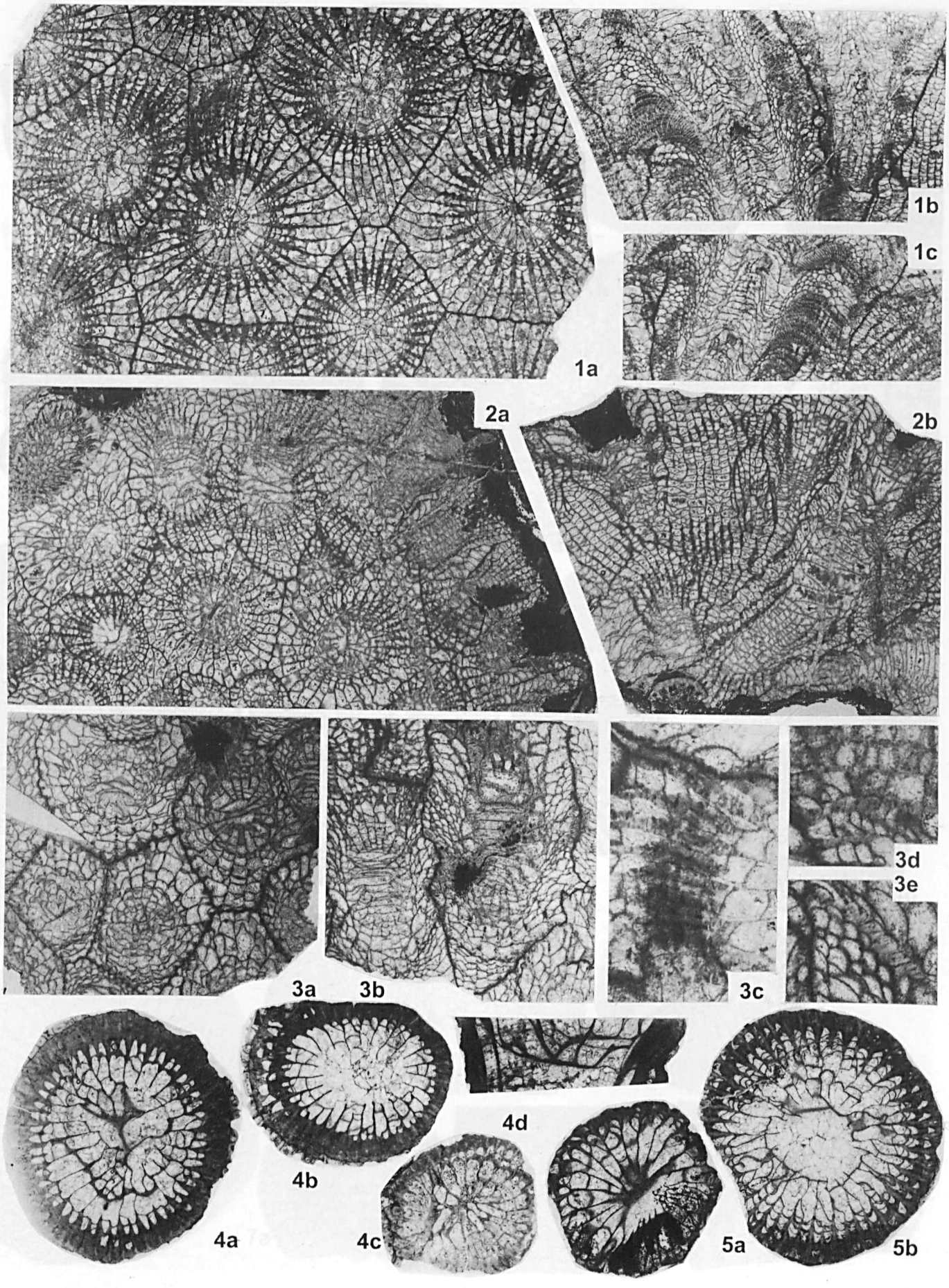


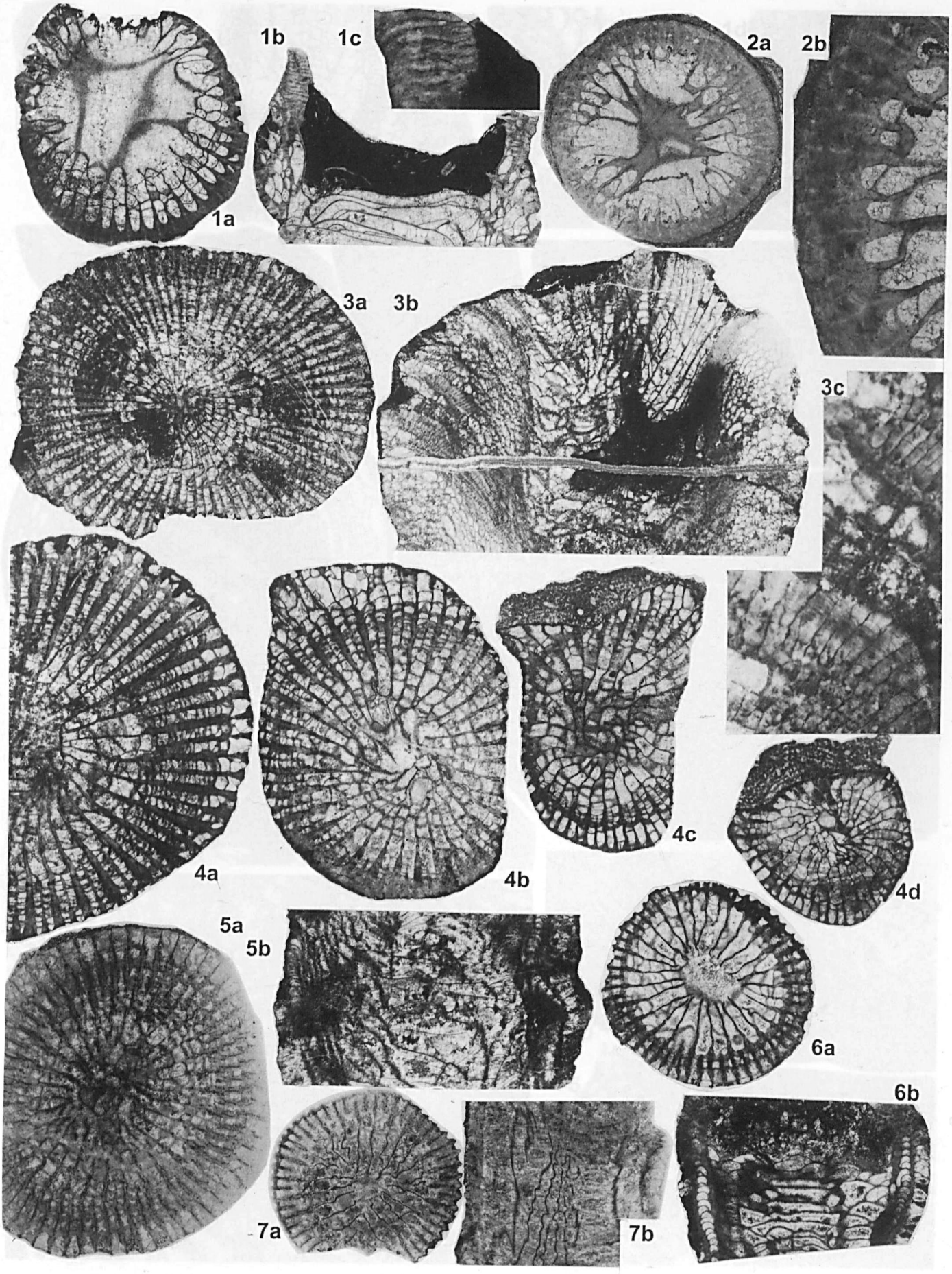


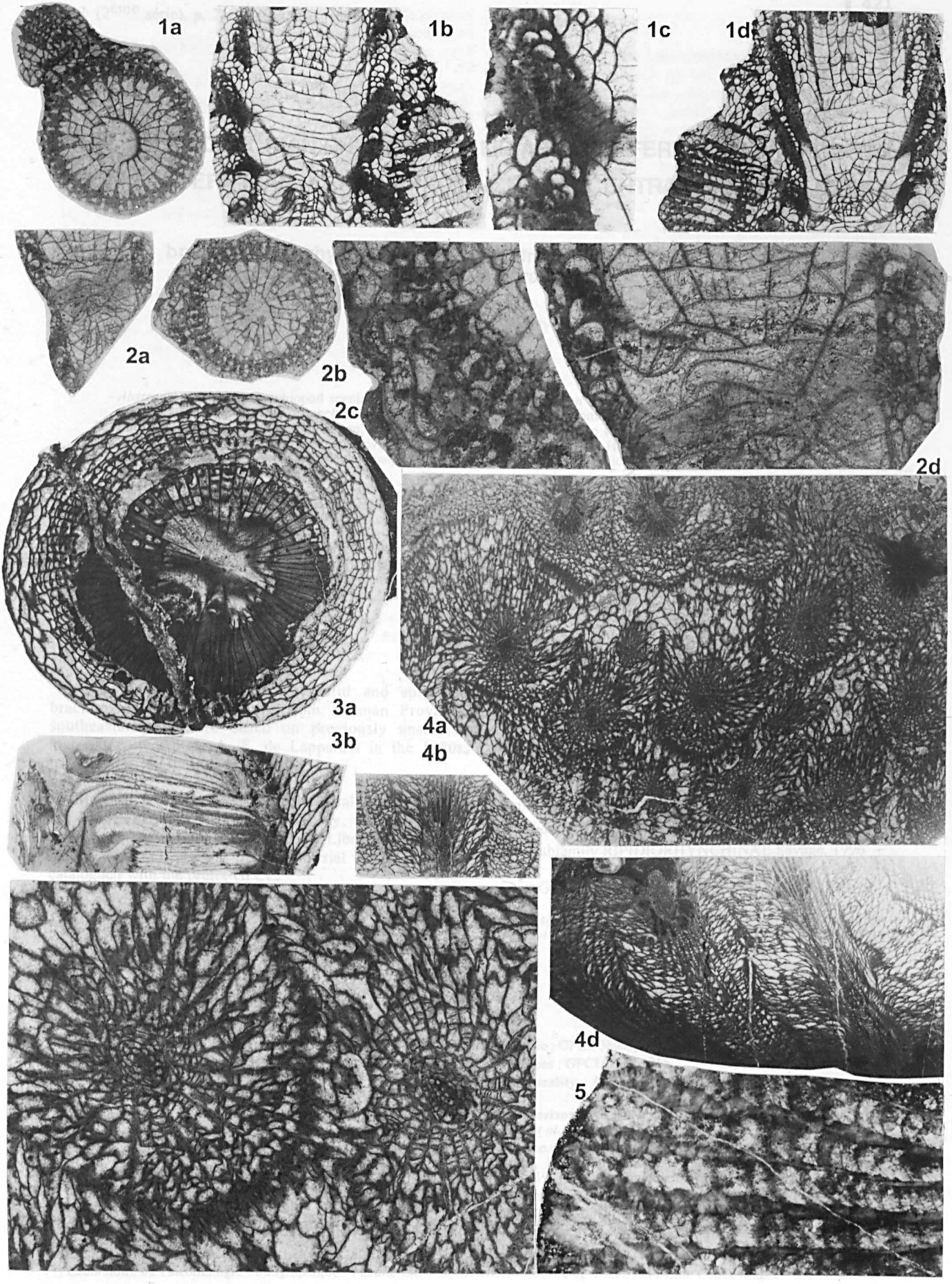












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NEW UPPER DEVONIAN RHYNCHONELLID AND SPIRIFERID BRACHIOPOD TAXA FROM EASTERN IRAN (KERMAN PROVINCE) AND CENTRAL IRAN (SOH REGION)

Nouveaux brachiopodes rhynchonellides et spiriferides du Dévonien supérieur d'Iran oriental (Province de Kerman) et d'Iran central (région de Soh)

by Denise Brice (*)

(Plate XI)

Abstract. — Six new brachiopod species are described. Five from Kerman Province eastern Iran are Frasnian in age, three rhynchonellids-*Ripidiorhynchus kermanensis* and *R. minutissimus* from the Bidu area, *Ladogilina persanica* (= *Ladogia meyendorfi in* Brice & Farsan, 1977) from the Hutk section-and two spiriferids : *Cyrtospirifer kermanensis,* abundant in many sections in Kerman Province-and *Rigauxia huktensis* from the Hutk section. One species is Famennian in age (probably Middle to Upper Famennian) : *Cyrtiorina iranica* from the Ab-Bid section, Kerman Province, and from the Soh region of central Iran.

Résumé. — *Six nouvelles espèces de brachiopodes sont décrites. Cinq d'entre elles sont d'âge frasnien et proviennent de la Province de Kerman, Iran oriental : trois rhynchonellids, Ripidiorhynchus kermanensis et R. minutissimus de la région de Bidou, Ladogilina persanica (= Ladogia meyendorfi in Brice & Farsan, 1977) de la coupe de Hootk, et deux spiriferids, Cyrtospirifer kermanensis, présent dans plusieurs coupes de la Province de Kerman et Rigauxia hutkensis dans la coupe de Hootk. Un spiriferid est famennien (probablement famennien moyen à supérieur) : Cyrtiorina iranica découvert dans la coupe de Ab-Bid, région de Bidou, et dans la région de Soh, en Iran central.*

I. — INTRODUCTION

The new species of rhynchonellid and spiriferid brachiopods described herein from Kerman Province, southeastern Iran, are based on previously unstudied material collected by A. F. de Lapparent in the 1970s, particularly 1973.

Material from the Soh region, central Iran, collected by M. Zahedi in 1973 is partially revised. These collections are housed in the Faculté Libre des Sciences, Lille (France). Types and figured material in this paper are catalogued with the prefix GFCL.

The geological sections in southeastern and central Iran, where the brachiopod faunas were collected, probably correspond to the Bahram and Shistu (Shishtu-1) formations of the Tabas area. The Upper Devonian brachiopod faunas are very similar to those of Afghanistan (Axial Zone and northern part of Central Mountains) and Iran (eastern Alborz Mountains), but apparently less diverse. Though the present material may appear to be less important than the previously described Afghan material, it includes six new taxa now described. Five Frasnian taxa from Kerman Province are discriminated ; three are rhynchonellids : *Ripidiorhynchus kermanensis* and *R. minutissimus* from the Bidu area, *Ladogilina persanica* (= *Ladogia meyendorfi in* Brice & Farsan, 1977) from the Hutk section, and two spiriferids : *Cyrtospirifer kermanensis,* abundant in many sections in the Bidu area and *Rigauxia huktensis* from the Hutk section. One species is Famennian (probably middle to upper Famennian): *Cyrtiorina iranica* from the Ab-Bid section (Kerman Province) and the Soh region (central Iran).

II. — SYSTEMATIC

Order RHYNCHONELLIDA Kuhn, 1949
Superfamily RHYNCHOTREMATOIDEA Schuchert, 1913
Family TRIGONIRHYNCHIIDAE Schmidt, 1965
Subfamily RIPIDIORHYNCHINAE Savage, 1996

Genus *RIPIDIORHYNCHUS* SARTENAER, 1966

Type species : *Terebratula livonica* von BUCH, 1834 (= *Camarotoechia pskovensis* NALIVKIN, 1941 after Sartenaer, 1997)

Ripidiorhynchus kermanensis nov. sp.

(Pl. XI, fig. 34-41)

Holotype : GFCL 3809.

Paratypes : GFCL 3810-3815.

Type locality : Ab-Bid, Kerman Province (Brice *et al.*, 1999, fig. 1,2).

Type horizon : Ab-Bid North section, Bidu area, level I-AB.BR 1s (Brice *et al.*, 1999).

Age. The new species is associated with *Uchtospirifer multiplicatus* BRICE, 1971, (Brice *et al.*, 1999) index fossil of the biozone 6 (Brice, 1977), lower to middle Frasnian in age (Brice *et al.*, 1999).

Type material : Ab-Bid North section, level I-AB.BR 1s : 46 specimens of which 26 are well preserved and 17 juveniles ; Bidu River section, level I-BR 1bc, 1 specimen.

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Diagnosis

Ripidiorhynchus of medium size for the genus, weakly dorsi-biconvex, subpentagonal in outline with greatest width forward of the midlength ; sulcus and fold narrow, well defined, not very developed, beginning forward of umbonal region ; tongue often low ; anterior commissure uniplicate.

Description

Ventral valve weakly convex ; ventral beak erect ; interarea well delineated ; ventral sulcus narrow, moderately deep, originating between umbonal region and mid-length ; tongue often low and weakly recurved.

Dorsal valve more convex than ventral one but not very deep, sometimes with a faint medial depression on the umbonal region ; fold not very high, beginning forward of the umbo, inclined towards ventral valve near anterior commissure.

Costae all simple and angular, with some parietal costae disappearing near the anterior commissure-general formula for median costae: 4/3 (74 %), 5/4 (17 %), 3/2 (4.5 %), (2/1 4.5 %) ; parietal costae 1/0-1/1 (50%) ; 1/1-1/1 (40 %) ; 1/0-0/0 or 1/1-0/0 or 0/0-1/1 (10 %) ; lateral costae 8 to 13.

GFCL	3809	3810	3811	3812	3813	3814	3815
L	9.9	10.4	10.6 ?	9.9	10.2+	10	11
W	11.3	11.5	11.1	12.2	13.1	1.,4	11.7
Th	6.8	6.3	6.4	-	8.8	5.4	-
L/W	0.87	0.98	-	-	-	0.93	0.94
Th/L	0.66	0.60	0.60	-	-	0.55	-
Th/l	0.68	0.54	0.57	-	0.67	0.54	-
aa	98°	94°	98°	103°	97°	94°	93°

Tabl. I. — **Measurements** (in mm) ; Abbreviations : L = Length ; W = width ; Th = thickness ; aa = apical angle in degrees

Tabl. I. — Mesures (en mm) ; Abréviations : L = longueur ; W = largeur ; Th = épaisseur ; aa = angle apical en degrés

Internal structures slender. Umbonal cavities open, central one very large. Dental plates parallel. Dorsal septalium covered anteriorly by a solid connectivum and supported by septum only posteriorly.

Discussion

This species is close to *Ripidiorhynchus boloniensis sensu* Nalivkin (1930) but the Turkestan species is larger and has more parietal costae. Types of *R. boloniensis* (d'Orbigny, 1850) from the Boulonnais, northern France, are also larger and have more numerous median costae (generally 6/7 or 7/6) than *R. kermanensis*. The outline of *R. aldoga* recalls that of the Iranian species but its general costae formula is different, its sulcus and fold are more developed and its tongue is higher.

Ripidiorhynchus minutissimus nov. sp.

(Pl. XI, fig. 42-52)

Holotype : GFCL 3816.

Paratypes : GFCL 3817-3823.

Type locality : Bidu area, Kerman Province (Brice *et al.*, 1999, fig. 1,2).

Type horizon : Bidu Crest section (Brice *et al.*, 1999, fig. 4), level I-BR.2c, coquina limestone with many brachiopod remains (spines of productellids, incomplete valves of spiriferids) and some tentaculites.

Age. Frasnian (Brice *et al.*, 1999).

Type material : Bidu Crest section : 22 specimens and about 20 incomplete shells.

Diagnosis

Small *Ripidiorhynchus*, dorso-biconvex, transversely subelliptical to subpentagonal in outline, with greatest width forward of midlength maximum thickness near anterior margin ; fold and sulcus narrow, well developed, beginning forward of umbonal region ; commissure sharp, uniplicate at anterior.

Description

Ventral valve shallow, weakly convex ; beak erect ; interarea elliptical and concave, well defined ; sulcus beginning just forward of umbonal region, deep at the anterior margin, extending forward into high, triangular, more or less recurved tongue.

Dorsal valve strongly convex ; fold beginning forward of umbonal region, well differentiated, with maximum height at the crest of the tongue.

All costae are simple and angular. Some parietal costae disappear near anterior commissure. The general formula for the median costae is : 3/2 (59 %), 2/1 (23 %), 4/3 (18 %) ; parietal costae 1/1-1/1 (46%) ; 1/0-1/1 or 1/1-0/1 (36%) ; 1/0-0/0 (9%), 0/1-0/0 (9%) ; lateral costae 9 to 12.

Interior with slender structures similar to those of the genus.

GFCL	3817	3818	3819	3816	3820	3821	3822	3823
L	8	8.3	7.5	7.5	8.5	6.5	9.1	7.4
W	9.9	9.1	9.2	9.5	9.4	7.2	10.2	9
Th	6	7.2	5.3	6.7	6.8	6.9	5.6	5.3
L/W	0.80	0.91	0.81	0.78	0.90	0.90	0.89	0.82
Th/L	0.75	0.86	0.70	0.89	0.8	1.06	0.61	0.71
Th/l	0.60	0.79	0.57	0.70	0.72	0.95	0.54	0.58
aa	96°	94°	95°	96°	93°	91°	99°	99°

Tabl. II. — **Measurements** (in mm) ; Abbreviations : L = Length ; W = width ; Th = thickness ; aa = apical angle in degrees

Tabl. II. — Mesures (en mm) ; Abréviations : L = longueur ; W = largeur ; Th = épaisseur ; aa = angle apical en degrés

Discussion

Ripidiorhynchus minutissimus nov. sp. is close of *R. farsani* BRICE & FARSAN, 1977. The Iranian forms differs only in its median formula costae number , smaller size and triangular (not trapezoidal) appearance of the tongue.

Superfamily PUGNACOIDEA Rzhonsnitskaja, 1956

Family LADOGIIDAE Liashenko, 1973

Genus *LADOGILINA* LIASHENKO, 1973

Type species : *Ladogilina rossica* LIASHENKO, 1973

Ladogilina persanica nov. sp.

(Pl. XI, fig. 25-33)

1977. *Ladogia meyendorfi* ; Brice *in* Brice D. and Farsan M., p. 228, pl. 13, fig. 13,15 (14 ?), text.-fig. 1D.

Holotype : GFCL3824.

Paratypes : GFCL 3825-3829.

Type locality : Hutk, Kerman Province (Brice *et al.*, 1999, fig. 1,2).

Type horizon : Hutk section (Brice *et al.*, 1999, fig. 3), level : I-H.73 5.

Age. The new species is associated with *Cyphoterorhynchus koraghensis* (REED, 1922) in the Hutk section (Brice *et al.*, 1999), index fossil of biozone 6 (Brice, 1977), Lower to Middle Frasnian in age (Brice *et al.*, 1999).

Type material : 12 + 1 ? specimens. Collections A.F. de Lapparent, Hutk, Kerman Province, eastern Iran, Hutk section, level I-H.73 5 (8 sp.) ; Zard Sang, Axial Zone, Afghanistan (1 + 1 ?) sp.; Collection Farsan, Robat-e Paï, Axial Zone, Afghanistan, Robat-e Paï section, level 20 in Brice & Farsan, 1977 (3 sp.).

Diagnosis

Medium to large *Ladogilina*, subpentagonal to subtriangular in outline ; width greater than length with a ratio between 0.76 and 0.92 and with greatest width forward of midlength ; ventral valve shallow ; sulcus poorly limited, beginning at midlength and extending weakly posteriorly into a broad tongue (not very high) ; dorsal valve inflated with fold absent or poorly differentiated ; costellae flattened, covering the entire surface, 8-9/5 mm from 15 mm to the beak.

Description

Ventral valve shallow, almost flat or weakly convex posterior to mid-length, subpentagonal in outline, with greatest width anterior to mid-length ; sulcus large, poorly defined, beginning generally at mid-length, ending in rounded, not very high tongue.

Dorsal valve moderately convex ; fold often inconspicuous and not differentiated from the lateral slopes of the shell.

Ornament of large, low striae separated by narrow grooves, with 8-9 striae in 5 mm at 15 mm from the beak.

Internal structures solid and thick (text-fig. 1D in Brice & Farsan, 1977) ; dental plates weakly bent inwards ; umbonal cavities open, with lateral cavities smaller than central one ; hinge plate in dorsal valve divided by an open septalium supported by a dorsal septum extending forwards as far forward as the articulation.

GFCL	3825	3824	3826	3827	3828	3829
L	16.4	19.2	18.7	20.3	23.1	20.7
W	21.4	23.1	23.4	23.8	25	24.4
Th	12.2	14.5	13	14.5	15.6	14.5
L/W	0.76	0.83	0.79	0.85	0.92	0.84
Th/L	0.74	0.75	0.69	0.71	0.67	0.70
Th/l	0.57	0.62	0.55	0.62	0.62	0.59
aa	103°	102°	111°	105°	95°	110°

Tabl. III. — **Measurements** (in mm) ; Abbreviations : L = Length ; W = width ; Th = thickness ; aa = apical angle in degrees

Tabl. III. — Mesures (en mm) ; Abréviations : L = longueur ; W = largeur ; Th = épaisseur ; aa = angle apical en degrés

Discussion

Specimens attributed to *Ladogia meyendorfi* (Brice *in* Brice & Farsan, 1977, p. 228) belong to a new species reassigned to *Ladogilina* LIASHENKO, 1973. They differ from *Ladogia* in their less excavated ventral valve, less deep sulcus, not so high tongue and non-acuminate, less numerous costellae. The new species is closer to *Ladogilina simensis* than to the type species : *L. rossica*. Nevertheless, *L. persanica* may be easily distinguished from *L. simensis* by the following features : size larger, outline subpentagonal to subtriangular, greatest width forward of midlength, and by its larger, less numerous — 8-9 in 5 mm at 15 mm from the beak when *simensis* has 9-11. A specimen from Robat-e-Paï (Brice & Farsan, 1977, pl. 13, fig. 14) in Afghanistan is larger than other specimens ; its ventral valve is flat posterior to mid-length. It possibly belongs to another species but being only a single specimen, it is not possible to know if this feature is significant.

Ladogilina rossica and *L. simensis* have been found in the Volga-Ural and southern Timan regions in horizons dated as Frasnian by conodonts : Lower and Middle *Polygnathus asymmetricus* Zones (Sartenaer, 1985, p. 312).

Superfamily SPINELLOIDEA Johnson, 1970

Family ECHINOSPIRIFEROIDEA Liashenko, 1973

Genus *RIGAUXIA* BRICE, 1988

Type species : *Spirifer acutosinu* RIGAUX, 1908

Rigauxia hutkensis nov. sp.

(Pl. XI, fig. 14-16)

Holotype : GFCL 3830.

Paratypes : GFCL 3831-3835, GFCL 3835 internal structures.

Type locality : Hutk, Kerman Province (Brice *et al.*, 1999, fig. 1,2).

Type horizon : Hutk section (Brice *et al.*, 1999, fig. 3), level I-H.73.5-6.

Age. The new species is associated with *Cyphoterorhynchus koraghensis* (REED, 1922) in the Hutk section (Brice *et al.*, 1999), index fossil of biozone 6 (Brice, 1977)), Lower to Middle Frasnian in age (Brice *et al.*, 1999).

Type material : 8 specimens (of which 2 are incomplete), Hutk section, level I-H.73.5-6 : 3 sp., level I-H.73.6 : 5 sp.

Diagnosis

Rigauxia of medium size for the genus, equithyrid with short mucros (often broken), equiconvex or slightly ventribiconvex, subpentagonal in outline, and weakly transverse ; ventral interarea well developed, generally weakly concave, strongly concave in gerontic form ; lateral costae simple with possible bifurcation for one rib near sulcus or fold ; sulcus and fold well defined but narrow.

Description (B, fig. 1)

Ventral valve convex, with maximum depth in posterior part ; beak weakly recurved (except in gerontic forms) ; interarea well developed, triangular, high, delineated by one pair of ridges, catacline near hingeline, apsacline near the beak, very concave in gerontic form ; delthyrium open ;

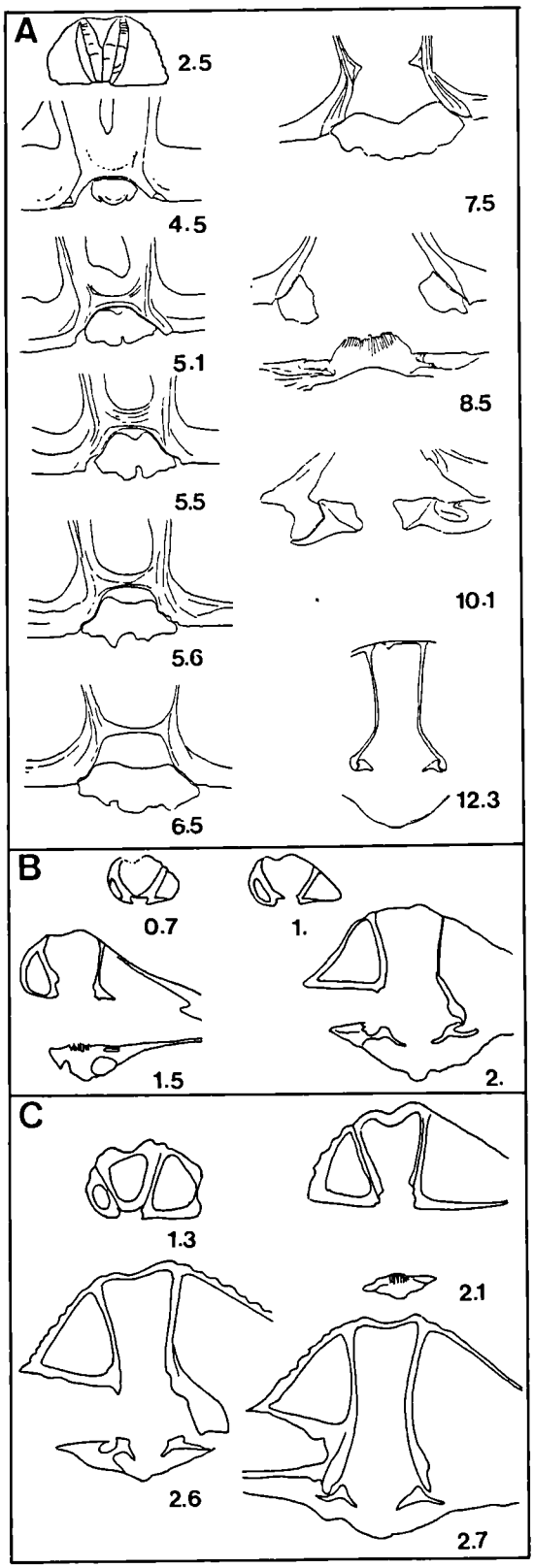

Fig. 1. - Serial transverse sections and peels. Distance in mm forward of the ventral umbo is given for each section. Specimens from Kerman Province, eastern Central Iran. Collection A. F. de Lapparent.

Sections sériées transversales. Les distances en mm indiquées pour chaque figure sont mesurées depuis l'umbo ventral. Les spécimens proviennent de la Province de Kerman, Iran central oriental. Collection A.F. de Lapparent.

sulcus originating at beak, well defined, narrow, shallow, gently rounded at bottom.

Dorsal valve less convex than ventral valve with maximum depth at midlength : fold narrow, well defined, raising slightly above the flanks.

Lateral costae rounded, simple, occasionaly bifurcating on anterior part near sulcus or fold, numbering between 12 and 17 ; costae on fold and sulcus lower than those on flanks, bifurcating and disposed as in Cyrtospiriferids, but fewer in number ; spines numerous (but not well preserved) on radial capillae.

GFCL	3831	3830	3832	3833	3834
L	12.5	13.7	10.6	16.5	12.7
W	17.5	17.5	15.7	19.2	>16.5
Th	9.1	11.5	9.8	13.7	12
L/W	0.71	0.77	0.68	0.85	<0.76
Th/L	0.72	0.83	0.95	0.83	0.94
Th/l	0.52	0.65	0.65	0.71	<0.72

Tabl. IV. — **Measurements** (in mm) ; Abbreviations : L = Length ; W = width ; Th = thickness ; aa = apical angle in degrees

Tabl. IV. — Mesures (en mm) ; Abréviations : L = longueur ; W = largeur ; Th = épaisseur ; aa = angle apical en degrés

Interior with divergent dental plates in ventral valve and open umbonal cavities, the central one large . delthyrial plate and septum absent ; dorsal valve with striate cardinal process and crural bases but without septum.

Discussion

This species belongs to *Rigauxia* because of its small size, ornamentation (mega- and micro), and internal characters, particularly absence of a delthyrial plate and presence of crural bases.

The Iranian form differs from the type species *Rigauxia acutosina* (RIGAUX, 1908) mainly in following features : less transverse form, larger size, absence of umbonal callus, and absence of developed ventral and dorsal myophragms.

The outline and megascopic ornament of *Spirifer strigosus* MEEK, 1860 — assigned to *Indospirifer* by Cooper & Dutro (1982) — which perhaps belongs to *Rigauxia*, recall that of *R. hutkensis*. The Iowa species is a little larger, more transverse and megathyrid.

A : Cyrtiorina iranica nov. sp.
GFCL 3856. Sections 4, 8, 9, 11, 12, 14, 17, 21, 24 all magnified x 3.75. 26 magnified x 1.15.
GFCL 3856. Sections 4, 8, 9, 11, 12, 14, 17, 21, 24 Gr. = 3.75. 26 Gr. = 1.15.

B : *Rigauxia hutkensis* nov. sp.
GFCL 3835. Sections 1, 2, 3, 6 all magnified x 4.
GFCL 3835. Sections 1, 2, 3, 6 Gr. = 4.

C : Cyrtospirifer kermanensis nov. sp.
GFCL 3849. Sections 4, 7, 9, 10 all magnified x 4.1.
GFCL 3849. Sections 4, 7, 9, 10 Gr. = 4.1.

Superfamily CYRTOSPIRIFEOIDEA
Termier and Termier, 1949

Family CYRTOSPIRIFERIDAE Termier and Termier, 1949

Subfamily CYRTOSPIRIFERINAE
Termier and Termier, 1949

Genus *CYRTOSPIRIFER* Nalivkin *in* Frederiks, 1924

Type species : *Spirifer verneuili* MURCHISON, 1840

Cyrtospirifer kermanensis nov. sp.

(Pl. XI, fig 1-11)

1972 *Cyrtospirifer verneuili* (MURCHISON) nov. subsp. ; Brice D. *in* Golshani *et al.*, p. 2103.

Holotype : GFCL 3837.

Paratypes : GFCL 3838- 3844, 3887.

Type locality : Hutk, Kerman Province (Brice *et al.*, 1999, fig. 1,2).

Type horizon : Hutk section (Brice *et al.*, 1999, fig. 3), level I-H.73 6.

Age. The new species is associated with *Ripidiorhynchus elburzensis* (GAETANI, 1965) in the Hutk section (Brice *et al.*, 1999), index fossil of biozone 8 (Brice, 1977), Frasnian in age (Brice *et al.*, 1999).

Type material : 102 + 7 ? specimens and numerous isolated valves ; Hutk section, I-H.73 5 (1 sp.), I-H.73 6 (35 sp.) ; Bidu area, Bidu Gorge section, I-BR 1b (7 ? sp.), I-BR 1c (50 sp.), Bidu River South section, I-BR 1a (specimens in matrix), I-BR 1c (5 sp.), Bidu Crest section, I-BR 1ab (11 sp.).

Diagnosis

Shell small to medium sized for the genus, mucronate, ventribiconvex, subpentagonal in outline, wider than long, with greatest width at the hingeline or situated slightly forward of it in mucronate shells ; lateral margins weakly rounded, or nearly parallel posteriorly to rounded anteriorly ; anterior commissure uniplicate ; cardinal extremities subrectangular when mucros not developed.

Ventral valve very convex, inflated in the umbonal region ; beak incurved, overhanging part of interarea ; interarea long, corresponding to about one-fifth of width, sometimes gutter-like, concave and apsacline, delineated by angular ridges ; delthyrium open ; sulcus originating at the beak, shallow with rounded bottom ; tongue low, subtrapezoidal or rounded.

Dorsal valve moderately convex with maximum depth in posterior part ; fold moderately high, narrow, convex or flat, sometimes with a shallow median groove.

Costae simple (generally 17 to 21 lateral costae), bifurcating on sulcus and fold with median costae distributed as in cyrtospiriferid ; lateral costae and intercostal grooves similar, rounded in posterior region, with costae becoming lower and wider than grooves anteriorwards ; costae near cardinal extremities very narrow ; micro-ornament of capillae and fine spines on radial striae.

Internal structures

Dental plates and adminicula well developed, divergent ; umbonal cavities open ; cardinal process striate ; crural bases convergent extremities ; dorsal myophragm very long, about two-third of valve-length.

GFCL	3836	3837	3838	3839	3840	3841	3842	3843
L	16.4	15	15.2	19.1	14.8	15.6	15	16.7
W	24.9	22.7	23.5	25.1	20.8	22.3	18.7	23.4
Th	15.4	13.2	-	14.5	12.6	12.3	11.7	13.4
HDV	15.2	13.7	14.2	15.5	13.5	13.7	12.7	14.1
L/W	0.65	0.66	0.64	0.76	0.71	0.69	0.80	0.71

Tabl. V. — **Measurements** (in mm) ; Abbreviations : L = Length ; W = width ; Th = thickness ; aa = apical angle in degrees

Tabl. V. — Mesures (en mm) ; Abréviations : L = longueur ; W = largeur ; Th = épaisseur ; aa = angle apical en degrés

Discussion (C, fig. 1)

This forms belongs to *Cyrtospirifer* and is closely related to *C. archiaci* (Murchison, 1840) because of the following features : shape, proportions, size and internal characters. The main differences are the number of narrower and more numerous lateral costae, the deeper sulcus, longer dental plates and shorter dorsal myophragm.

Genus *TENTICOSPIRIFER* TIEN, 1938

Type species : *Spirifer tenticulum* VERNEUIL, 1845

Tenticospirifer aff. *cyrtiniformis*
(HALL & WHITFIELD, 1875)

Material : Collection A. F. de Lapparent, Kerman Province : Ab-Bid North section (Brice *et al.*, 1999, fig. 1,2), level I-AB.BR 1s (Brice *et al.*, 1999), 10 incomplete specimens, mostly poorly preserved.

Discussion

This megathyrid spirifer with catacline or slightly procline ventral interarea, 18 to 23 lateral costae and open delthyrium, recalls the species described by Balinski (1979) as *Tenticospirifer* aff. *cyrtiniformis*, from the Frasnian of the Debnik Anticline, southern Poland in shape and proportions. The Iranian material is too poorly for specific determination.

GFCL	3845	3846	3847
L	8.6	8.5	10.9
W	17?	16.4 ?	19
Th	9.3	9.7	11

Tabl. VI. — **Measurements** (in mm) ; Abbreviations : L = Length ; W = width ; Th = thickness ; aa = apical angle in degrees

Tabl. VI. — Mesures (en mm) ; Abréviations : L = longueur ; W = largeur ; Th = épaisseur ; aa = angle apical en degrés

Subfamily CYRTIOPSINAE Ivanova, 1972

Genus *UCHTOSPIRIFER* LIASHENKO, 1957

Type species : *Uchtospirifer nalivkini* LIASHENKO, 1957

Uchtospirifer ? sp.

(Pl. XI , fig. 12)

Material : Collection A.F. de Lapparent. Hutk, Kerman Province, Hutk section (Brice *et al.*, 1999, fig. 1,2,3), level I-H 73.5 5 specimens and 4 ventral valves.

Description

Shell ventribiconvex, slightly megathyrid with short mucros and with subpentagonal or quadrate, rounded outline ; sulcus and fold narrow ; lateral costae numbering about 23 ; surface covered entirely by capillae and growth lines.

Ventral valve strongly convex in lateral profile with maximum depth in posterior part ; sulcus originating at beak, limited by bounding costae a little wider than lateral costae ; beak strongly incurved, overhanging ventral subtriangular, orthocline or weakly apsacline and concave interaea ; pseudodeltidium present.

Discussion

In spite of some similarities concerning outline, pseudodeltidium, micro-ornament, this species does not belong to *Uchtospirifer* because the hingeline corresponds to the maximum width, and the sulcus and fold are narrow and not sufficiently developed.

Uchtospirifer ? rarus COOPER & DUTRO is similar in outline but is smaller and has only 13 lateral costae.

Superfamily THEODOSSIOIDEA Ivanova, 1959

Family ULBOSPIRIFERIDAE Johnson & Carter, 1994

Genus *CYRTIORINA* COOPER & DUTRO, 1982

Type species : *Cyrtospirifer kindlei* STAINBROOK, 1847

Cyrtiorina iranica nov. sp.

(Pl. XI, fig. 17-24)

Holotype : GFCL 3850.

Paratypes : GFCL 3851-3859 3859 = Z187.

Type locality : Ab-Bid North, Bidu area, Kerman Province (Brice *et al.*, 1999, fig. 1,2).

Type horizon : Ab-Bid North section (Brice *et al.*, 1999), level I-AB.BR 4.

Age. The new species is associated with *Dmitria seminoi* (VERNEUIL, 1850) and *Leptocaryorhynchus jamensis* in the Ab-Bid North section (Brice *et al.*, 1999), index fossils of biozone 10 and *Araratella* index genus of biozone 11 (Brice 1977), Middle and Upper Famennian (Brice *et al.*, 1999).

Type material : 49 specimens and fifty isolated valves. Collection A.F. de Lapparent, Ab-Bid (Kerman Province), Ab-Bid section, levels I-AB.BR 3-4 (1sp., 13 ventral valves, 4 dorsal valves), I-AB.BR 4s (12 sp.), Madbun (Kerman Province), Madbun section, levels I-ME.AB 1 (8 sp., 6 vv, 5 dv), I-ME.AB 2 (3 sp., 4 vv, 19 dv). Collection Zahedi, Soh area : levels Z113 (5 sp.), Z187 (20 sp.).

Diagnosis

Shell medium to large, biconvex, equithyrid to slightly brachythyrid ; sulcus shallow and not well delimited ; fold obsolete, delineated by distinct bounding grooves ; cardinal extremities generally obtuse or subrectangular ; dental plates and adminicula well developed ; Pseudodeltidium thick ; hingeline not denticulate ; crural bases short.

Description (A, fig. 1)

Ventral valve moderately convex ; beak elevated, erect or slightly incurved — with interarea triangular, apsacline, flat and inclined in the first case, or weakly concave in second case ; sulcus well delineated near the beak, shallow and indistinct forward of the umbonal region, delimited by a pair of costae that are wider than lateral ones ; delthyrium showing apical plate below the beak form a kind of very thick, convex pseudodeltidium, with rounded foramen.

Dorsal valve convex, increasing in convexity according to age, particularly in the umbonal region ; beak incurved, overhanging the hinge-line and the dorsal interarea ; fold obsolete in the umbonal region rising weakly above the flanks in anterior part of valve ; surface completely covered by numeros costae, simple laterally (number between 30 and 40), rounded posteriorly, flattening anteriorly.

GFCL	3859	3850	3851	3852	3853	3854	3855	3856	3857	3858
L	34.4	36.8	34.1	36	44.1	35	38.3	-	32.6	34.8
W	37.5	39.3	33.8	-	40	-	41.7	33	38 ?	34
Th	23.3	26.9	24.8	24.5	33	28.7	30.5	27	23.9	24.5
L/W	0.91	0.93	1	-	1.10	-	0.91	-	0.85 ?	1.02
Th/L	0.67	0.73	0.72	0.68	0.82	0.82	0.79	-	0.73	0.70
Th/I	0.62	0.68	0.73	-	0.74	-	0.73	0.81	0.62 ?	0.72

Tabl. VII. — **Measurements** (in mm) ; Abbreviations : L = Length ; W = width ; Th = thickness ; aa = apical angle in degrees

Tabl. VII. — Mesures (en mm) ; Abréviations : L = longueur ; W = largeur ; Th = épaisseur ; aa = angle apical en degrés

Internally, the ventral valve bears dental plates and slightly divergent dental adminicula reaching nearly to valve mid-length, inner prismatic layer.

Dorsal valve interior with striate cardinal process and socket plates supporting short crural bases. When shells are exfoliated, it is possible to observe some granulations similar to those of the genus *Enchondrospirifer* BRICE, 1971.

Discussion

Cyrtiorina iranica is assigned to the genus *Cyrtiorina* COOPER & DUTRO, 1982 for the reasons the authors of that genus used in erecting for erecting a new taxon for their material from New Mexico. They pointed out analogies between the type species of their new genus and forms referred to *Dmitria* and *Uchtospirifer*. We have noted similar analogies concerning ornament — the fine costellae and delicate spines — the very thick "pseudodeltidium", and the similar internal structures. The Iranian species is easily distinguished by its outline (not so transverse, i.e. more elongate, length/width ratio (generally 0,91 to 1) and, less important, the shape of the fold and sulcus. The new species externally resembles *Dmitria* but there is never a pseudodeltidium in that genus.

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BIBLIOGRAPHY

BRICE D. (1971). — Etude paléontologique et stratigraphique du Dévonien de l'Afghanistan. *Notes et Mémoires du Moyen Orient. Mémoire* 11: 1-364. Paris.

BRICE D. (1977). — Biostratigraphie du Dévonien d'Afghanistan. *Mémoire hors série Société géologique de France,* 8 : 267-276. Paris.

BRICE D. (1988). — Brachiopodes du Dévonien de Ferques (Boulonnais-France). *In* BRICE D. (Ed.), "Le Dévonien de Ferques ; Bas-Boulonnais (N. France)". *Biostratigraphie du Paléozoïque,* 7 : 323-395. Brest.

BRICE D. (1999). — Reassignment and new systematic precisions for some Famennian Spiriferids from Afghanistan and Iran. *Senckenbergiana lethaea* (in press).

BRICE D. & M. FARSAN (1977). — Brachiopods from the Upper Devonian of Robat-e-Paï (Afghanistan). Discovery of the genera *Ladogia* NALIVKIN, 1941 and *Eoparaphorhynchus* SARTENAER, 1961 (Rhynchonellida). *Annales Société Géologique du Nord,* 96 : 225-232. Lille.

BRICE D., MISTIAEN B. & ROHART J.C. (1999). — New data on distribution of brachiopods, rugosa and stromatoporoids in Upper Devonian from central and eastern Iran. Paleobiogeographical implications. *Annales Société Géologique du Nord, 7 : pp.21-32.* Lille

CARTER J.L., JOHNSON J.G., GOURVENNEC R. & HOU Hongfei. (1994). — A revised classification of the Spiriferid Brachiopods. *Annals of Carnegie Museum,* 63 (4) : 327-374. Pittsburgh.

COOPER G.A. & DUTRO J.T. Jr. (1982). — Devonian Brachiopods of New Mexico. *Bulletin of American Paleontology,* 82-83 (315) : 215 p. Ithaca.

DJAFARIAN M.A. et BRICE D. (1973). — Biostratigraphie des brachiopodes dans le Famennien supérieur de la région d'Ispahan (Iran central). Mise en évidence de la zone d'Etroeungt. *Comptes Rendus de l'Académie des Sciences de Paris,* 276 : 2125 - 2128. Paris.

GOLSHANI F., JANVIER Ph., BRICE D., CORSIN P. et A. F. de LAPPARENT (1972). -Découverte d'une faune de Poissons et de Végétaux dans le Dévonien supérieur de Bidu, en Iran central. *Comptes Rendus de l'Académie des Sciences de Paris,* 275 : 2103-2106. Paris.

GOLSHANI F., JANVIER Ph., BRICE D. et A. F. de LAPPARENT (1973). — Sur la Paléogéographie et la Paléobiologie du Dévonien dans la région de Kerman, en Iran. *Comptes Rendus de l'Académie des Sciences de Paris,* 276 : 697-700. Paris.

GRECHISHNICOVA, I.A. (1966). — Stratigraphy and brachiopods of the lower Carbon of the Rudny Altaï. *Transactions of the Moscow Society of Naturalists,* 20, 183 p. Moscow.

IWANOWSKI A. B. & KUKOV N.P. (1974). — Rugose, Brachiopods and stratigraphy of mountanious Altai and Sajan. *Transactions of the institute of Geology and Geophysics,* 231 : 5-121. Moscow.

LIASHENKO A.I. (1973). — Brachiopods and stratigraphy of the Lower Frasnian deposits of the South Timan and Volga-Urals oil-gas bearing province. *NEDRA,* 278 p. Moscow.

MISTIAEN, B. (1985). — Phénomènes récifaux dans le Dévonien d'Afghanistan (Montagnes centrales). Analyse et systématique des stromatopores. *Publication Société Géologique du Nord,* 11 (2) : 1-245. Lille.

NALIVKIN D. V. (1930). — Brachiopods from the Upper and Middle Devonian of the Turkestan. *Mémoire du Comité géologique,* nouvelle série, 180 : 221 p. Moscow.

SARTENAER P. (1985). — The biostratigraphical significance of Rhynchonellid genera at the Givetian-Frasnian boundary. *Courier Forchungsinstitut Senckenberg,* 75 : 311-318. Frankfurt.

WENDT J., HAYER J. & K., BAVANDPUR (1997). — Stratigraphy and depositional environment of Devonian sediments in northeast and east-central Iran. *Neues Jahrbuch für Geologie und Paläontologie Abhandlungen,* 206 (3) : 277-322. Stuttgart.

EXPLANATION OF PLATE XI

Fig. 1-11. *Cyrtospirifer kermanensis* nov. sp. Type material : Hutk section , Kerman Province, level I-H 6, Frasnian. 1-10 all magnified x 1 ; 11 magnified x 4.

1-3 : Paratype GFCL 3885 : 1. Ventral view ; 2. Dorsal view ; 3. Anterior view.

4-6 : Holotype GFCL 3837 : Specimen — mostly exfoliated so borders of sulcus appear rounded ; 4. Dorsal view; 5. Lateral view.

7-10 : Paratype GFCL 3839 : 7. Ventral view ; 8. Dorsal view ; 9. Posterior view ; 10.Anterior view.

11 : GFCL 3883. Micro-ornament.

Matériel type Type material : coupe de Hootk , Province de Kerman, niveau I-H 6, Frasnien. 1-10 Gr. = 1 ; 11 Gr. = 4.

1-3 : Paratype GFCL 3885 : 1. Vue ventrale ; 2. Vue dorsale; 3. Vue antérieure.

4-6 : Holotype GFCL 3837 : Spécimen — très exfolié, aussi les bords du sinus apparaissent arrondies ; 4. Vue dorsale; 5. Vue latérale.

7-10 : Paratype GFCL 3839 : 7. Vue ventrale; 8. Vue dorsale; 9. Vue postérieure; 10. Vue antérieure.

11 : GFCL 3883. Micro-ornementation.

Fig. 12.ce, level I-H 5, Frasnian, magnified x 1

Coupe de Hootk, Province de Kerman, niveau I-H 5, Frasnien., Gr. = 1. GFCL 3848. Vue dorsale.

Fig. 14-16. *Rigauxia hutkensis* nov. sp. Type material : Hutk section , or view.

Matériel type : Coupe de Hootk, Province de Kerman, niveau I-H 5-6, Frasnien.

14-16 Gr. = 1. Holotype GFCL 3830. 14. Vue ventrale. 15. Vue dorsale. 16. Vue antérieure. 17. Vue postérieure.

Fig. 17-24. *Cyrtiorina iranica* nov. sp. Type material Ab-Bid North section. Bidu area, Kerman Province, level I-AB.BR 4. Famennian.

17-22, 24 all magnified x 1. 23 magnified x 4.

17-21 : Holotype GFCL 3850 : 17. Ventral view ; 18. Dorsal view ; 19. Posterior view ; 20. Anterior view ; 21. Lateral view.

22 : GFCL 3859 from Soh region. Central Iran. Prismatic layers inner structures.

23 : Paratype GFCL 3854 : Micro-ornament on costae of the sulcus.

24 : Paratype GFCL 3853 : Dorsal view showing ventral interarea and pseudodeltidium.

Matériel type, coupe de Ab-Bid Nord. Région de Bidou, Province de Kerman, niveau I-AB.BR 4. Famennien.

17-22, 24 Gr. = 1. 23 Gr. = 4.

17-21 : Holotype GFCL 3850 : 17. Vue ventrale; 18. Vue dorsale; 19. Vue postérieure; 20. Vue antérieure; 21. Vue latérale.

22 : GFCL 3859 de la région de Soh. Iran central. Structures internes prismatiques.

23 : Paratype GFCL 3854 : Micro-ornementation sur les côtes du sinus.

24 : Paratype GFCL 3853 : Vue dosale montrant l'interarea ventrale et le pseudodeltidium.

Fig. 25-33. *Ladogilina persanica* nov. sp. Type material Hutk section, Kerman Province , level I-H 5, Frasnian.

25-32 all magnified x 1, 33 magnifed x 2.

25-26 : Paratype GFCL 3826 : 25. Ventral view ; 26. Dorsal view.

27-28 : Paratype GFCL 3827 : 27. Anterior view; 28. Posterior view.

29-32 : Holotype GFCL 3824 : 29. Ventral view ; 30. Dorsal view ; 31. Anterior view ; 32. Posterior view.

33 : Paratype GFCL 3825 : Ventral view showing macro-ornamentation.

Matériel type de la coupe de Hootk, Province de Kerman, niveau I-H 5, Frasnien.

25-32 Gr. = 1, 33 Gr. = 2.

25-26 : Paratype GFCL 3826 : 25. Vue ventrale; 26. Vue dorsale.

27-28 : Paratype GFCL 3827 : 27. Vue antérieure; 28. Vue postérieure.

29-32 : Holotype GFCL 3824 : 29. Vue ventrale; 30. Vue dorsale; 31. Vue antérieure; 32. Vue postérieure.

33 : Paratype GFCL 3825 : Vue ventrale montrant la micro-ornementation.

Fig. 34-41. *Ripidiorhynchus kermanensis* nov. sp.Type material Ab-Bid North section, Bidu area, Kerman Province level I-AB.BR 1s, Frasnian. 34- 41 all magnified x 2.

34-35 : Paratype GFCL 3813 : 34. Ventral view ; 35. Anterior view.

36 : Paratype GFCL 3815 : Anterior view.

37-39 : Holotype 3809 : 37. Ventral view ; 38. Lateral view. 39 ; Anterior view.

40-41 : Paratype 3810 : 40. Ventral view ; 41. Dorsal view.

Matériel type de la coupe de Ab-Bid Nord, région de Bidou, Province de Kerman, niveau I-AB.BR 1s, Frasnien. 34-41 Gr. = 2.

34-35 : Paratype GFCL 3813 : 34. Vue ventrale; 35. Vue antérieure.

36 : Paratype GFCL 3815 : Vue antérieure.

37-39 : Holotype 3809 : 37. Vue ventrale; 38. Vue latérale; 39. Vue antérieure.

40-41 : Paratype 3810 : 40. Vue ventrale; 41. Vue dorsale.

Fig. 42-52. *Ripidiorhynchus minutissimus* nov. sp. Type material, Bidu area, Kerman Province, Bidu Crest section , level I-BR.2c, Frasnian. 42-52 all magnified x 2.

42-45 : Paratype 3821 : 42. Lateral view ; 43. Anterior view ; 44. Dorsal view ; 45. Ventral view.

46-50 : Holotype GFCL 3816 : 46. Dorsal view ; 47. Ventral view ; 48. Anterior view. 49. Lateral view.

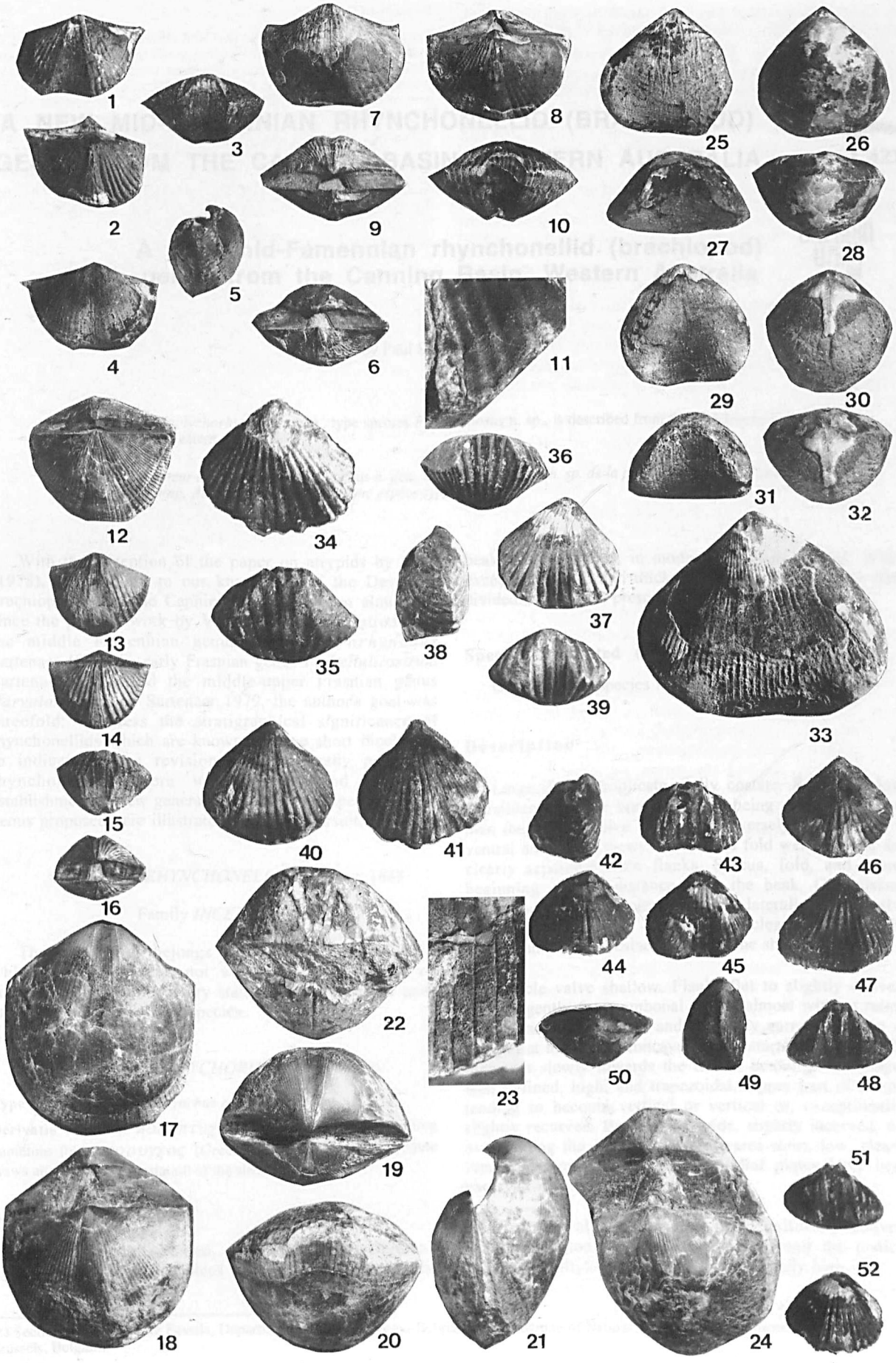
51-52 : Paratype 3817 : 51.Anterior view ; 52. Dorsal view.

Matériel type de la région de Bidou, Province de Kerman, coupe de Bidou Crest, niveau I-BR.2c, Frasnien. 42-52 Gr. = 2.

42-45 : Paratype 3821 : 42. Vue latérale; 43. Vue antérieure; 44. Vue dorsale; 45. Vue ventrale.

46-50 : Holotype GFCL 3816 : 46. Vue dorsale; 47. Vue ventrale; 48. Vue antérieure view. 49. Vue latérale.

51-52 : Paratype 3817 : 51.Vue antérieure ; 52. Vue dorsale.



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A NEW MID-FAMENNIAN RHYNCHONELLID (BRACHIOPOD) GENUS FROM THE CANNING BASIN, WESTERN AUSTRALIA

A new mid-Famennian rhynchonellid (brachiopod) genus from the Canning Basin, Western Australia

by Paul SARTENAER (*)

Abstract. — *Polyptychorhynchus* n.gen., type species *P. cavernosus* n. sp., is described from the mid-Famennian of the Canning Basin, Western Australia.

Résumé. — *L'auteur décrit* Polyptychorhynchus *n. gen., avec* P. cavernosus *n. sp. de la partie moyenne du Famennien du Bassin du Canning, Australie de l'Ouest, comme espèce-type.*

With the exception of the paper on atrypids by Grey (1978), contribution to our knowledge of the Devonian brachiopods from the Canning Basin has been almost nil since the pioneer work by Veevers (1959). In introducing the middle Famennian genus *Hypseloterorhynchus* Sartenaer 1971, the early Frasnian genus *Flabellulirostrum* Sartenaer 1971, and the middle-upper Frasnian genus *Parvulaltarostrum* Sartenaer 1979, the author's goal was threefold: to stress the stratigraphical significance of rhynchonellids which are known to have short biochrons, to indicate that a revision of the already published rhynchonellid genera was needed, and that the establishment of new genera could not be escaped. The new genus proposed here illustrates this triple pursuit.

Superfamily *RHYNCHONELLACEA* Gray, 1848

Family *INCERTAE* sedis

The new genus belongs probably to a new family, which the author does not want to name formally on account of the unsatisfactory state of preservation of most of the material of its type species.

Genus *POLYPTYCHORHYNCHUS* n. gen.

Type species: *Polyptychorhynchus cavernosus* n. sp.

Derivatio nominis: πολυπτυχος,ος,ου (Greek) = forming numerous folds; τορυγχος (Greek, neuter) = beak. The name draws attention to the costation of the shell.

Diagnostic features

Shell thick. Large-sized, fully costate, subelliptical. Apical angle very wide. Sulcus and fold starting near to the beak. Costae simple, in moderate to high number. Width exceeding length and thickness considerably. Hinge plate divided. No septum present.

Species attributed to the genus

Only the type species is attributed to the genus.

Description

Large-sized. Uniplicate. Fully costate. Relatively low. Dorsibiconvex, the brachial valve being markedly higher than the pedicle valve. Outline transversely subelliptical in ventral and dorsal views. Sulcus and fold well marked, and clearly separated from flanks. Sulcus, fold, and costae beginning a short distance from the beak. Commissure sharp and projecting clearly postero-laterally where valve margins are concave. Commissure clearly indented by median and lateral costae. Cardinal line short.

Pedicle valve shallow. Flanks flat to slightly convex, sloping gently from umbonal region almost without relief. Sulcus moderately deep, and relatively narrow. Bottom of sulcus flat to slightly concave. Sulcus starts wide and width increases slowly towards the frontal commissure. Tongue well defined, high, and trapezoidal. Upper part of tongue tending to become vertical or vertical or, exceptionally, slightly recurved. Beak small, wide, slightly incurved, not overhanging the cardinal line. Interarea short, low, clearly separated from flanks. Stout deltidial plates have been observed in serial transverse sections.

Brachial valve moderately high, uniformly convex. Umbonal region slightly extending beyond the pedicle valve (generally) or vertical. Fold moderately high.

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Costae in moderate to high number, clearly marked, wide, simple, regular, rounded or angular with rounded top, and relatively low. One adventitious costa commonly present on each side.

Width is by far the greatest dimension. Top of brachial valve at frontal commissure (generally) or slightly posterior to it. Top of pedicle valve located posteriorly. Maximum width of shell located slightly anterior to mid-length. Very wide apical angle and angle of the cardinal commissure.

Shell thick. Neither septum, nor septalium present. Contour of delthyrial cavity irregular in serial transverse sections. Hinge plate divided, short. Teeth stout, wide, and short. Dental sockets wide with low internal socket ridges. Denticula stout and very developed. Crura slender, curved ventrally at their distal end, and remaining close to each other. In serial transverse sections crura are L(inverted)-shaped in their proximal part and stick-shaped in their distal part.

Comparisons

Polyptychorhynchus n. gen. and the middle and late Famennian [to IV (late middle Famennian) to Vβ (early late Famennian) according to the most reliable and most precise information available] genus *Trifidorostellum* Sartenaer 1961 have a few characters in common, e.g.: subelliptical outline; sulcus and fold beginning near to the beak; width of sulcus; commissure clearly indented by costae; very wide apical angle and angle of the cardinal commissure; neither septum, nor septalium present.

Polyptychorhynchus n. gen. can easily be separated from *Trifidorostellum* by many external and internal characters, e.g.: its larger size; its width considerably larger than its length and thickness, and, accordingly, its very different l/w and t/w ratios; its relatively smaller thickness; its dorsal umbonal region only slightly extending beyond the pedicle valve (in *Trifidorostellum* the dorsal umbonal region generally extends markedly beyond the pedicle valve); its sulcus and fold starting not as near to the beak; its sulcus starting wider; its lower fold and tongue; the upper part of tongue (of which the top is not arched) only exceptionally slightly recurved (in *Trifidorostellum* the upper part of tongue is systematically, then often strongly, recurved); its higher number of costae; its simple median costae (in *Trifidorostellum* median costae are only simple when their ratios are 2/1 or 3/2); the internal lateral costa on each flank is slightly higher than the other lateral costae (in *Trifidorostellum* this is not the case, and the internal lateral costae also commonly stick out at front); its thick shell; the outer hinge plates not inclined towards each other; its differently shaped crura.

Polyptychorhynchus cavernosus n. gen., n. sp.

(Figures 1 to 4)

Giant rhynchonellids - Becker & House 1997, p.140.

Derivatio nominis: *cavernosus, a, um* (Latin) = full of caves. The name draws attention to the camp site, Cave Spring, located near the visited outcrops.

Types : all from Canning Basin, Western Australia.

Remarks (*)

Paratypes EE and FF are the two best preserved specimens, but the available stratigraphical information is not as precise as one would expect. Therefore the holotype has been selected among the poorly preserved specimens from the Casey Falls area, from where 94 per cent of the specimens derive; the stratigraphical information at hand is good to excellent, and the chances to collect more topotypes in the future are also better.

For localities on 1:100,000 topographic maps 4061 (Fitzroy Crossing) and 4160 (Bohemia), and for lithostratigraphical units mentioned in the present paper, see Becker & House (1997, fig.2, p.131, fig.3, p.132). For Tunnel Creek see George & Powell (1997, figs.1, 2, p.936).

Holotype, F50974 (fig. 1, E and F), paratypes A, F50975, B, F50976. Point 701 near Casey Falls, 1:100,000 topographic map 4160 (Bohemia), Emanuel Range. Upper part of Virgin Hills Formation, GSWA 19390B. UD II. Collector: P.E.Playford, 1968.

Paratypes C-G, F50977-50981. Between points 944 and 945, above Casey Falls, 1:100,000 topographic map 4160 (Bohemia), Emanuel Range. Upper part of Virgin Hills Formation, GSWA 19953. UD II or UD III. Collector: P.E.Playford, 1968.

Paratypes H-J, IRScNB a10775-10777. About 2.5 km SE Cave Spring (section L796 of P.E.Playford; Casey Falls section as it is named nowadays), 1:100,000 topographic map 4160 (Bohemia), Emanuel Range. Between 98.15 and 114.30 m (0 m = bottom of a small gully N Millard Creek), WA-69-14a,i,k. Upper part of Virgin Hills Formation regional, Upper *Palmatolepis quadrantinodosa* Zone (Upper *P. marginifera* Zone in subsequent terminology; Late *P. marginifera* Zone in present terminology). Collector: P.Sartenaer, 1969.

Paratypes K-O, F50982-50986, lower part of bed 33, GSWA 109200a; paratypes P, Q (fig.4), R, S, F50987-50990, bed 35a, GSWA 109200b; paratypes T-Y, F50991-50996, bed 35b, GSWA 109306a; paratypes Z, AA-DD, F50997-51001, lower two metres of bed 37a, GSWA 109306b. Casey Falls section, 1:100,000 topographic map 4160 (Bohemia), Emanuel Range. Upper part of Virgin Hills Formation, *Pernoceras delepinei* Zone (UD III-A2). Collectors: R.T.Becker and M.R.House, 1990.

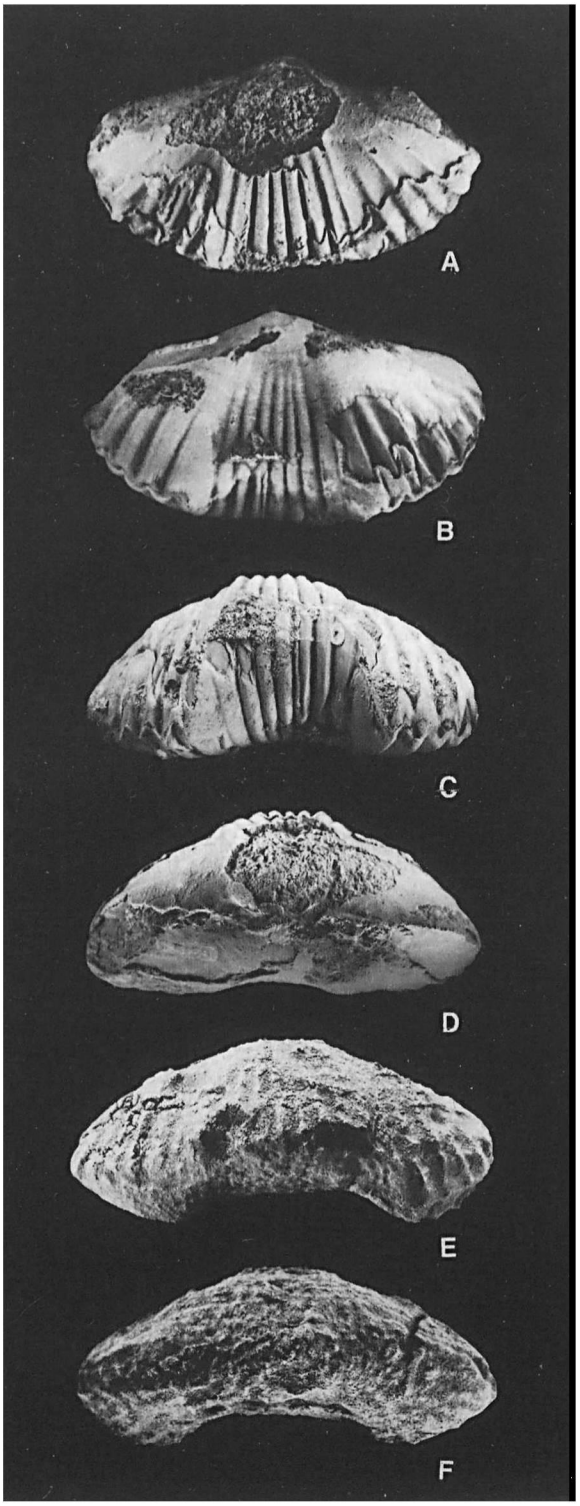
Paratype EE, IRScNB a10778 (fig. 2 and 3). Southwest side of Mount Pierre, West Kimberley, 1:100,000 topographic map 4061 (Fitzroy Crossing). Virgin Hills Formation, lowest rhynchonellid horizon, 7 feet above flat. Collector: C.Teichert, 1941. This specimen numbered A24 (26065) in the collection of the Geology Department of the University of Western Australia, was presented to the author by Patrick J. Coleman.

Paratype FF, F51002 (fig.1, A to D). Tunnel Creek, 1:100,000 topographic map 3962 (Leopold Downs), Napier Range. Napier Formation. Collectors: P.E.Playford and D.C.Lowry, 1964.

(*) GSWA and F = Geological Survey of Western Australia, Perth. IRScNB = Belgian Royal Institute of Natural Sciences, Brussels.

Fig. 1. — All figures are natural size.
A-D, paratype FF, F51002. Ventral, dorsal, frontal and apical views; costal formula: $\frac{8}{7}$; 0; $\frac{7}{8}$.
E-F, holotype, F50974. Frontal and apical views; costal formula: $\frac{11}{?}$; 0; $\frac{7}{?}$.

Fig. 1. — Toutes les figures en grandeur naturelle. A-D, paratype FF, F51002. Vues ventrale, dorsale, frontale et apicale; formule des côtes: $\frac{8}{7}$; 0; $\frac{7}{8}$.
E-F, holotype, F50974. Vues frontale et apicale; formule des côtes: $\frac{11}{?}$; 0; $\frac{7}{?}$..



Locus typicus: Point 701 near Casey Falls, 1:100,000 topographic map 4160 (Bohemia), Emanuel Range, Canning Basin, Western Australia.

Stratum typicum: Upper part of Virgin Hills Formation. UD II. This is a satisfactory age assigned at a time (1968) when pioneer work was still being carried out in the Canning Basin. A more precise age (UD III-A2), recently fixed in the Casey Falls section near by, is now available (see under Types).

Material: 31 of the 33 available specimens are in poor state of preservation (see fig.1, E and F), although good serial transverse sections could be obtained from one of them (Fig.4); seven of them are fragmental, and two mere fragmental external molds. The two remaining specimens (paratypes EE, FF) are in good to satisfactory state of preservation; one of them has been photographed (fig.1, A to D), and serial transverse sections were made in the other (fig. 2 and 3).

Description

This refers only to specific characters in need of further elaboration.

Sulcus starting at 16 to 30 per cent of shell length or 19 to 25 per cent of the unrolled length of the valve. Sulcus starting with a width of 20 to 30 per cent of its width at front, and reaches its greatest width (52 to 68 per cent of the shell width, most of the values varying from 54 to 64 per cent) at the junction of the frontal and lateral commissures.

Length of ventral interarea varying from 38 to 45 per cent of shell width.

The general costal formula, which is a grouping of at least 75 per cent of the specimens in median, parietal, and lateral categories, is $\frac{8 \text{ to } 12}{7 \text{ to } 11}$; 0; $\frac{6 \text{ to } 8}{7 \text{ to } 9}$. Ratios of median costae are as follows: 8/7: 4sp.(16.5%); 9/8: 6sp.(25%); 10/9: 3sp.(12.5%); 11/10: 5sp.(21%); 12/11: 4sp.(16.5%); 13/12: 2sp.(8.5%) (Remark: adventitious costae have been counted as median costae). Ratios of lateral costae are as follows: 5/6: 1sp.(6%); 6/7: 4sp.(23.5%); 7/8: 6sp.(35%); 8/9: 4sp.(23.5%); 9/10: 1sp.(6%); 10/11: 1sp.(6%). A divided median costa has been observed in two specimens, and a divided lateral costa also in two specimens. Median costae begin either somewhat anterior to, or somewhat posterior to, or on a level with the beginning of sulcus and fold. Width of costae at front varies between 2 and 4 mm, generally between 2 and 3 mm.

Measurements of 12 specimens, of which two have been photographed, are given on Table 1.

Width exceeds by far (often more than two times) length and thickness, which have similar values. Maximum width occurs at a point between 49 and 59 per cent (exceptionally 42 and 64 per cent) of the shell length anterior to the ventral beak. Top of pedicle valve located posteriorly at a variable point between 20 and 25 per cent of the shell length. Frontal commissure is located at a point varying between 61 and 92 per cent posterior to point of maximum length. Apical angle varying from 140° to 155°. Angle of the cardinal commissure varying from 148° to 166°.

Serial transverse sections of paratype EE (IRScNB a10778) are shown in figures 2,3. Because this paratype is the only specimen found so far at Mount Pierre, and also because some internal structures are distorted and obscured (especially the deltidial plates, the dental plates, and the umbonal cavities), due to unsatisfactory preservation,

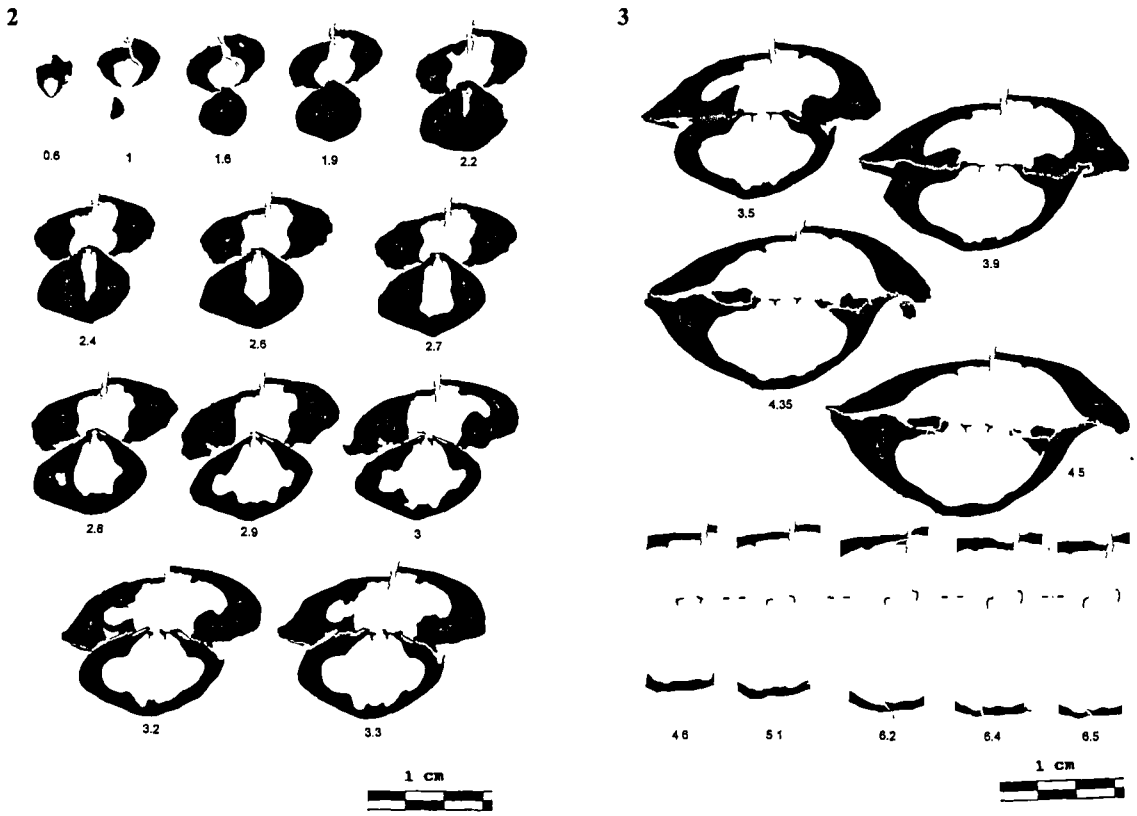


Fig. 2 and 3. — *Polyptychorhynchus cavernosus* n. gen., n. sp.
Camera lucida drawings of serial transverse sections; figures are distances in mm forward of the ventral umbo.
Paratype EE, IRScNB a 10778. Measurements: length = (24) mm; width = (41.5) mm; thickness = (23.2) mm.

Fig. 2 et 3. — Sections sériées transverses dessinées à la chambre claire; les chiffres indiquent les distances en mm depuis l'umbo ventral. Paratype EE, IRScNB a10778. Dimensions: longueur = (24) mm; largeur = (41.5) mm; hauteur = (23.2) mm.

in mm	Paratype EE a10778	Paratype M F50984	Paratype L F50983	Paratype FF F51002	Paratype U F50992	Paratype S F50990	Holotype F50974	Paratype R F50989	Paratype Q F50988	Paratype A F50975	Paratype T F50991	Paratype C F50977
w	(41.5)	(47.8)	(52.9)	(53.1)	54.5	(55.2)	(56.1)	(57)	(58.8)	(59.8)	(61.4)	(61.9)
l	(24)	(27.9)	(25.2)	(27)	28.6	(25.1)	(27)	(28.2)	(30)	(29.3)	(31.9)	(28.9)
lpv unrolled	?	(39)	?	(44)	(53.5)	(43)	(44)	(46.5)	(48)	(43.5)	(46.5)	(42.5)
t	(23.2)	(21.6)	(27.2)	25.6	32.9	(23.6)	(26.8)	(25.8)	(25)	(22.5)	(26.5)	(26.8)
tpv	(6.8)	(6)	(5.8)	7.5	8.3	(6.5)	(7.3)	8.5	7	(6.5)	(7.8)	(6.7)
tbv	(16.4)	(15.6)	(21.4)	18.1	24.6	(17.1)	(19.5)	(17.3)	(18)	(16)	(18.7)	(20.1)
l/w	(0.58)	(0.58)	(0.48)	(0.51)	0.52	(0.45)	(0.48)	(0.49)	(0.51)	(0.49)	(0.52)	(0.47)
t/w	(0.56)	(0.45)	(0.51)	(0.48)	0.60	(0.43)	(0.48)	(0.45)	(0.43)	(0.38)	(0.43)	(0.43)
t/l	(0.97)	(0.77)	(1.08)	(0.95)	1.15	(0.94)	(0.99)	(0.91)	(0.83)	(0.77)	(0.83)	(0.93)
apical angle	?	145°	?	148°	145°	?	?	(143°)	147°	?	155°	?
angle of the commissure	?	150°	?	156°	152°	?	?	?	158°	(149°)	166°	?

Table I. — Measurements (in mm) based on twelve specimens; figures in parentheses are reasonable estimates on damaged specimens.
Abbreviations used: l = length; w = width; t = thickness; pv = pedicle valve; bv = brachial valve.

Tab. I. — Mesures (en mm) basées sur douze specimens; les chiffres entre parenthèses correspondent à des estimations raisonables faites sur des spécimens endommagés. Abréviations utilisées: l = longueur; w = largeur; t = hauteur; pv = valve pédonculaire; bv = valve brachiale.

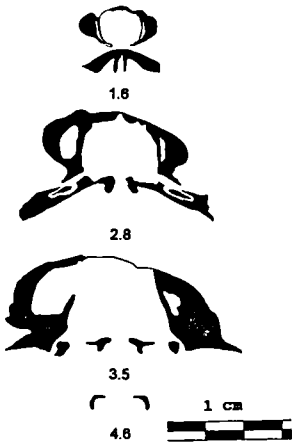


Fig. 4. — *Polyptychorhynchus cavernosus* n. gen., n. sp. Camera lucida drawings of serial transverse sections; figures are distances in mm forward of the ventral umbo. Paratype Q, F50998. Measurements: length = (30) mm; width = (58.8) mm; thickness = (25) mm. Sections show the deltidial plates that are obscured in figure 2, and the dental plates that are only indirectly indicated by umbonal cavities and dental spurs in figures 2 and 3.

Fig. 4. — Sections sériées transverses dessinées à la chambre claire; les chiffres indiquent les distances en mm depuis l'umbo ventral. Paratype Q, F50998. Dimensions: longueur = (30) mm; largeur = (58.8) mm; hauteur = (25) mm. Les sections montrent les plaques deltidiales, qui sont cachées dans la figure 2, et les plaques dentales, qui ne sont qu'indirectement indiquées par les cavités umbonales et les ergots dentaires dans les figures e et 3.

serial transverse sections were made in a topotype (paratype Q, F50988). Four of these sections are given in figure 4.

Geographical location and stratigraphical position

The bulk of the material (31 out of 33 specimens) derives from the upper part of the Virgin Hills Formation in the Casey Falls area in the Emanuel Range. As can be read under Types, the stratigraphical information has been consistent since 1964 while becoming progressively more precise. In a paper in preparation Becker & House give a detailed log of the Casey Falls section, and describe its ammonoids. Some information contained in this paper is used here in conjunction with data already published by Becker & House (1997, fig.3, p.132, fig.5, p.134, fig.7, p.137, fig.8, p.141, fig.9, p.142) and allows workers to locate stratigraphically the 20 specimens of *Polyptychorhynchus cavernosus* n. gen., n. sp. that these authors collected in the section. Beds containing these specimens (see under Types) represent a thickness of 5.90 m between 35.02 and 40.92 m above the Casey Falls Biostrome. In terms of the ammonoid zonation these rocks belong to the *Prolobites* Stufe (UD III), more precisely to the *Pernoceras delepinei* Zone (UD III-A2). UD III is divided into three parts -A to C from base to top - and extends, in terms of the conodont zonation, from the upper part of the Middle *Palmatolepis marginifera* Zone to the lower part of the Late *P. trachytera* Zone. UD III-A2 straddles the topmost Middle and the lowermost Late *P. marginifera* Zones.

The two remaining specimens (paratypes EE, FF) derive from the Virgin Hills Formation at Mount Pierre, and from the Napier Formation at Tunnel Creek in the Napier Range. No further information is available. These localities are located, respectively, at about 55 km and about 206 km NW of Casey Falls.

Paratypes H-J, and Z, AA-DD of *Polyptychorhynchus cavernosus* n. gen., n. sp. are associated with *Nyege scopimus* Veevers, 1959, but this association can only be accepted with the following restrictions. Veevers [1959, pp.20-21, table 1, fig.3, p.24 (= fig.6, p.26 *in* Rattigan & Veevers, 1961)] established the mid-Famennian "zone of *Nyege scopimus*" (or "*scopimus* zone") based on a new genus and a new species, and considered the species "a very important index fossil" "associated with both upper and lower "*Sporadoceras*" zone fossils". He collected the species in the Virgin Hills Formation (essentially in the uppermost beds), in the lower half of the Bugle Gap Limestone, and in the Napier Formation. Roberts & Jones (*in* Roberts *et al.*, 1972, p.471, p.472, p.474) confirmed this age in adding the following precision: "to II-to IIIa". This is also the conclusion reached by the author according to the conodont samples collected in the section he studied in 1969 (see under Types). *Nyege scopimus* was found between 51.35 and 52.60 m, and between 98.15 and 176.80 m, with coquinites at 51.35 (40 cm), 52.60 (3 cm), and 108.20 m (4 cm); in terms of the conodont zonation, the species was found from the *Palmatolepis rhomboidea* to the Upper *P. quadrantinodosa* Zones (from the Upper *P. rhomboidea* to the Upper *P. marginifera* Zones in subsequent terminology; from the Late *P. rhomboidea* to the Late *P. marginifera* Zones in present terminology). The 40 cm thick coquinite indicates that this is the level of the main bed of *Nyege scopimus* in the Wapet C section as indicated by Becker & House (1997, fig.7, p.137); this level corresponds to the middle part of UD II-G, i.e. to the *Maeneceras* Genozone and the Early *marginifera* Zone. If a thickness of 125.45 m is accepted for the range zone in the section, then the association mentioned above only occurs in its middle part (between 98.15 and 114.30 m; see under Types). A more important matter is of systematical order at the generic and specific level. Is *Nyege* Veevers, 1959 a valid genus? Is *Nyege* encompassing more than one genus? Is *N. scopimus* encompassing more than one species? This is not the place to deal with these problems. Suffice it to recall that the author has given a hint (1967, p.1054; 1969, p.171; *in* Ferrari & Vai, 1973, p.184).

In the Casey Falls section the *Polyptychorhynchus cavernosus* Zone occurs a few metres above the rocks containing *Hypseloterorhynchus pennatus* Sartenaer 1971 (*H. pennatus* Zone). The latter zone is proposed here for the first time.

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BIBLIOGRAPHIE

BECKER R.T. and HOUSE M.R. (1997). — Sea-level changes in the Upper Devonian of the Canning Basin, Western Australia. In: *On sea-level fluctuations in the Devonian* (M.R.House & W.Ziegler, eds.). *Courier Forschungsinstitut Senckenberg*, 199, p.129-146, 9 fig. Frankfurt am Main.

GEORGE A.D. and POWELL C.McA. (1997). Paleokarst in an Upper Devonian reef complex of the Canning Basin, Western Australia. *Journal of Sedimentary Research, A, Sedimentary Petrology and Processes*, 67 (5): 935-944, 9 fig. Tulsa.

GREY K. (1978). — Devonian atrypid brachiopods from the reef complexes of the Canning Basin. *Report of the Geological Survey of Western Australia*, 5, 71 p., 25 fig., 5 pl., 5 tab. Perth.

FERRARI A. and VAI G.B. (1973). — Revision of the Famennian rhynchonellid genus *Plectorhynchella*. *Giornale di Geologia*, 39 (1), 1971, p.163-220, 17 fig., pl.20-25. Bologna.

RATTIGAN J.H. and VEEVERS J.J. (1961). — Devonian. In: *The geology of the Canning Basin, Western Australia* (J.J.Veevers and A.T.Wells). *Bulletin of the Bureau of Mineral Resources, Geology and Geophysics*, 60, p.22-61, fig.5-37, tabl.3. Sydney.

ROBERTS J., JONES P.J., JELL J.S., JENKINS T.B.H., MARSDEN M.A.H., McKELLAR R.G., McKELVEY B.C. and SEDDON G. (1972). — Correlation of the Upper Devonian rocks of Australia. *Journal of the Geological Society of Australia*, 18 (4), p.467- 490, 1 fig., 1 chart. Sydney.

SARTENAER P. (1961). — Late Upper Devonian (Famennian) rhynchonelloid brachiopods. *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, 37 (24), 10 p., 2 pl. Brussels.

SARTENAER P. (1967). — Famennian rhynchonellid brachiopod genera as a tool for correlation. In: *International Symposium on the Devonian System, Calgary* (D.H.Oswald, ed.), 2, p.1043-1060, 3 fig., 1 pl. Calgary.

SARTENAER P. (1969). — Late Upper Devonian (Famennian) rhynchonellid brachiopods from Western Canada. *Bulletin of the Geological Survey of Canada*, 169, 269 p., 47 fig., 19 pl. Ottawa.

SARTENAER P. (1971). — Genres Rhynchonellides (Brachiopodes) nouveaux. *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, 47 (4), 7 p., 1 fig., 1 pl. Brussels.

SARTENAER P. (1979). — *Parvulaltarostrum*, genre Rhynchonellide (Brachiopode) nouveau du Frasnien de l'Australie de l'Ouest. *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, 51, *Sciences de la Terre*, 16, 4 p. Brussels.

VEEVERS J.J. (1959). — Devonian brachiopods from the Fitzroy Basin, Western Australia. *Bulletin of the Bureau of Mineral Resources, Geology and Geophysics*, 45, 220 p., 102 fig., 18 pl., 1 map. Canberra.

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