RUGOSE CORALS FROM THE CARBONIFEROUS OF NORTHERN PALENCIA (SPAIN)

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CONTENTS

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ABSTRACT

From Carboniferous deposits exposed on the southern slope of the Cantabric mountain chain, 58 rugose coral species are described. The rugose coral fauna of this area is not yet completely known. 32 of the species are new, 13 are unnamed and 12 are identical with or closely related to Upper Middle Carboniferous species from the Moscow and Donetz basins of Russia. These species have a fairly long stratigraphic range and their occurrence is largely conditioned by favourable environment.

Hillia is erected as a subgenus of *Lithostrotionella*. New genera have not been founded, existing genera have been interpreted rather widely. The species recorded belong to the following genera or subgenera: *Rotiphyllum, Bradyphyllum, Amplexocarinia, Polycoelia, Sochkineophyllum, Ufimia, Cyathaxonia, Lophophyllidium, Stereostylus, Zaphrentites, Duplophyllum?, Euryphyllum, Lithostrotion, Arachnastraea, Clisiophyllum, Dibunophyllum, Koninckophyllum, Corwenia, Pseudozaphrentoides, Bothrophyllum, Lonsdaleia, Lithostrotionella, Hillia, Koninckocarinia, Carcinophyllum, Axolithophyllum, Lonsdaleoides, Amygdalophylloides, Ivanovia.*

The distribution of the corals in the Carboniferous of Palencia is shown on Tables I to III (p. 108). The age of the formations from which the corals were obtained ranges from the Namurian up into the Westphalian D, as established by goniatite and plant evidence, or from the Bashkirian to the Upper Moscovian on fusulinid evidence.

INTRODUCTION

The corals described in this paper have been collected in the northern part of the province of Palencia. They were obtained during geological field work in an area which forms part of the southern slope of the Cantabric mountain chain by students from Leiden University. This area is for the greater part covered in the studies of Wagner & Wagner-Gentis (1952, 1963), Wagner (1955, 1960) and Nederlof (1960). In these works many data on the geology and the stratigraphy of this region are given and full reference is made to earlier studies.

The collections of Carboniferous corals from northern Palencia contain numerous rugose and tabulate corals. The study here presented concerns solely the rugose corals. Of these a selected number will be described. It is believed that they represent the most common elements of the Carboniferous rugose coral fauna of this region.

Previous work on Carboniferous corals from northern Spain

Barrois (1882) in his classical study on northern Spain, described a.o. a number of Carboniferous corals from Asturias. Barrois' descriptions and figures, made in a time when corals were investigated in a different way, do not permit to ascertain whether the species named by him are identical with some of those mentioned in this paper. Comparison of the specimens concerned has as yet not been undertaken.

Grosch (1912) lists a number of Carboniferous coral species from the Picos de Europa. The species listed as such, unaccompanied by any figures, have not been recognized in the material from Palencia.

Weissermel (1937) was the first to describe Carboniferous rugose corals from Palencia. His specimens were collected in the neighbourhood of San Cebrián. One of his species, *Amygdalophyllum quiringi*, is redescribed in this paper as *Carcinophyllum* (*Axolithophyllum*) *quiringi* (Weiss.). The other species, *Zaphrentis* sp. from the Sierra Corisa limestone, is possibly identical with *Euryphyllum hispanicum* spec. nov., judging from the one section figured by Weissermel.

Sampelayo (1950) described from the Upper Dinantian of Asturias a specimen as *Dorlodotia* cf. *delepinei* Charles. Similar specimens have not been found in the Carboniferous of Palencia.

Stratigraphy

The stratigraphic sequence of the Carboniferous strata of northern Palencia is fully treated in Mr. and Mrs. Wagner's forthcoming publication. They kindly allowed me to use some of their data, which are incorporated in the review of the Carboniferous formations recognized in this area (further after Wagner, 1962):

Stephanian B	Peña Cildá formation
Asturian phase	
Stephanian A	Barruelo formation San Cristóbal coal-measures

	Leonian phase	
Westphalian D		Sierra Corisa limestone Cotarraso limestone San Cebrián coal-measures
Westphalian C?		Vañes formation, incl. Socavón limestone
Upper Westphalian B		Curavacas formation
	Palentian phase	
Westphalian A?		Carmen formation
	unconformity	
Namurian		Perapertú formation
	unconformity	
		Santa María limestone
Visean-Lower Namurian		Villabellaco limestone

The age determinations are the result of R. H. Wagner's palaeobotanical studies, laid down in various publications and of C. H. T. Wagner-Gentis's goniatite identifications (in Wagner, 1955; Wagner-Gentis 1960, 1963).

The coral-bearing lithostratigraphic units will be briefly referred to.

The Santa María limestone crops out near the village of Santa María de Nava. Its relation to the surrounding Carboniferous deposits is discussed by Wagner & C. H. T. Wagner-Gentis (1963).

The Perapertú formation consists of shales with reef-knolls or bioherms, which are described by Wagner & C. H. T. Wagner-Gentis (1952). The relation of the Perapertú formation to the Caliza de Montaña, developed further westwards, is treated by Wagner in another paper (Wagner, 1959).

The Vañes formation contains sandy shales and intercalated limestone beds. It is well exposed near the coal-mine of San Cebrián. Wagner (1955) described this unit as forming part of the San Cebrián formation. It was named Vañes formation by De Sitter (1957), who argued that the San Cebrián coal-measures lie stratigraphically at the base of the next formation and have to be separated from the underlying shales and limestones. Most corals, described from the Vañes formation, are from a limestone bed which lies just below the San Cebrián coal-measures. Quiring (1939) referred to it as "Korallenbank mit Amygdalophyllum quirini". Wagner & Wagner-Gentis (1963) name it Socavón limestone, after the "socavón" (= tunnel) of the mine of San Cebrián, which cuts through the limestone. They regard the Socavón limestone as the highest member of the Vañes formation.

The Cotarraso limestone directly overlies the San Cebrián coal-measures, which Wagner (1955) dated as lower Westphalian D. According to fusulinid determinations by A.C. van Ginkel (in Nederlof, 1960 and pers. comm.) various limestones in the northern part of the area correspond in age to the Cotarraso limestone. These will be discussed later.

The Sierra Corisa limestone is separated from the Cotarraso limestone by a zone of shales and sandstones. These three units vary considerably in thickness. The Sierra Corisa limestone is succeeded by the San Cristóbal coal-measures, dated by Wagner as lower Stephanian A (Wagner & Breimer, 1958). Several aspects of these Westphalian D limestones are discussed in detail by Nederlof (1960).

GEOLOGIC SETTING OF THE AREA, SHOWING MOST IMPORTANT LIMESTONE OUTCROPS AND INDICATING FOSSIL-LOCALITIES (after Wagner, 1960 and Nederlof, 1960)

0 1 2 3 4 5 km.

Mesozoic
Stephanian
Westphalian D and Stephanian A coal-measures
VA Vañes formation
P Perapertú formation
S.M. Santa María limestone
V Villabellaco limestone
Devonian

N

Piedras Luengas
Casavegas
Peña Abismo
S. Juán de Redondo
Sta María de Redondo
Peña del Moro
Peña Tremaya
Verdiana
Sosa
Peña Tejedo
Celada
Verdeña
Río Pisuerga
Cotarraso
S. Felices
Herreruela
Sierra Corisa
Vañes
S. Cristóbal
Alto Sierra
Vergaño
Rabanal
P
VA
S. Cebrián
Perapertú
Peña Cildá
S. Martín
Barruelo de Santullán
Brañosera
Villabellaco
V
Vallejo
S.M.
Sta María de Nava
Verbios
Orbó
Mudá
Cervera de Pisuerga
Río Rubagón

SYSTEMATIC DESCRIPTIONS

Introductory note. The classification of the Rugosa, proposed by Hill (1956), is adopted in this paper, with some minor variations. The terminology, used in describing rugose corals, is also for the greater part after Hill (1956) with additions by several authors. Diagnoses of families and genera are given, in order to avoid needless repetitions when describing the species. The stratigraphic and geographic range of a genus, as far as it has been recorded in previous literature, is given under the heading: occurrence.

The text-figures are schematic drawings. The transverse sections illustrate the septal plan, other elements are left out. In sections with very thick septa only the septal lines and the interseptal spaces are indicated. The protosepta are marked by short lines. The lettering of the sections starts from the proximal end. The size of the enlargements mentioned is in many cases approximate.

All specimens mentioned are registered in the "Rijksmuseum van Geologie en Mineralogie" at Leiden, The Netherlands, under the numbers 112501—112800.

Ordo RUGOSA
Subordo STREPTELASMATINA
Superfamilia CYATHAXONIICAE
Familia METRIOPHYLLIDAE Hill, 1939

Diagnosis. Small, solitary Rugosa with marginarium a very narrow stereozone. All major septa unite at the axis with axial end of counter septum, swollen in some forms; counter pseudofossula may be present; minor septa short; the septa may be flanged parallel to their calycal edges; tabulae distant (after Hill, 1956).

Genus ROTIPHYLLUM Hudson, 1942

Type-species. Densiphyllum rushianum Vaughan, 1908, from the Visean of Ireland.

1953 *Stereolasma* Simpson — Fomichev, p. 96
1953 *Monophyllum* gen. nov. — Fomichev, p. 110

Diagnosis. Metriophyllid coral with at first a zaphrentoid stage and later with evenly-spaced, radial, major septa which meet axially and form a stereocolumn; counter septum may be longer than others; near the calyx septa may withdraw from centre (after Hudson).

Remarks. Schindewolf (1952, p. 177) regards *Rotiphyllum* as a synonym of *Fasciculophyllum* Thomson, 1883. But *Fasciculophyllum* is characterized by a palmate grouping of the septa and lacks a stereocolumella (Thomson, 1883, p. 448; Hudson, 1942, p. 260).

It must be added that the genus *Fasciculophyllum* is not adequately known; it is not certain if Hudson's further interpretation of the genus is correct. Judgment

thereon must be suspended till a neotype of the type-species *F. dybowskii* Thomson has been found. The specimens on which Thomson based this species have been lost in a fire which partly destroyed the Thomson collection (Hill, 1940, p. 130).

Occurrence.	Dinantian	British Isles
	Mississippian	N. America
	Middle Carboniferous	Russia — Ural Mts., Donetz basin
	Permo-Carboniferous	Spitsbergen
	Lower Permian	Russia — Ural Mts.
		?N. Zealand

Rotiphyllum exile spec. nov.

Pl. 1, figs. 1, 2; text-fig. 1

Diagnosis. Rotiphyllum in which all septa, including counter, are irregularly withdrawn from the centre near the calyx; counter quadrants accelerated.

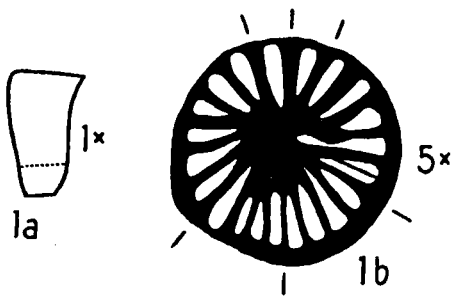


Fig. 1. *Rotiphyllum exile* spec. nov. holotype RGM no. 112501. a, outline, showing position of section b.

Description. The corals are about 15 mm long, and reach a diameter of 7 to 9 mm. They are nearly straight or slightly curved. The alar septa lie in the latter case on the concavo-convex sides.

In early stages at a diameter of ca. 4 mm with 16 to 20 septa, the septa are pinnately arranged. They are very thick and near the centre they are joined together, where they form a solid mass. The cardinal septum is somewhat thinner and mostly the fossular break is apparent.

Further in the ontogeny, at a diameter of 5—7 mm with 20 to 23 septa, the septa become thinner and more radially arranged, axially united in a stereocolumn, as is typical for *Rotiphyllum*. Just below the calyx the septa retreat a little from the centre. Often the septa of two quadrants remain joined with their axial ends. In a few specimens all septa are joined that way, forming around the centre a small ring, which is quite soon broken up again. The cardinal septum does not differ much in length from the metasepta: in calycular sections it may be a little shorter. The counter septum, if at all differing from the other septa, is only slightly longer.

Near the calyx, at a diameter of 7 to 8 mm there are 22 to 24 major septa. The counter quadrants number 3 tot 6 metasepta more than the cardinal quadrants. Minor septa appear late and are poorly developed, appearing only as short ridges on the wall.

Remarks. These corals show a general resemblance with some forms from the Moscovian of the Donetz basin, described by Fomichev as *Stereolasma monophylloides* (Fomichev, 1953, p. 101, Pl. 3, figs. 11 a—d). In the Russian specimens, however, no septa of the second order are developed. Hill (1957, p. 51) was the first to indicate that the species described by Fomichev under *Stereolasma* Simpson and *Monophyllum* Fomichev belong to the genus *Rotiphyllum.*

Another species in which the septa do not remain joined in a stereocolumn, is *Rotiphyllum granulare* from the Upper Visean of Great Britain. Here "all septa, except the counter retreat from the axis, leaving a central axial tube surrounded by the joined axial ends of the septa" (Hudson & Fox, 1943, p. 108). Such an axial tube may occasionally be formed in the Spanish corals, but it does not form a constant feature. Besides, in *R. granulare* the counter septum remains long and has a strongly lobed axial end.

Material. The holotype, specimen st. no. 112501, and several other specimens, st. no. 112501—112508, are from the Sierra Corisa limestone, coll. R. H. Wagner, loc. 58, near the Corisa triangulation point. Specimens st. no. 12509—12510 are from a lower part of the Sierra Corisa limestone, coll. D. Boschma, near Vergaño.

Rotiphyllum aequabile spec. nov.

Pl. 1, figs. 3, 4; text-figs. 2, 3

Diagnosis. Rotiphyllum with septa withdrawn from the centre near the calyx; counter quadrants not accelerated; in young stages a counter pseudofossula.

Description. The corals are about 25 mm long and reach a diameter of 9 mm. Their form is cornute or like a narrow cone, slightly curved. The alar septa lie on the concave and convex sides. The calyx is rather deep.

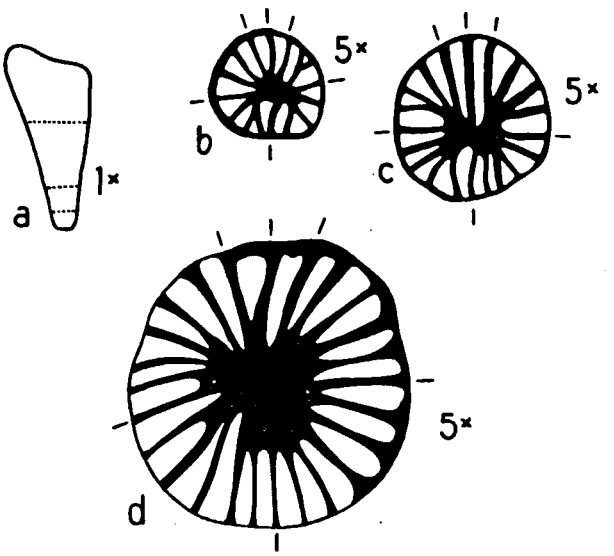


Fig. 2. *Rotiphyllum aequabile* spec. nov. holotype RGM no. 112511. a, outline, showing position of sections b—d.

In the early stages the cardinal fossula is well-marked, it is parallel-sided or expanding axially, when the metasepta are curved concave to the cardinal septum. Sometimes alar breaks are apparent too. The counter septum and the counter-laterals lie nearly parallel to each other and thus a pseudofossula is suggested, which in a few cases extends nearly to the centre, where all septa are joined in a stereo-column. In later stages the septa are more radially disposed. After rejuvenation the old pattern may recur.

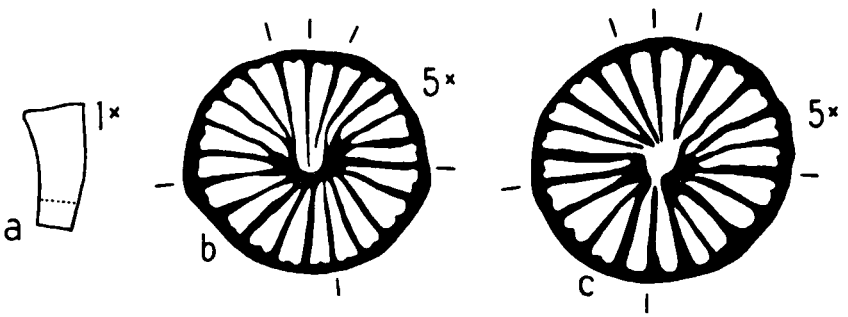


Fig. 3. *Rotiphyllum aequabile* spec. nov. paratype RGM no. 112513. a, outline; b, c, proximal and distal side of section, indicated in a. The coral is distally crushed.

Near the calyx the septa retreat from the centre. The cardinal septum which has remained long during the whole ontogeny, shortens. The counter septum is long, compared with the other septa of the counter quadrants, which are shorter than those of the cardinal quadrants. The metasepta are equally divided over the quadrants, otherwise the cardinal quadrants number one or two septa more.

The measurements and number of septa for the type-specimen are:

diameter	number of septa	division of metasepta
7—9 mm	25	$\frac{4\|5}{5\|5}$
5—6 mm	22	$\frac{4\|4}{4\|4}$
4 mm	20	$\frac{3\|3}{4\|4}$
3 mm	16	$\frac{2\|2}{3\|3}$
2 mm	14	$\frac{2\|2}{2\|2}$

Rudimentary minor septa are present. For the greater part they remain buried in the wall, near the calyx they appear as short ridges on it. The wall is not very thick. The tabulae rise steeply from the wall and are flat or sagging in the central part.

Remarks. In the development of the counter pseudofossula, *Rotiphyllum aequabile* resembles *Rotiphyllum costatum* (McCoy) from the British Visean. In the latter species, however, the counter pseudofossula is characteristic of the late ephebic stage, while in the Spanish specimens it is present before the corals reach maturity, and disappears later.

Material. The holotype, st. no. 112511, and specimens st. no. 112512—112513 are from the Sierra Corisa limestone, coll. R. H. Wagner, loc. 58.

Genus BRADYPHLYLLUM Grabau, 1928

Type-species. Bradyphyllum bellicostatum Grabau, 1928, from the Moukou formation (Middle Carboniferous) of Kansu, China.

Diagnosis. Metriophyllid coral with in the young stages septa first joining in a stereocolumn, later retreating from the centre; septa about equal in length with possible exception of a shortened cardinal septum and a lengthened counter septum.

Remarks. The concept of the genus *Bradyphyllum* is based on the description and figured sections of the holotype of *Bradyphyllum bellicostatum*: Grabau, 1928, p. 39, Pl. 2, figs. 11a—e. Grabau's other described and figured examples of the species are rather divergent and partly in contrast with his description of the holotype. Fig. 12c shows the calyx of a specimen where, according to Grabau, the counter septum is quite aborted, fig. 17 shows the calyx of another specimen with a much lengthened counter septum. Figs. 18a—e show sections where the septa are radially arranged and centrally united but without forming a distinct stereocolumn. Fomichev (1953, p. 118) considers these sections as typical of his species *Monophyllum parvum.*

Grabau in his description of the genus, stresses the shortening of both cardinal and counter septa in adult stages. The figured sections of the holotype of the type-species *B. bellicostatum* Grabau, show that the counter septum is not shortened, in fact it is in some sections a little longer than the neighbouring septa.[1])

Occurrence.	Mississippian	N. America
	Middle Carboniferous	China
		Russia — Donetz basin
	Upper Carboniferous	Russia — Donetz basin
	Pennsylvanian	? N. America — Oklahoma
	Lower Permian	Asia — Salt Range, China

[1]) Recently, Easton (1962) has given another interpretation of Bradyphyllum. According to him, Grabau wrongly assumed that a stereocolumn is present in these corals from studying sections taken in the tabular plane. Easton's emendation to assign corals without a stereocolumn in the young stages to Bradyphyllum, is not followed here. Mislead perhaps by the lettering of Grabau's figures, Easton remarks that the stereocolumn is discontinuously distributed in the holotype of Bradyphyllum bellicostatum. Yet the stereocolumn is shown in the earliest section of the specimen (Grabau, 1928, Pl. 2, fig. 11c) and it is absent in later sections (ibid., figs. 11b, d, e).

Bradyphyllum oppositum Fomichev, 1953

Pl. 1, fig. 5; text-fig. 4

1953 *Bradyphyllum oppositum* sp. nov. — Fomichev, p. 130, Pl. 5, figs. 6, 7.

Description. The coral is nearly straight, for the greater part cylindrical and about 30 mm long. The apical portion is incomplete, it is conical and slightly curved. In this part the alar septa lie in the plane of curvature. The lowest section obtained measures 3.5 mm in diameter, the number of septa is 23. The septa are moderately thick and more or less radially arranged, their axial ends are fused together, making up a stereocolumn.

A slightly higher section, still in the curved part, has 25 septa at a diameter of 7—8 mm. The septal arrangement is less regular. The axial ends are still partially joined, but a small space in the centre has become free. The septa lying on the concave side of the coral tend to be longer than those on the opposite side, the former have their axial ends curved concave to the cardinal septum, the latter convex. The counter septum is slightly longer than its neighbouring septa. The cardinal septum is just as thick and about as long as the other septa.

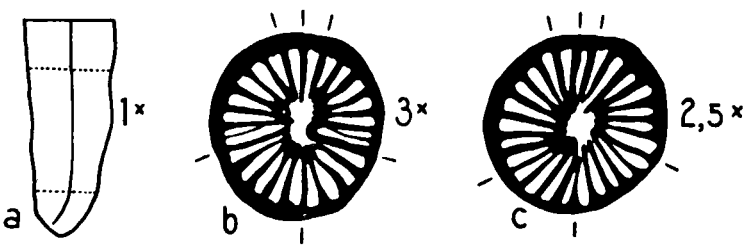


Fig. 4. *Bradyphyllum oppositum* Fomichev. RGM no. 112514. a, outline, showing position of cardinal septum and of sections b and c.

In the cylindrical part of the coral the septa are about equal in length and thickness and radially arranged, leaving the centre unoccupied. The counter septum is in some sections slightly longer than those in the immediate vicinity. The cardinal septum thins and shortens only near the calyx. The wall is rather thick, septa of the second order are developed but they scarcely protrude from the wall. The tabulae are incomplete and steeply raised near the periphery, in the central part they are flat or sagging.

Remarks. This coral resembles closely the Moscovian and Gzhelian forms from the Donetz basin, described by Fomichev as *Bradyphyllum oppositum* (Fomichev, 1953, p. 130, Pl. 5, figs. 6, 7). Fomichev compares the septal arrangement in the young stages of this species with that of *Rotiphyllum densum* Carruthers (as figured in Carruthers, 1908, p. 29, Pl. 4, figs. 7, 8): inner ends of the septa concave to the cardinal septum, cardinal septum thinner than the others, septa of the cardinal quadrants shorter than those of the counter quadrants, counter septum and adjacent septa long and straight. Later, however, a small free central space is developed.

In the Spanish coral the curvature of the septa with regard to the cardinal septum is not constant and the cardinal septum is not thinner. For the rest the Russian and Spanish forms have the same number of septa at the same diameter,

the same character of the tabulae. They also agree in the development of the minor septa and in the shortening of the cardinal septum near the calyx and in the slight withdrawal of the septa from the centre.

Material. Specimen st. no. 112514 from the Sierra Corisa limestone, coll. R. H. Wagner, loc. 58.

Occurrence elsewhere. Lower Moscovian (zone $C_2^m a$) and Lower Kasimovian (zone $C_3 a$) of the Donetz basin.

Bradyphyllum (?) sp. no. 1

Pl. 1, fig. 6; text-fig. 5

Description. One coral, nearly straight and about 35 mm long, is tentatively regarded as a representative of *Bradyphyllum.* The coral is a little worn, the external features could not be observed and the apex is missing.

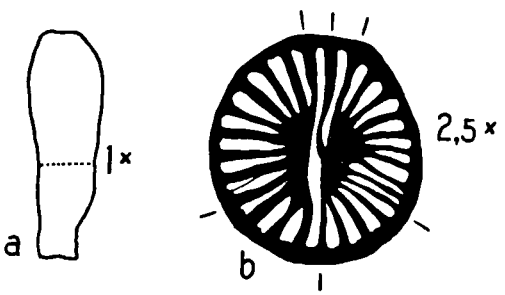


Fig. 5. *Bradyphyllum* (?) sp. no. 1. RGM no. 112515. a, outline, showing position of section b.

In the proximal part of the specimen the centre is occupied by a solid stereocolumn in which the radially spaced septa are joined.

After this rotiphylloid stage, the septa retreat from the centre. They become then quite short, less than half the radius in length, leaving a wide tubulate area in the centre. On the whole the septa have about the same length. The cardinal septum tends to be a little shorter, the counter a little longer. The counter quadrants show an accelerated development. The earliest section measures 4—5 mm, with 22 septa, division of the metasepta over the quadrants is $\frac{5|5}{3|3}$. A section in the distal part has a diameter of 12 mm with 30 septa, the division is here $\frac{9|9}{3|3}$.

Minor septa are developed as short ridges on the epitheca. They appear early in the ontogeny but do not gain in length.

Remarks. This coral appears intermediate between *Rotiphyllum* and *Bradyphyullm.* This will be discussed further after the description of *Bradyphyllum* (?) sp. no. 2.

Material. Specimen st. no. 112515 from the Sierra Corisa limestone, coll. R. H. Wagner, loc. 58.

Bradyphyllum (?) sp. no. 2

Pl. 1, fig. 7; text-fig. 6

Description. The coral, questionably assigned to *Bradyphyllum*, is ceratoid, reaches a diameter of 8 mm and is 25 mm long as measured on the cardinal side. It is curved in the alar plane.

Early in ontogeny, the stereocolumn is well developed, as shown in a section measuring 4,5 mm and numbering 19 septa (text-fig. 6b). Quite soon afterwards (Pl. 1, fig. 7a) the stereocolumn is broken up on one side. In this stage the coral shows a certain resemblance with *Rotiphyllum aequabile* spec. nov., since a counter pseudofossula is vaguely indicated and the metasepta are equally divided over the four quadrants. Further in growth, however, all septa are withdrawn to the periphery and about equal in length, which is approximately two thirds of the radius. Distally the coral is cylindrical and in this part the septal plan does not change. Minor septa are present as small ridges on the epitheca.

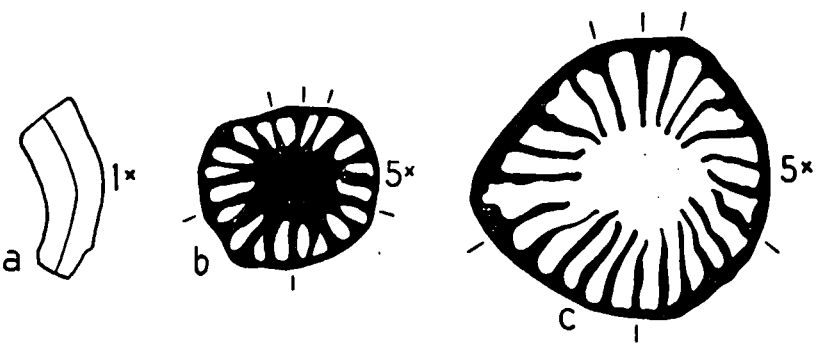


Fig. 6. *Bradyphyllum* (?) sp. no. 2. RGM no. 112516. a, outline, showing position of cardinal septum; b, c, septal plan of proximal and distal ends of the fragment.

Remarks. The full-grown stages of *Bradyphyllum* (?) sp. no. 1 and no. 2 are readily comparable with those of *Pleramplexus*, *Pentamplexus* and *Lomphamplexus*. The youthful stages of thse corals are markedly different, they are respectively rotiphylloid, plerophylloid, pentaphylloid and lophophylloid. As for *Bradyphyllum* (?) sp. no. 1 and no. 2, the rotiphylloid stage persists till fairly advanced stages, the septa withdraw from the centre only when the coral has become cylindrical. Carruthers (1908, p. 162), in his description of *Caninia cornucopiae* Mich., drew attention to the fact that the septa are shortened when the coral aquires a cylindrical habit. He also found, that such a breviseptal phase may be followed by a phase with long septa, that is, when the form of the coral becomes conical. He came to the conclusion, that the septal development of these corals depends on a habit of growth, and not on a particular stage of growth. If the same factor controlled the septal formation in the Spanish corals, described above, they would have to be regarded as *Rotiphyllum*, and *Bradyphyllum* (?) sp. no. 2 perhaps as *Rotiphyllum aequabile* sp. nov. But since this is not proved, they are for the time being included in the genus *Bradyphyllum*.

Material. Specimen st. no. 112516 from the Sierra Corisa limestone, coll. R. H. Wagner, loc. 58.

Familia LACCOPHYLLIDAE Grabau, 1928

Diagnosis. Small, solitary Rugosa with axial ends of major septa united at an aulos which divides horizontal inner tabellae from inclined outer tabellae; minor septa may be contratingent; dissepiments absent (Hill, 1956).

Genus AMPLEXOCARINIA Soshkina, 1928

Type-species. Amplexocarinia muralis Soshkina, 1928 from the Artinskian of the Ural Mountains.

Diagnosis. Laccophyllid corals with septa and aulos thin (Hill, 1956).

Remarks. Amplexocarinia is listed by Hill (1956) under the family Laccophyllidae. Schouppé & Stacul (1959, p. 293), who give a detailed description of *Amplexocarinia*, its synonymy and its generic position, regard it wrongly placed there. According to them, the Amplexocariniinae form a subfamily of the Amplexidae. They interpret the Laccophyllidae less widely than Hill (1956) and regard the genus *Paralleynia* Soshkina, 1936 as a true representative of this family. *Paralleynia* closely resembles *Amplexocarinia*, but has an inner wall, formed by the deflected and partly loosened axial septal ends. In *Amplexocarinia* the aulos is formed chiefly by the vertical portions of the sharply raised tabulae. The latter kind of aulos may also be developed in mature stages of *Paralleynia* (Schouppé & Stacul, 1959, p. 338). The distinction between these two types of aulos does not appear to be very rigid, since they may occur together. Therefore it is not held necessary to remove *Amplexocarinia* from the family of the Laccophyllidae. Smith (1955) widens the concept of *Amplexocarinia*. He includes in it also corals in which dissepiments are developed: *Amplexocarinia cravenensis* Smith from the Tournaisian of England and *Amplexocarinia simplex* (Hill) from the Visean of Australia. These species are not considered to belong to *Amplexocarinia*. They probably represent a new genus, as Schouppé & Stacul (1959, p. 301) suppose.

Occurrence.	Mississippian	N. America — Montana
	Upper Carboniferous	Carnic Alps
		Chios
		Spitsbergen
	Pennsylvanian	N. America — Oklahoma, Texas
	Lower Permian	Carnic Alps, Julic Alps, Karawanken
		Russia — Ural Mts.
	Upper Permian	Asia — Asia Minor, Salt Range, Timor
		N. America

Amplexocarinia wagneri spec. nov.

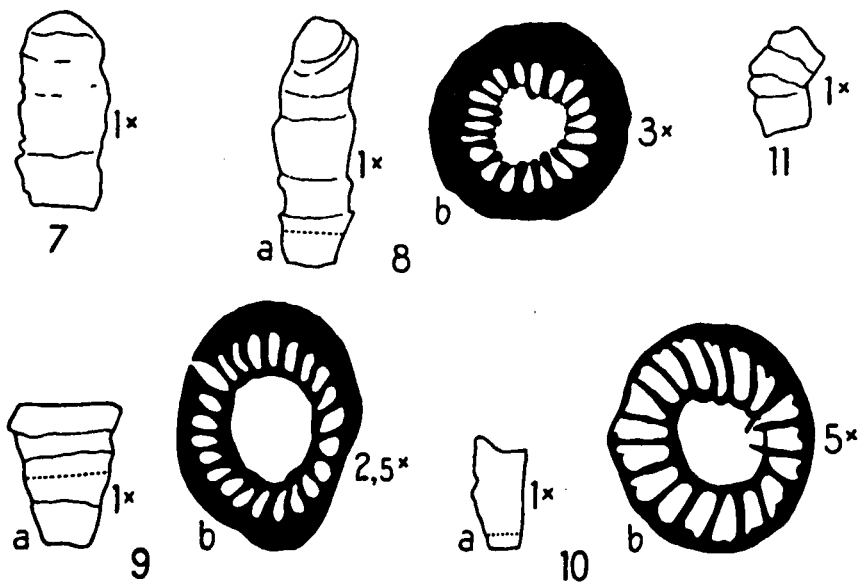
Pl. 2, figs. 1—3; text-figs. 7—11

Diagnosis. Amplexocarinia with a diameter of 10 to 12 mm and 20 to 23 major septa; minor septa not projecting from the epitheca; no reduction of the cardinal septum.

Description. Only coral fragments from 15 to 35 mm long have been found. They are either cylindrical or have the form of a slightly tapering cone, which may

increase in diameter from 6 or 8 to 10 or 12 mm. The corals show many rejuvenations. Some are straight, others may be geniculated in the parts where rejuvenation occurs. The epitheca shows externally longitudinal striation. It is fairly thick. In some sections which are taken at a stage of rejuvenation its thickness may appear considerable because the rejuvenated coral is still enclosed by the old wall.

The length of the major septa, as seen in transverse sections, is slightly more or slightly less than a quarter of the diameter and depends apparently on the section being taken just above or below a tabula. None of the septa, i.c. the cardinal septum, is shorter than the others. Minor septa remain buried in the wall. The tabulae are not closely set; there is a distance of about 2 mm between the successive tabulae. The inner wall is generally continuous. Locally it may be interrupted, or passed by some of the septa.



Figs. 7—11. *Amplexocarinia wagneri* spec. nov. Fig. 7. holotype RGM no. 112517, outline. Fig. 8. RGM no. 112522. a, outline, showing position of section b. Fig. 9. RGM no. 112521. a, outline, showing position of section b. Fig. 10. RGM no. 112518. a, outline, showing position of section b. Fig. 11. RGM no. 112530, outline.

Remarks. Other species of *Amplexocarinia*, which have about the same number of septa at a given diameter, are provided with better developed minor septa or/and with a shortened cardinal septum. Several varieties might be recognized of *A. wagneri*. But there is not much constancy in the variations in the thickness of the wall or thickness and length of the septa. In this respect, even sections of one individual are apt to differ from each other. Therefore no attempt is made to define these specimens more closely. One specimen, st. no. 112530, a very incomplete one at that, does have a much thinner wall and thinner septa, and also a greater number of septa; 25 at a diameter of 6.5 mm. It could even belong to a different species but to settle this question, more material would be needed.

Material. The holotype, st. no. 112517 and 13 other specimens st. no. 112518—112530, are from the Sierra Corisa limestone. They were collected by Mr. R. H. Wagner, after whom the species is named, at loc. 58.

Familia Polycoeliidae Roemer, 1883

Diagnosis. Small solitary Rugosa in which some or all of the 6 protosepta are longer and thicker than other septa. Tabulae are raised towards the centre, where they are flat or slightly concave. No dissepiments, except in highly developed genera (after Schindewolf, 1942).

Subfamilia Polycoeliinae Roemer, 1883

Diagnosis. Polycoeliidae in which the cardinal may be and the counter and alar septa are strongly developed (after Schindewolf, 1942).

Genus Polycoelia King, 1849
(= *Calophyllum* King, 1849)

Type-species. Turbinolia donatiana King, 1848, from the Magnesian Limestone of England. This species is a synonym of *Cyathophyllum profundum* Geinitz, 1842, from the Zechstein of Germany.

Diagnosis. Genus of the Polycoeliinae in which the cardinal septum is not shortened.

Remarks. Schindewolf (1942, p. 65) discusses the genus fully and gives a redescription of the type-species, as it occurs in the Zechstein of Germany.

Hill (1940, p. 125) and Schindewolf (loc. cit.) have already pointed out that *Calophyllum* Dana, 1846 and 1848, is a nomen nudum, since the name was published without an indication and with a description that might fit a number of other genera.

Occurrence.	Visean	Germany
	Middle Carboniferous	Japan
	Permo-Carboniferous	Spitsbergen
		N. America — Alaska
	Permian	W. Europe
		Russia — Ural Mts.
		Mongolia
		Timor
		Australia

Polycoelia cantabrica spec. nov.

Pl. 2, fig. 4; text-fig. 12

Diagnosis. Polycoelia in which the first pair of metasepta in the cardinal quadrants is as strongly developed as the alar septa.

Description. The coral is about 45 mm long. The maximum diameter is 12 mm. The apical part is gently curved.

There are several rejuvenations and many transverse wrinkles on the wall. Longitudinal striation is not noticeable.

Near the apex the typical pattern of the septa is established, which does not change during ontogeny. The longest septa are the counter, the alar and the first pair of metasepta in the cardinal quadrants, these nearly meet in the centre. The cardinal septum does not reach so far, but it is longer than the adjacent septa. The counter-laterals are as long as the next pair of metasepta. The metasepta decrease in length, according to their order of appearance. Minor septa are present in mature stages as short ridges on the wall, which is not very thick.

The tabulae are thin and raised as broad cones towards the centre.

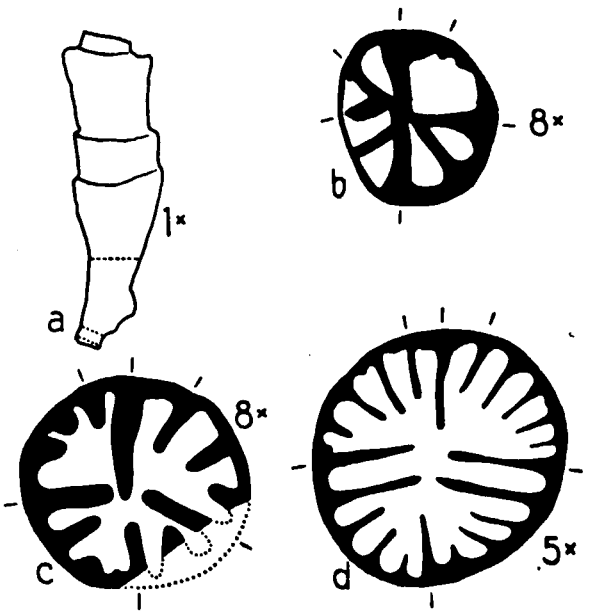


Fig. 12. *Polycoelia cantabrica* spec. nov. holotype RGM no. 112531. a, outline, showing position of sections b—d.

Measurements and corresponding number of septa are as follows:

diameter	number of septa	division of metasepta
12 mm	25	$\frac{5\|5}{4\|5}$
7 mm	21 (+ 1)	$\frac{4\|3}{4\|4}$ (+ 1)
5 mm	16 (?)	$\frac{2\|2}{3\|3}$ (?)
4 mm	14 (?)	$\frac{2\|2}{2\|2}$ (?)
2.5 mm	8 (?)	$\frac{\|}{1\|1}$

Remarks. Polycoelia cantabrica spec. nov. does not show a close resemblance with other species of *Polycoelia*. The septal plan in the early ontogenetic stages differs markedly from that in the type-species, where the septa are pinnately arranged. The septal development in *Polycoelia cantabrica* may be compared, however, with that in *Polycoelia angusta* Rothpletz, from the Permian of Timor, as described by Schindewolf (1942, p. 86, text-figs. 32, 33). But the resemblance ends there, since in the species from Timor the first pair of metasepta in the cardinal quadrants does not differ from the other metasepta, and the minor septa reach a considerable length.

Material. The holotype, st. no. 112531, is the only specimen known. It is from the Diablo limestone breccias, coll. M. M. Fischer, loc. 80, about 2.5 km E of Santa Maria de Redondo.

Genus Sochkineophyllum Grabau, 1928

Type-species. Plerophyllum artiense Soshkina, 1925, from the Artinskian of the Ural Mountains.

Diagnosis. Polycoeliid corals with in adult stages a shortened cardinal septum; apart from the three remaining long protosepta, one or two pairs of metasepta in cardinal and counter quadrants may be strongly developed; minor septa present.

Remarks. Schindewolf (1942, p. 94) discusses *Sochkineophyllum* and its generic position. He regards it as a subgenus of *Polycoelia*, distinguished from *Polycoelia* s. str. by its short cardinal septum. But there are other differences as well, especially in the development of the counter septum. Therefore *Sochkineophyllum* is regarded in this paper as a separate genus, having closer affinities to *Claviphyllum*, *Timorphyllum* and *Stereostylus* than to *Polycoelia*.

The genera *Claviphyllum* Hudson, 1942, *Timorphyllum* Gerth, 1921, and *Stereostylus* Jeffords, 1947, are, like *Sochkineophyllum*, marked by an elongate, axially strengthened counter septum.

Wang (1947, p. 335) regarded both *Sochkineophyllum* and *Stereostylus* as synonyms of *Timorphyllum*. *Timorphyllum* seems certainly very close to *Sochkineophyllum*. It differs in the following points:

1. Although in youthful stages the alar septa are dominating, later in the ontogeny they are not conspicuous. The septa may then be subequal in length, sometimes one alar septum and a few metasepta may be longer than others.
2. The columella is mainly formed by the axial end of the counter septum, but may be fortified by other elements.
3. The columella is not continuously linked to the counter septum, even in early stages they may become separated.
4. Tabulae are flat in the central part of the corallite and raised a little towards the columella.
5. Septa of the second order are absent. (For further details see Schouppé & Stacul, 1955, p. 152 and 1959, p. 344.)

Stereostylus is characterized by the counter septum being the only dominating septum. In mature stages the other septa are subequal in length. In late stages the columella may become separated from the counter septum.

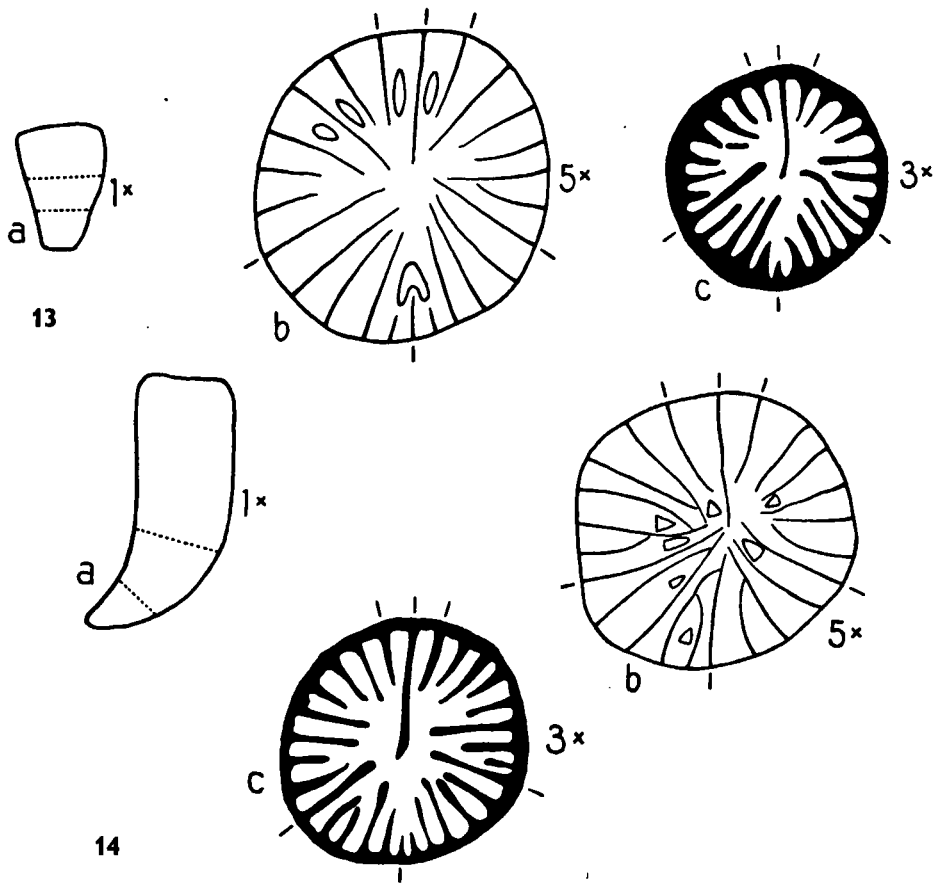
Claviphyllum is readily distinguished from *Sochkineophyllum* by the shortness of the alar septa; it is the first pair of metasepta in the cardinal quadrants which is dominant (Hudson, 1942, p. 262).

Occurrence.	Tournaisian	Germany
	Visean	British Isles
	Lower Permian	Russia — Ural Mountains
		? N. America — Kansas
		? Japan

Sochkineophyllum corisense spec. nov.

Pl. 2, figs. 5, 6; text-figs. 13, 14

Diagnosis. Sochkineophyllum, with 26 to 29 septa at a diameter of 10 to 12 mm; in one of the counter quadrants the fourth metaseptum outstanding; counterlaterals not extremely short.



Figs. 13, 14. *Sochkineophyllum corisense* spec. nov. Fig. 13. holotype RGM no. 112532. a, outline, showing position of sections b and c. Fig. 14. paratype RGM no. 112533. a, outline, showing position of sections b and c.

Description. The coral, designated as the holotype of this species, specimen st. no. 112532, attains a length of about 35 mm. It is conical and curved in the apical part, with the cardinal septum situated on the convex side. Distally, it is straight and cylindrical. In the cylindrical portion the septal pattern does not change, but the septa become thinner. The other corals of this species are conical and about 20 mm long. Externally, the epitheca shows transverse wrinkles and a faint longitudinal striation.

In the apical region the septa are very thick and laterally contiguous. The counter septum reaches past the centre. The other septa, except for the counter-laterals and the last formed metasepta, extend to the centre.

At a later stage the cardinal septum is much shortened and the septa have become thinner. All but the counter septum are withdrawn from the centre which is then occupied by the thickened axial end of the counter septum. Most of the septa are axially slightly thickened. The longest metasepta in the counter quadrants are not of the same pair. In one quadrant the longest septum is always the fourth metaseptum, while in the other quadrant it is either the third or the fifth. In the cardinal quadrants the second or third pair of metasepta may be more strongly developed than the others, but not regularly so. Minor septa appear late and are poorly developed.

The diameter, number of septa and division of the metasepta over the four quadrants of the sections are as follows:

diameter	number of septa	holotype	paratypes
12 mm	29	$\frac{7\|7}{5\|4}$	
10 mm	26		$\frac{6\|6}{4\|4}$ $\frac{5\|5}{5\|5}$
8 mm	24	$\frac{5\|6}{4\|3}$	$\frac{5\|5}{4\|4}$
7 mm	22		$\frac{5\|5}{3\|3}$ $\frac{4\|4}{4\|4}$
7 mm	20		$\frac{4\|4}{3\|3}$

Remarks. This species differs from the type-species, *Sochkineophyllum artiense* (Soshkina) in numbering more septa at a given diameter and in having better developed counter-lateral septa. It shows some resemblance with another species from the Artinskian of the North Urals, *Sochkineophyllum lophophylloides* (Soshkina, 1928). The latter is, however, distinguished by an earlier shortening of the cardinal septum, and by having markedly rhopaloid septa and a shorter counter septum.

Material. The holotype, st. no. 112532 and one paratype, st. no. 112533, are from the Sierra Corisa limestone, coll. A. Breimer, near Vergaño; specimen st. no. 112534 is from the upper shale member of the Sierra Corisa limestone, author's collection, loc. 103, between Vergaño and Herreruela.

Subfamilia PLEROPHYLLINAE Koker, 1924

Diagnosis. Polycoeliid corals in which the cardinal may be, and the alar and counter-lateral septa are longer and thicker than others; in youthful stages the septa pinnately arranged and the counter septum well developed but later shortened (after Schindewolf, 1942).

Genus PLEROPHYLLUM Hinde, 1890

Type-species. Plerophyllum australe Hinde, 1890, from the Permian of Australia.

Diagnosis. Genus of Plerophyllinae with 5 long protosepta: cardinal, alars and counter-laterals.

Subgenus UFIMIA Stuckenberg, 1895

Type-species. Ufimia carbonaria Stuckenberg, 1895, from the "Oberer Kohlenkalk" of the Ural Mountains (probably lower Permian — Fomichev, 1953, p. 93, footnote).

Diagnosis. Like *Plerophyllum* s.s. but with cardinal septum shortened in adult stages (after Schindewolf, 1942).

Remarks. Discussion and synonymy of *Ufimia* are given by Schindewolf, 1942, p. 122.

Occurrence.	Upper Devonian	Germany
	Dinantian	British Isles
		Germany
	Lower Carboniferous	Russia — Moscow basin, Donetz basin
	Lower Silesian, Namurian	Central Europe — Upper Silesia
	Middle Carboniferous	Russia — Donetz basin
	Upper Carboniferous	Russia — Donetz basin
	Permian	Russia — Ural Mts.
		? China
		Timor
		? Australia

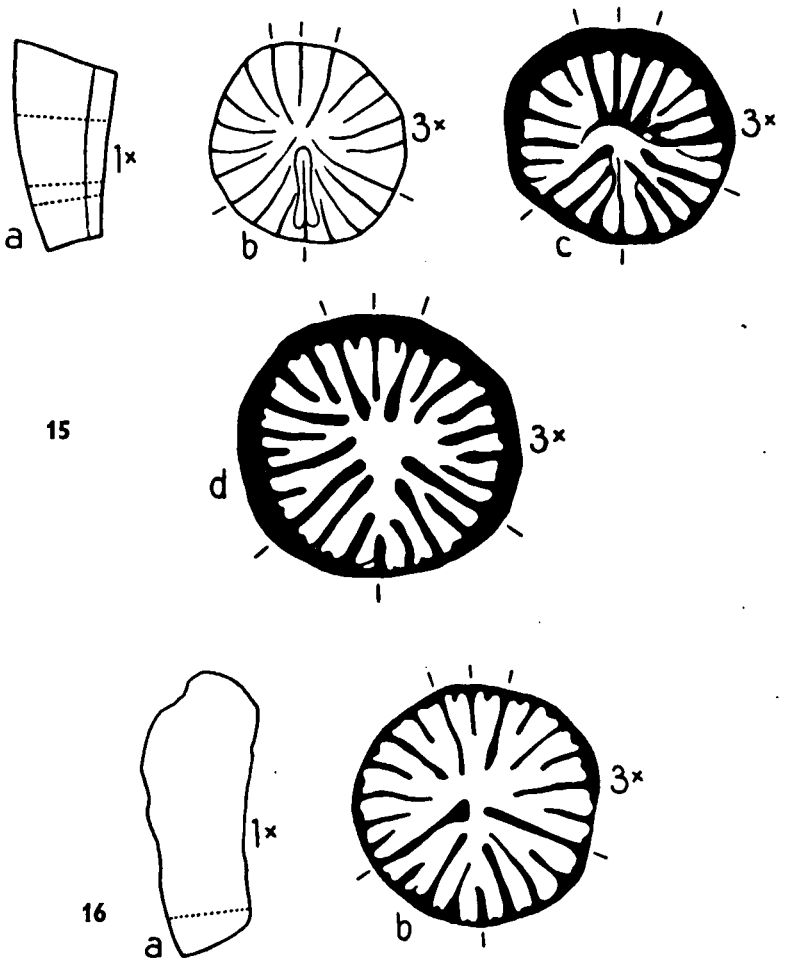
Plerophyllum (Ufimia) alternans spec. nov.

Pl. 2, figs. 7—10; text-figs. 15, 16

Diagnosis. Ufimia with the counter septum relatively long and with alternately long and short metasepta in the counter quadrants; minor septa poorly developed.

Description. The corals reach a length of about 40 mm and a diameter of 13 mm at the calyx. The epitheca is longitudinally grooved. The cardinal septum lies on or near the concave side. The lower half of the corallite is curved. Early in the ontogeny all septa are very thick, filling the whole lumen. The cardinal septum is the first to

become thinner. It lies in a wedge-shaped fossula, which extends to the centre. The plerophylloid character is not yet strongly expressed in this section. The alar and counter-lateral septa exceed the metasepta slightly in length, the counter septum is as thick and as long as the counter-laterals. In a higher section it is somewhat reduced. All septa are decreased in thickness and length, being a little withdrawn from the centre. The alar and counter-lateral protosepta and some metasepta are, sometimes strongly, rhopaloid.



Figs. 15, 16. *Ufimia alternans* spec. nov. Fig. 15. holotype RGM no. 112535. a, outline, showing position of cardinal septum and of sections b—d. Fig. 16. paratype RGM no. 112538. a, outline, showing position of section b.

Gradually the cardinal septum shortens. The counter septum is clearly thinner and shorter than the counter-laterals. The metasepta are unequal in length, ± alternately long and short. The counter quadrants are strongly accelerated, containing twice as many metasepta as the cardinal quadrants.

Measurements of the sections are as follows:

diameter	number of septa
13 mm	24
12 mm	22—23
10 mm	20—22
7 mm	20
6 mm	18
5 mm	14

Of the minor septa, those flanking the counter septum are best developed. The other minors appear merely as short ridges on the epitheca.

The tabulae are regularly spaced, gently raised from the periphery and nearly flat in the central part.

Remarks. Ufimia alternans spec. nov. does not show a close resemblance with species of *Ufimia*, hitherto described. The differentiation in length, shown by the metasepta of the counter quadrants and the rudimentary minor septa, are the chief distinguishing features of the Spanish species.

Material. The holotype, st. no. 112535 and an immature individual, st. no. 112536, are from the lower part of the Sierra Corisa limestone, coll. Mrs. Wagner, loc. 72, near Vergaño; specimen st. no. 112537 is from the same horizon, coll. A. Breimer, specimens st. no. 112538 and 112539 are from an impure biostromal limestone, coll. M. H. Nederlof, loc. 17, near Celada de Roblecedo.

Familia CYATHAXONIIDAE Edwards & Haime, 1850

Diagnosis. Small, ceratoid rugose corals with tall columella developed independently of, but in contact with, the major septa; minor septa long and contratingent, inserted alternately with the metasepta; septa may bear "carinae"; tabulae complete, inclined down to the epitheca; no dissepiments (after Hill, 1940, 1956).

Genus CYATHAXONIA Michelin, 1847

Type-species. Cyathaxonia cornu Michelin, 1847 from the Tournaisian of Tournai, Belgium.

Diagnosis. As for family.

Remarks. The septal insertion in *Cyathaxonia* has been described and figured by Faurot (1909). Other features of the genus are discussed by Carruthers (1913, p. 53).

The characters on which different sepcies of *Cyathaxonia* can be based are necessarily rather vague because the generic features offer little variation. The most important specific determinant seems to be the number of septa at a given diameter, although variation in diameter of the corals is relatively great.

The size and the form of the columella, as seen in transverse sections, have also been used in designing a species. After comparing the small, rounded columella of *Cyathaxonia cornu* with the larger, oval columella of *Cyathaxonia rushiana*, Carruthers (1913, p. 55) concludes that, apart from a difference in size, there is no further difference between the two species. He adds, however, that all gradations can be found between them.

The presence of "carinae" on the sides of the septa is not of diagnostic value, this holds at least for the type-species (Carruthers, 1913, p. 56).

Length and form of the corals are to some extent at least dependent on conditions of growth. Other things being equal, one cannot attach too much importance to the difference in length of corals found in different facies, especially when the cylindrical stage has been reached and there is no more lateral expansion of the coral.

Thickness of the epitheca and of the septa are in themselves not regarded as very important features. It is not known how far dilation of skeletal elements is influenced by external circumstances, and how far it may be considered a diagnostic character. In this paper it is not considered of specific importance.

Finally, the length of the minor septa must be taken into account. Some species appear to be characterized by the relative shortness of the minor septa. This is best seen in sections taken just below the calyx. Smith (1931, p. 10), describing a specimen of *Cyathaxonia* from the Middle Coal Measures of S. Wales, regards the retrogressive development of the minor septa as a feature of a phylogerontic condition.

Occurrence.	Lower Carboniferous	worldwide
	Silesian	S. Wales
	Middle Carboniferous	Russia — Donetz basin
	Upper Carboniferous	Russia — Donetz basin, Moscow basin
	Lower Permian	Russia — Ural Mts.

Cyathaxonia cornu Michelin, 1847

Diagnosis. Subcylindrical *Cyathaxonia*, usually not more than 15 mm long, with thin epitheca; 36 to 40 septa at a diameter of 3.5 or 5.5 mm; septa sometimes with tuberculated sides; columella typically small and rounded (after Carruthers, 1913 and Smith, 1931).

Cyathaxonia cornu Michelin var. *cantabrica*

Pl. 3, figs. 1, 2

Description. Several fragments of small corallites, some of them cylindrical and reaching a length of 20 to 30 mm, show characters which agree well with those of *Cyathaxonia cornu*. Since they are embedded in the matrix, their outward appearance is unknown.

The epitheca forms a narrow stereozone. It is thicker than that in the typical West-European specimens. Commonly there are 36 septa, 18 of each order, at a diameter of 4 to 4.5 mm. The septa are moderately thin. In two specimens from the same locality, the septa bear small spines, in the other corals the sides of the septa are free of spines. The septa of the second order are generally slightly thinner than those of the first. They coalesce at or near the columella.

Remarks. The differences between these corals and typical representatives of *Cyathaxonia cornu* from the Dinantian of Western Europe are found in the length of the corals and in the thickness of the epitheca. These differences are considered too slight to separate the corals specifically, or to rank them as a subspecies.

Cyathaxonia archangelskyi Fomichev, 1953, from the Kayalian of the Donetz basin, resembles the Spanish specimens closely. It has about the same diameter and number of septa, also a small, rounded columella and a fairly thick epitheca. In short, it might likewise represent a variety of *Caythaxonia cornu*. Fomichev states in fact that his species have perhaps only local stratigraphic importance.

Material. All specimens are embedded in black, very fine-grained limestone. The typical specimen of this variety, st. no. 112540, and specimen st. no. 112541 are from the Perapertú formation, coll. R. H. Wagner, loc. 31, near San Martín, specimen st. no. 112542 is from the Vañes formation, coll. Mrs. Wagner, loc. 38, near the mines of San Cebrián; specimen st. no. 112543 is from the Frechilla limestone, coll. M. H. Nederlof, loc. 31, near Redondo.

One specimen, st. no. 112544 (Pl. 3, fig. 3) agrees with those described above only in having a slender columella. It has somewhat more septa (40) at a diameter of nearly 5 mm. The epitheca is thin, the septa extremely so. The coral fragment is 23 mm long, embedded in fine dark limestone, forming part of a limestone-breccia of the Perapertú formation. It has been collected at Mrs. Wagner's locality 84, between Mudá and Monasterio. This specimen is perhaps more closely related to the typical forms of *Cyathaxonia cornu* than the variety *cantabrica*.

Cyathaxonia sp. no. 1

text-fig. 17

Description. One incomplete specimen of *Cyathaxonia* is distinguished by its larger size and greater number of septa. It is a cylindrical fragment, for the greater part halved lengthwise, with a length of 20 mm, the calyx included. The diameter amounts to 6 mm, the number of septa to 46 or 48, that is 23 or 24 of each order. Proximally, the epitheca is rather thick. The septa are but slightly dilated, they are thin in comparison with the epitheca. The minor septa join the major in the last quarter of their course. The columella occupies about a fifth of the corallite-diameter. Distally, all these structures become thinner: near the base of the calyx the septa are attenuate, the epitheca is reduced in thickness and the columella has a diameter which is one tenth of the corallite.

Tabulae are distant, with an interval of about 2 mm between them.

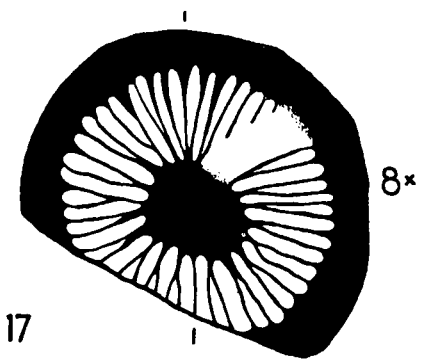


Fig. 17. *Cyathaxonia* sp. no. 1. RGM no. 112545. incomplete section, fractured in upper right hand side.

Remarks. In size and number of septa this coral, as far as it is preserved, does not resemble any other species of *Cyathaxonia.*

Material. Specimen st. no. 112545, embedded in dark-grey, fine-grained limestone, from the Perapertú formation, coll. R. H. Wagner, loc. 35, N of San Martín.

Cyathaxonia corisensis sp. nov.

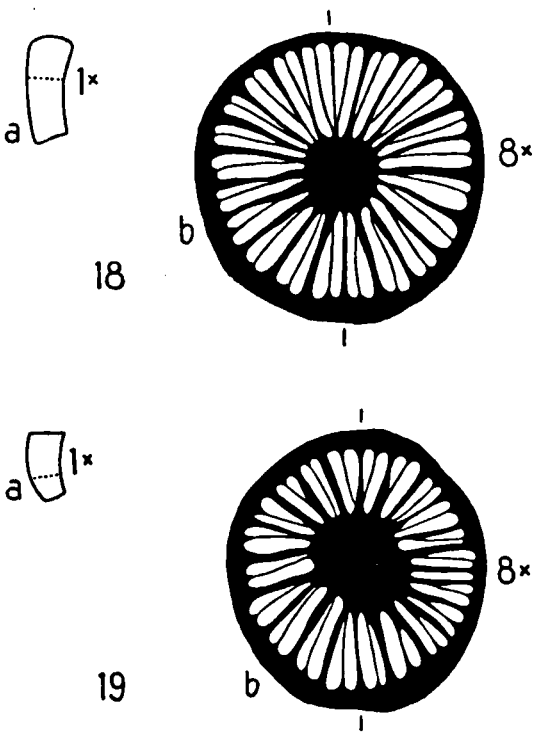
Pl 3, figs. 4, 5; text-figs. 18, 19

Diagnosis. Cyathaxonia with 40 to 44 septa at a diameter of 4—4.5 mm and a columella occupying ± one fourth of the corallite.

Description. The slightly curved corallites are at least 15 mm long and have a relatively deep calyx. The diameter at the calyx is 4.5—5.5 mm. The epitheca is not very thick.

The septa are much thickened in young stages, distally they grow thinner. The major septa reach to the columella. Their axial ends are thickened and form a ring around the columella. Just outside this ring, the minor septa are joined to them. On the whole, the minor septa are distinctly thinner than the majors.

The columella, as seen in transverse sections, is oval to subquadrate in form. It is relatively large. The diameter, transverse to the countercardinal plane, amounts to about $\frac{1}{4}$ of the diameter of the corallite.



Figs. 18, 19. *Cyathaxonia corisensis* spec. nov. Fig. 18. holotype RGM no. 112546. a, outline, showing position of section b. Fig. 19. paratype RGM no. 112548. a, outline, showing position of section b.

Remarks. The corals here described are larger than those considered to belong to *Cyathaxonia cornu.* Also the columella is relatively larger, with regard to the diameter of the corallite. In these respects the corals resemble somewhat Fomichev's *Cyathaxonia lomonosovi* from the Kayalian of the Donetz basin. This species may be distinguished by its round columella. As minor differences may be noted its greater length and thicker epitheca.

Material. The holotype, st. no. 112546, and specimen st. no. 112547, are from the upper shale member of the Sierra Corisa limestone, coll. Mrs. Wagner, loc. 74, SE of the Alto Sierra; specimen st. no. 112548—112550 are from approximately the same horizon, author's collection, loc. 102 and 103, S of the Alto Sierra.

Cyathaxonia sp. no. 2

Pl. 3, fig. 6; text-fig. 20

Description. One small, slightly curved specimen of *Cyathaxonia*, is treated separately, since it has shorter minor septa than the specimens described above. The coral is apically imcomplete, 10 mm long, increasing in diameter from 3.8 to 4.5 mm, and numbers 36 septa, 18 of each order. During nearly the whole ontogeny, the septa are much dilated and contiguous with each other. Near the calyx the septa of the counter quadrants become thinner. The minor septa are about half as long as the major septa. In the cardinal quadrants they may be somewhat longer, in the counter quadrants they are shorter, except the counter minors. The columella occupies one fourth of the corallum, its inner part is oval.

In a slightly higher section all septa have become thinner. Most minor septa are still in contact with the majors; a few may have free axial edges. The epitheca is thick.

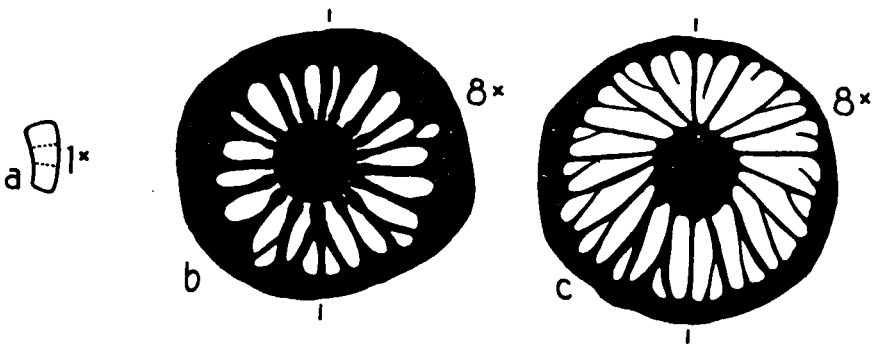


Fig. 20. *Cyathaxonia* sp. no. 2. RGM no. 112552. a, outline, showing position of sections b and c.

Remarks. The diameter and number of septa of this specimen correspond with those of *Cyathaxonia cornu.* The columella, however, is large and oval, as in *Cyathaxonia corisensis.* The minor septa are shorter than in either of the two species. *Cyathaxonia* sp. no. 2 is also distinguished by the strong dilation of the septa.

Material. Specimen st. no. 112552, from the Sierra Corisa limestone, coll. R. H. Wagner, loc. 69, near the Corisa triangulation point.

Familia LOPHOPHYLLIDIIDAE Moore & Jeffords, 1945

Diagnosis. "Small solitary Rugosa without dissepiments and with conical tabulae; septa long, arranged in quadrants in young stages, meeting enlarged counter septum at the axis; columella formed by swollen, vertically produced axial edge of counter septum which may be reinforced by vestigial axial ends of other septa; cardinal septum shortened and other septa withdrawn from the axis in adult stages, commonly rhopaloid" (Hill, 1956).

Genus LOPHOPHYLLIDIUM Grabau, 1928

Type-species. Cyathaxonia prolifera McChesney, 1860, from the Missourian of Illinois.

Diagnosis. "(Lophophyllidiid corals with a) wide columella, typically with radial lamellae conjoined to median lamella but not tabellate, which may be separated from counter septum in adult stages; axial edges of other septa, except cardinal, may be thickened and fused to one another in a collar around the columella" (Hill, 1956).

Remarks. The genus is fully discussed by Jeffords (1942 and 1947).

Occurrence.	Silesian	Carnic Alps, Karawanken
	Middle and Upper Carboniferous	Russia
	Pennsylvanian	N. America
	Permian	Hungary
		Russia
		Asia — China, Timor
		? Australia
		? N. America

Lophophyllidium breimeri spec. nov.

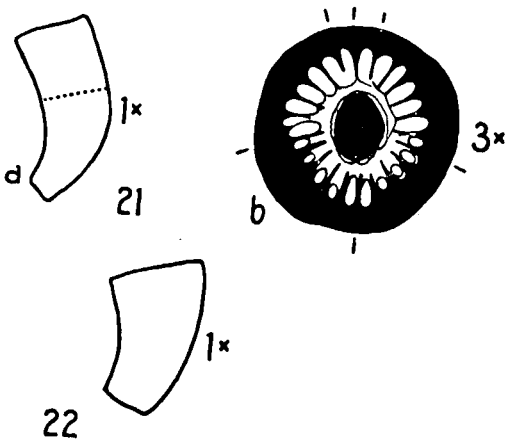
Pl. 3, figs. 7—9; text-figs. 21, 22

Diagnosis. Lophophyllidium with a large columella and septa much thickened till just below the calyx.

Description. The corallites are cornute and moderately curved. In all specimens the cardinal septum is situated on the convex side. The corals reach a length of about 30 mm and at the calyx a width of 10—12 mm. The calyx is deep. The wall is thick and has well-marked septal grooves.

Close to the apex the protosepta are about equal in length. The further neanic stage is characterized by the large counter septum which is axially expanded and prolonged well beyond the centre. The other septa abut against this columella. There is very little interseptal space, mostly the septa are touching with their sides.

Later the counter septum becomes as thick as the other septa. It remains in contact with the large columella which occupies about $\frac{1}{3}$ of the diameter of the corallite. Towards the calyx the septa get thinner, those in the counter quadrants first. The cardinal septum shortens and becomes half as long as the other septa.



Figs. 21, 22. *Lophophyllidium breimeri* spec. nov. Fig. 21. holotype RGM no. 112553. a, outline, showing position of section b. Fig. 22. paratype RGM no. 112557, outline.

In calycular sections all septa gradually retreat a little from the columella, the counter septum may or may not remain joined to the columella. The counter-laterals are distinctly shortened. Septa in the cardinal quadrants may be rhopaloid. The counter quadrants number 2 to 4 metasepta more than the cardinal quadrants. Measurements of the various sections are as follows:

diameter	number of septa	division of metasepta	
11—12 mm	24—26		$\frac{6\|6}{4\|4}$
9—10 mm	22—24		$\frac{5\|5}{4\|4}$
7—8 mm	20—22		$\frac{5\|5}{3\|3}$
5—6 mm	18—20		$\frac{4\|4}{3\|3}$
3—4 mm	16—18	$\frac{3\|3}{2\|2}$	$\frac{3\|3}{3\|3}$
2 mm	10—12	$\frac{1\|1}{1\|1}$	$\frac{2\|2}{1\|1}$

The minor septa remain for the greater part of the ontogeny embedded in the thick epitheca. In calycular sections they may appear as short ridges.

Remarks. The general aspect of *Lophophyllidium breimeri* in adult stages is very similar to that of *Lophophyllidium pendulum* (Grabau) from the Permian of China. But the young stages of the two species are quite different. Grabau (1928, Pl. 4, fig. 1) figures a section through the lower part of the corallum (taken at a diameter of 6—6.4 mm and with 23 septa) in which the septa are pinnately arranged around the cardinal septum. In the Spanish species a somewhat similar stage occurs, but it is restricted to the very tip of the corallum and followed by the stage in which the septa are grouped around the much enlarged counter septum. There are some other differences: the Chinese specimens have the cardinal septum on the concave side and proportionally a greater number of septa. The ratio diameter/number of septa in *L. breimeri* is about the same as in the type-species *L. proliferum* (McChesney). The latter is distinguished by a smaller columella, a thinner wall, earlier shortening of the cardinal septum and thinning of all septa, and the somewhat better developed minor septa.

Material. The holotype, st. no. 112553 and paratypes st. no. 112554—112559 have been collected by Dr. A. Breimer, after whom the species is named. They are from the Sierra Corisa limestone, near Vergaño.

Lophophyllidium minus spec. nov.

Pl. 3, fig. 10; text-fig. 23

Diagnosis. Small *Lophophyllidium* with only in late stages the typical columella developed.

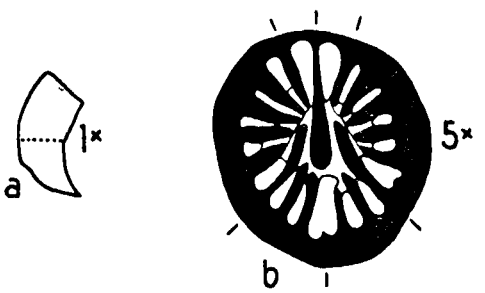


Fig. 23. *Lophophyllidium minus* spec. nov. holotype RGM no. 112562. a, outline, showing position of section b.

Description. The corals are cornute, curved in the lower part and later on cylindrical. The cardinal septum lies on the shorter side. The length of the corals is about 20 mm, the greatest diameter 6.5 mm. The calyx is very deep.

After an early zaphrentid stage, at a diameter of 2 mm the counter septum grows longer, reaches past the centre. Its axial end is dilated. The other septa, except the cardinal, are in contact with the thus formed columella. They are bent with the convex side to the cardinal septum. This is short and lies in a fossula which, owing to the curvature of the adjacent septa, expands axially.

Near the calyx the septa shorten, except the counter, which remains joined to the columella. Only in the late stages the columella is seen to possess also radial elements, while earlier in the ontogeny it was solely formed by the enlarged axial end of the counter septum.

Measurements of the sections are as follows:

diameter	number of septa
5.5—6.5 mm	20—22 (?)
4—5.5 mm	18
2 mm	11
1 mm	6

Minor septa are rudimentarily present, but they do not project from the wall, which is rather thick. Judging from the tabular intersections, tabulae are sparse.

Remarks. Lophophyllidium minus differs from *Lophophyllidium breimeri* in the smaller size of the corals and in the character of the columella, which is, moreover, relatively smaller.

Material. The holotype is specimen st. no. 112562, from shales underlying the Sierra Corisa limestone, coll. Mrs. Wagner, loc. 71, near Vergaño; specimens st. no. 112653 and 112654 are from the upper shale-members of the Sierra Corisa limestone, author's collection, loc. 103, S of the Alto Sierra; specimen st. no. 112655 is from shales overlying the Sierra Corisa limestone, coll. Mrs. Wagner, loc. 63, Alto Sierra.

Lophophyllidium sp.

text-figs. 24, 25

Description. To the genus *Lophophyllidium* are assigned two corals which are rather poorly preserved. One is much worn and the other is crushed in the calycular region. They are 20 resp. 25 mm in length reaching a diameter of 10 mm. Their form is cornute and the cardinal septum lies on the concave side.

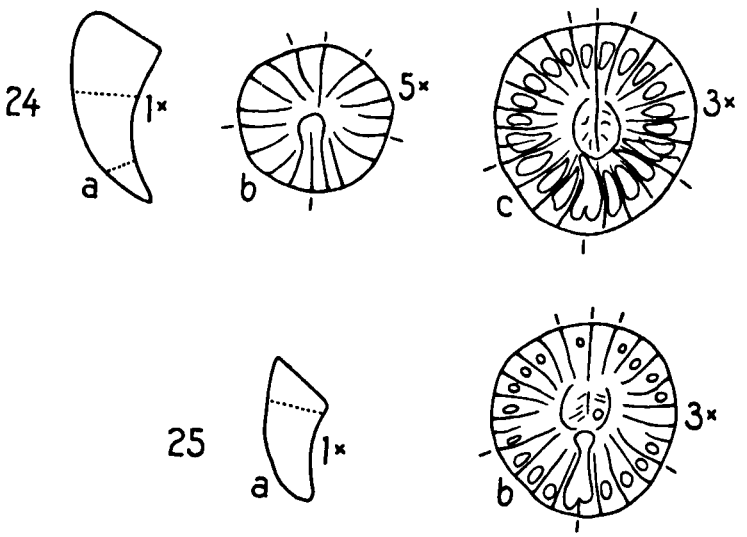
During nearly the whole ontogeny the septa are greatly thickened. In young stages the counter septum is not especially enlarged and the columella appears rather small. Till it becomes free from the septa, it has no well-marked boundary. It seems rather irregular and does not form a solid structure. There is no straight median lamina. Radial elements are conspicuous. As seen in transverse sections there are no "concentric layers". In the calyx it may reach a fairly large size.

The thinning of the septa near the calyx starts in the cardinal quadrants. The cardinal septum which is early shortened, lies in a "keyhole" fossula. Later on all septa shorten. The counter septum may remain joined to the columella.

Near the calyx at a diameter of 9 to 10 mm there are 24 major septa. Minor septa appear only as ridges on the wall of the calyx.

Remarks. This species has some characters in common with *L. breimeri* spec. nov. The number of septa at a given diameter is about the same and in both the thinning of the septa starts not far below the calyx. Yet the different structure of the columella and the presence of the keyhole fossula serve to distinguish this species from *L. breimeri.*

Material. Specimen st. no. 112566, from the Sierra Corisa limestone, coll. Mrs. Wagner, loc. 72, N of Vergaño; specimen st. no. 112567, from the Diablo limestone breccia, coll. M. M. Fischer, loc. 80, approx. 2 km E of Santa María de Redondo.



Figs. 24, 25. *Lophophyllidium* sp. Fig. 24. RGM no. 112566. a, outline, showing position of sections b and c. Fig. 25. RGM no. 112567. a, outline, showing position of section b.

Genus STEREOSTYLUS Jeffords, 1947

Type-species. Stereostylus lenis Jeffords, 1947, from the Missourian of Missouri.

Diagnosis. Lophophyllidid corals with a moderately thick axial column which contains no radiating laminae and which is only in late stages separated from the counter septum. Tabulae numerous and slightly inosculating. Septa are joined about the column near the apex and are thin and rhopaloid in higher sections. (After Jeffords, 1947, p. 16. For discussion of the genus ibid., p. 38.)

Occurrence.	Middle and (?) Upper Carboniferous	Russia — Donetz basin
	Pennsylvanian	N. America
	Permo-Carboniferous	India
	Permian	Carnic Alps
		Russia — Ural Mts.
		? Timor
		? New Zealand
		N. America

Stereostylus sp.

Pl. 3, fig. 11; text-fig. 26

cf. 1953 *Lophophyllidium rodygini* sp. nov. — Fomichev p. 193, Pl. 8, figs. 12—14

Description. The coral is slightly curved, with the cardinal septum lying on the concave side. It is about 20 mm long and has a very deep calyx, at which the diameter is 7 mm.

In young stages the septa are very thick, leaving no interseptal spaces. Their arrangement is pinnate. Cardinal and alar septa are longer than the others. At the base of the calyx the septa from the cardinal quadrants have become thinner. Especially the cardinal septum, which has also shortened. The counter septum, its swollen axial end forming the columella, reaches beyond the centre.

Higher in the calyx, at a diameter of 5.5—6 mm with 19 septa $\left(\frac{5|4}{2|2}\right)$, the cardinal septeum is very short and the columella is more pronounced. The septa of the counter quadrants are thicker than the others and in contact with their axial ends. Still higher in the calyx they become free.

The columella does not become separated from the counter septum. Minor septa remain buried in the wall. In some cases their presence is indicated by faint bulges on the wall.

Remarks. The diagnostic features of this coral approach closely those of *Lophophyllidium rodygini* Fomichev, from the Moscovian and Kasimovian of the Donetz basin. But the columella of *L. rodygini* shows distinct radial lamellae (Pl. 8, fig. 13c), which are lacking in the Spanish specimen. In a slightly higher section, figured on Pl. 8, fig. 13d, the columella is a thin lath without radial lamellae, as is typical for *Stereostylus*.

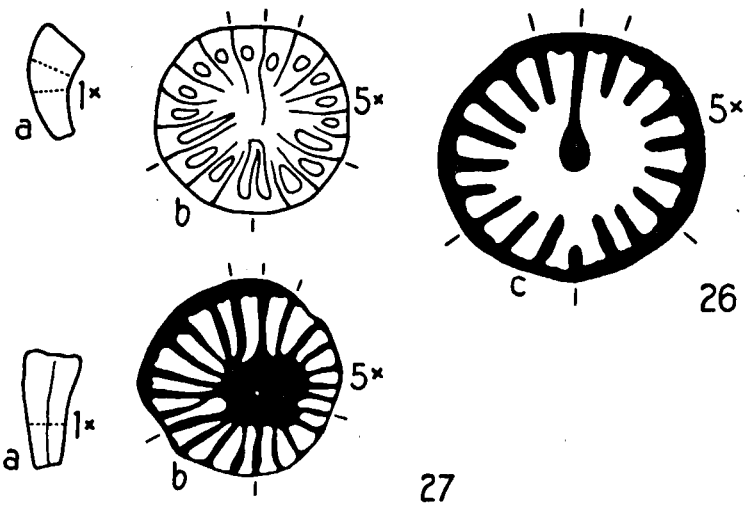


Fig. 26. *Stereostylus* sp. RGM no. 112568. a, outline, showing position of sections b and c.

Fig. 27. *Stereostylus* (?) sp. RGM no. 112569. a, outline, showing position of cardinal septum and of section b.

Material. Specimen st. no. 112568, from an impure biostromal limestone, coll. M. H. Nederlof, loc. 17, near Celada de Roblecedo.

Stereostylus (?) sp. ex gr. *newelli* (Jeffords)

Pl. 3, fig. 12; text-fig. 27

cf. 1942 *Lophophyllidium distinctum* n. sp. — Jeffords p. 243, Pl. 7, fig. 1

Description. The corallite is slender, about 20 mm long, slightly curved and reaches a diameter of 7 mm. The apex and part of the periphery are eroded. Near the apex the septa are very thick and pinnately arranged around the axially enlarged counter septum. Distally they become thinner. Up to the calyx they remain in touch with the columella. The axial ends of the counter-lateral septa are sharply turned away from the counter septum. In this manner a conspicuous counter pseudofossula is suggested. Alar pseudofossulae are generally marked. The septal break in the cardinal region is also obvious. The cardinal septum is for the greater part as long as but thinner than the rest of the septa. It shortens near the calyx.

In the fairly deep calyx the contact between the septa and columella is soon ended. Apart from the short cardinal, all septa are equal in length. Minor septa are buried in the wall. Only the counter minors protrude a little from it in the calyx.

Tabulae seem to be sparse, judging from the intersections in transverse sections. The columella as seen in transverse sections has a more or less pentagonal form. One side faces the cardinal septum.

Remarks. The coral here described shows a strong resemblance with some forms, assigned to *Stereostylus*, from the Lower Pennsylvanian of Kansas and Oklahoma. In 1942 Jeffords erected several species of *Lophophyllidium*, such as *L. newelli* and *L. distinctum.* He (Jeffords, 1942, p. 213) remarked that they differed from the other species of *Lophophyllidium* by "restriction of the immature characters to a very small part of the apical region, the scarcity or absence of tabulae, and the large alar pseudofossulae. The youthful septa are separated into four symmetrical groups by the cardinal fossula, the two prominent alar pseudofossulae and the two large interseptal spaces between the counter-laterals and counter septum. Mature parts have very straight septa with little or no axial thickening. Minor septa are very short or absent".

When proposing the genus *Stereostylus*, Jeffords (1947) included the above mentioned corals provisionally in *Stereostylus* "until knowledge of these peculiarities can be considerably extended" (ibid., p. 40).

The Spanish coral is especially like *Stereostylus distinctus* of this group. The American corals reach a greater diameter, characteristically having a broadly conical form. Further they have an earlier shortened cardinal septum and a less pronounced counter pseudofossula.

Material. Specimen st. no. 112569, from the Verdiana limestone, coll. R. H. Wagner, loc. 75.

Familia HAPSIPHYLLIDAE Grabau, 1928

Diagnosis. "Small, solitary, ceratoid or trochoid coralla with fossula bounded laterally by cardinal lateral septa and axially (in young stages at least) by a wall consisting of fused axial ends of major septa of the counter quadrants. The septa may withdraw from the axis. Tabulae incomplete, conical, with highest point at inner edge of fossula. No dissepiments. Minor septa present or absent" (Hill, 1956).

Remarks. Several attempts have been made to create order in the "*Zaphrentis*" nomenclature. Special reference is made here to Schindewolf (1938), Hudson (1941), Easton (1944), Hill (1956), Sutherland (1958) and Schouppé & Stacul (1959). On various points, either nomenclatorially or taxonomically, there exists no agreement between these authors; what genera should be included in the Hapsiphyllidae and which name should be given to them. One of the reasons for this is the fact that several hapsiphyllid genera are insufficiently known; their type-specimens which are only externally described or from one section, await restudy. Apart from that, the generic characters of these corals, which have a simple structure, are difficult to evaluate.

Genus ZAPHRENTITES Hudson, 1941 emend.

Type-species. Zaphrentis parallela Carruthers, 1910 from the Tournaisian of Scotland.

Synonymy. ? 1933 *Cypellophyllum* Tolmatchoff
1938 *Zaphrentoides* Stuckenberg sensu Schindewolf
1938 *Hapsiphyllum* (non) Simpson sensu Schindewolf
1940 *Amplexi-Zaphrentis* non Vaughan sensu Lang, Smith & Thomas
1944 *Triplophyllites* Easton
1953 *Stereophrentis* Fomichev

Diagnosis. Curved hapisphyllid corals with the cardinal fossula variously disposed (concave, lateral or convex side of curvature); the pronounced cardinal fossula generally remains bounded for the greater part of the ontogeny; cardinal septum long at first, may shorten later; septa typically curved convex to fossula; withdrawal of the septa may start in the cardinal or in the counter quadrants; minor septa when present, poorly developed.

Remarks. Zaphrentites is here interpreted rather widely, including more than only the *Z. delanouei* gens. It is used in the same sense in which Schindewolf interpreted *Zaphrentoides* Stuckenberg, or Sutherland *Amplexi-Zaphrentis* non Vaughan.

Hill (1956) lists *Zaphrentites*, *Amplexizaphrentis*, and *Zaphrentoides* as separate genera; *Triplophyllites* Easton, 1944 she considers synonymous with *Amplexizaphrentis*.

Some characters used for distinguishing the genera "*Zaphrentoides*", "*Amplexi-Zaphrentis*", *Triplophyllites* and *Zaphrentites* s.s. are shortly referred to.

1. *The position of the cardinal fossula with regard to the curvature of the corallum.* This has been thought by some authors a generic (e.g. Hill, 1956) or a subgeneric (e.g. Schindewolf, 1938) feature. Thus Hill (1956) divides the Hapsiphyllidae in two groups according to the position of the fossula: *Zaphrentoides* is placed in the group with the fossula on the convex side, the other 3 genera under consideration in the group with the fossula on the concave side. Earlier, Schindewolf (1938, 1952) commented on the undesirability and inconvenience of separating coral genera solely on a different position of the fossula. Yet he thought it sufficiently important to regard it as a subgeneric character.

Others attach less importance to the position of the fossula (Moore & Jeffords, 1945; Sutherland, 1958; Schouppé & Stacul. 1959). They do not even hold it to be a specific determinant. In this they agree with earlier authors. Carruthers for example, notes that in *Zaphrentis delanouei* "the fossula lies on the concave side of the corallum. It is, however, sometimes laterally disposed, and in one or two rare instances lies distinctly on the convex side of curvature" (Carruthers, 1908, p. 64, footnote).

There are no convincing arguments to regard the position of the fossula in itself as a feature of diagnostic importance. In my opinion, it cannot be used to distinguish genera, subgenera or species.

2. *Length of the protosepta.* Of the species referred by Hudson to *Zaphrentites*, those whose septa have become free may show strongly developed counter-lateral and alar septa, so much so that, as Schindewolf (1952, p. 68) points out, they might as well be included in *Plerophyllum*. Yet in other species, for instance *Zaphrentites carruthersi* Hudson, 1941, these septa, when free, do not differ much in length from the metasepta. The latter condition occurs usually in corals, referred to *Amplexi-Zaphrentis*, and in some species of *Triplophyllites*. In *Triplophyllites palmatus*, on the other hand, counter and alar septa are distinctly elongated (Easton, 1944b, Pl. 8, fig. 5), while in *Triplophyllites exiguus* (Miller) the counter septum is somewhat shorter than the counter-laterals (Easton, 1944b, Pl. 10, fig. 1). The cardinal septum is in all genera shortened, but this happens in different stages of growth.

These examples show, that differentiation in length of the protosepta is not constant in corals of the same genus. Moreover, if the corals show a pronounced differentiation, they may be referred to a different family. Therefore it cannot be used as a criterion for generic separation.

3. *Withdrawal of the septa from the fossula.* When the septa do not remain joined around the fossula, as is the case in the type-species of *Zaphrentites*, withdrawal of the septa may start in the cardinal quadrants (typically in *Zaphrentites* s.s.) or in the counter quadrants (typically in *Amplexi-Zaphrentis*). This feature is not considered a very important one. It may be added that it is not a very regular one either, since in the genera mentioned shortening of the septa appears also to begin in all quadrants together.

4. *Sparse development of dissepiments*, is mentioned by Easton as typical for *Triplophyllites*. His figured sections of *T. exiguus*, showing dissepiments, are not quite convincing. Probably these dissepiments are better regarded as "interseptal structures" (Interseptalbildungen, Schouppé & Stacul, 1955, p. 123).

Moreover, Easton also refers corals in which these "dissepiments" are not observed to *Triplophyllites*, for instance *T. cliffordanus*. From this one might conclude that he did not think these structures very important.

5. *Size and number of septa.* Speaking generally, corals described as *Amplexi-Zaphrentis* or *Triplophyllites* are about twice as large as, and number much more septa than, *Zaphrentites* s.s. This cannot be seen as a generic, but only as a specific difference.

After reviewing these points, one may conclude that there are no recognizable differences between the genera mentioned, as they are now currently used. Therefore I think it justified to assign all their species for the time being to one genus, until it can be demonstrated that there are true and constant differences between them. This agrees with the conclusions of Schindewolf and Sutherland. Schindewolf's proposal to divide this genus in two subgenera is not followed, however, as stated above.

For reasons set out below, neither the generic name *Zaphrentoides*, used by Schindewolf, nor *Amplexi-Zaphrentis*, sensu Sutherland, is considered suitable for use. Therefore the name *Zaphrentites* Hudson is employed here.

Schindewolf (1938) proposed the name *Zaphrentoides* Stuckenberg, 1895, for corals, till then described as *Zaphrentis*. He had come to the conclusion that the true *Zaphrentis* is quite a different, Devonian coral. Since *Zaphrentoides* lacked a type-species, Schindewolf had to choose one. His choice fell on *Zaphrentis griffithi* Edwards & Haime, which Stuckenberg mentioned also to belong to *Zaphrentoides* in his description of the genus. Schindewolf supposed *Z. griffithi* to be well known. But Thomson's description of this species, on which Schindewolf based his concept of *Z. griffithi*, does not represent *Z. griffithi* Edwards & Haime. The only specimen known so far of this species is the type-specimen, the calycal view of which was figured by Edwards & Haime. Until more is known of the internal structure of the type-species, *Zaphrentoides* cannot be interpreted correctly. It must be considered insufficiently known.

It may be remarked, that *Zaphrentoides griffithi* (Edw. & Haime) need not be congeneric with the corals on which Stuckenberg founded *Zaphrentoides*. Those are from the Lower Permian (fide Fomichev: formerly considered Upper Carboniferous) of the Ural Mountains, now kept at the Central Geological Museum in Leningrad. (The species from Timan, *Zaphrentoides mylensis* Stuck., 1895, represents, according to Dobrolyubova (1940, p. 23) "a youthful stage of *Timania schmidti* Stuckenberg").

Sutherland (1958) advocates the use of the name *Amplexi-Zaphrentis* Vaughan, 1906. On this name the following note may be added. In his original description of *Amplexi-Zaphrentis*, Vaughan (1906, p. 315) referred to a section of *Zaphrentis bowerbanki* (non) Edwards & Haime, figured bij Thomson (1883, Pl. 6, fig. 3) as being typical for the intermediate stage. In the same passage he points to "the convergence between this stage and the group of *Zaphrentis* aff. *Enniskilleni*, notwithstanding the fact that the early and late stages of the two groups are entirely distinct". How distinct is best illustrated in the latest stage of *Amplexi-Zaphrentis*: "the outer wall partly splits, and the interspace is broadly vesicular, thus simulating a *Caninia*". Vaughan figures a section (intermediate stage) of *Amplexi-Zaphrentis*, variant convergent on *Zaphrentis* aff. *Enniskilleni* (ibid., Pl. 29, fig. 7). This section shows a narrow ring of dissepiments (left hand side of the figure) and the septa in the cardinal quadrants more dilated than those in the counter, two *Caninia*-like features.

Carruthers (1908, p. 158, p. 159) was the first to point out that *Amplexi-Zaphrentis* should be considered synonymous with the genus *Caninia*. Vaughan clearly agreed with this. In a later paper (Vaughan, 1911, p. 555) the corals called *Amplexi-Zaphrentis* are referred to *Caninia* aff. *cornucopiae* Mich., mut. D_{2-3}. Under the latter name they are also described by Vaughan in Carruthers 1908, p. 169.

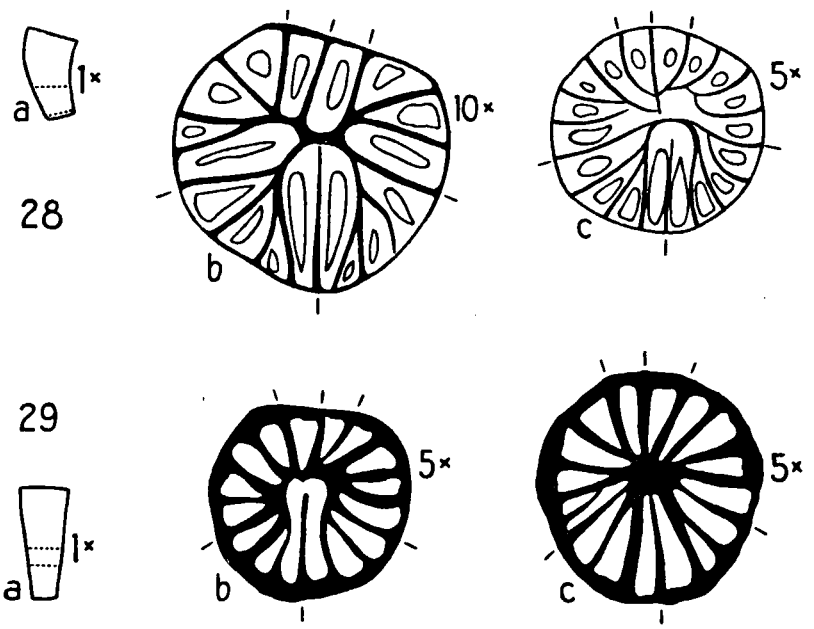
Lang, Smith & Thomas (1940) thought to revive the genus by choosing as type-species *Zaphrentis bowerbanki* Thomson, 1883, a species which is apparently congeneric with *Zaphrentis enniskilleni*. By doing so they altered the concept of the genus as defined by Vaughan. They disregarded the fact that *Amplexi-Zaphrentis* had already been redescribed as a mutation of Caninia cornucopiae. Under this consideration the name *Amplexi-Zaphrentis* is held to have no value as a hapsiphyllid genus.

Occurrence.	Dinantian	British Isles, Belgium
	Lower Carboniferous	Russia — Donetz basin
		Asia — Kuznets basin, China
	Mississippian	N. America
	Silesian	British Isles, Belgium, Holland
	Middle Carboniferous	Russia — Donetz basin
		China
	Upper Carboniferous	Chios
	Pennsylvanian	N. America — Texas

Zaphrentites paralleloides spec. nov.

Pl. 4, figs. 1—5; text-figs. 28, 29

Diagnosis. Zaphrentites with typically a parallel-sided fossula; cardinal septum shortens in calyx region, where counter septum is axially elongated.



Figs. 28, 29. *Zaphrentites paralleloides* spec. nov. Fig. 28. holotype RGM no. 112570. a, outline, showing position of sections b and c. Fig. 29. paratype RGM no. 112574. a, outline, showing position of sections b and c.

Description. The corals are conical, expanding gradually, nearly straight but generally gently curved. The cardinal fossula may be placed on the concave, convex or lateral side.

The corals reach a length of 20 to 30 mm and a diameter of 7 to 9 mm, at which there are about 20 or 22 major septa.

In neanic stages the septa are much dilated. The fossula is long and wide, parallel-sided or expanding axially. Alar pseudo-fossulae may be marked. Later on

the sides of the fossula are parallel or sometimes slightly constricted. Proportionally the fossula is less wide.

The counter septum may already in young stages appear somewhat longer. In the neighbourhood of the calyx, when the cardinal septum is shortened, it is decidedly longer. In the calyx the alar septa are shortened. Minor septa are only indicated by grooves on the exterior of the coral and by swellings or ridges on the wall in the highest sections.

diameter	number of septa	division of metasepta over the quadrants
7—8 mm	22 septa	$\frac{5\|5}{3\|3}$
6—7 mm	20 septa	$\frac{4\|4}{3\|3}$
4—6 mm	18 septa	$\frac{3\|3}{3\|3}$ or $\frac{4\|4}{2\|2}$
3—5 mm	16 septa	$\frac{3\|3}{2\|2}$
3 mm	14 septa	$\frac{2\|2}{2\|2}$

Remarks. Several sections of these corals show a strong resemblance with those of *Zaphrentites parallelus* (Carruthers, 1910). The Spanish species differs, however, in the late shortening of the cardinal septum, in the greater length of the counter septum and in the stronger dilation of the septa.

The fossula of most specimens is nearly parallel-sided in sections taken just below the calyx. Specimen st. no. 112574 (text-fig. 29c) shows, however, a section in which the sides of the fossula converge towards the centre. Such a V-shaped fossula is also observed in specimens of the *Zaphrentites delanouei* gens, at a further advanced stage of development: Hudson (1941, p. 298) refers to it as a fossula at the late *constrictus* stage. With the material at hand, it is tempting to make a close comparison between the development of the Spanish specimens and that of the *delanouei* gens, on the assumption that the fossula in these species-groups has developed along similar lines. But there is no similarity in another aspect of their development, that is in the differentiation in length of the protosepta. In the species of the *delanouei* gens this is plerophylloid (long alar and counter-lateral septa), in *Zaphrentites paralleloides* it is claviphylloid (counter septum long and alar septa shortened). Other hapsiphylloid corals with an elongate counter septum are recorded from Visean and Moscovian deposits of China (Grabau, 1922) and from the Upper Carboniferous of Chios (Heritsch, 1941c). Yet in other details these corals show no close similarity with the Spanish species.

Material. The holotype, st. no. 112570, and specimens st. no. 112571—112579 are from the upper shale-member of the Sierra Corisa limestone, author's coll, loc. 102 and 103 and Mrs. Wagner's coll., loc. 74, S and SE of the Alto Sierra.

Zaphrentites clithria spec. nov.

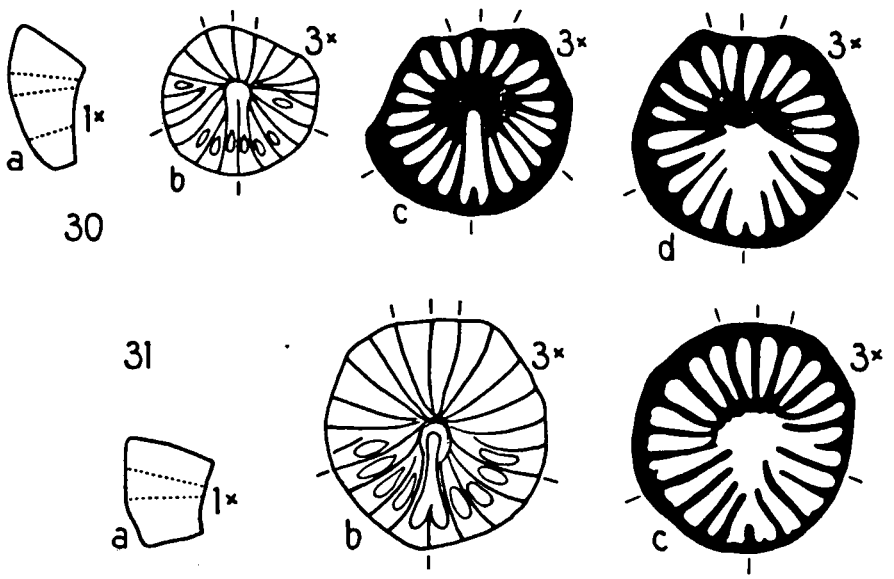
Pl 4, figs. 6, 7; tex-figs. 30, 31

Diagnosis. Zaphrentites with a constricted cardinal fossula; cardinal septum long till calyx region.

Description. The corals are 20 or 25 mm long and have a deep calyx. They are conical and slightly curved. The cardinal fossula may lie on the concave side of curvature or it may be laterally disposed.

Early in ontogeny the septa are much dilated. The fossula is almost parallel-sided, but somewhat further in growth it becomes constricted; the inner end of the fossula narrows. The fossula is wholly bisected by the cardinal septum, which is somewhat thinner than the rest of the septa.

This septal plan does not change with further growth until the calyx is reached. Dilation of the septa decreases gradually. At the base of the calyx the cardinal septum is shortened.



Figs. 30, 31. *Zaphrentites clithria* spec. nov. Fig. 30. holtype RGM no. 112580. a, outline, showing position of sections b—d. Fig. 31. paratype RGM no. 112581. a, outline, showing position of sections b and c.

The diameter, number of septa and their division over the quadrants for successive sections is as follows:

diam. 8—10 mm	22 septa	$\frac{5\|5}{3\|3}$
6— 7.5 mm	20 septa	$\frac{4\|4}{3\|3}$
3.5 mm	16 septa	$\frac{3\|3}{2\|2}$

Minor septa are indicated by septal grooves on the exterior of the corallite. In transverse sections their presence may be inferred from slight swellings on the wall. The wall is rather thick.

The septal plan in the calyx is in specimen st. no. 112580 ± claviphylloid, in specimen st. no. 112581 ± plerophylloid.

Remarks. For specific delimitation of corals of the *Z. delanouei* gens, Carruthers paid solely attention to sections cut just below the calyx floor (Carruthers, 1910, p. 592) and the same procedure is followed here. Yet it is interesting to note, that the septal plan of a section, taken just above the calyx floor (text-fig. 30c) is very similar to that of the ephebic stage of *Zaphrentites pseudoparallelus* Hudson (figured in Carruthers, 1910, Pl. 37, fig. 6B) or to the "post-*parallelus*" stage of *Zaphrentites crassus* Hudson, 1944. A section taken somewhat higher through the calyx (text-fig. 30d, 31c) strongly resembles the calycular section of *Zaphrentites pseudoparallelus* (ibid, fig. 6A). This resemblance is especially strong for specimen st. no. 112581, in which the alar septa are as long as in the English specimen. Specimen st. no. 112581, on the other hand, has shortened alar septa and a slightly lengthened counter septum. *Zaphrentites clithria* differs, however, from *Z. pseudoparallelus* in its earlier growth stages, which are very like those of the Visean *Zaphrentites constrictus* (Carruthers, 1910, p. 534, Pl. 37, fig. 5A—D). But the Spanish species may be distinguished by the much dilated septa and by the long cardinal septum.

The presence of a long cardinal septum brings to mind Hudson's observation, that the tendency to a shortening of the cardinal septum is parallel to, but does not keep step with, the changes in fossular outline. Following this line of thought, the Spanish corals would be in the *delanouei* stage in the development of the cardinal septum, but would have reached the *constrictus* growth stage in their septal plan. Such an explanation presupposes a very close affinity between the English and the Spanish forms.

Another explanation for the presence of a constricted fossula might be sought in a different direction. Carruthers (1910, p. 528) considered the possiblity that the Devonian ancestor of the *Z. delanouei* gens was of the *constrictus* type, since among the earliest specimens of *Z. delanouei* the neanic cardinal fossula is sometimes constricted at the inner end. As a possible ancestor he mentions *Zaphrentis guilleri* Barrois, described from the Arnao and Moniello limestones (Middle Devonian) from Asturias, Spain. This coral possesses a constricted fossula. The development of such a fossula could then be seen as the return of an old chracter, as Carruthers suggests for the Visean *Z. constrictus*. The strong dilation of the septa may also be seen, as Hudson (1941, p. 367) suggests, as a phylogenetically old character. He (ibid, p. 309) considers the possibility that environmental conditions may influence the reappearance in species of *Zaphrentites* of "the suppressed and once dominant character of dilation".

Material. The holotype, st. no. 112580 and specimens st. no. 112581—112582 are from the upper shale-member of the Sierra Corisa limestone, author's coll. loc. 102 and coll. Mrs. Wagner, loc. 74, S and SE of the Alto Sierra.

Genus DUPLOPHYLLUM Koker, 1924

Type-species. Duplophyllum zaphrentoides Koker, 1924 from the Permian of Timor.

Diagnosis. Hapsiphyllid coral with long major septa, pinnately arranged around a narrow fossula in which the cardinal septum is long in early, short in late stages; minor septa long and contratingent.

Remarks. The genus is fully discussed by Schouppé & Stacul (1959, p. 241).

Occurrence.	Permian.	N. America — Texas China Timor

Duplophyllum (?) sp.

Pl. 4, fig. 8; text-fig. 32

Description. One incomplete, rather worn coral fragment, 17 mm long and with a calyx-diameter of 8 mm, is questionably assigned to *Duplophyllum.* The lowest section available is not typical for the genus. It has a diameter of 5 mm and numbers 42 septa, that is 21 of each order. The septa are not thick. Those of the second order are nearly as long as those of the first. Their axial ends are joined at a short distance from the centre, leaving a small free axial space. There is not much regularity in the septal arrangement.

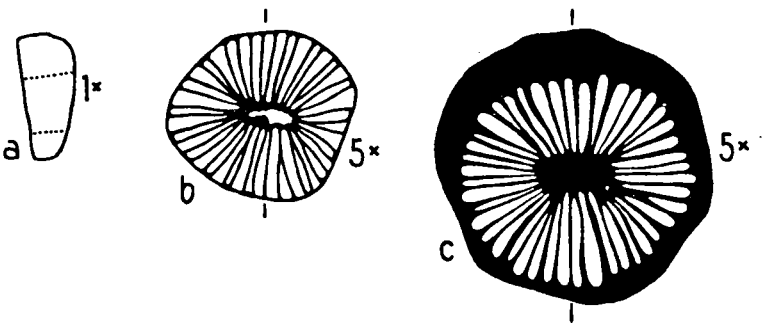


Fig. 32. *Duplophyllum* (?) sp. RGM no. 112584. a, outline, showing position of sections b and c.

In a higher section, taken at 7 mm diameter, the wall is thick. The septa are regularly arranged about the narrow fossula, which is bisected by the cardinal septum. The number of septa is still 42. The minor septa coalesce with the major septa near the centre. The central space is occupied by the joined axial septal ends. In the calyx the minor septa are shorter than the majors.

Remarks. While this coral shows characters typical for *Duplophyllum,* it does not bear much resemblance to any of the species of *Duplophyllum* described until now.

Material. Specimen st. no. 112584, from the Perapertú formation, coll. A. Breimer, Rabanal.

Genus EURYPHYLLUM Hill, 1937

Type-species. Euryphyllum reidi Hill, 1937 & 1938, from the Lower Permian of Australia.

Diagnosis. Hapsiphyllid corals with initially strongly dilated septa, extending to the axis and pinnately grouped around a long fossula, bisected by a long cardinal septum which shortens in late stages; minor septa very short (after Hill (1937), modified after Schouppé & Stacul (1959)).

Remarks. Euryphyllum, its synonymy and affinities, have recently been discussed by Schouppé & Stacul (1959, p. 294). They regard *Euryphyllum* as a subgenus of *Duplophyllum* Koker. The main difference between *Duplophyllum* and *Euryphyllum* lies in the development of the minor septa. The minor septa in *Duplophyllum* reach a considerable length, and each leans against the next major septum, during part of the ontogeny. This contrasts sharply with the rudimentary, or only faintly indicated minor septa in *Euryphyllum*. This difference is, moreover, constantly and clearly expressed. Therefore I think it justified to regard *Euryphyllum* and *Duplophyllum* as separate genera.

Schouppé & Stacul (loc. cit.) enlarge to some extent the diagnosis of *Euryphyllum*, given by Hill in 1937 and 1938. They point out a.o. that decrease of dilation of the septa, which typically begins in a zone midway between the periphery and the axis, may also start from the centre or near the periphery; that the cardinal septum may shorten distally and that its position with regard to the curvature is variable.

Occurrence.	Lower Permian	? Russia — Ural Mts.
		Australia
		New Zealand
	Lower Upper Permian	Timor

Euryphyllum hispanicum spec. nov.

Pl. 4, figs. 9—11; text-figs. 33, 34

Diagnosis. Euryphyllum with axial ends of longest septa loosely joined; in calyx a long counter septum.

Description. The corals are conical and gently curved, the cardinal septum being situated on the convex side. The theca shows externally faint septal grooves and some transverse wrinkles. The calyx is nearly subquadrate, its diameter is about 17 mm with a number of septa from 30 to 36. In the calyx the cardinal fossula is conspicuous.

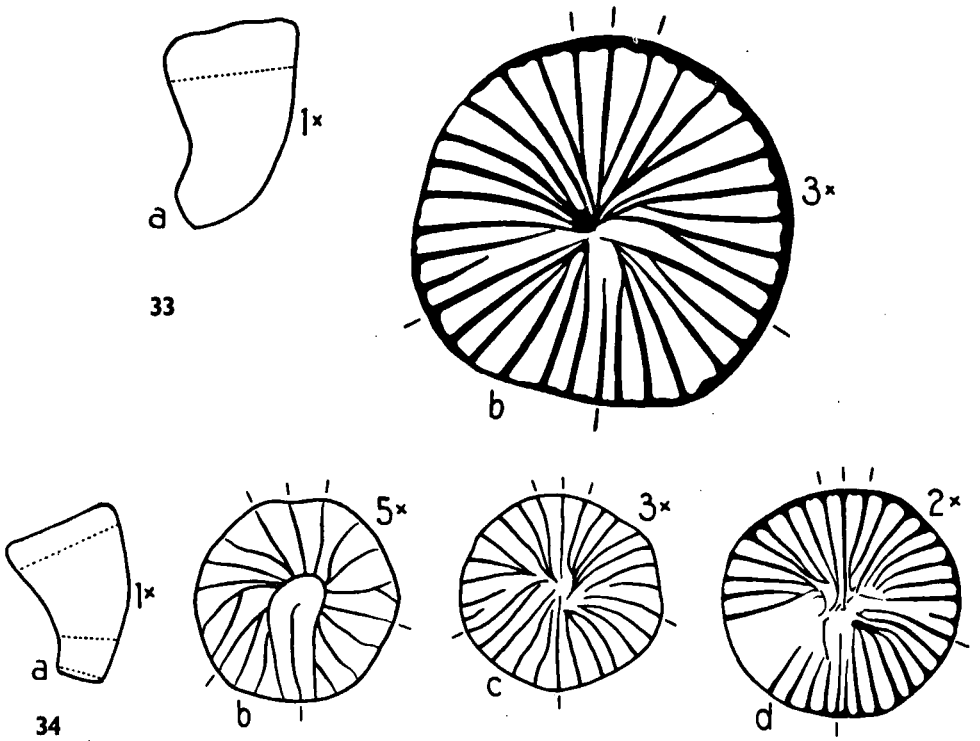
Near the apex the septa are much thickened and laterally contiguous. They are pinnately arranged around the large cardinal septum, which reaches past the centre. Further in growth the cardinal septum looses its prominence and is the first septum to become thin.

The general thinning of the septa starts in the counter quadrants. Some of the septa also become shorter and may lean on adjacent longer ones. The longer septa extend to the centre, where their ends are twisted and united to each other, thus closing the inner end of the fossula in which the distally shortened cardinal septum lies. In the calycular region the septal ends are no longer joined and the fossula is open. Only the counter septum reaches the centre. Its axial end may be slightly swollen.

The number of septa at different diameters is as follows:

16—18 mm	30—36 septa
11—15 mm	29—32 septa
8—10 mm	25—27 septa
5— 6 mm	20—24 septa

Minor septa are faintly developed or just indicated. Tabulae are raised gently in the peripheral part and sagging in the centre.



Figs. 33, 34. *Euryphyllum hispanicum* spec. nov. Fig. 33. holotype RGM no. 112585. a, outline, showing position of section b. Fig. 34. paratype RGM no. 112586. a, outline, showing position of sections b—d.

Remarks. These corals have some characters in common with the Australian representatives of this genus, especially the joining of the septa in the centre. On the other hand, there is also a certain resemblance with those from Timor, mainly in the absence of excessive dilation in adult stages. Yet the Spanish species shows no close similarity with either of these groups.

The long counter septum, as developed in *Euryphyllum hispanicum*, is not a typical feature of *Euryphyllum*. Hill (1956, p. F 267) mentions in her diagnosis of *Euryphyllum*, that the counter septum is long and thin, but probably counter is here misprinted for cardinal.

Material. The holotype, st. no. 112585 and specimen st. no. 112586 are from the Sierra Corisa limestone, coll. R. H. Wagner, loc. 69; specimens st. no. 112587—112588 are also from the Sierra Corisa limestone, coll. A. Breimer, near Vergaño.

Family LITHOSTROTIONIDAE d'Orbigny, 1851

Diagnosis. Compound Rugosa with an axial structure, generally a columella formed by elongation and vertical prolongation of axial end of counter septum, and conical tabulae; typically with a regular concentric dissepimentarium in which major and minor septa are continuous; diphymorphs are characteristic, when the axial structure disappears and tabulae flatten (after Hill, 1956).

Genus LITHOSTROTION Fleming, 1828

Type-species. Lithostrotion striatum Fleming, 1828, from the Carboniferous limestone of Wales.

Diagnosis. Phaceloid or cerioid; typically with columella, long major septa and large conical tabulae, generally supplemented by outer, smaller and nearly horizontal tabulae; dissepiments absent in very small forms, well developed in large forms; increase nonparricidal; diphymorphs common (after Smith & Lang, 1930).

Remarks. Lithostrotion is an extremely variable genus. The variation may be demonstrated in different corallites of the same corallum. Therefore it is not considered feasible to define the genus more closely. Instead, the genomorph concept has been used. A full discussion on trends and the genomorph concept in connexion with *Lithostrotion* has recently been given by McLaren & Sutherland (1949) and again by Sutherland (1958). A short review of this subject is given, pertinent to the corals described in this paper: Lang (1923, 1938) has shown how a given structure might develop in widely different corals, following a same pattern. He called such a mode in changes a trend. A trend operating on a coral genus may, if fully expressed, lead to another genus. But it also happens that in a compound corallum only a part of the corallites is so affected, the rest retaining the original structure. Smith & Lang (1930) introduced the term genomorph for corals which contain corallites of different generic types. To denote a genomorph, the name of the genus to which the affected corallites belong, is placed in square brackets after the name of the genus to which the coral originally belongs.

As for *Lithostrotion*, several trends are recognized which may operate together or singly on its corals. These are listed by Hill (1934). Two of these are important for the present study:

1. diphyphylloid trend. This leads to the situation where the columella is discontinuous or disappears altogether, the major septa shorten axially and the tabulae flatten. This trend is fully expressed in the genus *Diphyphyllum*, but diphymorphs are common in many species (specially fasciculate ones) of *Lithostrotion*. It is customary to include both fasciculate and cerioid lithostrotionoid corals in one genus. Yet the cerioid colonies in which diphymorphic conditions obtain, differ in several points from *Diphyphyllum*. They will therefore be described here as *Stylastraea*.

2. lonsdaleoid trend. This trend leads to the development of lonsdaleoid dissepiments, interrupting the septa at the periphery. Lithostrotionoid corals in which this trend is fully expressed, have been mostly described as *Lithostrotionella*. In this paper, however, *Lithostrotionella* is used in a restricted sense. The corals referred to should be removed to another genus, *Eolithostrotionella* (see further the remarks on the genus *Lithostrotionella*).

1 + 2. The combination of the diphyphylloid trend and the lonsdaleoid trend leads to the genus *Thysanophyllum*. *Thysanophyllum* is a polyphyletic genus, since it may stem either from *Diphyphyllum* or from *Eolithostrotionella*. In that case the genus must be classed with the Lithostrotionidae. But in other cases *Thysanophyllum* has close affinities with *Lonsdaleia*. It is possible that *Thysanophyllum* has given rise to *Lonsdaleia*, as Smith (1916) suggested. Hill (1940) on the other hand points out, that *Thysanophyllum* could be derived from *Lonsdaleia* and that it may represent a diphymorph of *Lonsdaleia*.

A similar relation may exist between *Lithostrotionella* and *Thysanophyllum*.

Occurrence.	Lower Carboniferous	worldwide
	Middle Carboniferous	Czechoslovakia
		Russia
		China
	Permo-Carboniferous	Russia — Ural Mts.
		Spitsbergen
		S. China
	Permian	N. America — Grinnel peninsula

Lithostrotion reticulatum (Fomichev, 1939)

Pl. 5, figs. 1, 2

1939 *Donophyllum reticulatum* Fomichev — Fomichev, p. 59, Pl. 9, fig. 2
1953 *Donophyllum reticulatum* Fomichev — Fomichev, p. 443, Pl. 29, fig. 9

Diagnosis. Fasciculate *Lithostrotion*; corallites generally 3 to 4 mm in diameter with 12 to 15 septa of each order; typically one row of globose dissepiments and a loose, net-like structure in the centre; diphymorphs occur.

Description of Spanish material. The coralla of this species may reach large dimensions. No complete coralla have been found. One fragment is 170 mm high, its lower and upper surfaces measure 90 × 120 mm². Another fragment has a height of 60 mm, the surface is ca. 150 × 150 mm².

The corallites tend to be flexuous, sometimes they are close to each other, sometimes rather distant. The diameter of the corallites varies from 2 to 5 mm. Specimen st. no. 112597 from the Perapertú formation of San Martín, and specimen st. no. 112598 from the Vañes formation, have on the average slightly smaller corallites than the coralla from Rabanal, when 13 or 14 major septa are present. The former seldom have a larger diameter than 3 or 3,5 mm, the latter measure mostly 4 or 4,5 mm. The few corallites that attain a diameter of 5 mm may number 16 or 18 major septa.

The major septa may all reach the centre. Those that fail to reach it, either abut on a tabula or join a neighbouring longer septum. The axial ends of the long

septa are loosely joined. When crossed by intersecting tabulae, a net-like structure is formed. This does not have a constant character, however.

Minor septa reach well into the tabularium. In different corallites their length varies from $\frac{1}{3}$ to $\frac{1}{2}$ of the length of the major septa. The dissepimentarium may exceptionally consist of two series of regular globose dissepiments. The tabulae are mostly incomplete and conically elevated towards the centre. Except in diphymorphic conditions the centre is occupied by the vertically elongated axial end of one of the major septa.

Remarks. The Spanish corals regarded here as *Lithostrotion reticulatum* are in all respects quite similar to the Russian specimens described by Fomichev as *Donophyllum reticulatum.* This species does not possess characteristics which necessitate a removal from the genus *Lithostrotion*, as defined above.

Fomichev founded the genus *Donophyllum* in 1939 (p. 59) for corals, differing from *Lithostrotion* in the absence of a columella. He described two new species as belonging to *Donophyllum*: *D. reticulatum* (Fomichev, 1939, p. 59, Pl. 9, fig. 2) and *D. diphyphylloideum* (ibid., p. 59, Pl. 9, fig. 3). The latter species, which is a typical *Diphyphyllum*, was chosen by Lang, Smith and Thomas (1940, p. 54) as type-species. Thereby *Donophyllum* became a synonym of *Diphyphyllum.*

In 1953 Fomichev proposed *Donophyllum* as a new subgenus of *Diphyphyllum*, naming as type-species *Donophyllum reticulatum.* The name *Donophyllum*, however, was no longer available. Apart from that, the species described by Fomichev (1939, 1953) as *Donophyllum*, do not represent a distinct genus or subgenus: *D. reticulatum* and *D. duvanense* may be assigned to *Lithostrotion*, *D. intermedium* to *Lithostrotion* [*Diphyphyllum*] and *D. diphyphylloideum* to *Diphyphyllum.*

A species which is similar to *Lithostrotion reticulatum* in the number of septa and the size of the corallites is *Lithostrotion sarmentosum* (Lonsdale, 1845). It is, however, distinguished from *L. reticulatum* by a lesser development of the minor septa and by the absence of dissepiments. Probably it is conspecific with *Lithostrotion junceum* (Fleming) recorded from the Visean of Western Europe.

Other species of *Lithostrotion* with corallites of a comparable diameter have a greater number of septa.

Material. Specimens st. no. 112589—112596 from the Perapertú formation of Rabanal de los Caballeros, coll. A. Breimer and author's coll.; specimen st. no. 112597 from the Perapertú formation, coll. R. H. Wagner, loc. 40, near San Martín; specimen st. no. 112598 from the Vañes formation, coll. Mrs. Wagner, loc. 59, N of Mudá.

Occurrence elsewhere. Lower Moscovian (zone $C_2^m a$ and $C_2^m b$) of the Donetz basin.

Lithostrotion [*Stylastraea*] [*Thysanophyllum*] *trimorphum* spec. nov.

Pl. 6, figs. 1, 2

Diagnosis. Cerioid *Lithostrotion* with adult corallites 4 or 5 mm in width, numbering mostly 13 or 14 major septa; minor septa poorly developed. The representatives of this species may follow a diphyphylloid trend, leading to *Stylastraea*; this may be supplemented by a lonsdaleoid trend, resulting in *Thysanophyllum.* Increase is peripheral.

Genus STYLASTRAEA Lonsdale, 1845

Type-species. Stylastraea inconferta Lonsdale, 1845 from the Carboniferous of Russia (East of the Ural Mountains).

1930 *Diphystrotion* Smith & Lang.

Diagnosis. Cerioid Lithostrotionidae with columella absent or discontinuous; minor septa discontinuous through inosculating dissepiments; tabulae flat or slightly domed.

Remarks. The name *Stylastraea* and not *Diphyphyllum*, is used here for cerioid diphymorphs of *Lithostrotion.* The difference between *Stylastraea* and *Diphyphyllum* lies not solely in the mode of growth of the corallum. According to Smith & Lang (1930, p. 179) *Stylastraea* is further distinguished by having peripheral, non-paricidal increase, tabulae not differentiated into a distinct inner and outer series, and coarser dissepiments.

Genus THYSANOPHYLLUM Nicholson & Thomson, 1876

Type-species. Thysanophyllum orientale Nicholson & Thomson, 1876 from the Lower Carboniferous of Scotland.

Diagnosis. Cerioid or fasciculate Lithostrotionidae (or Lonsdaleiidae) with a lonsdaleoid dissepimentarium; columella discontinuous or absent; tabulae typically complete and flat or slightly domed.

Remarks. The polyphyletic nature of this genus has already been mentioned under the remarks on the genus *Lithostrotion.*

Lithostrotion trimorphum spec. nov.

Pl. 6, fig. 1

Description. The diameter of the corallites ranges from 3 tot 5 mm, the number of major septa from 12 to 15. The major septa usually extend from the epitheca to the centre, where their axial ends are weakly joined together. In some sections the major septa are slightly shorter, and just fail to reach the centre. Occasionally the major septa are interrupted in the dissepimentarium, the minor septa regularly so, if they do not fail to develop altogether. Lonsdaleoid dissepiments occur, especially in corallite angles. The inosculating dissepiments may form a somewhat irregular herringbone pattern. As seen in longitudinal sections, dissepiments are rather steeply arranged. The tabularium diameter in full grown corallites is 3 or 3.5 mm. The interval between successive tabulae is about 0.5 mm. The inclination of the tabulae varies according to the presence or absence of the columella.

Remarks. Since the centre of the corallites is more often than not occupied by a columella, this corallum is regarded as a *Lithostrotion.* In other words, the diphyphylloid trend is but weakly expressed. In its other characters it resembles *Stylastraea inconferta* very closely, differing from that species mainly in the smaller size of the

corallites. Another similar coral has been described by Nelson (1960, p. 122, Pl. 23, figs. 1—2) as *Lithostrotion* (?) *macouni* Lambe, from the Mississippian of the Southern Canadian Rocky Mountains. It has smaller corallites and fewer septa than the Spanish specimen, and differs further in its even-sized dissepiments and regularly domed tabulae, set more closely together.

Material. The holotype, st. no. 112599, is an incomplete corallum from the Perapertú formation, coll. R. H. Wagner, loc. 35, SW of Perapertú.

Stylastraea [*Thysanophyllum*] *trimorpha* spec. nov.

Pl. 6, fig. 2

Description. The corallum contains corallites of the *Stylastraea*-type and of the *Thysanophyllum*-type. It differs from *Lithostrotion trimorphum* by the further development of the diphyphylloid trend: the major septa are shorter, reaching about halfway across the tabularium. A columella may occasionally be present, formed by one of the major septa reaching to the centre. Sometimes it is also continuous with the opposite septum.

The lonsdaleoid trend is also well expressed, several corallites have a completely lonsdaleoid dissepimentarium. Measurements and development of the minor septa are the same as for *Lithostrotion trimorphum.*

Remarks. The coralla described above are thought to represent two forms of one species, namely *Lithostrotion* [*Stylastraea*] [*Thysanophyllum*] *trimorphum* spec. nov. In the specimen first described, the diphyphylloid trend and the lonsdaleoid trend are not far advanced. In the second specimen, however, these trends are strongly expressed, so much so, that corallites of the *Lithostrotion*-type are exceptional.

Material. Specimen st. no. 112600, from the same locality as the holotype.

Genus ARACHNASTRAEA Yabe & Hayasaka, 1916

Type-species. Arachnastraea manchurica Yabe & Hayasaka, 1916 from the Lower Permian of South Manchuria.

Diagnosis. Lithostrotionid corals which are typically astreoid; major septa extending to a median plate, which is continuous with cardinal and counter septum; tabulae conical, complete or incomplete; regular dissepimentarium.

Occurrence.	Middle Carboniferous	Russia — Moscow basin and Donetz basin
		S. China
	Upper Carboniferous	Russia — Donetz basin
	Uppermost Carboniferous or Permian	Korea
	Lower Permian	N. China

Arachnastraea molli (Stuckenberg, 1888)

1888 *Phillipsastraea molli* Fischer — Stuckenberg, p. 25, Pl. 2, figs. 16—21.
1935 *Cystophorastraea molli* (Stuck.) — Dobrolyubova, p. 32, Pl. 10, figs. 3—4; Pl. 11, fig. 3; Pl. 13, fig. 6; Pl. 14, fig. 2.
1953 *Arachnastraea molli* (Stuck.) — Fomichev, p. 436, Pl. 30, figs. 2 a—b, 3.

Diagnosis. *Arachnastraea* with outer wall of the corallites partially developed; corallites typically have a diameter of 4 to 6 mm (greatest diagonal 5 to 6 mm) with 9 to 11 major septa; dilation may or may not occur; axial structure variable.

Arachnastraea molli (Stuck.) var. *delicata*

Pl. 7, figs. 1—3

Diagnosis. Like *Arachnastraea molli* but with nearly no dilation of the skeletal parts; with a narrow, rather primitive axial structure; tabellae not sharply differentiated into periaxial and axial zones.

Description. The coralla are flat and spreading. The dimensions of one of the specimens are: height 40 mm, upper surface 90 × 120 mm^2. Around the corallites the external wall is mostly present, but it is often interrupted. The diameter of the corallites and the corresponding number of septa vary in the different coralla. Measurements as in typical specimens of *Arachnastraea molli*, that is 9 to 11 septa at a diagonal of 5 to 6 mm, are found in corallum st. no. 112601 and other specimens from the Celada limestone. Corallites of specimen st. no. 112607, from the Verdiana limestone, number as many septa but measure diagonally 4 to 4.5 mm. The other corals may number more septa. For instance, specimen st. no. 112608, from the Peña Tejedo limestone, contains corallites with 17 septa; the greatest diagonal is about 7 mm. Septa of neighbouring corallites may alternate with each other, or they may be confluent. Most major septa reach the axial structure, only a few abut on tabulae.

The minor septa extend to just within the tabularium. The dissepimentarium occupies about half the corallite. Dissepiments are relatively large, elongate in form and not much inclined. Smaller, more globose dissepiments also occur.

The tabularium has a diameter of 1.5 to 2.5 mm. The tabulae are conically elevated, complete or incomplete. The axial tabellae and the periaxial tabellae are about similarly inclined. The median plate of the axial structure may be slightly thickened.

Remarks. The Spanish corals and the Russian representatives of *Arachnastraea molli* (Stuck.) as described by Dobrolyubova, resemble each other closely. The differences between them are not strong and mainly gradual. Therefore they are considered to be of infrasubspecific importance. Briefly, they concern the more regularly attenuate character of the skeletal elements and the better development of the outer wall of the corallites in the Spanish specimens.

Material. Specimens st. no. 112601—112605 from the Celada limestone, author's coll., loc. 28; specimen st. no. 112606 from the Cotarraso limestone, coll. R. H. Wagner, loc. 65; specimen st. no. 112607 from the Verdiana limestone, coll. R. H. Wagner, loc. 75; specimen st. no. 112608 from the Peña Tejedo limestone, coll. M. H. Nederlof, loc. 22.

Arachnastraea molli (Stuck.) *dilatata* subsp. nov.

Pl. 7, figs. 4, 5; Pl. 8, figs. 1, 2

Diagnosis. Like *Arachnastraea molli* but with greater dimensions of the corallites and a larger number of septa; septa, inner wall and axial structure generally dilated; axial structure complex, with axial tabellae raised more sharply upwards than the periaxial tabellae.

Description. This subspecies includes large corals, partly astreoid, partly cerioid. One of the largest specimens (an incomplete corallum) is 40—100 mm high, and has an upper surface of 200 × 200 mm². Other coralla are not flat, but round.

The corallites have an average diamter of 6 to 7 (diagonal: 7 to 8) mm with 14 or 15 major septa. The range of variation in the diameter is from 5 to 9 mm, in the number of septa from 10 to 14. The smaller corallites appear to be restricted to the edge of the coral.

Dilation of the septa occurs mainly near the inner wall, but the septal parts in the dissepimentarium may also be affected, so much that the septa become wedge-shaped. Lateral dissepiments, elongate as seen in transverse sections, are developed in many corallites. The regular dissepiments are relatively small, globose and very little inclined, except near the inner wall.

The diameter of the tabularium varies around the average of 3, from 2.5 to 3.5 mm. The tabulae are incomplete, the tabellae of the axial part are more densely split and more sharply raised towards the columella than those of the periaxial part. The axial structure occupies about half, or a third of, the tabularium. Generally it is a compact axial complex with several thickened elements. Sometimes it is wholly dilated.

Remarks. The differences between these corals and the Russian representatives of *Arachnastraea molli* (Stuck.) as described by Dobrolyubova, are, although gradual, more marked than those, noted between *A. molli* and the variety *delicata.* Therefore the corals are designated as a subspecies of *A. molli.* This subspecies, named *dilatata,* is chiefly distinguished by the constant dilation of the skeletal elements from *A. molli molli* (Stuck.). Perhaps this subspecies occurs in Russia as well. Dobrolyubova (1935, p. 35) mentions a specimen of *A. molli* from Svistunov, in which the septa are strongly dilated, especially in the tabularium, and the inner wall is also thickened.

Material. The holotype of this subspecies is specimen st. no. 112609, from the Vañes formation, coll. Mrs. Wagner, loc. 59; specimen st. no. 112610, also from the Vañes formation, coll. Mrs. Wagner, loc. 54, near the mine of San Cebrián; specimen st. no. 112611, from the Frechilla limestone, coll. M. H. Nederlof, loc. 31, near San Juán de Redondo; specimen st. no. 112612 from the Cotarraso limestone, coll. Mrs. Wagner, loc. 47, E of the Sierra Corisa; specimen st. no. 112613 from the Cotarraso limestone, coll. R. H. Wagner, loc. 53, near Mina Portillo; specimens st. no. 112614—112616 from a limestone outcrop NW of Cotarraso, coll. R. H. Wagner, loc. 66; perhaps also a fragment, st. no. 112617, from R. H. Wagner's collection, loc. 67.

Occurrence elsewhere of Arachnastraea molli (Stuckenberg). Upper Moscovian (Podolskian and Myachkovian) of the Moscow basin; Upper Moscovian (zone C_2^{me}) and Lower Kasimovian (zone C_3a) of the Donetz basin.

Arachnastraea orboensis spec. nov.

Pl. 8, figs. 3, 4

Diagnosis. *Arachnastraea* with corallites about 10 mm in diameter and generally 16 or 17 septa of each order; axial structure variable.

Description. The holotype, st. no. 112618, is a rounded corallum, 100 mm high, with an upper surface of 100 × 150 mm².

The corallites are polygonal. Their external wall is, although indistinct, mostly developed, but fairly frequently interrupted.

Many corallites number 16 to 18 septa, corresponding to a diameter of 9 to 11 mm, the greatest diagonal being 12 mm. The diameter varies from 7 to 12 mm, the number of septa from 14 to 19, only rarely more.

Septa of neighbouring corallites may be confluent. The major septa are unequal in length, a few may extend to the centre, but often they fail to reach it. There may be a slight dilation of the septa in the tabularium. Minor septa cross the whole dissepimentarium, in most cases they pass only a little beyond the inner wall. In the dissepimentarium the septa are sometimes tortuous, occasionally interrupted near the periphery. Lateral dissepiments are not uncommon.

The width of the dissepimentarium approximates half the radius of the corallite. The dissepiments are globose or elongate and moderately inclined. At the periphery the dissepiments are sometimes nearly horizontal, when the dissepimentarium is wide. There appears to be some regularity in the alternation of fine and globose dissepiments with coarser and more elongate ones.

The axial structure is formed by an axial rod, which is mostly reinforced by axial parts of the tabulae and some septal ends. The columella is sometimes continuous with one of the septa, more often with two opposite septa. Occasionally it is interrupted. The tabulae are mostly incomplete, raised conically or domelike towards the columella. Increase is peripheral.

Remarks. The corals here described are referred to *Arachnastraea*, although the axial structure is less constantly developed than is usual in species of this genus.

As for comparison with corals from other regions, there is a general resemblance with "*Lonsdaleiastraea*" *longiseptata* Dobrolyuvova, 1936, from the Upper Carboniferous of the Ural Mountains. The Russian species differs, however, in numbering more septa (up to 26), while the corallite-diameter is about the same as for the Spanish species, and in the poor development of the minor septa. The Russian species belongs probably also to *Arachnastraea*, and not to *Lonsdaleiastraea* Gerth, which is characterized by thamnasterioid to aphroid coralla with downturned tabulae.

Another species which appears similar to *Arachnastraea orboensis*, has been described and figured by Dobrolyubova (1936b) from the Upper Carboniferous of the Ural Mountains as "*Cystophora*" *wischeriana* (Stuckenberg). The corallites of this species are, in size and number of septa, comparable with those of *Arachnastraea orboensis*, they have likewise regular dissepiments and domed tabulae, but the axial structure is a simple columella, which is often interrupted, and the minor septa may be poorly developed or lacking altogether. This species appears to be intermediate between *Arachnastraea* and *Orionastraea*. It does not belong to *Cystophora* Yabe & Hayasaka, which is a member of the Lonsdaleiidae.

Material. The holotype, st. no. 112618 and paratype st. no. 112619 are from the limestone of Orbó, coll. R. H. Wagner, loc. 105.

Family AULOPHYLLIDAE Dybowski, 1873

Diagnosis. "Simple or less commonly compound Rugosa with numerous septa, a regular dissepimentarium, incomplete conical tabulae and generally an axial structure. Septa are equally spaced and seldom curved about the small, open cardinal fossula, which is marked by extension of the tabularium into the dissepimentarium; major septa may be dilated in the tabularium, particularly in cardinal quadrants; minor septa may be degenerate. Dissepiments are small and globose, concentric, angulo-concentric or inosculating, rarely lonsdaleoid. The axial structure normally consists of straight or curved septal lamellae, commonly with a columella or median plate, and an inner series of tabellae" (Hill, 1956).

Subfamily AULOPHYLLINAE Dybowski, 1873

Diagnosis. "Aulophyllidae with tabularial part of fossula short, open and narrowing axially" (Hill, 1956).

Genus CLISIOPHYLLUM Dana, 1846

Type-species. Clisiophyllum keyserlingi MacCoy, 1849, from the Upper Visean of Derbyshire.

Diagnosis. Solitary aulophylline corals with normal minor septa in a regular dissepimentarium; typically a wide axial structure whose septa lamellae are about half as numerous as the major septa, often twisted spirally and abut on a short (thickened) median plate (after Hill, 1938).

Remarks. Clisaxophyllum Grabau in Chi, 1931 is regarded as a synonym of *Clisiophyllum* Dana. The type-species of *Clisaxophyllum* is *Cyathophyllum coniseptum* Keyserling, 1846 from the (Lower?) Carboniferous limestone of the W. Urals. It is a species of *Clisiophyllum* and, according to Hill, 1938, perhaps synonymous with *Clisiophyllum keyserlingi* MacCoy.

Several authors are inclined to regard *Clisaxophyllum* as a separate genus, which is then referred to as *Clisaxophyllum* Grabau & Yü, 1933. By mistake Yü (1933) described *Clisaxophyllum* as a new genus. He chose as type-species *Clisiophyllum bowerbanki* Edwards & Haime, 1851. *Clisaxophyllum* Grabau & Yü has therefore no status. Apart from that, the corals Yü described as *Clisaxophyllum* are congeneric with *Clisiophyllum* Dana, since C. *keyserlingi* is one of the species Yü mentioned especially as belonging to *Clisaxophyllum.*

The confusion existing around *Clisiophyllum* Dana and *Clisaxophyllum* Grabau appears to have originated from Dana's description and figures of *Clisiophyllum.* Dana himself did not name any species, and his figures are not of recognizable species. MacCoy was the first to refer described species to *Clisiophyllum,* among which *C. keyserlingi.* Dingwall's designation of *C. keyserlingi* MacCoy as the type-species must be held valid, according to art. 69A of the International Code of Zoological

Nomenclature. This article reads: If an author established a nominal genus, but did not designate or indicate its type-species, any zoologist may subsequently designate as the type-species one of the originally included nominal species, or, if there were no original nominal species, one of those first subsequently referred to the genus.

Occurrence.	Dinantian	W. Europe
	Lower Carboniferous	Russia, China, Japan
	Mississippian	N. America
	Namurian	British Isles
	Middle and Upper Carboniferous	Japan
	Permian	? N. America

Clisiophyllum sp. no. 1

Pl 9, fig. 1

Description. The coral, provisionally assigned to *Clisiophyllum*, is cylindrical and about 130 mm long. The specimen is embedded in fine-grained, black limestone. It has severely been crushed and rejuvenation has occurred a few times. The early stages are lacking. The outer part of the marginarium has disappeared from nearly the entire length of the specimen.

The diameter of the coral is about 30 mm, and there are 40 septa of each order. In sections where the outer dissepimentarium is still present, some septa appear thick, but perforate; others are thin and sinuous, lined with lateral dissepiments. In the inner dissepimentarium the septa are straight and slightly thicker. The major septa are distinctly dilated in the tabularium, where they reach close to the axial structure. The cardinal septum is shorter and lies in a fossula. The minor septa cross the dissepimentarium. They may protrude a little into the tabularium; their axial ends are not dilated.

The dissepimentarium is wide, occupying half the radius of the corallum. Apart from the lateral dissepiments in the outer part, it is regular, concentric or angulo-concentric. Locally it may be arranged in a pseudo-herringbone pattern. As seen in longitudinal sections the dissepiments vary greatly in size. Their form is globose. At the periphery they are less steeply inclined than towards the inner wall, where they may be nearly vertically disposed.

The axial column occupies about half the tabularium diameter. In transverse sections it has a cuspidate form, since it is slightly prolonged towards the cardinal fossula. The structure may be open or dense, varying considerably in different sections. On the whole the development of septal lamellae keeps step with that of the axial tabellae. When the number of septal lamellae is limited, about half that of the major septa, the axial tabellae are not very closely set together. The axial structure appears then somewhat dibunophylloid. But when the septal lamellae surpass the major septa in number, the axial tabellae are also crowded. This may be especially pronounced in the central part, resulting in a nucleate structure. The median plate is not short and thickened, as in typical *Clisiophyllum*, but rather long and thin. It does not cross the entire structure, however, only the cardinal part. The axial tabellae are variously inclined. Locally they have the same gentle slope as the periaxial tabulae. It also happens that they are sharply deflected upwards.

Remarks. The structure of the axial column in some sections of this coral shows a resemblance to that of several Lower Carboniferous *Clisiophyllum* species: to the nucleate clisiophyllids from W. Europe and to some species from China, described by Yü (1933) as *Auloclisia.* (Hill, 1938, has pointed out already that these species belong to *Clisiophyllum.*) Yet the inconstancy in the elements of the axial structure and the presence of lateral dissepiments are no common characteristics of *Clisiophyllum* and prevent any close comparison. This will be discussed further after the description of *Clisiophyllum* sp. no. 2.

Material. Specimen st. no. 112620, from R. H. Wagner's collection, loc. 39, near San Martín, Perapertú formation.

Clisiophyllum sp. no. 2

Pl. 9, fig. 2

Description. One incomplete coral is referred to *Clisiophyllum* on account of its axial structure, although in other features it differs from typical representatives of this genus. The fragment is 45 mm high, including the calyx, in which some offsets are developed. The early ontogenetic stages are not preserved. The section figured is taken just below the calyx, measures 22 mm and numbers 32 septa of each order. In the outer zone of the dissepimentarium the septa are hardly discernible, their peripheral ends are thin, twisted and tortuous. Further inwards the septa are dilated, the majors more strongly than the minors. Lateral dissepiments are very common, both on major and on minor septa. The dissepimentarium is as wide as half the radius of the corallite. The minor septa are a little longer. A dissepitheca is not developed. In the tabularium the major septa decrease slightly in dilatation towards their axial ends. Except for the shorter cardinal septum, they extend to the axial column. In this structure the median plate is straight in the direction of the cardinal septum, with which it is continuous in earlier stages. The septal lamellae are as numerous as the major septa, but not directly in contact with them. The lamellae are strongly and regularly rotated. The axial tabellae are set very close to each other. As seen in longitudinal sections, they are thinner and more steeply upwards inclined than the tabellae of the periaxial zone.

Remarks. Clisiophyllum sp. no. 1 and *Clisiophyllum* sp. no. 2 have some characters in common, but differ on the following points: No. 1 has a greater number of septa and is considerably larger than no. 2. The corals differ chiefly from each other in the development of the axial structure. No. 1 has a very irregular structure, which may be nucleate, while no. 2 has a very regular column, not crowded in the centre, with strongly rotated lamellae.

The corals belong certainly to the same genus, although perhaps not to *Clisiophyllum.* The wide dissepimentarium and the lateral dissepiments are not uncommon in other aulophylloid corals, for instance *Dibunophyllum* and *Koninckophyllum,* but they have not, as far as I am aware, been recorded in any species of *Clisiophyllum.* Perhaps these corals are generically separate from *Clisiophyllum.* Since, however, only two incomplete specimens are present, and nothing is known of their early ontogenetic stages, they are for the time being included in *Clisiophyllum.*

Material. Specimen st. no. 112621, from R. H. Wagner's collection, loc. 105, near Orbó.

Genus DIBUNOPHYLLUM Thomson & Nicholson, 1876

Type-species. Clisiophyllum bipartitum McCoy, 1849 from the Carboniferous Limestone of Derbyshire.

Diagnosis. Large, solitary Aulophyllinae with a variable axial column; typically it is $\frac{1}{3}$ as wide as the corallum and consists of long median plate, few septal lamellae (4 to 8 on either side) and numerous tabellae; less typically, the median plate may disappear, the septal lamellae become curved and the bilateral arrangement be lost; with minor septa degenerate, the dissepiments are inosculating (after Hill, 1938).

Remarks. The genus and its synonymy have been fully discussed by Hill, 1938.

Occurrence.		
	Visean	W. Europe
		N. Africa
	Lower Carboniferous	Russia, China, Japan
	Mississippian	N. America
	Namurian	British Isles
	Middle Carboniferous	? Russia
		China
	Upper Carboniferous	? Carnic Alps, ? Carpathians
	Pennsylvanian	N. America
	Permo-Carboniferous	Spitsbergen
	Permian	Greece

Dibunophyllum sp.

Pl. 9, figs. 3, 4

Description. One coral, of which the apex and part of the marginarium are weathered away, is assigned to *Dibunophyllum*. The specimen is cylindrical, straight, 40 mm high, and shows rejuvenation. Its diameter is about 18 mm, the number of septa before and after rejuvenation is 32, resp. 28. The peripheral edges of the septa are dilated, strengthening the epitheca. The major septa are slightly dilated in the dissepimentarium and in the outer part of the tabularium. In some cases their thin axial ends are continuous with the septal lamellae of the axial column. Prior to the rejuvenation, some septa shorten axially and coalesce with a neighbouring septum. Minor septa are developed as septal ridges on the epitheca. The inosculating dissepiments are often arranged in a herringbone-pattern. As seen in longitudinal section, they are varying in size, more or less globose and moderately to steeply inclined. The section figured (Pl. 9, fig. 4) shows, as thickened layers, the form of the calyx (slope of calycular platform and surface of calycular pit). The layers must have been formed in periods of rest between periods of growth-activity. The axial column shows some peculiarities. The median plate may bisect the structure completely, but it is sometimes discontinuous in the centre, divided into a cardinal and a counter part. The number of septal lamellae varies between 8 and 17. A section taken through the apical part of the specimen, shows an open structure, with few septal lamellae. More distally the structure becomes dense, and contains more lamellae, but after rejuvenation the open axial column reappears. The tabellae of the axial zone are fairly large, domed plates. In the periaxial zone the plates are smaller, horizontal and gently upwards inclined.

Specimen st. no. 112623, which is longitudinally halved by weathering, apparently belongs to the same species. It agrees in all details, as far as they can be observed.

Remarks. This species cannot be readily compared with typical representatives of *Dibunophyllum.* This regards especially the character of the axial column, but also the structure of the septa. Yet the range of variability in this genus, as now understood, is such, that inclusion of this species appears justified.

Material. Specimen st. no. 112622, from the Santa María limestone, coll. R. H. Wagner, loc. 21. Probably also specimen st. no. 112623, from a reef SE of San Martín de Perapertú, coll. R. H. Wagner, loc. 43.

Genus KONINCKOPHYLLUM Thomson & Nicholson, 1876

Type-species. Koninckophyllum magnificum Thomson & Nicholson, 1876, from the Upper Visean (coral zone 3) of Scotland.

Diagnosis. "Solitary or fasciculate aulophylline corals; minor septa may be shortened axially in dissepimentarium; axial structure a columella, which may be supported by a few septal lamellae; tabulae tented and incomplete; if columella is absent, the tabulae flatten and may become complete" (Hill, 1956, p. F 288).

Remarks. In her redescription of *Koninckophyllum magnificum*, Hill (1939, p. 89) points out that the septa and the axial structure show a great variability. Lateral dissepiments are frequently developed, and in some forms the septa may be dissepiseptate. In neanic stages, when minor septa and dissepiments begin to develop, an axial column is formed, which may be clisiophylloid or dibunophylloid. The septal lamellae are vertically discontinuous, and ultimately disappear altogether. The median plate usually persists as a columella. Sometimes it is strongly dilated, sometimes it is thin and inconspicuous. Finally it may also disappear.

Fomichev (1939, 1953) proposes a new genus, *Neokoninckophyllum*, for corals whose youthful stages have not a clisiophylloid or dibunophylloid axial structure, but a simple lamellar columella. In other respects they agree quite well with the type-species of *Koninckophyllum* especially in having a variable axial structure, lateral dissepiments, and septa split at the periphery.

Occurrence.	Dinantian	Western Europe
		Africa — Sahara
	Lower Carboniferous	Russia — Nova Zembla, Moscow basin, Donetz basin, South Ural
		Asia — Asia minor, Central Asia, China
	Mississippian	N. America — Nova Scotia, Missouri
	Namurian	British Isles
	Middle Carboniferous	Carnic Alps
		Russia — Donetz basin
		China
	Pennsylvanian	N. America

Koninckophyllum multilamellatum spec. nov.

Pl. 9, figs. 4—7; Pl. 10, fig. 1

Diagnosis. Koninckophyllum in which the axial structure, when fully developed, numbers as many septal lamellae as there are major septa; with 30 septa of each order at a diameter of 20 mm; lateral dissepiments not uncommon.

Description. The corals are trochoid and may be 40 to 60 mm high. None of the corals has the apex preserved, the early ontogenetic stages are therefore unknown. In the earliest stage of which a section could be obtained, minor septa and dissepiments are already developed. Septa of both orders are thin in the dissepimentarium, which is bounded by a strong dissepitheca. In the tabularium the major septa are strongly dilated, the dilated axial ends are joined around the axial structure. This consists of thin septal lamellae and tabellae, and a faint but recognizable medial plate. The section numbers 21 major septa and has a diameter of about 6 mm. Further in growth, dilatation of the major septa decreases and the ring around the axial column disappears. The minor septa just enter the tabularium. Occasionally, lateral dissepiments are developed. The regular dissepiments are concentric or angulo-concentric. The axial column may continue to exist, sometimes with a slightly dilated median plate, bisecting the whole structure, or with the median plate short, dilated only in the centre.

In adult stages the dissepimentarium is as wide as $\frac{1}{2}$ or $\frac{1}{3}$ the radius of the corallite. Lateral dissepiments occur generally in a wide, outer zone, an inner, narrow zone consists only of concentric dissepiments. A fully developed axial structure at this stage occupies $\frac{1}{3}$ to $\frac{1}{2}$ of the tabularium. The numerous, thin septal lamellae may be slightly twisted. But the axial column is not constant: the septal lamellae may disappear, and the tabulae flatten. Then only the medial plate is left, and even that may be locally interrupted.

Remarks. Corals of this species, sectioned at a plane where the axial column is completely developed, could well be included in *Clisiophyllum.* Except for the dissepimentarium, they resemble especially corals, described under the generic name *Clisaxophyllum* Grabau, which is a synonym of *Clisiophyllum* MacCoy (see above). There are several specimens (st. no. 112624—112628) in which the axial column is fairly constant, as long as the form of the coral is an expanding cone. After the coral has become cylindrical, the column tends to disappear. It is not yet certain that the axial structure changes always with the form of the coral, but there are several indications that this might be the case:

1. the conical parts of the corallites have a completely developed axial column
2. the longitudinal section, figured on Pl. 9 fig. 7b shows in the lower half a $\pm$ parallel-sided, koninckophylloid tabularium. Distally, the coral expands slightly, and the tabularium becomes clisiophylloid, i.e. divided in a periaxial and an axial zone
3. the cylindrical fragments of this species are without an axial column.

So perhaps the development of the axial structure is influenced by the form of the corallum. Other factors, affecting degeneration of the axial structure, have been discussed by Dobrolyubova (1948b) and by Johnson (1956). Both studied corals of the species *Dibunophyllum bipartitum* (MacCoy). Dobrolyubova examined specimens from the Lower Carboniferous (Okian and Serpukhovian) from the Moscow basin. She recognizes a phylogenetic development from *D. bipartitum* to *Caninia okensis* Stuck. by the reduction of the axial structure.

Dobrolyubova's study is summarized as follows:

D. bipartitum is wide-spread in the Okian, but does not continue far in the Serpukhovian. Its place is taken by corals whose axial column is reduced in adult stages (Upper Tarussa and Lower Steshevo zones). In corals from the Upper Steshevo zone, this reduction starts in earlier stages and the axial structure becomes a simple columella. The corals are koninckophylloid. The development of an axial structure is restricted to ever younger ontogenetic stages, in the adult it lacks altogether. At the end of this lineage the corals are caninioid.

The possibility is not excluded that the Spanish *Koninckophyllum multilamellatum* represents an intermediate phase in an analogous development, but there is no evidence to support this.

Johnson (1956) studied the variability of the axial structure in *Dibunophyllum bipartitum* and its subspecies, which were thought to represent an evolutionary change: *D. bipartitum bipartitum*, with a wellformed axial column, in which the median plate is long and the septal lamellae straight — *D. bipartitum koninckí*, in which the median plate is shortened and the lamellae tend to be twisted, regarded as transitional to *D. bipartitum craigianum*, in which the axial column is still more degenerate: the median plate may disappear and the septal lamellae retreat to the periphery. Johnson did not find confirmation for the idea of an evolutionary development. Study of two populations of *D. bipartitum* showed, that the greatest number of the supposedly youngest *craigianum*-type were found in the lowest stratigraphical horizon. He found further, that variability of the axial column in one individual does not tend in one direction. The well-developed *bipartitum* type of axial column may be regained after considerable degeneration. The fact that muddy inclusions in the centre of the corallite are seen to accompany a deterioration of the axial column, led to the assumption that its formation is directly influenced by environmental conditions, i.e. relative clarity of the surrounding water.

So far, no mud-inclusions have been observed in the Spanish corals, assigned to *Koninckophyllum multilamellatum.*

Material. The holotype, st. no. 112624 and specimens st. no. 112625—112632 are from R. H. Wagner's collection, loc. 44, near Perapertú; specimens st. no. 112633—112638 from Mrs. Wagner's collection, loc. 75, near Monasterio; specimen st. no. 112639 from R. H. Wagner's collection, loc. 35, NW of San Martín; all specimens from the Perapertú formation.

Koninckophyllum gentisae spec. nov.

Pl. 10, figs. 2, 3

Diagnosis. Koninckophyllum in which the axial structure, when fully developed, is dibunophylloid; with 33 to 38 septa of each order at a diameter of 20 mm; width of dissepimentarium about $\frac{1}{3}$ of the radius of the coral.

Description. The corals assigned to this species are conico-cylindrical. They are incomplete in the apical part. The holotype, st. no. 112640, is nearly 50 mm long and shows several times rejuvenescence. The paratype st. no. 112641 is ca. 30 mm long.

A section of the late neanic stage (Pl. 10, fig. 3a) has a diameter of 18 mm, and numbers 35 septa of each order. The major septa are dilated in the tabularium

and extend close to the axial structure. The minor septa extend as far as the dissepimentarium is wide, which is $\frac{1}{7}$ or $\frac{1}{6}$ of the radius of the corallite. The dissepiments may be arranged in a pseudo-herringbone pattern. At the periphery they are crowded. At the margin of the tabularium a dissepitheca is developed. The vague axial structure is loosely built of some septal lamellae, one of which is continuous with the counter septum, and some tabular intersections.

With further growth the dissepimentarium gains a width of $\frac{1}{4}$ to $\frac{1}{3}$ of the radius of the coral. The septa in the dissepimentarium are lined with lateral dissepiments, occasionally (Pl. 10, fig. 2c) or commonly (Pl. 10, fig. 3b), the septa having then often a zig-zag course. Minor septa may still cross the dissepimentarium entirely, or not, leaving an inner zone of inosculating dissepiments. The axial structure occupies $\frac{1}{3}$ of the tabularium. When completely developed, it consists of a somewhat thickened median plate, which may be continuous with cardinal and/or counter septum, with 4 or 5 slightly curved lamellae on either side. Seen longitudinally, the median plate shifts and is not continuous. The tabulae are but a little raised towards it.

Remarks. Sections of *Koninckophyllum gentisae*, in which a dibunophylloid axial structure is developed, show a close resemblance with the specimen, described by Heritsch as *Dibunophyllum yui* Chi from the Permo-Carboniferous of Spitsbergen (Heritsch, 1939, p. 6). The section figured (ibid., Pl. 13, fig. 1) numbers more septa at the same diameter and has shorter minor septa. The Spanish specimens, however, have a too inconstantly developed axial structure to be included in *Dibunophyllum*.

Koninckophyllum multilamellatum differs from *K. gentisae* in the character of the axial structure, with its numerous septal lamellae, in the wider dissepimentarium and in the longer minor septa.

Material. The holotype is specimen st. no. 112640 from the Socavón limestone, collected by Mrs. C. H. T. Wagner-Gentis, after whom the species is named, from loc. 54, near the mine of San Cebrián. Specimens st. no. 112641—112642 are from the same locality.

Koninckophyllum gentisae f. *minor.*

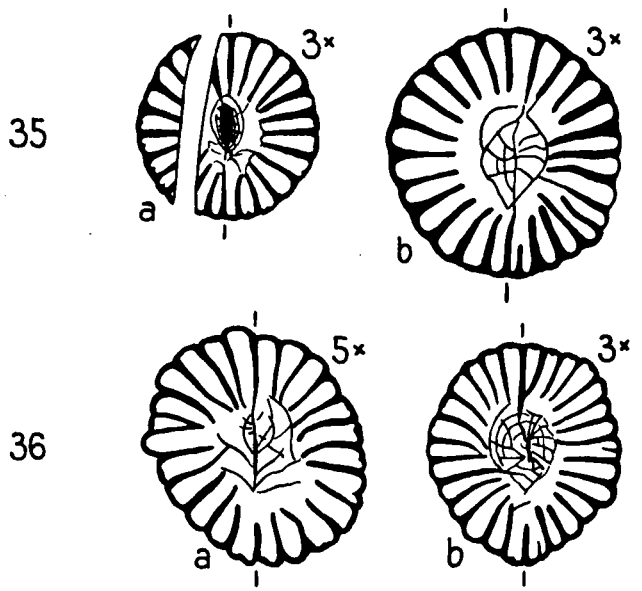
Pl. 10, figs. 4—7; text-figs. 35, 36

Diagnosis. Like *Koninckophyllum gentisae*, but with smaller diameter and with fewer septa.

Description. The corals reach a diameter of 16 to 18 mm, and may number 28 to 30 septa. The completest specimen is about 35 mm long. A section from the early neanic stage numbers 18 major septa at a diameter of 4,5 mm. It shows the septa of the cardinal quadrants pinnately arranged around the conspicuous fossula, which is completely bisected by the cardinal septum. The septa are but slightly dilated. With further growth the fossula becomes less pronounced, the twisted inner ends of the septa are joined together in the centre and then the axial structure becomes differentiated. The axial structure is very variable. It may be developed as in the typical form of *Koninckophyllum gentisae*. In some sections, however, it is formed chiefly by the long and dilated median plate. In other sections the median plate is short and inconspicuous. The septal lamellae may be half as numerous as the major septa, or there may be just a few short lamellae on either side of the median plate. Sometimes the lamellae are slightly rotated.

Generally the septa are not much thickened. Only in specimen st. no. 112647 the septa, especially those of the cardinal quadrants, are considerably dilated in the tabularium. The minor septa are as long as the dissepimentarium is wide, or slightly longer. In late stages they may be withdrawn towards the periphery. The dissepimentarium varies in width from $\frac{1}{5}$ to $\frac{1}{3}$ of the corallite radius. In early stages the dissepiments are usually regular and concentric. Later, the dissepiments have a more complicated appearance: at the periphery they may be crowded, and more inwards lateral dissepiments are currently developed.

Longitudinal sections show the inconstant development of the axial structure. Accordingly, the tabulae are inclined upwards and divided into tabellae to a stronger or lesser degree.



Figs. 35, 36. *Koninckophyllum gentisae* f. *minor*. transverse sections of tabularia, showing differences in development of axial structure. Fig. 35. holotype RGM no. 112643. Fig. 36. paratype RGM no. 112644.

Remarks. The description given above is based on a number of coral-fragments. These corals are not regarded as immature individuals of *Koninckophyllum gentisae*, to which they are essentially similar, but as a smaller form of that species, since corresponding growth-stages are reached at different diameters.

Specimen st. no. 112647 differs from the other representatives of this form in the dilation of the septa. It shows some resemblance with the young stages of *Koninckophyllum multilamellatum*, although in the latter the axial structure is wider and numbers more septal lamellae.

The sections of a fragmentary specimen, st. no. 112648, all show an axial structure consisting of a strongly dilated median plate with some short, twisted septal lamellae. A comparable structure is observed in a section of the typical specimen of this form (text-fig. 35a). Such a structure is also developed in *Koninckophyllum grabaui* Chi (1931, p. 13, Pl. 2, fig. 1) from the Middle Carboniferous of China. There is

no further resemblance, however, since in the Chinese species the minor septa are lacking altogether or rudimentary and the dissepiments are simple and inosculating.

Some sections are very similar to *Neokoninckophyllum tanaicum vesiculosum* Fomichev (1953, p. 362, Pl. 24, figs. 7—10) from the Upper Moscovian of the Donetz basin. This species is characterized by a complicated dissepimentarium and an axial structure which consists chiefly of a median plate, sometimes supported by a few short septal lamellae. But a dibunophylloid axial structure, as developed in the Spanish specimens, does not occur in the Russian corals.

Material. Specimens st. no. 112643—112647 from the Socavón limestone, coll. Mrs. Wagner, loc. 54 and specimens st. no. 112648—112649, from loc. 55, near the mine of San Cebrián; specimen st. no. 112650, coll. Mrs. Wagner, loc. 56, NW of San Cebrián; specimen st. no. 112651 from the Cotarraso limestone, coll. Mrs. Wagner, loc. 47, E of the Sierra Corisa.

Koninckophyllum histiophylloides spec. nov.

Pl. 11, figs. 1—4

Diagnosis. Koninckophyllum in which the axial structure, when fully developed, is histiophylloid; with 35 to 40 septa of each order at a diameter of 20 to 40 mm; wide dissepimentarium in which the septa are in part dissepiseptate; septal lamellae of the axial structure from early neanic stages discontinuous.

Description. The corals are trochoid to broadly cylindrical. The most complete specimen, the holotype, is 90 mm long. Rejuvenation takes place several times in the cylindrical part, but after a considerable interval.

None of the corals is quite complete in the apical part. A section of the earliest stage preserved shows a zaphrentoid septal pattern: the septa are much dilated, pinnately arranged around the fossula and coalescing axially. In the next stage, minor septa and a few series of dissepiments are developed. Minor septa cross the dissepimentarium. The major septa, specially those of the cardinal quadrants, are strongly dilated in the tabularium. The fossula is slightly extended in the dissepimentarium. Most major septa are withdrawn from the centre. Cardinal and counter septum are continuous with a slightly dilated median plate, on which a few septal lamellae abut, intersected by some tabellae. Thus a dibunophylloid axial structure is formed (Pl. 11, fig. 2a). This is not constant, however. In succeeding sections of the neanic stages the median plate may be the only axial element, forming a simple columella. It may be straight or deflected away from the counter septum.

As growth proceeds, the dissepimentarium becomes wider. The minor septa grow longer and extend for a short distance into the tabularium. There are 30 to 35 septa of each order at a diameter of 20 to 24 mm. The axial structure may be developed as an axial column of the *Histiophyllum*-type: the septal lamellae of the counter part, including the median plate, are slightly rotated.

In fullgrown stages the septa are radially differentiated: In the outer zone of the dissepimentarium they are thin and sinuous, in the middle zone the major septa are dissepiseptate, while the minor septa are less generally thus affected, and in the inner zone the major septa are mostly somewhat dilated. In the tabularium the dilation is stronger, but it decreases distally. The length of the minor septa and the width of the dissepimentarium vary from $\frac{1}{2}$ to $\frac{2}{3}$ of the coral-radius. In most specimens the minor septa are slightly longer than the dissepimentarium is wide. In specimen st. no.

112653, from the Sierra Corisa limestone, only the counter minors extend into the tabularium, while the other minor septa reach no further than the margin of the tabularium. The late stages of the holotype, however, have proportionally shorter minor septa, which do not cross the inner zone of the dissepimentarium.

The outer zone of the dissepimentarium consists of irregularly arranged dissepiments. Further inwards the dissepiments are regular and concentric. In the holotype, the innermost zone, which is not crossed by minor septa, shows a herringbone arrangement. A dissepitheca is generally present where the septa are strongly dilated. As seen in longitudinal sections, the dissepiments are globose and variable in size. At the periphery they are nearly horizontal, towards the tabularium they are steeply, sometimes almost vertically inclined. The tabularium consists of cystose tabellae, which may be arranged in a periaxial and an axial zone. The axial structure is very irregularly developed. A median plate is mostly present, often it is continuous with the cardinal septum. A histiophylloid axial column may be formed, but since the septal lamellae are sporadically developed, the axial structure varies in character from section to section. In the late stages of the holotype it disappears altogether. The tabulae are then nearly complete, more or less horizontal and sagging in the centre. After rejuvenation an axial structure may be formed again, but more weakly than before.

There are 39 to 41 septa of each order in the late stages of the holotype. The diameter increases from 30 mm to approximately 40 mm, and decreases, after several rejuvenations, to 17 mm. Specimen st. no. 112657, from the Celada limestone, numbers 32 septa at a diameter of 25 to 34 mm. It is a long, nearly cylindrical fragment, in some respects differing from the other members of this species. It corresponds in number of septa and length of the minor septa to the late neanic or early ephebic stages, but it reaches a larger diameter, the septa are not so frequently dissepiseptate, and the axial structure is wider, at least in the proximal part of the fragment. The apical portion has not been preserved, so nothing is known of the early ontogenetic stages.

Remarks. Some sections of these corals resemble *Koninckophyllum gentisae* spec. nov. *K. histiophylloides* may be distinguished by the greater width of the dissepimentarium and greater length of the minor septa, and typically by the presence of dissepiseptate septa, the stronger vesicularity of the tabulae and the character of the axial structure.

Histiophyllum mediocarbonicum Fomichev (1953, p. 377, Pl. 26, figs. 5, 6) from the Upper Moscovian of the Donetz basin appears closely similar to *Koninckophyllum histiophylloides* spec. nov., at any rate in its late stages. The earlier stages of the Russian species are characterized by a less loosely built axial column, with more constantly developed septal lamellae. Fomichev notes that only in the late ephebic stages the septal lamellae tend to disappear from the axial structure. *Histiophyllum mediocarbonicum* is then much closer to *Dibunophyllum* than the Spanish species.

As for the generic name *Histiophyllum*, Hill (1938, p. 70, 77) has shown that *Histiophyllum* Thomson, 1879 is a synonym of *Dibunophyllum*. Most species of *Histiophyllum*, including the type-species, are referable to *Dibunophyllum bipartitum koninckl.*

Material. The holotype, specimen st. no. 112652 and specimens st. no. 112653, 112654 are from the Sierra Corisa limestone, coll. R. H. Wagner, loc. 58; specimen st. no. 112655 and specimen st. no. 112656 are from the upper shale member of the Sierra Corisa limestone, coll. Mrs. Wagner and author's coll., loc. 74 and loc. 103, between Vergaño and Herreruela; specimen st. no. 112657 is from the Celada limestone, coll. M. H. Nederlof, loc. 20.

Genus CORWENIA Smith & Ryder, 1926 emend.

Type-species. Lonsdaleia rugosa MacCoy, 1849, from the Upper Visean of North Wales.

Synonymy. 1941 *Amandophyllum* Heritsch.
1950 *Heritschioides* Yabe.
1953 *Dibunophylloides* Fomichev
1953 *Sestrophyllum* Fomichev.

Diagnosis. Solitary or phaceloid aulophylline corals with a radially or bilaterally symmetrical axial column; septa thin or dilated in all quadrants; dissephitheca may be developed; in some forms lonsdaleoid dissepiments; tabularium with periaxial and axial series of tabellae, strongly arched, distally and peripherally convex.

Remarks on synonymy. Corwenia has been founded for phaceloid corals with a variable axial structure. They "agree closely with earlier and less specialized forms of *Dibunophyllum*" (Smith and Ryder, 1926, p. 151). Unlike *Dibunophyllum*, the corals do not reach a large size and they generally lack a recognizable cardinal fossula. The axial structure is not always dibunophylloid, but may also be clisiophylloid or koninckophylloid, i.e. the number of septal lamellae and the length of the medial plate varies. Smith (1916, p. 267), describing the type-species, points out that the septa on the cardinal side of the corallite are never stouter than those on the counter side, and in this *Corwenia* differs again from typical *Dibunophyllum*. Smith & Ryder state in their description of *Corwenia rugosa* (MacCoy) that the septa are of fairly uniform thickness. That the septa may be dilated at the margin of the tabularium in all quadrants is shown in fig. 12 of Smith, 1916, Pl. 21, a section of the ephebic stage of a specimen of *Corwenia rugosa* from the type-locality.

A section of an earlier stage of the same corallum (ibid., fig. 11) shows likewise a slight dilation of the septa and the presence of a dissepitheca. Corals in which both features are expressed in a stronger degree, but which are otherwise similar to *Corwenia*, constitute the genus *Heritschioides* Yabe, 1950. Since *Corwenia* and *Heritschioides*, as defined by Yabe, differ only in the degree of dilation of the major septa, there is no material reason to regard them as generically distinct. Yabe based this genus on *Waagenophyllum columbicum* Smith, 1935, from the Upper Carboniferous or Lower Permian of Canada. *Waagenophyllum columbicum* Smith differs from *Corwenia rugosa* by having a stronger dilation of the septa in the tabularium, better developed minor septa and a larger and more complicated axial column. Such differences may well exist between two species of the same genus, as for instance in *Koninckophyllum*.

The corals, described by Merriam (1942) as *Waagenophyllum washburni* and *W. ochocoense* from the Permian of Oregon show, as Merriam points out, a close resemblance to *Corwenia columbica* (Smith) and do not represent true *Waagenophyllum*. Like the Canadian corals, they can better be regarded as species of *Corwenia*.

For solitary corals whose structure is similar to that of *Corwenia*, Heritsch erected the genus *Amandophyllum*. He included two species from the Middle Carboniferous of Russia and one species from the Upper Carboniferous of the Carnic Alps in this genus. Corals belonging to the Middle Carboniferous species were discovered by Fomichev in deposits of the same age in the Donetz basin. Fomichev states that these corals have a verying mode of growth, sometimes solitary, sometimes weakly compound. He proposed the genus *Dibunophylloides* for these corals, which differ from *Corwenia*, according to Fomichev, chiefly in comprising also solitary corals.

This distinction I do not think clear enough for a generic separation. For this reason *Corwenia* is emended here to include also solitary corals.

Following this argument, another group of corals described by Fomichev as *Sestrophyllum*, must be taken into consideration. *Sestrophyllum* comprises small solitary corals with a clisiophyllid or dibunophyllid axial structure, with or without dilated septa and dissepitheca, and tabulae as in *Corwenia*. Fomichev distinguished these corals from *Dibunophylloides* by the development of an outer zone of lonsdaleoid dissepiments. Now lonsdaleoid dissepiments may also occur in some species of *Corwenia*, for instance *C. rugosa* and *C. carnica* (type-species of *Amandophyllum*). It seems therefore justified to consider *Sestrophyllum* a synonym of *Corwenia*.

Discussing *Corwenia rugosa*, Hill (1939, p. 101) considers it probable that the aseptate areas in the dissepimentarium represent the origin of offsets. It is not clear whether this consideration could also hold for *C. carnica*, from which no instance of increase is given, or for *C. astraeformis* (type-species of *Sestrophyllum*) of which increase is known to be peripheral.

Occurrence.	Visean	British Isles
		Belgium
	Lower Carboniferous	Russia — Moscow basin, S. Ural
	Middle Carboniferous	Russia — Moscow basin, Donetz basin, W. Ural
	Upper Carboniferous	Carnic Alps
		Russia — Donetz basin
	Lower Permian	Russia — N. Ural
		N. America — Canada, Oregon

Corwenia symmetrica (Dobrolyubova, 1937)

Pl. 12, figs. 1—3

1937 *Cyathoclisia* (?) *simmetrica* Dobrolyubova — Dobrolyubova, p. 58, Pl. 19, figs. 9—14.
1941 *Amandophyllum symmetricum* (Dobrolyubova) — Heritsch, p. 134, text-figs. 7—10.
1948 *Cyathoclisia? simmetrica* Dobrolyubova — Dobrolyubova & Kabakovich, p. 32, Pl. 16, figs. 1—3.
1953 *Dibunophylloides symmetricus* (Dobrolyubova) — Fomichev, p. 394, Pl. 27, figs. 2—7.

Diagnosis. Solitary or weakly compound *Corwenia* whose corallites have a diameter of 5 to 9 mm, with 16 to 20 septa of each order; axial structure in young stages radially symmetrical, in adult stages dibunophylloid (after Dobrolyubova and Fomichev).

Remarks. As described by Dobrolyubova (1937) the species contains small, solitary corals with a radially symmetrical axial structure, i.e. in which the septal lamellae converge towards one point. Fomichev's description and figures of this species differ slightly from Dobrolyubova's. The specimens of the Donetz basin may be branching, they are a little larger, and their axial structures are only in youthful stages radially symmetrical, becoming later dibunophylloid. Perhaps the specimens described by Dobrolyubova (1937) had not yet reached full maturity, or perhaps they represent a phylogenetically older representative of this group of corals, in which the axial structure retains longer the radial symmetry. In favour of the latter speculation it may be noted that Dobrolyubova described the specimen with the radial axial structure from the Podolskian. Later she described (with Kabakovich, 1948) a

specimen of this species from the Myachkovian in which the axial structure is in the young stage radial and later possesses a well-defined medial plate. But since only a few specimens have been found, this assertion will need further confirmation.

Fomichev regards *Cyathoclisia* (?) *myatshkovensis* Dobrolyubova, 1937, as a synonym of *C. symmetrica*. This might well be the case, but as yet the development of the axial structure in *C. myatshkovensis* is not known. Dobrolyubova distinguished the two species on account of the difference in dilatation of the skeletal elements. As Fomichev pointed out, the dilatation is not very pronounced, at least in neither of the two species the septa or the innermost row of dissepiments is strongly affected, as judged from the figures given by Dobrolyubova. Only the axial structure of *C. myatshkovensis* is very dense at the centre. Dobrolyubova states that this dense structure is formed by the closely packed axial tabellae, while the medial plate is thin and the number of septal lamellae is extremely variable. This is not quite clear from the figured sections.

Description of Spanish material. Several large fragments of coralla of this species are present. The compound character of the corals may be seen in some weathered specimens (Pl. 12, fig. 2). The corals are silicified. The diameter of the corallites ranges from 6 to 10 mm, when 16 to 21 major septa are present. The septa may be slightly dilated near the margin of the tabularium. Most major septa reach to or into the axial column. Minor septa are about half as long as the major septa. For a short distance they extend in the tabularium. The dissepimentarium has a width of $\frac{1}{3}$ the radius of the corallite. There are two or three rows of regular concentric dissepiments. In the specimen from the Verdiana limestone, only one series of dissepiments is developed. The boundary between dissepimentarium and tabularium is clear, in some corallites a dissepitheca is formed. The tabularium is occupied by many series of tabellae. Those of the axial zone are more closely set and usually more sharply inclined than those of the periaxial zone. As seen in transverse sections, the axial structure is mostly not well differentiated from the rest of the tabularium. Generally, it is an open structure with a recognizable medial plate and a varying number of septal lamellae, in large corallites mostly 4 or 5 on each side. The septal lamellae may be spirally twisted.

Remarks. The Spanish corals of this species agree completely with those described by Fomichev from the Donetz basin.

Material. Specimens st. no. 112658—112661 are from a limestone outcrop NE of Cotarraso, coll. R. H. Wagner, loc. 72; specimen st. no. 112662 is from the Verdiana limestone, coll. R. H. Wagner, loc. 75.

Occurrence elsewhere. Upper Moscovian (Podolskian — Myachkovian) of the Moscow basin; Upper Moscovian (zone $C_2^m d$) of the Donetz basin.

Corwenia longiseptata (Fomichev, 1953)

Pl 12, figs. 4—9

1953 *Dibunophylloides longiseptatus* Fomichev — Fomichev, p. 396, Pl. 27, figs. 8—11.

Diagnosis. Corwenia with corallites numbering 24 to 26 major septa at a diameter of about 9 mm; minor septa long; axial structure bilaterally symmetrical (after Fomichev).

Description of Spanish material. The corals are solitary or branching, the lateral offsets arising at various angles from the parent corallites. Rejuvenation occurs, but not very frequently. The corallites reach a diameter of 7 to 10 mm, and number then 22 to 26 major septa. The septa are in a varying degree dilated in the outer part of the tabularium, in some sections also in the dissepimentarium. Major septa extend to the axial structure, minor septa are about two thirds as long as the major septa, sometimes shorter, but always reaching into the tabularium. The width of the dissepimentarium varies. In some sections it equals half the radius of the corallite, often it is about a third of the radius, and sometimes but a fourth. The dissepimentarium may be bounded by a dissepitheca from the tabularium. The axial structure generally contains a long, slightly thickened medial plate, directly or indirectly continuous with cardinal and counter septum. The number of septal lamellae may be the same as that of the major septa, or nearly half as small. Often the axial structure is rather dense and clearly marked off from the surrounding periaxial zone. In several sections the septal lamellae are rotated.

Remarks. The corals here described show a great resemblance with the Russian representatives of *C. longiseptata.* Fomichev distinguishes this species from *C. symmetrica* on account of the larger number of septa, longer minor septa and the wider dissepimentarium. The Spanish specimens of *C. longiseptata* show that the length of the minor septa and with it the width of the dissepimentarium, are apt to vary. The axial structure in *C. longiseptata* differs on the whole from that of *C. symmetrica* by having a better defined medial plate and more numerous septal lamellae.

Fomichev states that the septa show no dilatation. Herein the Spanish corals differ, having in some sections rather strongly dilated septa. But other sections of the same corallite may not be similarly affected.

Material. Specimens st. no. 112663—112676 from the Socavón limestone, coll. Mrs. Wagner, loc. 54, W of San Cebrián de Mudá.

Occurrence elsewhere. Upper Moscovian (zone $C_2^{m}d$) of the Donetz basin.

Corwenia cantabrica spec. nov.

Pl. 12, fig. 10

Diagnosis. Solitary or branching *Corwenia* with part of the septa dilated in the dissepimentarium; well-defined axial column with strong medial plate and with a variable number of septal lamellae.

Description. The diameter of the corallites varies from 3 to 6 mm, the corresponding number of major septa from 15 to 22. In some sections the septa are uniform in thickness, in others some or all of the septa are dilated in the dissepimentarium, or especially near the margin of the tabularium. The major septa become thin, sometimes abruptly, in the tabularium. Minor septa appear as septal ridges in the tabularium. The dissepimentarium consists of 2 or 3 rows of mostly regular concentric dissepiments. It is somewhat irregular where offsets are formed. The boundary between dissepimentarium and tabularium is clearly marked, in some corallites a dissepitheca is developed. The tabularium occupies about $\frac{2}{3}$ of the corallite diameter. The axial structure varies in width. The column is bisected by a slightly thickened medial plate, which is often continuous with cardinal and counter septum. Locally

but a few, short septal lamellae and a few series of axial tabellae are present. Often the number of septal lamellae is the same as that of the major septa, and several series of axial tabellae are developed.

Remarks. The corals of this species show a striking resemblance to some corals from the Upper Carboniferous of the Donetz basin, described by Fomichev (1953, p. 381, Pl. 26, figs. 7—12) as *Sestrophyllum astraeforme*, here regarded as *Corwenia*. The corallites of the Russian species attain, however, a somewhat greater diameter, while the number of septa is the same. Fomichev states that in *C. astraeformis* the septa nearly nowhere extend from the epitheca, but are interrupted by the outermost row of dissepiments. The corallites of *C. cantabrica*, on the contrary, have nearly always complete septa. Thirdly, the axial column of *C. astraeformis* has no constant median plate.

C. cantabrica may be closely related to *C. myatshkovensis* (Dobrolyubova). But since the nature of the axial structurs in the latter species is not clear, no further comment can be given. As stated before, Fomichev holds *C. myatshkovensis* conspecific with *C. symmetrica*. From the latter species *C. cantabrica* differs chiefly in the development of the axial structure.

Material. The holotype is specimen st. no. 112678 from a limestone outcrop NW of Cotarraso, coll. R. H. Wagner, loc. 66.

Familia CYATHOPSIDAE Dybowski, 1873

Diagnosis."Solitary or fasciculate Rugosa with an open tabular fossula; septa typically dilated and amplexoid in the wide tabularium; tabulae complete, domed or flat, with downturned edges; marginarium a regular or (in some) a lonsdaleoid dissepimentarium; cardinal septum short, counter septum commonly elongate" (Hill, 1956).

Genus PSEUDOZAPHRENTOIDES Stuckenberg, 1904

Type-species. Pseudozaphrentoides jerofejewi Stuckenberg, 1904 (= *Caninia inostranzewi* Stuckenberg, 1904), from the Lower Carboniferous of Central Russia.

Diagnosis. Solitary cyathopsid corals with in mature stages a well-developed regular dissepimentarium, in which the septa are thin but continuous; in the tabularium septa withdrawn from centre, and those of the cardinal quadrants dilated; in youth all septa may be dilated and some or all may extend to the centre; minor septa present.

Remarks. The corals referred here to *Pseudozaphrentoides* have formerly been included in *Caninia*, and namely in the group of *Caninia juddi* (Thomson).

Pseudozaphrentoides differs in its well-developed dissepimentarium from *Caninia* s.s., where, as in *Caninia cornucopiae* Michelin, dissepiments are only sparsely developed in late stages. Moore & Jeffords (1945, p. 143) were the first to propose a restricted use of the genus *Caninia*, and to raise the different species-groups of *Caninia* s.l., as recognized by Hill (1939, p. 102), to generic rank.

At that time *Pseudozaphrentoides* was only known by Stuckenberg's description and figures. Since then, Dobrolyubova (1952) redescribed *Caninia inostranzewi* Stuck., 1904, fro n the Steshevo horizon (Serpukhovian, Lower Carboniferous) of the Moscow basin, which, according to her, is identical with *Pseudozaphrentoides jerofejewi* Stuck. The type-species thus being better known, the interpretation of *Pseudozaphrentoides* as given by Moore & Jeffords is confirmed.

Recently, Schouppé (1961) discussed a.o. the advisability of restricting the genus *Caninia* to forms without a well developed dissepimentarium. Corals of the "*Caninia juddi*-group" are, at least partly, included by him in the genus *Gshelia*, Stuckenberg, 1888.

The latter conclusion is not accepted here, since apparently the genus *Gshelia* can be distinguished from other caniniids (see below, and Dobrolyubova, 1940, for a full description and discussion of *Gshelia*).

Occurrence.	Visean	W. Europa
		China, Japan
	Lower Carboniferous	Russia
	Mississippian	N. America
	Silesian	Carnic Alps
	Middle and Upper Carboniferous	Russia, China
	Pennsylvanian	N. America
	Permian	Carnic Alps
		Spitsbergen
		Russia
		? N. America

Pseudozaphrentoides rabanaliensis spec. nov.

Pl. 13, figs. 1—5; Pl. 14, figs. 1, 2

Diagnosis. Moderately large *Pseudozaphrentoides* with major septa as long as a third of the radius of the tabularium and dissepimentarium about one quarter as wide as the radius of the corallum.

Description. The corals are proximally conical, becoming cylindrical distally. They may be straight or partly slightly curved. In the curved part, either one of the alar septa or the counter septum is situated on the convex side. Rejuvenation occurs rather frequently in the cylindrical part of the corallum. The greater number of specimens is much worn; where the wall is preserved it shows fine transverse wrinkles.

Many adult corals are crushed or fractured, mostly in the alar plane. The cardinal quadrants in the tabularium of which the septa are dilated are more or less intact. They have not suffered so badly from crushing as the counter quadrants.

The youngest stages of this species have not been preserved; perhaps it has been weathered away or, as Lewis supposed for *Caninia juddi*, perhaps the earlier formed portion of the corallum decayed before the life of the coral ended.

In the youngest stage observed, nearly all septa meet at the centre, notably the cardinal and counter septum. The septa nearest to the cardinal are near the periphery curved convex to the cardinal septum and axially turned towards it, thus marking the fossular wall.

Dilation of the septa varies; in the cardinal quadrants it is in general appreciably stronger than in the counter quadrants. The counter septum may be somewhat thinner than the surrounding septa.

Septa of the second order are present at this stage. In some forms they are only developed in the dissepimentarium but they may also form bulges or dilated ridges on the inner wall. The dissepimentarium is very narrow, consisting generally of crowded dissepiments.

Further in the ontogeny, the septa are withdrawn from the centre. It must be noted that the cardinal and counter septum may remain joined after the other septa have shortened, this connection does not last long, however. Dilation of the septa in the counter quadrants decreases, septa in the cardinal quadrants remain dilated. Gradually the free central space becomes wider, as the septa dwindle in length. In adult stages the septa mostly extend for a third of the way across the tabularium. They may become shorter than that.

The cardinal septum may shorten at an early stage. Quite often it keeps about the same length as the other septa for a fairly long part of the ontogeny. In fullgrown stages it is always shorter and lies in a fossula which is withdrawn into the dissepimentarium. Septa of the second order do not pass the innermost row of dissepiments. As growth of the coral continues, they retreat further to the periphery. Usually those in the cardinal quadrants are longer than those in the counter. They may extend halfway through the dissepimentarium, or be quite restricted to the periphery.

The dissepimentarium does not have a constant width, only exceptionally it surpasses $\frac{1}{4}$ of the radius of the corallite, more often it is less. Dissepiments are crowded at the periphery. Depending on the length of the minor septa the arrangement of the dissepiments is regular concentric or spicate. The tabulae rise gently from the periphery, in the central part they are nearly horizontal or sagging a little. There is about 1 mm distance between them.

Remarks. The corals here described show undoubtedly a great likeness to *Pseudozaphrentoides juddi* (Thomson) as described by Lewis (1924). They could perhaps be thought to represent a variety of that species. There are, however, some differences: full-grown representatives of *Pseudozaphrentoides juddi* attain a larger size and a greater number of septa, have a broader dissepimentarium, somewhat longer major septa and mostly shorter minor septa. Moreover, Lewis mentions as an apparently specific character the intercalation of one or more breviseptal stages in the coral's early life and such stages have not been observed in the Spanish specimens.

The young stages of *Pseudozaphrentoides rabanaliensis* resemble closely those of the type-species, described by Dobrolyubova as *Caninia inostranzewi.* The ratio diameter/number of septa, however, differs considerably.

Material. The holotype, st. no. 112679 and paratypes st. no. 112680—112713 are from the Perapertú formation of Rabanal de los Caballeros, coll. A. Breimer and author's coll. Several "nests" of these corals have been found: a great number of specimens lying in a heap together. Their worn appearance and the many fractures suggest that they have been transported and rolled on the sea bottom before they were finally covered by sediment.

Some distal fragments, probably also belonging to this species, are specimen st. no. 112714, from the Perapertú formation, coll. R. H. Wagner, loc. 39, NE of San Martín and specimens st. no. 112715 and 112716 from the Piedras Luengas limestone, author's coll., loc. 22, S of Piedras Luengas.

Genus Bothrophyllum Trautschold, 1879

Type-species. Bothrophyllum conicum Trautschold, 1879, emend. Dobrolyubova, 1937, from the Myachkovian of Myachkovo.

Diagnosis. Solitary cyathopsid corals with long major septa, whose axial ends may form a weak axial structure, generally joined to the lengthened counter septum; dilation of septa in tabularium variable, generally strongest in cardinal quadrants; fossula extended into dissepimentarium; dissepiments at periphery small and crowded, inwards regular or inosculating; tabulae incomplete, raised periaxially, flat or domed in central part.

Occurrence.	Upper Visean	British Isles
	Lower Carboniferous	Russia — Donetz basin
	Lower and Middle Carboniferous	China
	Middle and Upper Carboniferous	Russia — Donetz basin, Moscow basin, Ural Mts.
	Pennsylvanian	? N. America — Missouri

Bothrophyllum sp., cf. *pseudoconicum* Dobrolyubova, 1937

Pl. 14, fig. 3

Compare: 1937 *Bothrophyllum pseudoconicum* Dobrolyubova — Dobrolyubova, p. 41, p. 75, Pl. 5, figs. 2—7; Pls. 12—17.
1937 *Timania stuckenbergi* Kabakovich — Kabakovich, p. 95, p. 110, Pl. 3, figs. 1—5.

1940 *Bothrophyllum pseudoconicum* Dobrolyubova — Dobrolyubova, p. 22, Pl. 9, figs. 3—6; Pl. 10, figs. 1—2; Pl. 11, figs. 1—7.
1948 *Bothrophyllum pseudoconicum* Dobr. — Dobrolyubova, p. 48, Pl. 2, figs. 12—35; Pl. 3; Pl. 4.
1953 *Bothrophyllum* aff. *pseudoconicum* Dobr. — Fomichev, p. 332, Pl. 22, figs. 1—3.

Diagnosis of Bothrophyllum pseudoconicum. A species of *Bothrophyllum* with short minor septa; major septa are long only on the upper surfaces of the tabulae; the counter septum is not constantly elongate and the dissepimentarium, if not narrow, is clearly divided in two parts, according to size and character of the dissepiments (after Dobrolyubova).

Remarks. Bothrophyllum pseudoconicum is an extremely variable species and closely resembles *B. conicum* Trautschold. This variation and resemblance are better understood by referring to Dobrolyubova's (1948) discussion on the phylogenetic development of *Bothrophyllum* to *Gshelia.* All corals of this sequence show a considerable variation in their skeletal elements. Septa, dissepiments and tabulae vary always during ontogeny of one individual, and also in different individuals of one species. Dobrolyubova's study is based on hundreds of corals from the Middle and Late Carboniferous of the Moscow basin.

B. pseudoconicum is the earliest representative of this group. It is first recorded in the Kashirian, persists in the Podolskian, nearly vanishes in the Myachkovian and reappears in the Kasimovian. The fact that Myachkovian representatives of this species are scarce, is, according to Dobrolyubova, apparently due to the paucity of clayey limestones and marls in that zone. In the Myachkovian pure limestones have a wide distribution, while in the other zones mentioned the clayey facies predominates. In the Myachkovian *Bothrophyllum conicum* makes its appearance and continues, with *B. pseudoconicum*, up into the Kasimovian.

These two species of *Bothrophyllum* are distinguished from each other chiefly by the length of their minor septa. Dobrolyubova (1948, p. 48—49, Pl. 2) has shown that in both species the minor septa become longer in the course of time. The difference in length of the minor septa is usually well expressed in typical specimens, at a diameter of more than 18—20 mm in diameter.

Another difference between *B. conicum* and *B. pseudoconicum* lies in the length of the counter septum. In specimens of *B. conicum* the counter septum is usually long, reaching past the centre. In specimens of *B. pseudoconicum* this may be occasionally the case, but oftener it is as long as the other major septa.

The development of the cardinal septum in the bothrophyllids is as follows:

B. pseudoconicum: the cardinal septum reaches only in some young specimens the centre, and is rarely a little dilated at its axial end; usually its length does not differ from that of the other major septa.

B. conicum: the cardinal septum is lengthened in adult stages as well. This is also the case in *B. pseudoconicum* var. *conicum* Dobrolyubova & Kabakovich, 1948.

Description of Spanish material. One straight, broadly conical coral, 60 mm long and reaching a diameter of about 30 mm, appears closely comparable to *Bothrophyllum pseudoconicum* Dobr.

In the apical part of the corallum all septa except the cardinal are much dilated in the tabularium. They join in the centre. A narrow zone of dissepiments is present. Apparently it is formed in a very early growth-stage.

Further in growth, dilation of the septa is restricted to the cardinal quadrants. The septa no longer reach the centre. Some extend to the axial structure which

consists of a conspicuous median plate, linking cardinal and counter septum, and some intersecting tabulae.

In later stages, the axial structure is composed of a few septal lamellae and axial parts of tabulae. Some of the major septa may be joined to it. This weak structure persists till full-grown stages. By then, dilation of the septa has decreased; all septa have nearly the same thickness in the tabularium. The cardinal septum is distinctly shorter than the other major septa. The counter septum, on the whole, does not differ in length from the rest of the septa. The dissepimentarium has become much broader.

The width of the dissepimentarium is variable. It may, in adult stages, occupy nearly half the radius of the corallum. The outermost zone of dissepiments is for the greater part destroyed, but where it is preserved, it is seen to consist of crowded, small dissepiments. Further inward the dissepiments are regular and concentric. They become inosculating, irregularly or in the herringbone pattern, in the part not crossed by the minor septa. At their greatest length the minor septa do not reach farther than halfway the dissepimentarium. The tabulae are split in the outer tabularium. They extend across the inner part, where they are horizontal or slightly raised.

Number of septa and diameter of the sections:

53 × 2 septa	32 mm
44 × 2 septa	23 mm
40 × 2 septa	17 mm
36 or 38 septa	12 mm

Remarks. On several points the coral just described differs from typical representatives of *Bothrophyllum pseudoconicum*:

1. A conspicuous medial plate, joining cardinal and counter septum, is lacking in the Russian species. If a weakly developed plate is present, it does not persist till such an advanced growth-stage. In *Gshelia rouilleri* such a plate is characteristic, but for an earlier growth-stage (Dobrolyubova, 1940, Pl. 16, fig. 7). Later it develops into an independent columella, which may be considerably dilated, but which disappears before the full-grown stage is reached. The Spanish specimen with its weak axial structure, shows quite a different further development.
2. The dissepimentarium is usually not so wide in *B. pseudoconicum*. The specimens from the Kasimovian of this species have a wider dissepimentarium, especially no. 535, figured by Dobrolyubova (1940, Pl. 10, figs. 1—2). But they have also relatively longer minor septa. In this respect the full-grown stages of the Spanish coral are very like those of the corals from the Donetz basin, described by Fomichev as *Bothrophyllum* aff. *pseudoconicum* Dobr. (Fomichev, 1953, Pl. 22, figs. 2—3).
3. The Spanish coral numbers somewhat more septa at the same diameter in full-grown stages, as compared with typical specimens of *B. pseudoconicum*. Some large individuals, reaching a much greater diameter, do not number so many septa as the Spanish specimens.

Material. One nearly complete specimen, st. no. 112717, from the lower part of the Sierra Corisa limestone author's collection, loc. 160.

Occurrence elsewhere of Bothrophyllum pseudoconicum. Middle and Upper Carboniferous (Kashirian — Kasimovian) of the Moscow basin.

Since the genus *Gshelia* will be referred to presently, it seems necessary to state how it is interpreted in this paper, and to review some recent interpretations.

Genus GSHELIA Stuckenberg, 1888

Type-species. Gshelia rouilleri Stuckenberg, 1888, emend. Dobrolyubova 1940, from the Gzhelian of the Moscow basin.

Diagnosis. Solitary cyathopsid corals with a narrow regular dissepimentarium; in neanic stages a median plate, initially continuous with cardinal and counter septum, becomes free and dilated; columella disappears before adult stage is reached.

Remarks. Dobrolyubova (1940, p. 71), redescribing the type-species, mentions the close similarity between *Bothrophyllum*, especially the species *conicum* and *pseudoconicum*, and *Gshelia rouilleri*. Later, she (1948) discusses these three species as members of the same lineage, from which *Gshelia rouilleri* is the youngest representative.

Recently, the genus *Gshelia* has been discussed by Fomichev (1953) and by Schouppé (1961). Fomichev (1953, p. 319) concludes from Dobrolyubova's (1940) description of *Gshelia rouilleri*, that in *Gshelia* the columella must be joined to the counter septum and that the cardinal septum is short. Dobrolyubova (1940, p. 79) states that the columella is initially continuous with both cardinal and counter septum, and that it is probably formed by the axial end of the counter septum. Later, she (1948, p. 51) mentions that the columella originates from the cardinal septum, although she adds in a footnote that in many specimens of all members of the *Bothrophyllum-Gshelia* group the columella is developed from the axial end of the counter septum.

Fomichev founded the genus *Yakovleviella* for corals, resembling *Gshelia* very much, but in which the medial plate, initially continuous with cardinal and counter septum, remains joined to the cardinal septum and may eventually become free. The cardinal septum shortens only in quite adult stages. Earlier it may become thinner.

The figured sections of the corals assigned by Fomichev to *Yakovleviella* do not show a close resemblance with *Gshelia*. A thickened medial plate or an isolated columella is not observed in any of the sections. The holotype of the type-species, *Yakovleviella tschernyschewi*, Fomichev, 1953 (Pl. 21, figs. 3a-c), is extremely similar to *Bothrophyllum pseudoconicum* var. *conicum* Dobr. & Kab. 1948 (Pl. 7, figs. 5—7). The other figured sections of *Y. tschernyschewi* are comparable to *Bothrophyllum*, although in *Bothrophyllum* the dissepimentarium is usually not so wide.

The other species of *Yakovleviella*, *Y. lissitzini* Fomichev, does not resemble *Gshelia* either. It appears to be a member of *Pseudozaphrentoides*. Fomichev notes the resemblance with corals of the "*Caninia juddi*" group, but does not discuss it further.

Schouppé (1961) gives another interpretation of *Gshelia*. It must be mentioned, however, that Schouppé does not refer to Dobrolyubova's redescription of the genus and of the type-species. Some of the corals he assigns to *Gshelia*, are in this paper regarded as *Pseudozaphrentoides*. Schouppé further regards *Caninophyllum* as a synonym of *Gshelia*, but the type-species, *C. archiaci*, is not taken into account. In this paper *Caninophyllum* and *Pseudozaphrentoides* are not thought to be congeneric, but several corals, described as *Caninophyllum*, must probably be included in *Pseudozaphrentoides*.

Bothrophyllum? sp.

Pl. 14, fig. 4; text-fig. 37

Description. The specimen which is questionably assigned to *Bothrophyllum*, is not well preserved: The earliest stages are lacking, part of the marginarium is worn away, the central part is muddy and the distal end is destroyed. The fragment is cylindrical and ca. 55 mm long.

The first section available has a tabularium diameter of 17 mm, with 38 or 40 major septa. Minor septa are also represented, as very small ridges. All septa except cardinal and counter, are strongly dilated. The cardinal septum is very short, the septa near to it are twice as long. The older metasepta are longer, they reach about halfway or two-thirds across to the centre. The thin counter septum appears to be longer. Its axial end is extremely thin, however, and not clearly discernible amid the tabular intersections, which occupy the central space.

The following sections are very like those of the late neanic stages of *Gshelia rouilleri* Stuckenberg, figured by Dobrolyubova (1940, Pl. 13, fig. 17, Pl. 14, fig. 1). They agree in the arrangement of the septa, the strong dilation of the septa in the cardinal quadrants, the lessening of the dilation of the septa in the counter quadrants,

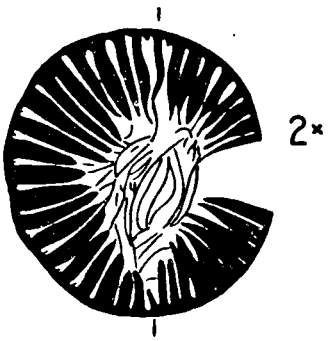


Fig. 37. *Bothrophyllum* ? sp. RGM no. 112718. transverse section from proximal end of fragment.

in having a thin counter septum, not longer than the other septa, and a regular dissepimentarium and in the length of the minor septa, which reach to the margin of the tabularium. The sections of the Spanish coral are about 25 mm in diameter and number 42 major septa. Since the Spanish specimen lacks the apical portion, there can be no indication that it has indeed affinities with *Gshelia rouilleri*. In fact the earliest section available does not make this seem likely, but suggests rather comparison with some specimens of *Bothrophyllum*. The further development is not typically bothrophylloid, as far as observable.

The longitudinal section shows a typically cyathopsid tabularium: the tabulae are horizontal or sagging in the central part, and their peripheral edges are downturned.

Better preserved material is needed before a conclusion on the generic position of this coral can be drawn.

Material. Specimen st. no. 112718 from the upper shale member of the Sierra Corisa limestone, coll. Mrs. Wagner, loc. 74.

Subordo COLUMNARIINA

Familia LONSDALEIIDAE Chapman, 1893

Diagnosis. Simple or compound (fasciculate to ? aphroid) Rugose corals with typically a non-septate or crestal-septate dissepimentarium; axial structure an axial column or a columella; tabulae in periaxial part of tabularium horizontal or sagging, with in some forms an outer zone of clinotabellae.

Remarks. The family Lonsdaleiidae, and in it the genus *Lonsdaleia*, are here interpreted widely. For the time being, several cerioid species from the Permian of Asia are included in *Lonsdaleia*, for instance "*Stylidophyllum*" *orientale* Douglas and "*Stylidophyllum*" *chaoi* Huang. They differ from typical representatives of the genus in the structure of the tabularium, which contains also an outer zone of clinotabellae, apart from the periaxial zone of transverse tabellae and the central zone of axial tabellae. Hudson (1958) thinks the presence of such a tabularium a highly important diagnostic character. Therefore he includes *Lonsdaleia chaoi* (Huang) in the family of the Waagenophyllidae. This family is mainly characterized by the trizonal division of the tabularium.

The mere presence of clinotabellae in some species of *Lonsdaleia* does not seem of sufficient importance to remove them from the family of the *Lonsdaleiidae*. Nor does it seem advisable, as matters stand now, to create a new genus for such forms. It may be noted that the presence of clinotabellae has also been observed in a Lower Carboniferous species of *Lonsdaleia*, *L. siblyi* Smith. This is a phaceloid *Lonsdaleia*, with a wide zone of clinotabellae and a very narrow zone of transverse tabellae (Smith, 1916, p. 244, Pl. 18, fig. 10). It has been recorded from the Visean (zone D_2) of England.

Genus LONSDALEIA MacCoy, 1849

Type-species. Lonsdaleia duplicata (Martin, 1809) from the Visean of the British Isles

Diagnosis. Fasciculate or cerioid Lonsdaleiidae with a wide lonsdaleoid dissepimentarium; axial structure formed by a medial plate, septal lamellae and axial tabellae.

Occurrence.	Dinantian	W. Europe
		N. Africa
	Lower Carboniferous	Russia
		Asia
	Mississippian	N. America
	Namurian	British Isles
	Middle Carboniferous	Russia
		Asia
	Permo-Carboniferous	Carnic Alps
		Russia — Ural Mts.
	Permian	Asia
		N. America

Lonsdaleia portlocki (Stuckenberg) *densiconus* subsp. nov.

Pl. 15, fig. 1

subspecies of:

non 1851 *Stylaxis portlocki* Edwards & Haime — Edwards & Haime, p. 453.
1888 *Petalaxis portlocki* (Edwards & Haime) — Stuckenberg, p. 22, Pl. 2, figs. 44—49.
1935 *Lonsdaleia portlocki* (Stuckenberg, non Edwards & Haime) — Dobrolyubova, p. 29, Pl. 9, figs. 1—4; Pl. 10, figs. 1—2.
non 1953 *Cystolonsdaleia portlocki* (Dobrolyubova) — Fomichev, p. 467, Pl. 32, figs. 4 a—c.

Diagnosis. Cerioid *Lonsdaleia* with full-grown corallites 6 to 8 mm in diameter and numbering 16 to 18 septa of each order; minor septa slightly developed; axial column with but few lamellae and tabellae, often completely dilated.

Description. The corallites are irregularly polygonal, their sides are often curved. The epitheca is strong and denticulate. Their diameter ranges from 3 to 9 mm (greatest diagonal: 4 to 10 mm), the number of major septa increases from 10 to 20. Except for the cardinal, the major septa are generally not in contact with the axial structure. Minor septa are only developed as crests and/or ridges, also on the dissepitheca. The dissepimentarium varies in width. Dissepiments may be non-septate (often at the periphery) or crestal-septate. In some parts of the corallites they are crowded. A dissepitheca surrounds the tabularium, which has in full-grown corallites a diameter of 3.5 or 4 mm. The tabellae in the outer zone of the tabularium are about horizontal: sometimes sloping down a little towards the dissepitheca, sometimes with slightly upturned edges. A narrow zone of rather globose and steeply arranged axial tabellae is usually present. Locally the tabellae are replaced by steeply conical inner ends of tabulae, or there is no differentiation in the central part of the tabularium. A varying number of septal lamellae is present, sometimes there are none. In some cases, when tabellae and lamellae fail to develop, the axial structure consists only of the thickened medial plate. The medial plate is always well developed, bisecting the whole column. Generally, the elements are welded together by dilation, forming a compact structure. Increase is peripheral. Young corallites are formed within the dissepimentarium, not necessarily in an angle of the parent corallite.

Remarks. The corallum does not differ materially from *Lonsdaleia portlocki*, as described by Dobrolyubova from the Moscow basin. It has, however, more septa at the same diameter; minor septa are more uniformly developed and the axial structure is oftener dilated and less commonly represented by the medial plate only.

The differences with the corals, described by Fomichev as *Cystolonsdaleia portlocki*, appear more pronounced. The corals from the Donetz basin have a partly repressed epitheca, and a series of clinotabellae in the outer zone of the tabularium (Fomichev, 1953, Pl. 32, figs. 4b-c). In these respects they show a closer resemblance with representatives of *Ivanovia*.

Cystolonsdaleia was proposed by Fomichev (1953) as a subgenus of *Lithostrotionella* for corals differing from typical forms of the genus in having a more elaborate axial structure, containing a medial plate, axial tabellae and septal lamellae. Fomichev distinguished these corals from *Lonsdaleia*, because their axial structures are narrower, contain fewer elements and may now and then consist of a simple columella. These conditions appear to hold only for *Lonsdaleia portlocki* as described above. The type-species, *Cystolonsdaleia lutugini* Fomichev (ibid., p. 464, Pl. 33, figs. 2a-b) and some Chinese Permian species assigned by Fomichev to *Cystolonsdaleia*, for example

Lonsdaleia chaoi (Huang) are provided with a well-developed axial column. They belong to the group of *Lonsdaleia* with a zone of clinotabellae.

As far as the axial structure is concerned, *Lonsdaleia portlocki* appears indeed intermediate between *Lonsdaleia* and *Lithostrotionella*. It does not appear advisable, however, to found a new subgenus for this species.

Material. The holotype of the subspecies *densiconus* is specimen st. no. 112719 from the Celada limestone, author's coll., loc. 29.

Occurrence of Lonsdaleia portlocki (Stuckenberg) s.s. Upper Moscovian (Podolskian and Myachkovian) of the Moscow basin.

Genus LITHOSTROTIONELLA Yabe & Hayasaka, 1915

Type-species. Lithostrotionella unicum Yabe & Hayasaka, 1915 from the Lower Permian of South China.

Diagnosis. Cerioid (or fasciculate) Lonsdaleiidae with axial structure a simple columella, formed by the elongated axial end of the cardinal septum; tabulae approximately horizontal.

Remarks on the diagnostic characters of Lithostrotionella.

Columella. It has been generally assumed that in corals of *Lithostrotionella* the columella is derived from the counter septum. One would expect this in corals which have *Lithostrotion* as ancestor, or which may be regarded as genomorphs of *Lithostrotion.* Perhaps it is the case in such corals, which will be discussed in the next paragraph as *Eolithostrotionella*, but there is no information on this subject.

Regarding *Lithostrotionella* s.s., it must be borne in mind that it is not always possible to recognize the cardinal septum. Several authors, describing species of *Lithostrotionella*, state therefore that the columella is joined to one of the major septa. For many Spanish corals, in this paper referred to *Lithostrotionella* or to its subgenus *Hillia* subgen. nov., it has been established that the columella is joined to the cardinal septum. A columella, derived from the cardinal septum, seems to be characteristic for most lonsdaleoid genera, if not for the whole family. It is assumed here that this is also a typical feature of *Lithostrotionella.* In order to settle this point definitely, the type material will have to be restudied.

Tabulae. Yabe & Hayasaka (1915) defined *Lithostrotionella* as "having a vesicular peripheral zone, well-bounded by an inner wall, the inside of which has essentially the same structure as *Lithostrotion*". Describing the type-species they state that the tabulae are nearly horizontal. Subsequently, Hayasaka (1936) referred to *Lithostrotionella* a number of Mississippian corals in which the tabulae are conically elevated, as in *Lithostrotion.* Other authors had also assigned corals with conical tabulae, i.e. as in *Lithostrotion*, but with a lonsdaleoid dissepimentarium, to *Lithostrotionella.* For this group of corals, Zhizhina (publication not seen) erected the genus *Eolithostrotionella*, restricting *Lithostrotionella* to corals with flat or gently inclined tabulae. *Eolithostrotionella* has been recorded from Lower Carboniferous strata of the Donetz basin, of the Kuznetsk basin and of China, and from the Mississippian of North America (Vassiljuk, 1960). Fomichev (1953, p. 593) mentions its occurrence in the Permo-Carboniferous of the western slope of the Urals.

Remarks on nomenclature. According to Vassiljuk (1960) the type-species of *Eolithostrotionella* designated by Zhizhina as *Lonsdaleia longisepta* Lissitzin, is a representative of *Lonsdaleia.* Nothing definite can be said here on this subject, since I have seen neither Lissitzin's nor Zhizhina's publication. Apart from this, there seem to be other genera to which these corals might belong, or to which they show a close relation: *Stelechophyllum* Tolmatchoff, 1933, *Dorlodotia* Salée, 1920 or *Lytvophyllum* Dobrolyubova, 1941. The two latter genera contain fasciculate coralla. It has been customary to assign the fasciculate forms of *Lithostrotionella* s.l. to another genus than the cerioid forms. If there is no other difference between the two, a generic separation does not seem justified. Sutherland (1958) points out that it is unadvisable to separate two genera solely on the form of the corallum. The genera *Lithostrotion* and *Lonsdaleia* for example, comprise both fasciculate and cerioid forms.

Fomichev (1953), giving an account of several Middle Carboniferous species of *Lithostrotionella* from the Donetz basin, names them *Petalaxis.* The name *Petalaxis* was proposed by Edwards & Haime (1852) for two species, formerly referred by them to *Stylaxis* McCoy: *Stylaxis maccoyana* Edwards & Haime, 1851 and *Stylaxis portlocki* Edwards & Haime, 1851. Fomichev thought he was free to select a type-species for *Petalaxis* and choose *P. maccoyana,* a species from the (Middle) Carboniferous of Russia, and undoubtedly a *Lithostrotionella.* But Fomichev apparently oversaw the fact, that Hill (1940) had already chosen as type-species *P. portlocki,* which is *Lithostrotion maccoyanum* Edwards & Haime 1851. Thereby *Petalaxis* had become a synonym of *Lithostrotion.*

Remarks on ontogeny. All Spanish corals, referred to *Lithostrotionella* or to *Hillia,* multiply by way of peripheral increase. The skeleton of a young polyp is formed within the dissepimentarium, in an angle between the sides of a parent-corallite. In other words, the young polyp attached itself to the epitheca inside the calyx of the parent-polyp. From then on, the process is visualized as follows: The septa in that part of the corallite where a young polyp has settled, are withdrawn from the periphery and coarse lonsdaleoid dissepiments are formed. One of these, adjoining the epitheca, is provided with a thick wall. This will be the common epitheca between parent and offset. The space thus partitioned off from the parent-corallite, encloses some septal ridges which were present on the old epitheca, and also some extensions of the septa (both major and minor) of the parent-corallite, which are prolonged past the new, common epitheca. Thus the young corallite does not only possess an epitheca, but also a number of septal ridges. These ridges soon grow longer, and are then seen as major septa. The septa functioning as protosepta can be recognized when intercalation of new septa starts.

One of the consequences of this mode of increase is, that the dissepimentarium has a variable width. In that part of a corallite where an offset has been formed, the dissepimentarium has either become very narrow or its place is taken wholly by the young corallite.

Occurrence.	Carboniferous	Asia, Arabia
	Middle Carboniferous	Russia — Moscow basin, Donetz basin
		China
		Japan
	Upper Carboniferous	Russia — N. Ural
	Pennsylvanian	N. America
	Permo-Carboniferous	Spitsbergen
	Lower Permian	S. China
		N. America

Lithostrotionella celadensis spec. nov.

Pl. 15, fig. 2

Diagnosis. Cerioid *Lithostrotionella* with corallites about 4 mm in diameter and mostly 14 or 15 major septa; minor septa poorly developed; dissepimentarium narrow; columella may be replaced by an axial column of a primitive type.

Description. The corallites have fairly straight sides. The epitheca may be thin, but is sometimes dilated and may then have a beaded appearance. The diameter of the corallites ranges from 3.5 to 5 mm, the greatest diagonal from 4.5 to 6, exceptionally 7 mm; the number of major septa from 12 to 16. The major septa extend in the tabularium (where they may be slightly dilated) about halfway to the centre. One of them may be continuous with the columella. It is not known with certainty whether this is the cardinal. Minor septa, if present, are but slightly developed. Only quite seldom they appear as septal ridges in the tabularium.

In most adult corallites the dissepimentarium consists of one row of generally non-septate dissepiments. Locally more series may be developed. The tabularium has a diameter of 3 or 3.5 mm. The tabulae are nearly always incomplete, flat or sagging in the outer part of the tabularium. They may be raised a little towards the columella, or for a short distance axial tabellae may be formed. A weak impersistent axial column may then appear, in which columellar ridges or septal lamellae play also a part. Further in growth, these reinforcements disappear, and the axial structure consists only of the medial plate.

Remarks. This species is assigned to *Lithostrotionella*, since the forming of an axial column seems to be the exception rather than the rule. Like *Lonsdaleia portlocki*, this species may be considered intermediate between *Lithostrotionella* and *Lonsdaleia*, but it is closer to *Lithostrotionella* than *Lonsdaleia portlocki*. Dobrolyubova (1935, p. 15) mentions a similar development of the axial structure in *Lithostrotionella stylaxis* (Trautschold). Corallites of that species differ, however, in having a larger size when numbering as many septa and in having a wider dissepimentarium.

Compared with *Lithostrotionella maccoyana* (Edw. & Haime), in which the corallites are similar in size and number of septa, *L. celadensis* differs in the poorer development of the minor septa and in the occasional development of axial tabellae.

Material. The holotype, st. no. 112720, is the only specimen found. It is a fragment from the Celada limestone, coll. J. A. van Hoeflaken, loc. 30.

Lithostrotionella maccoyana (Edwards & Haime, 1851)

Pl. 16, fig. 1

1851 *Stylaxis M'Coyana* Edwards & Haime — Edwards & Haime, p. 453, Pl. 12, fig. 5.
? 1879 *Lithostrotion flexuosum* Trautschold — Trautschold, p. 37, Pl. 5, fig. 7.
1935 *Lithostrotionella flexuosa* (Trautschold) — Dobrolyubova, p. 18, Pl. 3, figs. 1, 2.
1953 *Petalaxis maccoyana* (Edwards & Haime) — Fomichev, p. 453, Pl. 31, figs. 1, 2.

Diagnosis. Cerioid *Lithostrotionella*; corallites with in the adult stage 14 to 17 septa, of both orders each, at a diameter of 4 to 6 mm; minor septa well developed; dissepimentarium variable in width and in size of the dissepiments (after Dobrolyubova and Fomichev).

Description of Spanish material. The corallites have a strong, denticulate epitheca. Adult corallites number 14 to 16 major septa at a diameter of 4 to 5 mm (greatest diagonal: 5 to 6 mm). Major septa are dilated near the margin of the tabularium, thinning towards the centre. Except the cardinal, they terminate axially near the columella. When the septa are also developed in the dissepimentarium, they may be strongly dilated. Minor septa extend in the tabularium half as far as the major. The dissepimentarium consists of one or two, sometimes three series of dissepiments. Dissepiments are typically coarse, non-septate or crestal-septate. In some sections of some corallites they may be interseptal. The tabularium has a diameter of about 3 mm. The tabulae may be complete or incomplete. Some of them are in the outer zone of the tabularium sharply deflected downwards, suggesting clinotabellae. For the rest they are more or less horizontal, sometimes sagging a little. Near the centre they may be slightly raised towards the columella. The interval between successive tabulae is about 0.5 mm. The columella is somewhat dilated, often lath-shaped as seen in transverse sections. In some cases it is bent double, or there may be a few (one or two) columellar ridges.

Remarks. These corals agree quite well with the Russian representatives of this species; the number of septa and size of the corallites are similar, minor septa are equally long and some corallites may have a partly interseptal dissepimentarium. This latter characteristic is emphasized by Dobrolyubova (1935) in her description of *Lithostrotionella flexuosa* (Trd.). She states that the dissepiments are finer than in other species of *Lithostrotionella.* Of the specimens figured by her, some corallites have a lonsdaleoid or partly lonsdaleoid dissepimentarium, and some have an interseptal dissepimentarium. The same has been noted in the Spanish material. Possibly the corallum contains some corallites of the *Hillia*-type, since corallites of that kind occur.

Fomichev is followed here in regarding *Lithostrotionella flexuosa* (Trd.) as synonymous with *L. maccoyana* (Edw. & Haime). Comparison of the type-specimens of these species would settle this point satisfactorily.

Material. Specimens st. no. 112721—112724 from the Vañes formation, coll. Mrs. Wagner, loc. 59, SW of San Cebrián; specimen st. no. 112725 from the Cotarraso limestone, coll. Mrs. Wagner, loc. 47, E of the Sierra Corisa.

Occurrence elsewhere. Lower Moscovian (Kashirian) and Upper Moscovian (Myachkovian) of the Moscow basin; Lower Moscovian (zone C_2^ma and C_2^mb) of the Donetz basin.

Lithostrotionella maccoyana f. *major*

Pl. 16, fig. 2

Diagnosis. Like *Lithostrotionella maccoyana,* but corallites reach a larger diameter (4 to 7 mm) and number more septa (up to 22); columellar ridges rather frequently developed; clinotabellae may occur.

Description. The corallites of this form are in all respects like *Lithostrotionella maccoyana* s.s. but for their greater size. The diameter is 5 to 7 mm (greatest diagonal: 7 to 9 mm) when 17 to 22 major septa are present. The diameter of the tabularium is mostly 3.5, sometimes 4 mm. Adult corallites have generally non-septate dissepiments at the periphery, crestal-septate or interseptal dissepiments near the conspicu-

ous dissepitheca. The columella, when dilated, may bear also dilated columellar ridges, sometimes 5 on each side. Axial tabellae have not been observed. Locally, steeply inclined or cystose tabellae, just inside the dissepitheca, may be recognized as clinotabellae.

Remarks. Fomichev (1953) describes from the Lower Moscovian of the Donetz basin two varieties of *Lithostrotionella maccoyana*, which likewise differ from the typical form in the greater size of the corallites and a greater number of septa: *L. maccoyana belinskiensis* and *L. maccoyana multiseptata*. The former is distinguished by a broad, wholly non-septate dissepimentarium, the latter by the inclination of the tabulae, some of which are raised towards the columella. Columellar ridges and clinotabellae, as developed in the Spanish specimen, have not been observed in the Russian corals.

The differences between the typical form and the *major* form are not thought to be of more than infrasubspecific rank.

Material. One corallum, specimen st. no. 112726, from the Vañes formation, coll. Mrs. Wagner, loc. 7, NE of San Cebrián.

Lithostrotionella sexangula spec. nov.

Pl. 16, figs. 3, 4

Diagnosis. Lithostrotionella containing small-sized corallites with a narrow dissepimentarium and short minor septa.

Description. The corallites are regularly hexagonal. Adult corallites have a diameter of 3 to 4 mm (greatest diagonal: about 4 mm) with 13 to 15 major septa. The major sept usually reach close to the columella. In some corallites they are shorter, extending only halfway across the tabularium. Minor septa are developed as septal ridges on the epitheca, and sometimes as septal crests. Only seldom they appear as septal ridges in the tabularium, when dissepiments are present. Dissepiments are not always developed, often lack along a few sides of the corallites. Otherwise there is one series of non-septate or crestal-septate dissepiments. The tabularium has a diameter of 2.5 to 3 mm. Tabulae are sometimes placed close together (15 in an interval of 5 mm) or farther apart (9 in 5 mm). Generally they are flat and horizontal, but in some parts they are raised towards the columella, and may then have either upturned or downturned peripheral edges. The columella is often dilated, lath-shaped as seen in transverse sections. In the corallites with short major septa, the columella is unthickened and may be discontinuous.

Remarks. This species may be compared with *Lithostrotionella maccoyana* (Edw. & Haime), from which it differs chiefly in the smaller size of the corallites and in the shortness of the minor septa. By the latter feature it is also distinguished from *Hillia wagneri* spec. nov., whose corallites may have the same diameter. Apart from this, sections of *Lithostrotionella sexangula* differ usually from those of *Hillia* by having non-septate dissepiments. In some sections, however, the dissepiments may appear mainly interseptal, e.g. Pl. 16, fig. 4. In some cases this is certainly due to the plane of section. In other cases it appears probable that the coralla contain also corallites of the *Hillia*-type.

Material. The holotype is specimen st. no. 112727, from R. H. Wagner's collection, loc. 23, between Barruelo de Santullán and Vallejo de Orbó. From the same locality a large number of fragments, registered as st. no. 112728 and 112729 has been collected. Paratype st. no. 112730 is also from R. H. Wagner's collection, loc. 140, SW of Orbó.

Lithostrotionella monocyclica spec. nov.

Pl. 17, fig. 1

Diagnosis. Cerioid *Lithostrotionella*; adult corallites have a diameter of 5—7 mm with 20 to 22 major septa; minor septa not developed.

Description. The corallites have a broadly denticulate or beaded epitheca. The diameter of the corallites ranges from 3 to 8 mm. Young corallites, at a diameter of 3 to 4.5 mm, number 14 to 18 major septa. The greatest diagonal of adult corallites is 7 to 9, rarely 10 mm. In a few corallites 24 major septa are counted. The major septa extend in the tabularium about halfway to the centre. One of the septa is continuous with the columella, fairly often two opposite septa. Minor septa may be represented by denticles on the epitheca.

Increase takes place frequently and the dissepimentarium varies in width accordingly. At the periphery, dissepiments are coarse and non-septate. More inwards several rows of septate dissepiments may be developed. Sometimes they are arranged in the herringbone-pattern. A dissepitheca is generally present. The tabularium in adult corallites measures 4 to 4.5, in a few cases 5 mm. Tabulae are usually complete. The interval between successive tabulae is about 0.5 mm. Flat or sagging periaxially, the tabulae may be raised towards the columella. The columella is often dilated. It is never very broad, but in some sections traces of columellar ridges appear incorporated in it.

Remarks. The only species which shows some resemblance to the species just described, is *Lithostrotionella berthiaumi* Merriam, from the Permian of N. America. The resemblance concerns the number of septa at a given diameter, the length of the major septa, lack of minor septa and a columella with "faint radial markings suggesting lamellae". The columella is much thicker in the American species and even seems a compact axial column. Further, *Lithostrotionella berthiaumi* has tabulae which are sharply downturned from the periphery, and a wholly non-septate dissepimentarium.

Lithostrotionella monocyclica differs from *L. maccoyana major* in a somewhat greater number of septa at the same diameter, in the absence of minor septa and in the character of the tabulae.

Material. The holotype, st. no. 112731, is the only specimen known. It is from the Santa María limestone, coll. R. H. Wagner, loc. 21, E of Santa María de Nava.

Lithostrotionella orboensis spec. nov.

Pl. 17, fig. 2

Diagnosis. Lithostrotionella with adult corallites reaching a diameter of 6 to 8 mm, and numbering 17 to 19, sometimes up to 21 major septa; minor septa well developed; tabulae may be slightly raised towards the centre; columella occasionally absent.

Description. Measurements and number of septa are as follows:

number of major septa	diameter of tabularium	diameter of corallite
16	3 to 3.5 mm	4.5 to 5 mm
17	3.5 to 4 mm	5.5 to 6 mm
18	3.5 to 4.5 mm	(5)6 to 7(8) mm
19	4.5 to 5 mm	6.5 to 8 mm
20	5 mm	7 mm
21	5 mm	7.5 mm

The greatest diagonal of the corallites with 16 to 21 major septa is 7 to 10 mm. The septa are thin. Within the tabularium the major septa extend sometimes halfway across, sometimes close to the centre. Minor septa are in some corallites only slightly shorter than the major. Generally they reach half as far as the major septa in the tabularium. The dissepimentarium varies in width. Size and inclination of the dissepiments are also variable. Young corallites have one series of dissepiments, which tend to be interseptal. The dissepimentarium in adult corallites consists of several series (sometimes 4), and is on the whole lonsdaleoid. Typically dissepiments are elongate and moderately inclined. The columella is formed by the undilated elongated axial end of one of the major septa. Locally none of the major septa is so prolonged and the columella fails to develop. When this is the case, the tabulae are nearly flat. When the columella is present, they may be about horizontal or slope gently upwards to the centre. Tabulae are often complete. There are about 24 tabulae in an interval of 10 mm.

Remarks. Unlike in other species of *Lithostrotionella* here described, the tabulae are not flat or downturned, but periaxially sloping upwards a little, yet not sharply elevated as in *Eolithostrotionella.* In this respect *L. orboensis* is comparable with *L. mohikana* (Fomichev), described from the Upper Moscovian of the Donetz basin. Another point of similarity between these species is the length of the minor septa. *L. mohikana* differs, however, in numbering fewer septa (14 to 16 at the same diameter) in having a wider dissepimentarium, and a strong, uninterrupted columella.

Material. The holotype, st. no. 112732, is from R. H. Wagner's collection, loc. 105, near Orbó. At the same locality another fragment has been found (st. no. 112733).

Subgenus HILLIA subgen. nov.

Type-species. Hillia wagneri spec. nov. from the Perapertú formation of the Cantabro-Asturic Mountains.

Diagnosis. Like *Lithostrotionella,* but with a narrow, mainly interseptal dissepimentarium; tabulae horizontal or concave with upturned edges, some forms with clinotabellae; increase peripheral.

Description. Hillia comprises cerioid corals with polygonal corallites whose sides may be straight on curved. The epitheca is dilated and denticulate, the peri-

pheral edges of the septa are wedge-shaped. When the denticles on the common epitheca of neighbouring corallites are placed opposite to each other, the epitheca has a beaded appearance; when they alternate with each other, it looks like a zig-zag-line. In the middle of the epitheca, the "dark line" or "axial line", forming the boundary between the corallites, may be observed.

The marginarium may be developed in various ways. Generally it is a narrow dissepimentarium, often absent along a few sides of a corallite. Where present, it is typically septate, although (closely) crestal-septate or non-septate dissepiments are not quite uncommon. Lonsdaleoid dissepiments occur especially in corallite-angles, prior to the forming of offsets. Otherwise they may also sporadically be developed. In some corals the marginarium consists of a peripheral stereozone, which may be partly replaced by (interseptal) dissepiments.

The presence of clinotabellae is noted in some species of *Hillia*. The clinotabellae are either cystose or steeply inclined. When clinotabellae are not present, the tabulae in the periaxial part of the tabularium are horizontal, or gently rising upwards to the periphery.

The columella is formed by the vertically elongated axial end of the cardinal septum. Generally it is somewhat dilated. In a few forms the columella is rather thin, and then it may be vertically discontinuous. Some corals have a much thickened columella. Only seldom it is strengthened by inner ends of tabulae. Nearly always it is continuous with the cardinal septum. No other major septa are joined to it.

Remarks. The corals assigned to *Hillia* appear in transverse sections rather like some kind of *Lithostrotion*. Most major septa extend from the epitheca close to the centre, while one of them is joined to a somewhat dilated lath-shaped or styliform columella. In *Hillia* it is not the counter septum however, to which the columella is joined, but the cardinal, and, unlike in *Lithostrotion*, other major septa do not reach the columella. In longitudinal sections, *Hillia* differs more obviously from *Lithostrotion*. In the former the tabulae are horizontal or downturned, in the latter they are conically elevated towards the columella.

Corals somewhat like *Lithostrotion* but possessing concave tabulae, have been described by Gorsky (1938) from the Lower Carboniferous of Nova Zembla as *Paralithostrotion*. This genus comprises fasciculate corals, with a narrow dissepimentarium developed between the major septa, apparently lacking minor septa. In the centre a kind of impersistent axial structure is formed by the weakly joined axial ends of several major septa. Apart from the inclination of the tabulae, there is no further resemblance with *Hillia*.

Hillia is in all respects like *Lithostrotionella*, except in the dissepimentarium. As to that, *Hillia* is thought to represent the result of a trend operating on *Lithostrotionella*, namely, a trend towards uninterrupted septa, or in other words, replacement of the lonsdaleoid, non-septate dissepimentarium by a regular, septate one. Theoretically, it could also be the other way round. Then *Lithostrotionella* would be the product of a lonsdaleoid trend working on *Hillia*. The process could even be reversible. It is, however, a matter of speculation into which direction the trend is working. Nothing can be inferred from their vertical distribution, since species of *Hillia* and *Lithostrotionella* are recorded from the same stratigraphic horizons in the region studied. [1]

[1]) Recently, Wilson & Langenheim (1962) erected the genus *Eastonoides* for corals which show at first sight a close resemblance to representatives of *Hillia*. The columella is, however, connected with the counter septum and the tabulae are raised towards the columella. Perhaps *Eastonoides* has the same relation to *Eolithostrotionella* as *Hillia* to *Lithostrotionella*.

Lithostrotionella (*Hillia*) *wagneri* spec. nov.
Pl. 18, figs. 1—3

Diagnosis. Hillia whose full grown corallites mostly number 14 to 16 major septa at a diameter of about 4 mm; minor septa extend into tabularium; usually one series of dissepiments.

Description. The diameter of adult corallites is never more than 5 mm. Occasionally, the number of major septa reaches 17. The relation between the number of septa and the average size of the corallites is as follows:

number of major septa	diameter of tabularium	diameter of corallite
14	2 to 2.5 mm	3 to 3.5 mm
15	2.5 to 3 mm	3.5 to 4 mm
16	3 to 3.5 mm	3.5 to 4.5 mm

With regard to their size, variation in diameter of these small corallites is considerable. Extreme values, measured in one corallum, for corallites with 15 major septa, are 2.5 and 5 mm, and for the corresponding tabularium diameter 2 and 3.5 mm. The major septa generally extend from the epitheca close to the columella. Their axial ends may be curved. Minor septa are usually half as long as the majors. They may reach well into the tabularium. Sometimes they appear there only as septal ridges. In the dissepimentarium both major and minor septa may be interrupted, especially in corallite angles. The lonsdaleoid dissepiments there developed, occur, as far as could be ascertained, always prior to the forming of offsets. Increase is very frequent. A single series of interseptal dissepiments normally occupies the dissepimentarium. Often it is lacking on a few sides of the corallites. A few coralla lack dissepiments nearly altogether (e.g. Pl. 18, fig. 3). The tabulae may be complete or incomplete. They may be horizontal or sloping gently downward from the periphery. Sometimes they sag periaxially and are slightly raised towards the columella. The columella may be dilated, but it is often unthickened, just the elongated axial end of the cardinal septum. Generally it reaches well past the centre, but locally it may fail to do so.

One or two corallites from specimen st. no. 112738 show an unusual feature: they possess two columellae (Pl. 18, fig. 3). This is observed throughout the entire length, as far as preserved. Possibly this development originated in the earliest stages of the corallite, when, in stead of one, two of the initially present septa were elongated.

Remarks. Except for the dissepimentarium, *Hillia wagneri* spec. nov. is very similar to *Lithostrotionella maccoyana* (Edw. & Haime): in *Hillia wagneri* the trend towards completeness of the septa is fully expressed. Besides, there are some minor differences in size, on the average the corallites of *Hillia wagneri* have a smaller diameter.

Material. The holotype, st. no. 112734, and specimens st. no. 112735—112739 are from the Perapertú formation, coll. R. H. Wagner, loc. 35, N of San Martín; specimens st. no. 112740—112742, also from the Perapertú formation, coll. R. H. Wagner, loc. 39, 40 and 47, between San Martín and Perapertú.

Lithostrotionella (*Hillia*) *perapertuensis* spec. nov.

Pl. 19, figs. 1, 2

Diagnosis. Hillia whose full grown corallites have an average diameter of about 4 mm with 16 to 18 or 19 septa of each order; marginarium may be partly or completely a peripheral stereozone; in the tabularium an outer series of cystose clinotabellae may be developed.

Description. The diameter of the corallites with their corresponding number of septa is as follows:

number of major septa	diameter of tabularium	diameter of corallite
14	2 mm	3.5 mm
15	2 mm	3.5 to 4 mm
16	2 to 2.5 mm	3.5 to 4 mm
17	2.5 to 3 mm	4 mm
18 } 19 }	3 mm	4 to 4.5 mm

The corallites are provided with a thick epitheca, which forms a narrow stereozone. In a number of corallites, especially in those situated at the periphery of the corallum, this stereozone is broader and occupies the whole marginarium. In other corallites the marginarium is partly or completely developed as a dissepimentarium, consisting of interseptal dissepiments which may be bounded from the tabularium by a dissepitheca. Minor septa are about half as long as the major septa and generally extend for a short distance in the tabularium. In some corallites they are scarcely developed. The dissepiments inosculate. Tabulae are incomplete. In the central part they are about horizontal, sometimes just a little raised towards the dilated columella. Periaxially they slope gently upwards and near the marginarium they may rise steeply or form cystose clinotabellae, simulating dissepiments.

Remarks. This species is in some points like *Hillia wagneri*, but its corallites have somewhat more septa at the same diameter, more strongly dilated elements and a more complicated tabularium.

Material. The holotype is specimen st. no. 112743, coll. R. H. Wagner, loc. 49, E of Perapertú; specimen st. no. 112744, coll. A. C. van Ginkel, near Perapertú; specimen st. no. 112745, rather ill preserved, but closely similar to the holotype, from biohermal limestone between Verbios and Monasterio, loc. 5.

Lithostrotionella (*Hillia*) *radians* spec. nov.

Pl. 20, fig. 1

Diagnosis. Hillia with adult corallites reaching a diameter of 9 mm, with 17 or 18 septa of each order; dissepimentarium a relatively broad, continuous border.

Description. The corallum contains mainly hexagonal corallites with usually straight sides. On the outside they are longitudinally striated. Measurements are as follows:

number of major septa	diameter of corallites	
14	5—6 mm	young individuals
15	6—7 mm	young individuals
16	7—8 mm	
17	8—9 mm	
18	about 9 mm	

The septa generally extend from the epitheca. There are some interruptions. This happens oftener to the minor than to the major septa. The major septa are slightly dilated in the tabularium. The cardinal septum is continuous with the columella, which is mostly lath-shaped. In some sections the columella is represented by the thin, sometimes twisted axial end of the cardinal septum, which may or may not reach to the centre. Minor septa are in some corallites more than half as long as the major septa, appearing then just inside the tabularium. In other corallites, all the minor septa or several of them are withdrawn to the periphery. As a result the dissepiments there may show the herringbone pattern. In most adult corallites several rows of dissepiments are developed. They are rather steeply inclined, elongate and they vary in size. The tabularium occupies about half the corallite diameter, or slightly more. The tabulae are incomplete and gently inclined.

Remarks. Hillia radians differs from other species of *Hillia* in the ratio of the diameter to the number of septa. Species of other genera do not show any close resemblance.

Material. The holotype, specimen st. no. 112746, is an incomplete corallum, somewhat worn and embedded in a brownish-grey limestone, from the Perapertú formation, coll. R. H. Wagner, loc. 35, near San Martín. The same locality has yielded a smaller fragment of this species, specimen st. no. 112747.

Lithostrotionella (*Hillia*) *intermedia* spec. nov.

Pl. 20, figs. 2, 3

Diagnosis. Corallum containing corallites of *Lithostrotionella* and *Hillia* type, numbering 16 to 19 major septa and measuring 5 to 6 mm (greatest diagonal: 6 to 7 mm); minor septa end axially just within tabularium; tabulae about horizontal.

Description. Corallites with a complete peripheral border of lonsdaleoid dissepiments are exceptional, and so are corallites with a completely interseptal dissepimentarium, as far as their full-grown stage is concerned. In young corallites septa generally extend from the epitheca. Some corallites, however, have in their early stages a lonsdaleoid dissepimentarium. In mature stages major septa often appear

complete, but consist of radially continuous septal crests in the dissepimentarium. Minor septa are often incomplete. There may be several (sometimes 4) rows of dissepiments, steeply inclined, globose or elongate. The diameter of the tabularium is 3.5 or 4 mm. Tabulae are sometimes complete, mostly incomplete. The distance between successive tabulae is about 0.5 mm. Tabulae may be quite flat, or sagging periaxially and raised a little towards the columella.

Remarks. The corals here described seem closely related to *Lithostrotionella maccoyana* (Edw. & Haime), although they lack the long minor septa, typical of that species, and number more septa. On the other hand, there is a strong resemblance with *Hillia wagneri.* The size of the corallites and the nature of the dissepimentarium constitute the chief differences.

From *Lithostrotionella orboensis,* of which the corallites have a comparable range of size and number of septa, *Hillia intermedia* differs in the shortness of the minor septa and in the inclination of the tabulae.

Material. The holotype, st. no. 112748, is a large corallum from the Perapertú formation, coll. R. H. Wagner, loc. 44, near Perapertú. At the same locality several other fragments have been found, specimens st. no. 112749—112750.

Lithostrotionella (*Hillia*) *santaemariae* spec. nov.

Pl. 21, fig. 1

Diagnosis. Hillia whose corallites are mostly 5 to 6 mm in diameter with 17 or 18 major septa; minor septa short or absent; at the periphery corallites of *Lithostrotionella* type occur.

Description. The corallites have often rounded sides. The epitheca is thickened and forms a narrow peripheral stereozone. The size of the corallites ranges from 3.5 to 7 mm (greatest diagonal: ca. 5 to 8 mm), the number of major septa from 16 to 19. Sometimes minor septa are not developed. Often they are represented by septal ridges on the epitheca. In corallites of the *Hillia* type, i.e. the greater part, one row of dissepiments, varying in size and form is developed on a few, sometimes all sides. Corallites at the periphery of the corallum have a relatively broad, completely lonsdaleoid dissepimentarium. The tabularium measures 3 to 4.5 mm in diameter. The tabulae are generally horizontal in the axial zone and raised peripherally, sometimes sharply so and then clinotabellae may be formed. In a vertical distance of 10 mm, 14 to 18 tabulae are counted.

Remarks. This species shows much resemblance with *Hillia perapertuensis* nov. sp. It differs mainly in the poor development of the minor septa and in the larger tabularium in which the tabulae are more widely spaced.

Measurements and number of septa are similar in *Hillia intermedia* and in *Hillia santaemariae,* but corals of these species do not show any further resemblance. Development of minor septa, dissepiments and tabulae is quite different.

Material. The species is only known by its holotype, st. no. 112751, from the Santa María limestone, coll. R. H. Wagner, loc. 21, E of Santa María de Nava.

Lithostrotionella (*Hillia*) *cantabrica* spec. nov.

Pl. 22, figs. 1—4

Diagnosis. Hillia with corallites numbering 20 to 24, sometimes to 28 major septa at an average diameter of 5 to 7 mm; minor septa enter tabularium; dissepitheca in some forms developed; columella may be strongly dilated; clinotabellae occur.

Description. Measurements of the corallites and number of septa are as follows:

number of major septa	diameter of tabularium	diameter of corallite
19—20	3 to 4 mm	4 to 6 mm
21—22	3.5 to 4.5 mm	5 to 6 mm
23—24	4 to 4.5 mm	6 to 7 mm
in some specimens:		
25—28	4 to 5 mm	7 to 8 mm

One corallum, st. no. 112755, is also assigned to this species, although the corallites, even when numbering 28 major septa, are not larger than 4.5 mm. In other respects they are quite similar. The corallites have a strongly denticulate epitheca. Major septa are generally complete, but in some instances they are crestal-septate. This is mostly due to increase, which occurs frequently. Perhaps some corallites are of the *Lithostrotionella*-type. This seems to be the case in the coralla st. no. 112756 and 112757 from the Celada limestone. In these corals also the minor septa are oftener interrupted, or they may be withdrawn to the periphery.

The dissepimentarium consists of one or two (or sometimes more) series of elongate or globose dissepiments, moderately or steeply inclined. Some corallites have in their young stages the marginarium formed as a peripheral stereozone. These corallites have in their adult stages a strong dissepitheca. This is in most corals assigned to this species an occasional occurrence, but al corallites of the holotype, specimen st. no. 112752 from the Santa María limestone, show such a development.

The tabularium comprises a narrow zone of cystose or steeply descending clinotabellae and a periaxial zone of nearly horizontal or gently sloping tabellae, which may be raised a little towards the columella. The columella is more or less strongly dilated. As seen in transverse sections, its outline varies from round to lath-shaped. Columellar ridges are commonly developed in the holotype. They may also occur in the corals from the Celada limestone.

Remarks. From other species of *Hillia*, *Hillia cantabrica* spec. nov. is distinguished by its greater number of septa at a corresponding diameter.

Some corallites, in which the columella reaches an important size, as in the holotype and the corals from the Celada limestone, show a general resemblance to *Ipciphyllum*, described by Hudson (1958) from the Permian of Iraq. In *Ipciphyllum*, however, the axial structure is an axial column, and clinotabellae are more regularly developed.

Material. The holotype is specimen st. no. 112752 from the Santa María limestone, coll. R. H. Wagner, loc. 21, near Santa María de Nava; specimen st. no. 112753 from the Perapertú formation, coll. R. H. Wagner, loc. 48, near Perapertú; specimens st. no. 112754 and 112755 from the Perapertú formation, coll. Mrs. Wagner, loc. 84, between Mudá and Monasterio; specimens st. no. 112756 and 112757 from the Celada limestone, author's coll., loc. 28.

Genus KONINCKOCARINIA Dobrolyubova, 1937

Type-species. Koninckocarinia flexuosa Dobrolyubova, 1937, from the Podolskian of the Moscow basin.

Diagnosis. Solitary Lonsdaleiidae, with the axial structure a columella formed by the elongated axial end of the cardinal septum, which may be somewhat dilated; septa in adult stages may bear carinae.

Remarks. Dobrolyubova (1937, p. 51) defined *Koninckocarinia* as a subgenus of *Koninckophyllum.* She stressed also the strong resemblance between some corallites of *Lithostrotionella flexuosa* Dobr. and *Koninckocarinia flexuosa,* by giving it the same specific name. This resemblance is considered more than superficial, *Koninckocarinia* appears really more closely allied to lonsdaleiid corals than to the koninckophyllids: the zone of non-septate dissepiments, the periaxially down-turned tabulae and the columella formed by the cardinal septum are typical features of the Lonsdaleiidae.

Igô (1958) describes some corals from the Middle Carboniferous of Japan, which he, for the time being, regards as subspecies of *Koninckocarinia flexuosa.* In many respects the Japanese corals agree with the Russian specimen, but they show peripheral increase; the columella is, according to Igô, derived from the counter septum, and may be reinforced by some other axial elements and the septa are not carinate. As yet only one Russian specimen of *Koninckocarinia* is known. More material is needed to make the relation between the Russian and Japanese forms clear.

Occurrence.	Middle Carboniferous	Russia — Moscow basin ? Japan

Koninckocarinia concinna spec. nov.

Pl. 23, fig. 1

Diagnosis. Large *Koninckocarinia*; septa not carinate.

Description. The specimen, which is apically incomplete, has a height of 40 mm. Rejuvenation occurs once in the distal part. A section, taken as close as possible to the apex, measures 7 mm in diameter, and numbers 24 septa of each order. The septa are thin and reach close to the columella. The marginarium consists of a peripheral stereozone. With further growth of the coral, non-septate or crestal-septate dissepiments appear at the periphery, more inwards the dissepiments are regular and concentric. The columella may be slightly dilated and bear a few columellar ridges. Distally, it becomes thinner. In adult stages the coral has a diameter of about 20 mm with 32 septa of both orders each. After rejuvenation the

diameter is 13 mm and the number of septa 30. The epitheca is strong, thickened by the dilated peripheral edges of the septa. The major septa have their axial ends somewhat twisted. Minor septa reach well into the tabularium. The width of the dissepimentarium is slightly less than half the radius of the corallite. Seen longitudinally, the dissepiments are elongate and moderately inclined. The tabulae are in the outer zone steeply downwards inclined, in the inner zone almost horizontal and scarcely raised towards the columella.

Remarks. Except for its size and the absence of carinae on the septa, this coral agrees quite well with *Koninckocarinia flexuosa*, as described and figured by Dobrolyubova (1937, p. 52, Pl. 11, figs. 11—15).

Material. The holotype is specimen st. no. 112758, from the Perapertú formation, coll. R. H. Wagner, loc. 48, near Perapertú.

Genus CARCINOPHYLLUM Thomson, 1880

Type-species. Carcinophyllum kirsopianum Thomson, 1880 from the Viséan of Scotland.

Diagnosis. Solitary Lonsdaleiidae, with an axial structure in which a median plate is present and the lamellae are irregular anastomising and dilated; marginarium in young stages a peripheral stereozone which later may be replaced by a peripherally non-septate dissepimentarium; tabulae flat or sagging periaxially, conical in the axial structure (after Hill, 1940).

Remarks. The question whether *Carcinophyllum* is synonymous with *Axophyllum* Edwards & Haime, 1850, has not yet been settled. About the type species of *Axophyllum*, *A. expansum* Edw. & Haime, nothing new has come to light since Salée (1913a, p. 370, Pl. 15, figs. 2, 3) described the cotypes and figured their calyces.

Meanwhile, Fomichev (1953) has erected the genus *Axolithophyllum* for Middle and Upper Carboniferous corals, formerly described as *Axophyllum*. He characterizes *Axolithophyllum* as distinct from *Carcinophyllum* by the presence of 1. a wide dissepimentarium, 2. complicatedly split septa, and 3. a more simply constructed columella, which is in young stages round and massive. Yet the corals described as *Axolithophyllum kalitvense* Fomichev (1953, p. 423, Pl. 29, figs. 2—3) do not have a wide dissepimentarium and their septa are not split.

1. In corals assigned to *Carcinophyllum* the dissepimentarium is often weathered away, but when present it may be wide, for instance in *C. parkinsoni* Ryder, 1930.
2. Owing to the weathering away of the dissepimentarium it cannot be said if the presence of naotic or otherwise modified septa is of common occurrence in *Carcinophyllum*. Hill (1940, p. 160) describing the lectotype of *C. kirsopianum* Thomson, mentions that the septa are wedge-shaped and occasionally show a *Naos*-like modification near the periphery. Earlier, she (1934, p. 77) had pointed out that the development of the *Naos*-trend is connected with a strong peripheral dilatation of the septa in younger stages. Septa, strongly dilated in youthful stages, may show other modifications as well in further stages of growth. They may become cavernous in their median parts, or dissepiseptate, or in another way appear "perforate". But strong dilatation of the septa does not necessarily lead to such modifications, as Hill (1934, p. 78) remarked.

Septal modifications, as indicated above, are also noted in the type-species of *Axolithophyllum*, *A. mefferti* Fomichev, 1953. Some corals of this species have sphenoid septa, which are naotic near the periphery (Fomichev, 1953, Pl. 28, fig. 10). The holotype of this species (ibid. fig. 14) however, has thin septa, locally dilated and rarely a little split.

3. The development of the axial structure in *Carcinophyllum* has been studied by Ryder (1930, p. 348, textfigs. 5a-l) for *C. vaughani* Salée. It is very like that in *Axolithophyllum*: in the earliest stages the columella is simple, formed by the elongated and dilated axial end of the cardinal septum. Quite soon some short, dilated septal lamellae are joined to the dilated plate. Later in ontogeny, the axial structure widens, and becomes more or less open in *Carcinophyllum*. It remains solid, yet showing the same kind of pattern, in *Axolithophyllum*. But the dilatation may disappear at a later stage, and the axial structure appears then carcinophylloid.

Several species of *Carcinophyllum* have been described, in which the axial structure does not contain "irregular anastomising septal lamellae" but a large number of fairly regular septal lamellae, about as numerous as the major septa, resembling rather the structure of the aulophyllid *Carruthersella*. A similar structure is noticed in one of the specimens of *Axolithophyllum mefferti* (Fomichev, 1953, Pl. 27, fig. 9) where it is discernible in the solid, round columella.

The available evidence points strongly to a close genetic relationship between *Carcinophyllum* and *Axolithophyllum*. The chief differences between the type-species of the two genera may be summarized as follows:

1. the open, irregular axial structure in *Carcinophyllum* against the generally compact, dilated structure in *Axolithophyllum*
2. the marginarium, consisting of a peripheral stereozone, interrupted by non-septate dissepiments in *Carcinophyllum* against the wide, septate to non-septate dissepimentarium in *Axolithophyllum*.

Between these two species are many intermediate forms, among them the corals which will be described below, which have a wide dissepimentarium, more or less split septa and a typical carcinophylloid axial structure from an early stage onwards.

It seems idle to minimize the difference between *Carcinophyllum* and *Axolithophyllum*, but, on the other hand, if both genera would have to be restricted to the forms as defined above, a number of new genera would have to be erected to accomodate the intermediate forms, and this had better be avoided. Therefore it is proposed here to regard *Axolithophyllum* as a subgenus of *Carcinophyllum*. *Axolithophyllum* is then defined as follows: like *Carcinophyllum*, but with an axial structure which is either solid and compact, or becomes carcinophylloid at a later stage of development than in *Carcinophyllum*.

Occurrence of Carcinophyllum s.s.

Viséan	British Isles
	Belgium, France
	NW Sahara
Lower Carboniferous	Russia — Ural Mountains,
	Donetz basin,
	Nova Zembla
	Central Asia, China, Japan
	Australia
Middle Carboniferous	China

Occurrence of Carcinophyllum (Axolithophyllum)

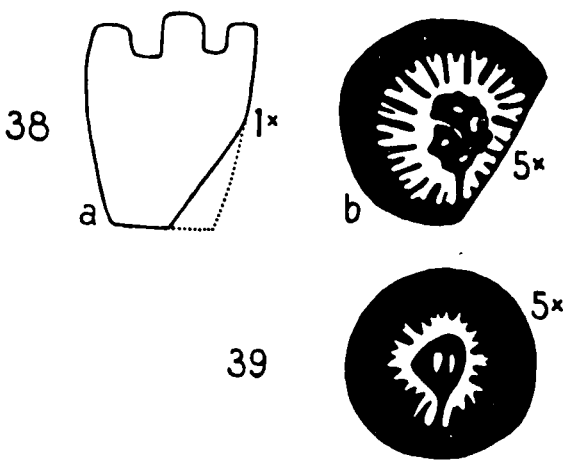
Middle Carboniferous	Spain
	Russia — Donetz basin, Moscow basin
Upper Carboniferous	Russia — Donetz basin

Carcinophyllum wagneri spec. nov.

Pl. 23, figs. 2—5; text-figs. 38, 39

Diagnosis. Conical to conico-cylindrical *Carcinophyllum* with earliest stages like *Carcinophyllum simplex*; later stages with a wide, partly non-septate dissepimentarium and sphenoid septa which become distally perforate or thin; axial structure bisected by the medial plate and about 8 septal lamellae on each side.

Description. The corals reach generally a diameter of 20 to 25 mm, numbering 30 to 35 septa, of both orders each. Some corals measure up to 30 mm in diameter with about 40 major septa.



Figs. 38, 39. *Carcinophyllum wagneri* spec. nov. Fig. 38. holotype RGM no. 112759. a, outline; b. transverse section from proximal end of fragment. Fig. 39. paratype RGM no. 112766. transverse section from proximal end of fragment.

None of the corals has the very tip preserved. Sections taken at the neanic stage (diameter 5 to 7 mm) show about 22 much dilated major septa, laterally contiguous at the periphery, ± pinnately grouped about the cardinal septum. The cardinal septum is joined to the axial structure, which consists of twisted, much dilated elements and which occupies about half the tabularium diameter. Minor septa may be present, either buried in the stereozone or protruding a little from it. These early stages are very similar to *Carcinophyllum simplex* Garwood, 1913, from the lower Viséan (C_2zone) of N.W. England. Further in growth, dissepiments (septate or non-septate) begin to develop, gradually replacing the stereozone. In full-grown stages the septa have strongly dilated, sometimes naotic peripheral edges. Often

they are interrupted in the outer zone of the dissepimentarium. Further inwards they may be

a. thin.
b. dilated, either in part or for their whole course, often sphenoid.
c. medially cavernous, i.e. the space between their lateral edges is not filled up.
d. occasionally dissepiseptate.
e. irregularly cavernous, they are then represented by patches of stereome-granules, which may be set close together, or slightly apart.

The major septa reach close to the axial structure, about halfway across the tabularium. Minor septa do not extend far into the tabularium. Inside the tabularium the septa may be strongly dilated, but become thin distally. Sections with strongly dilated septa have likewise a well-developed dissepitheca. The axial structure is composed of a long, dilated medial plate, more or less strongly dilated septal lamellae and for the greater part thin axial tabellae.

Remarks. The corals described as *Carcinophyllum wagneri*, vary considerably, both individually and among each other. Variation concerns mostly the degree of dilatation and the septal modification, and to some extent the elements of the axial structure.

One of these corals (st. no. 112763, Pl. 23, fig. 5), provisionally included in the species, differs in some important points from the typical form. It has smaller dimensions while numbering as many septa: at a diameter of 12 to 15 mm, there are 30 to 32 major septa. The septa are dilated, wedge-shaped in late neanic stages and in calycular sections. The axial structure is more irregular, rather like that in *C. kirsopianum* in adult stages, and the earliest section shows a very small columella. For the time being it is assumed that these variations fall within the range of this species.

Material. All specimens are from the Perapertú formation and have been collected by Mr. R. H. Wagner, after whom the species is named. The holotype st. no. 112759 is from loc. 31, near San Martín. Other specimens are st. no. 112760—112762 from loc. 32 and st. no. 112763—112768 from loc. 40, both in the vicinity of San Martín. Specimen st. no. 112769 is from loc. 48, near Perapertú.

Carcinophyllum (?) sp.

Pl. 24, fig. 1

Description. The specimen, questionably assigned to *Carcinophyllum*, is about 25 mm long and very much worn. Most of the marginarium and part of the tabularium are weathered away, except in the calyx region. The youngest stages are missing.

The earliest section available shows the strongly dilated axial ends of 28 major septa, reaching close to the axial structure. This is formed by a long, dilated median plate and numerous dilated septal lamellae, and several series of thin, axial tabellae.

The section figured on Pl. 24, fig. 1a is taken just below the calyx. The tabularium, which is the only part left, has a diameter of about 12 mm, 34 to 36 septa of each order are counted. The axial structure occupies half of the tabularium diameter. The median plate nearly bisects the whole structure, and the septal lamellae are about as numerous as the major septa.

In the calyx region 40 or 42 septa, of both orders each, are present. The diameter of the tabularium is 14 mm, and that of the corallite approximately 23 mm, increasing to 30 mm. The septa cross the dissepimentarium. Non-septate dissepiments are not observed. The septa are sphenoid, often "perforate" (cavernous or coarsely dissepiseptate). The axial structure is in the centre obscured by dilatation, the septal lamellae are spirally twisted.

As seen in longitudinal sections, the tabulae in the periaxial zone are horizontal or sagging. In the axial structure they are mainly thin and sharply elevated distally.

Remarks. The coral here described cannot with certainty be thought to belong to the genus *Carcinophyllum*. It seems to lack a peripheral zone of non-septate dissepiments, although one may suppose that this is not preserved. The presence of periaxially down-turned tabulae suggests affinity with the Lonsdaleiidae. The axial structure resembles that of some Viséan species of *Carcinophyllum*, for instance *Carcinophyllum vaughani* Salée, as figured in Salée, 1913b, Pl. 10, fig. 3.

Material. The coral (st. no. 112770) has been collected by Mrs. Wagner, from the Perapertú formation, loc. 40, N of Monasterio.

Carcinophyllum (*Axolithophyllum*) *quiringi* (Weissermel, 1935)

Pl. 24, figs, 2, 3

1935 *Amygdalophyllum quiringi* Weissermel — Weissermel, p. 274, Pl. 22, fig. 1.
1953 *Axolithophyllum mefferti* Fomichev — Fomichev, p. 417, Pl. 28, figs. 7—16, Pl. 29, fig. 1.

Diagnosis. Axolithophyllum with a broad conical form; just below the calyx at a diameter of about 20 mm numbering 28 to 32 septa, of both orders each; minor septa well developed; axial structure relatively small and generally compact.

Description. The corals are 20 to 25 mm high and may attain a calyx diameter of 50 mm. The calyx is very deep, about half the height. A section taken at the apical end measures 4 or 5 mm in diameter, with 20 major septa. The cardinal septum is axially elongated, its end forms a strongly dilated columella, in which also a few septal lamellae are incorporated. As seen in transverse sections, the columella may be slender, lath-shaped, or rounded. Somewhat further in growth, minor septa and a narrow zone of dissepiments appear, a few of which may be non-septate.

More distally, the dissepimentarium becomes wider, its width equals half the radius of the corallite. The outer zone consists of non-septate dissepiments, the inner zone of interseptal dissepiments. Peripherally, the septa may be naotic, in the inner dissepimentarium cavernous. At the margin of the tabularium a dissepitheca is developed, beyond which the minor septa do not pass or protrude just a little. The axial structure may be solid, or slightly porous. Generally its structure is clearly discernible: a medial plate, continuous with the cardinal septum, and several septal lamellae, all strongly dilated. The disposal of the dissepiments, as seen in longitudinal sections, is in the outer part nearly horizontal or gently sloping. Towards the tabularium they are steeply, sometimes vertically inclined. In the outer zone of the tabularium the tabulae plunge downwards, periaxially they are about horizontal and axially sharply raised.

Remarks. Most of the corals here described have been collected by Mrs. Wagner from approximately the same locality where Quiring found the specimen named *Amygdalophyllum quiringi* by Weissermel. The holotype of the species is rather badly preserved; in the one section figured by Weissermel the dissepimentarium is for the greater part broken up and destroyed. Yet the description and figure of this specimen agree so well with the corals at my disposal that they certainly belong to the same species.

Dobrolyubova (1937) thought *A. quiringi* synonymous with *Axophyllum cavum* Trautschold, a species which must be referred to *Carcinophyllum*, subgenus *Axolithophyllum*. *A. quiringi* differs from *A. cavum*, however, in having better developed minor septa, a smaller tabularium and a less irregular axial structure. In these points and in other details it is quite similar to Fomichev's *Axolithophyllum mefferti*, which is here regarded as a synonym of *A. quiringi*.

Material. Specimens st. no. 112771—112778 from the Socavón limestone, coll. Mrs. Wagner, loc. 54, near the mine of San Cebrián (topotypes); specimen st. no. 112779 from the Cotarraso limestone, coll. Mrs. Wagner, loc. 47, E of the Sierra Corisa; specimen st. no. 112780 from the Verdiana limestone, coll. R. H. Wagner, loc. 75; specimen st. no. 112781 from a limestone outcrop NW of Cotarraso, coll. R. H. Wagner, loc. 66; specimen st. no. 112782 from the Peña Tejedo limestone, coll. M. H. Nederlof, loc. 22.

Occurrence elsewhere. Lower Moscovian (zone C_2^mc) and Kasimovian (zone C_3a) of the Donetz basin.

Carcinophyllum (Axolithophyllum) quiringi f. *major*

Pl. 24, figs. 4—6

Description. Several coral fragments have been collected which might represent a large variety of *Axolithophyllum quiringi*, or perhaps an advanced form. The corals are more cylindrical, and may be at least 40 mm long (specimen st. no. 112785). Sections taken just below the calyx measure 30 to 35 mm in diameter and number about 40 septa of each order.

Apart from their greater size, the following points of difference from the typical forms of *A. quiringi* are noted:

a. a lesser development of non-septate dissepiments.
b. the septa show more elaborate modifications. The *Naos*-trend may be more strongly expressed, the septa may be perforate, straight or zigzag in their course through the dissepimentarium. In the specimen st. no. 112783 they are cavernous in the outer part of the tabularium.
c. the outer zone of clinotabellae is more pronounced; it is wide, and the clinotabellae are not cystose but steeply or vertically inclined.
d. the development of the minor septa varies; in the counter quadrants of some sections they end within the dissepimentarium. In other sections all minor septa reach well into the tabularium.
e. the dissepitheca may be less strongly developed.

These differences are but gradual. The earliest stages of the corals are not known.

Material. Specimen st. no. 112783 from the Sierra Corisa limestone, coll. Mrs. Wagner; specimen st. no. 112784 from the Verdeña limestone, coll. M. H. Nederlof, loc. 14; specimen st. no. 112785 from a limestone outcrop NE of Cotarraso, coll. R. H. Wagner, loc. 72; probably also specimen st. no. 112786, a badly preserved coral fragment from the Brañosera limestone, coll. R. H. Wagner.

Carcinophyllum (*Axolithophyllum*?) aff. *cylindricum* (Dobrolyubova & Kabakovich, 1948)

Pl. 25, fig. 1

1948 *Axophyllum cylindricum* Dobr. & Kab. — Dobrolyubova & Kabakovich, p. 32, Pl. 15, figs. 1—5; Pl. 16, figs. 1—3.

Diagnosis of Axolithophyllum cylindricum. Axolithophyllum with a cylindrical form; numbering 35 major septa at a diameter of 20 to 24 mm; minor septa well developed; septa may be sphenoid and cavernous; solid axial structure, distally becoming less massive (after Dobrolubova and Kabakovich).

Description of Spanish material. An incomplete coral eroded both at apical and distal ends and with part of the dissepimentarium weathered away, shows in several characters a close affinity to *A. cylindricum*. The coral fragment is ± cylindrical and about 25 mm long. At a diameter of ca. 20 mm, there are 36 septa of each order. Most septa extend from the epitheca, as far as this is preserved. In the section figured (Pl. 25, fig. 1) all septa are sphenoid in outline, but cavernous. A section taken at a different plane shows the septa to be but slightly dilated, the majors a little more than the minors. The minor septa extend for a short distance in the tabularium. The axial structure in the earliest section available (34 major septa at a tabularium diameter of 12 to 14 mm) is carcinophylloid, with strongly dilated elements, and joined to the cardinal septum. Distally, the axial structure may become quite open, as in the section figured, and afterwards regain its former appearance. The dissepiments are horizontally disposed at the periphery, and steeply inclined further inwards. The tabulae slope down periaxially and are slightly raised in the axial region.

Remarks. Since the early stages of this coral are not preserved, it cannot be stated whether this coral belongs to *Carcinophyllum* s.s. or to *Axolithophyllum*. The specimen described as *Axophyllum cylindricum* by Dobrolyubova & Kabakovich is not complete either, but its earliest sections figured show an axolithophylloid axial structure. Distally the structure becomes carcinophylloid. The resemblance between the distal part of *A. cylindricum* and the Spanish coral is striking, except in the dilation of the elements of the axial structure, which is stronger in the Russian coral.

Material. Specimen st. no. 112787 from the Cotarraso limestone, coll. Mrs. Wagner, loc. 47, E of the Sierra Corisa.

Occurrence of Carcinophyllum (*Axolithophyllum*?) *cylindricum* (Dobr. & Kab.). Upper Moscovian (Myachkovian) of the Moscow basin.

Genus LONSDALEOIDES Heritsch 1936, emend.

Type-species. Lonsdaleoides boswelli Heritsch 1936 from the lower Schwagerina-limestone (Lower Permian) of the Carnic Alps.

Diagnosis. Fasciculate lonsdaleiid corals, with carcinophylloid or axolithophylloid axial structure; part of the septa dilated or showing modifications; dissepimentarium may be completely interseptal, but non-septate dissepiments occur, either developed sporadically, or forming a peripheral zone of inconstant width.

Remarks. Heritsch (1936, p. 128) proposed the genus *Lonsdaleoides* for corals, resembling *Lonsdaleia*, but with a less regularly developed axial structure and with the zone of non-septate dissepiments narrow or failing altogether. The generic name is used here for corals, showing features which differ from those described by Heritsch, or which were not mentioned by him.

1. The septa of *Lonsdaleoides boswelli*, as figured by Heritsch (textfig. 33) are for the greater part dilated, sometimes thinner in the outer zone of the dissepimentarium. Naotic or cavernous septa, as developed in the Spanish corals, apparently do not occur.
2. Heritsch states that the axial structure is connected with the counter septum. Judging from the figured section (textfig. 33a) one would think it joined to the cardinal septum, as in carcinophylloid corals. This is the case in Spanish representatives of *Lonsdaleoides*.
3. Heritsch did not figure or describe longitudinal sections of *Lonsdaleoides*. The genus is here interpreted as having also lonsdaleiid tabulae, i.e. periaxially downturned and possibly accompanied by clinotabellae.

Minato (1955, p. 155, p. 162) comes to a different conclusion concerning the systematic position of *Lonsdaleoides*. He includes *Lonsdaleoides* in the Geyerophyllidae. This family, erected by Minato, 1955, comprises corals which, early in ontogeny, pass a lophophyllidioid stage: the septa are approximately pinnately arranged, the columella is compact and united with the counter septum. In mature stages the corals have usually an outer zone of non-septate dissepiments, and an axial structure which is amygdalophylloid to clisiophylloid, with strongly dilated elements. Minato does not mention the character of the tabulae in *Lonsdaleoides*, as interpreted by him.

The true position of *Lonsdaleoides* cannot be decided until the type-material is further studied. The corals in this paper assigned to *Lonsdaleoides* should have to be removed to another genus if Minato's interpretation proves to be correct.

Occurrence. Lower Permian Carnic Alps

Lonsdaleoides hispanicus spec. nov.

Pl. 25, figs. 2—5

Diagnosis. Lonsdaleoides with corallites reaching a diameter of 11 to 14 mm, with 24 to 31 septa of each order; dissepimentarium occupies $\frac{1}{3}$ to $\frac{1}{2}$ of the corallite-radius, minor septa usually do not extend in tabularium.

Description. The coralla are very loosely built. The corallites are found lying fairly close together. Many of them are broken or otherwise destroyed. Some of them reach a length of at least 50, perhaps 100 mm. Rejuvenation in some corallites takes place frequently, sometimes coupled with increase. Externally the corallites are longitudinally striated and transversely faintly wrinkled.

Early neanic stages have the marginarium developed as a peripheral stereozone. Dilation of the septa in the tabularium varies: the septa may be somewhat thickened, often they are thin. Except for the axially elongated cardinal septum the major septa are short and reach about halfway across the tabularium. Later, the marginarium becomes a narrow dissepimentarium and minor septa appear, as septal ridges on the epitheca. A dissepitheca is present. The axial end of the cardinal septum may be slightly or strongly dilated.

Sections, taken at adult stages, may vary considerably in the character of the septa, the dissepiments and the axial structure. The septa may be complete or interrupted, sometimes dilated in part, sometimes cavernous and sometimes naotic to dissepiseptate in the outer zone of the dissepimentarium. Generally the major septa reach close to the columella; the cardinal septum is often joined to it. A complete zone of non-septate dissepiments is not often developed. When interseptal, the dissepiments are set close together, inosculating or herringbone-patterned where not crossed by the minor septa. Seen longitudinally, they are globose or elongate, mostly steeply inclined. A dissepitheca is but occasionally present. The axial structure contains always a long median plate, which in many cases is continuous with the cardinal septum but may become free. The axial structure may be completely dilated, forming a solid columella. There is, however, a considerable variation in dilation, number and arrangement of the septa lamellae and tabellae. Apart from the axial tabellae, the tabularium consists of a periaxial zone of horizontal or sagging transverse tabellae and an outer zone of clinotabellae, which may be cystose.

Remarks. Transverse sections of the corallites of this species show a considerable resemblance to those of *Lonsdaleoides bowelli*, figured by Heritsch, 1936. The Spanish species may be distinguished, however, by the complicate character of the septa, by the width of the dissepimentarium and by the shortness of the minor septa.

Material. The holotype, specimen st. no. 112788, and several paratypes, specimens st. no. 112789—112794, are large corallum fragments from the Peña Tejedo limestone, coll. R. H. Wagner, loc. 73.

Genus Amygdalophylloides Dobrolyubova & Kabakovich, 1948

Type-species. Amygdalophyllum ivanovi Dobrolyubova, 1937 from the Myachkovian of the Moscow basin.

Diagnosis. Small, solitary lonsdaleiid corals with septa typically extending from the epitheca; dissepimentarium narrow; axial structure formed chiefly by the dilated and vertically elongated axial end of the cardinal septum, reinforced by some septal lamellae and tabellae.

Remarks. Corals which in transverse sections appear very similar to *Amygdalophylloides* have been described by Heritsch (1936) from the Lower Permian of the Carnic Alps as *Zeliaphyllum*. The apparent similarity may, however, be deceptive,

since no longitudinal sections are known of *Zeliaphyllum*. Hill (1956, p. F 266) presumably supposes that the tabulae in *Zeliaphyllum* are conical, since she lists the genus as a member of the Timorphyllidae. In *Amygdalophylloides* the tabulae are periaxially downwards inclined. If it should be found that this is also the case in *Zeliaphyllum*, the genera might be considered synonymous, there does not seem to be any generic difference between them.

Some other corals described by Heritsch (1936) from the Upper Carboniferous and the Lower Permian of the Carnic Alps as *Lophophylloides carnicum* and *Lophophyllidium profundum* (Edw. & Haime) are, according to Dobrolyubova (1940, p. 50—51) very close to, resp. synonymous with *Amygdalophylloides ivanovi*.

Amygdalophylloides is distinguished from *Kionophyllum* Chi by its lacking a zone of non-septate dissepiments. The two genera may be closely allied, but they are not identical, as Fomichev (1953) supposed.

Occurrence. Middle and Upper Carboniferous — Russia — Moscow basin
Upper Carboniferous and Lower Permian — Carnic Alps

Amygdalophylloides ivanovi (Dobrolyubova, 1937)

Pl. 26, fig. 1

1937 *Amygdalophyllum ivanovi* Dobr. — Dobrolyubova, p. 60, p. 79, Pl. 19, figs. 15—20.
1940 *Amygdalophyllum ivanovi* Dobr. — Dobrolyubova, p. 51, Pl. 20, figs. 2—11.

Diagnosis. Amygdalophylloides, reaching a diameter of 10 to 14 mm with 26 septa of each order; minor septa typically about half as long as the major septa (after Dobrolyubova).

Description of Spanish material. One small, incomplete specimen is assigned to *Amygdalophylloides ivanovi*. The coral is straight and conical, and has a height of about 20 mm, half of which is taken by the calyx.

At a diameter of 7 mm, 22 septa of each order are present. The septa have strongly dilated peripheral edges, forming a peripheral stereozone. The major septa extend close to the axial structure, which occupies $\frac{1}{3}$ of the corallum diameter, and the minor septa are very short. The axial structure is not solid. It appears formed as a loop of the dilated axial end of the cardinal septum. Further in growth it consists of a long, dilated median plate, continuous with the cardinal septum, some dilated lamellae and tabular intersections. A section taken through the calyx (diameter 11 mm, with 26 × 2 septa) shows the marginarium a narrow, interseptal dissepimentarium, the minor septa somewhat longer, $\frac{1}{3}$ to $\frac{1}{2}$ as long as the major septa, and the columella loosened from the cardinal septum.

Remarks. In the character of the axial structure and in the length of the minor septa, the Spanish coral agrees better with the representatives of *A. ivanovi* from the Kasimovian (Dobr., 1940) than with those from the Myachkovian. The latter have their axial structure a dense columella, and longer minor septa: up to $\frac{2}{3}$ as long as the major septa. Dobrolyubova & Kabakovich (1948) separate some other Kasimovian representatives of this species as a variety (or subspecies?), named by them *A. ivanovi kovrovi* (ibid., p. 24, Pl. 8, figs. 5—11). These corals are smaller, have even shorter minor septa and a strong dissephitheca The Spanish specimen differs less from the typical form.

Material. Specimen st. no. 112795 from Peña del Moro limestone, coll. M. H. Nederlof, loc. 28.

Occurrence elsewhere. Upper Moscovian and Upper Carboniferous (Podolskian — Kasimovian) of the Moscow basin.

Genus IVANOVIA Dobroluybova, 1935, emend.

Type-species. Ivanovia podolskiensis Dobrolyubova, 1935 from the Podolskian of the Moscow basin.

Diagnosis. Cerioid to aphroid Lonsdaleiidae, with septa dilated in tabularium; axial structure compact, formed by a columella which may be reinforced by septal lamellae and/or axial tabellae; clinotabellae present.

Remarks. Yabe & Hayasaka (1916, p. 70) erected the genus *Cystophora* for aphroid corals with a styliform or thick platy columella and with incomplete tabulae periaxially obliquely inclined, axially horizontal. They mention that these corals have rarely some traces of the external wall arond the corallites, but that in the type-species, *Cystophora manchurica*, traces of the wall are often observed (ibid., p. 71).

Dobrolyubova (1935, p. 35) founded the genus *Ivanovia* for aphroid corals, essentially similar to *Cystophora*, but differing in possessing an axial structure in which, apart from a median plate, thick radial plates occur. The figured specimen of the type-species. *Ivanovia podolskiensis*, shows that these plates may also fail to develop.

Yabe & Eguchi (1944, fide Minato 1955) thought *Ivanovia podolskiensis* so closely related to *Cystophora manchurica*, that they regarded it as a subspecies of the latter.

The name *Cystophora* is preoccupied, however, and has to be rejected as a homonym of *Cystophora* Nillson, 1820. This has been pointed out by Hill (1956) who replaces the invalid generic name by *Ivanovia.*

If the name *Ivanovia* is to be used to replace *Cystophora* Yabe & Hayasaka the genus has to be emended to include also corals that are partly cerioid. For instance *Cystophora manchurica*, and the corals described by Dobrolyubova (1935) as *Cystophora humboldti*, *Cystophora freieslebeni* and especially *Cystophora densivesiculosa*, have often well-developed walls between the corallites.

Another emendation regarding the axial structure is called for. The genus has to include forms where this is a columella, which may be discontinuous and which may be strengthened by septal lamellae and/or by inner ends of tabellae.

Ivanovia is treated here as a member of the Lonsdaleiidae. Hudson (1958) includes the genus (as *Cystophora*) in his new subfamily of the Waagenophyllidae, the Wentzelellinae. This subfamily comprises corals with septa of three or more orders, a compact axial column and clinotabellae in the outer zone of the tabularium. The latter feature, displayed also in corals of *Ivanovia*, Hudson considers typical for the Waagenophyllidae; in this paper, however, it is regarded as a not uncommon character of the Lonsdaleiidae as well (see remarks on Lonsdaleiidae). The other characteristics of the Wentzelellinae are lacking in *Ivanovia*: the presence of septa of the third order has not been demonstrated, it is not observed in the type-species (Dobrolyubova, 1935, p. 35, Pl. 12, fig. 1) and the axial structure is typically a simple columella, not an axial column.

Corallites in which exceptionally an axial column is developed, as in some specimens of *Ivanovia freieslebeni*, are very like *Polythecalis*, which is a member of the Wentzelellinae. The sporadical development of such a column and the absence of septa of the third order may serve to distinguish these genera from each other.

Occurrence.	Middle Carboniferous	Russia — Moscow basin, Donetz basin
		China, S. Manchuria
	Upper Carboniferous	Russia — Donetz basin
	Lower Permian	Japan, N. Korea

Ivanovia freieslebeni (Stuckenberg, 1888)

Pl. 26, figs. 2—4

1888 *Phillipsastraea freieslebeni* Fischer — Stuckenberg, p. 27, Pl. 3, figs. 22—26.
1888 *Phillipsastraea rossica* Stuck. — Stuckenberg, p. 26, Pl. 2, figs. 10—15.
1935 *Cystophora freieslebeni* (Stuck.) — Dobrolyubova, p. 20, Pl. 4, figs. 1—3; Pl. 5, figs. 1, 2; Pl. 8, fig. 3.
1953 *Lonsdaleiastraea freieslebeni* (Stuck.) — Fomichev, p. 502, Pl. 43, figs. 1—3.

Diagnosis. Ivanovia which may be partly cerioid, otherwise aphroid; septa much thickened, wedge-shaped; corallites with an average diameter of 6 mm (greatest diagonal: 7 or 8 mm) with 10 to 13 major septa; minor septa absent or poorly developed.

Description. The coralla are flat and spreading. More often than not the epitheca of the corallites is quite well developed, it is but occasionally wanting. As seen in longitudinal sections, it is sometimes absent, or it consists of a series of spines on the distal surfaces of the dissepiments.

The major septa reach about halfway across the tabularium. One of them is generally joined to the columella. It is not clear if this is either the cardinal or the counter septum.

In most corallites the septa are only dilated in the tabularium and in the dissepimentarium thin, if developed there. But they may be also dilated in the dissepimentarium, sometimes excessively so. They may then be laterally contiguous.

Minor septa are often absent and if developed, but poorly.

Dissepiments vary much in size, they may be small and globose, or coarse and elongate. Near the epitheca, or at the boundary between two corallites, they are nearly horizontal. Towards the tabularium they are generally inclined.

The dissepitheca is well-marked, sharply dividing the dissepimentarium from the tabularium. Generally it has a diameter of 3 or 3.5 mm.

The tabulae are generally incomplete. Those in the outer part of the tabularium, the clinotabellae, are often cystose, more or less elongate. Elsewhere they are steeply inclined. Locally some series of axial tabellae are developed.

Mostly the axial structure consists of a columella which may be thin or strongly dilated and sometimes discontinous.

The columella may be free, or joined to one of the major septa. Exceptionally it is joined to two opposite septa.

Remarks. On the whole, these corals are very like those described by Dobrolyubova from the Moscow basin. Some differences are to be noted:

1. in the development of the minor septa.

The Russian corals possess well-developed minor septa, often appearing as septal ridges on the inner wall. Only seldom they are quite wanting. The Spanish corals on the contrary often lack minor septa entirely, and when present they never enter into the tabularium.

2. in the development of the dissepitheca.

In the Spanish corals the tabularium is much more sharply marked off from the dissepimentarium than in the specimens from the Moscow basin.

3. in the development of the axial structure.

In the corals from Spain, the axial structure may occasionally be strengthened by radial plates and axial tabellae. Such a strengthening does not often take place, nor does it persist very long.

The corals of this species, described by Fomichev from the Donetz basin, differ on the same points from the typical forms of the Moscow basin. Fomichev (1953, p. 502) mentions also the local appearance of septa, split near the inner wall. On account of this, and of the occasional presence of axial tabellae in the axial structure, he refers the species to a genus where an axial column and dissepisepta are common features: *Lonsdaleiastraea* Gerth. Since these characters are only weakly and not constantly expressed in the corals under discussion, I prefer to regard them as representatives of *Ivanovia*. Besides, the coralla of *Lonsdaleiastraea* are essentially thamnasterioid, and have but few lonsdaleoid dissepiments. Probably they possess septa of the third order. *Lonsdaleiastraea* might be a member of the Wentzelellinae, as Hudson (1958) states.

Material. Specimens st. no. 112796—112798 from the Peña del Moro limestone, coll. M. H. Nederlof, loc. 28, S of Santa María de Redondo; specimen st. no. 112799 from the Peña Tremaya limestone, coll. M. H. Nederlof, loc. 64. A badly preserved specimen, st. no. 112800, from the Piedras Luengas limestone, coll. M. H. Nederlof, is questionably assigned to this species.

Occurrence elsewhere. Upper Moscovian (Podolskian and Myachkovian) of the Moscow basin; Kasimovian (zone C_3a and C_3b) of the Donetz basin.

DISTRIBUTION OF THE CORALS

In the rugose coral fauna of the Carboniferous of northern Palencia 58 species are recognized. 13 of the species have been previously described, 32 are new and 13 are presumably new, but specifically unnamed.

The species are divided over 27 genera and 3 subgenera. Most genera are represented by one or two species and the species number for the greater part few individuals. This may be partly due to collecting factors.

The species, here described, do not represent the complete rugose coral fauna of this area. A fairly large number of specimens is too incomplete or too much damaged to make a specific or, as in some cases, a generic identification possible. For purposes of describing new species, which they appear to represent, they are quite unsuited. It is hoped that future collecting will bring more and better preserved specimens of such corals to light.

The distribution of the corals in the different litho-stratigraphic units is to a large extent subject to facies control. It is known that some of the species have a long stratigraphic range. They may be found in deposits varying considerably in age, but formed under similar physical conditions. Individually, the corals have not much value as zonal indices. There are not enough data available to show whether species associations of corals in different types of rocks may be used for local correlation.

Tables I to III show the distribution of the corals in the various coral bearing units. Following Hill (1938), the coral fauna has been divided in three groups. Hill (1938) recognized the faunal types as follows: 1. *Cyathaxonia*-Fauna, containing the non-dissepimented solitary corals; 2. Caninid-Clisiophyllid Fauna, indicating the dissepimented solitary corals; 3. Reef-Coral Fauna, including massive and fasciculate compound corals.

Sando (1960) recognizes approximately the same types of coral faunas in his study of Early Mississippian corals from the Madison Group of Montana. The tabulate corals, which Hill associates with the *Cyathaxonia* fauna, are included by Sando in the colonial coral fauna. Sando's descriptive terms of the three coral fauna types are adopted in this paper.

Hill (1938) describes the litho-facies with which the faunal types are associated and the conditions under which they could best develop. Her conclusions, which are based on a study of the corals occurring in the Carboniferous of the British Isles, may be also applied to the Spanish fauna: Non-dissepimented corals lived in fairly shallow seas. The sea water was rich in argillaceous and calcareous material. On the sea floor organic matter might accumulate, but enough oxygen must have been present, The other types of coral fauna came to full development in clear, shallow seas with freely circulating, well aereated water and with but little clayey material and without much organic matter on the sea floor.

These environments represent, in a general way, optimum conditions for the growth of the faunal types. Opportunities for coral development were, however, much more varied. For example, non-dissepimented solitary corals are often found together with dissepimented forms, and also, although not frequently, with compound rugose corals.

Relations between coral types and environment are known to be more complicated. As shown by Dobrolyubova (1948) for the genus *Bothrophyllum*, species of the same genus may require different environmental conditions. Yet for a general survey of the coral fauna, division in the three faunal types facilitates comparison.

TABLE I

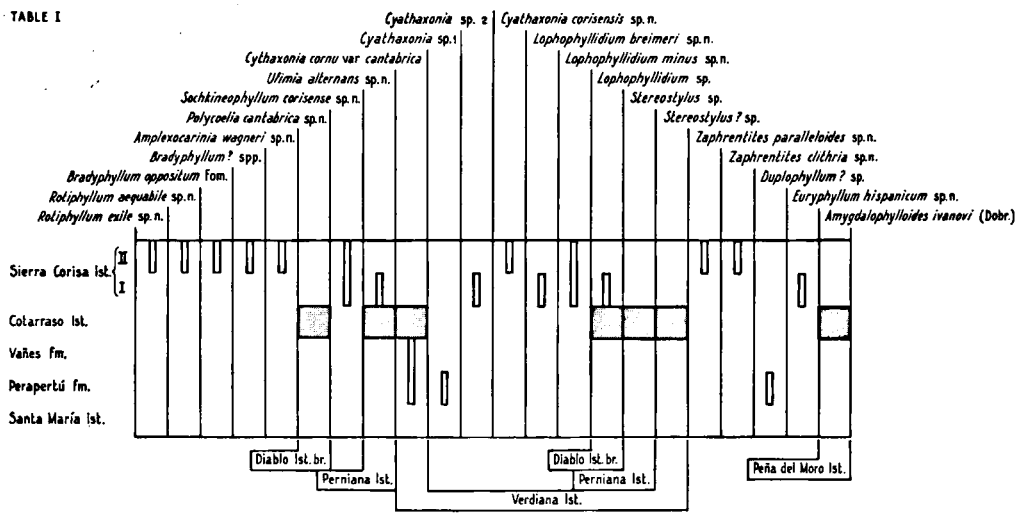


TABLE II

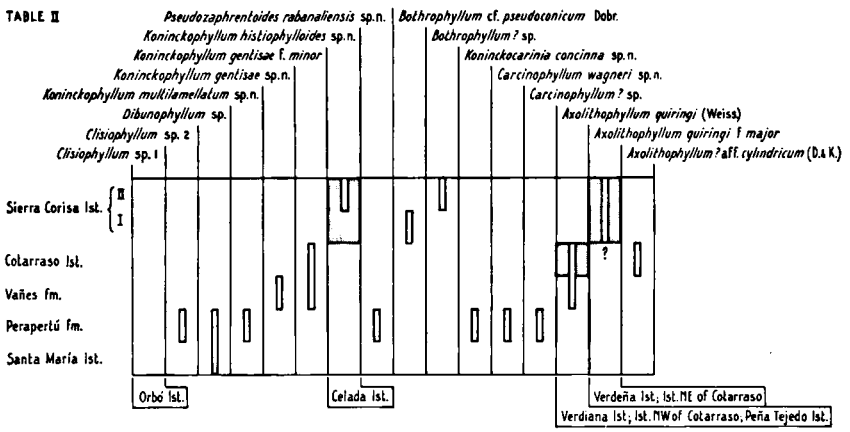
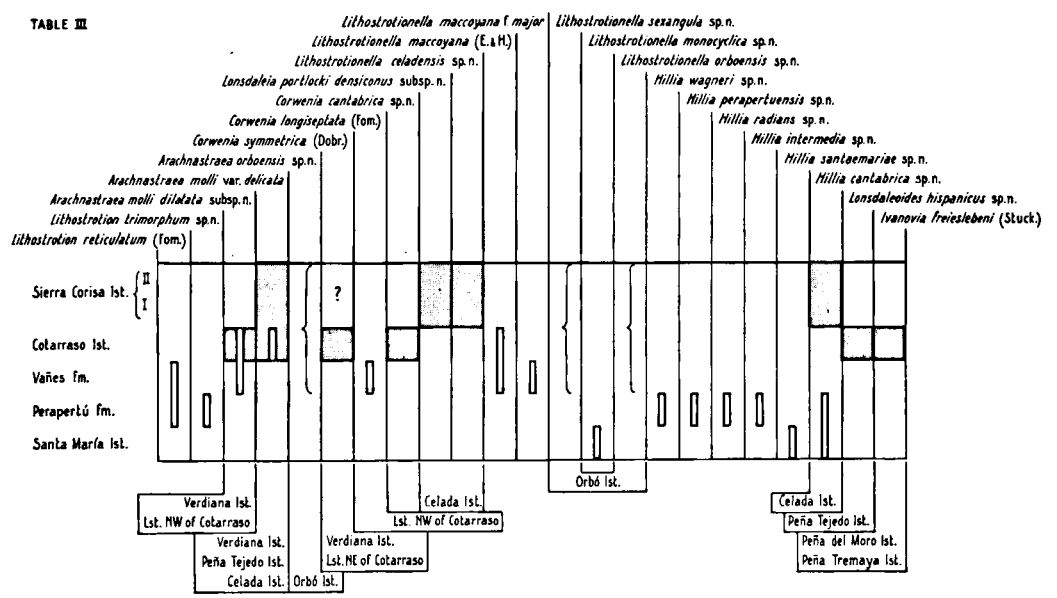


TABLE III



Santa María limestone

The coral assemblage found in the Santa María limestone consists of several new species, and gives therefore no information as to its stratigraphic position. The species are:

Lithostrotionella monocyclica spec. nov.
Lithostrotionella (Hillia) santaemariae spec. nov.
Lithostrotionella (Hillia) cantabrica spec. nov.
Dibunophyllum sp.

The last two species mentioned occur also in the Perapertú formation. *Hillia cantabrica* has further been recognized in the Celada limestone.

Wagner & Wagner-Gentis (1963) place the lowest limit of the age of the Santa María limestone at the top of the Namurian A, since C. H. T. Wagner-Gentis (1963) established the age of the underlying Villabellaco limestone, by means of her identifications of the goniatite fauna, as ranging from Lower Visean to Namurian A.

Direct information concerning the age of the Santa María limestone has been furnished by Mr. A. C. van Ginkel (pers. comm.), who identified the following species of foraminifera:

Pseudostaffella? sp.
Parastaffella sp.
Profusulinella sp.
Millerella (Millerella) ex gr. *prisca* (Raus.)
Millerella (Millerella) ex gr. *pseudostruvei* (Raus. & Bel.)
Millerella (Eostaffella) ex gr. *mutabilis* (Raus.)
Millerella (Eostaffella) ex gr. *chesterensis* (Cooper)
Millerella (Eostaffella) sp. (ex gr. *okensis?* Viss.)

According to Mr. Van Ginkel, this fauna belongs to the Bashkirian.

Perapertú formation

In the reef-knolls or bioherms of the Perapertú formation the "Reef-Coral Fauna" is well represented:

Lithostrotion reticulatum (Fom.)
Lithostrotion trimorphum spec. nov.
Lithostrotionella (Hillia) wagneri spec. nov.
Lithostrotionella (Hillia) perapertuensis spec. nov.
Lithostrotionella (Hillia) radians spec. nov.
Lithostrotionella (Hillia) intermedia spec. nov.
Lithostrotionella (Hillia) cantabrica spec. nov.

Tables I—III. Rugose coral faunas from the Carboniferous formations of northern Palencia.
Table I. Non-dissepimented solitary corals.
Table II. Dissepimented solitary corals.
Table III. Compound corals.
Bars indicate the occurrence of the species in the formations named at the left-hand side; shaded areas refer to the limestones mentioned at the foot of the Tables, as far as the corresponding units are known.

Also the dissepimented solitary corals:

Clisiophyllum sp.
Dibunophyllum sp.
Koninckophyllum multilamellatum spec. nov.
Pseudozaphrentoides rabanaliensis spec. nov.
Koninckocarinia concinna spec. nov.
Carcinophyllum wagneri spec. nov.
Carcinophyllum? sp.

With the exception of *Cyathaxonia* and *Duplophyllum?*, non-dissepimented solitary corals are not listed. From locality Wagner 44, near Perapertú, several metriophyllids, polycoeliids and hapsiphyllids have been forthcoming. These single specimens are too fragmentary and too ill preserved to allow even a generic identification. Another incomplete metriophyllid (?) has been collected near Rabanal.

The Perapertú formation is typically developed between Monasterio and Perapertú. More westwards, in the vicinity of Rabanal de los Caballeros, the external conditions must have been different. Cerioid colonial corals, flourishing in the reefs near Perapertú, are unknown at Rabanal. On the other hand, the fasciculate *Lithostrotion reticulatum*, common at Rabanal, is represented by one specimen in the eastern part. The fauna of Rabanal consists further of a great number of specimens of *Pseudozaphrentoides rabanaliensis*, which is again poorly represented near Perapertú. The contrast between the uniform fauna of Rabanal and the diversified fauna of Perapertú is striking.

The coral fauna offers no indication as to the age of the Perapertú formation. Nearly all species are new and they are not closely comparable to species of which the stratigraphic occurrence is known. The exception is formed by *Lithostrotion reticulatum* (Fomichev), which is recorded from the Lower Moscovian (Vereyan-Kashirian) of the Donetz basin. But the presence of this one species cannot furnish a sound basis for correlation.

Studying the foraminifera of various samples, Mr. A. C. van Ginkel came to the conclusion that the age of the Perapertú formation ranges from the Bashkirian to the Lower Vereyan, or that it has possibly a still longer range (pers. comm.).

Orbó limestone

The Orbó limestone has furnished three species of massive colonial corals:

Arachnastraea orboensis spec. nov.
Lithostrotionella orboensis spec. nov.
Lithostrotionella sexangula spec. nov.

These species occur exclusively in the Orbó limestone. The relation of this limestone to the stratigraphic succession in the western part of the area is not clear.

On account of his fusulinid determinations, Mr. A. C. van Ginkel could establish the age of the Orbó limestone as Upper Moscovian (pers. comm.).

Vañes formation

The coral assemblage of the Vañes formation consists of dissepimented solitary corals, slender fasciculate and massive colonial corals:

Koninckophyllum gentisae spec. nov.
Koninckophyllum gentisae f. *minor*
Carcinophyllum (Axolithophyllum) quiringi (Weiss.)
Corwenia longiseptata (Fom.)
Lithostrotion reticulatum (Fom.)
Arachnastraea molli (Stuck.) *dilatata* subsp. nov.
Lithostrotionella maccoyana (Edw. & Haime)
Lithostrotionella maccoyana f. *major*

Except for *Cyathaxonia cornu* Mich. var. *cantabrica*, non-dissepimented solitary corals have not been found.

Five of the species recognized have been described from the Donetz basin:

Lithostrotion reticulatum (Fomichev)
Corwenia longiseptata (Fomichev)
Lithostrotionella maccoyana (Edwards & Haime)
Arachnastraea molli (Stuck.)
Carcinophyllum (Axolithophyllum) quiringi (Weissermel)

These species occur in different substages of the Moscovian, the last two also in the Kasimovian.

Two of the species mentioned are moreover recorded from the Moscow basin: *Lithostrotionella maccoyana* and *Arachnastraea molli*. Both are mainly represented in the Myachkovian. They may, however, occur locally in lower substages, the former in the Kashirian, the latter in the Podolskian.

The association of these species agrees in general with an Upper Moscovian age, although *Lithostrotionella maccoyana* and *Axolithophyllum quiringi* are also to be found in the Lower Moscovian and *Lithostrotion reticulatum* is, at least in the Donetz basin, restricted to the Lower Moscovian.

Cotarraso limestone

The coral fauna of the Cotarraso limestone differs not strongly from that of the Vañes formation. They have several species in common:

Koninckophyllum gentisae f. *minor*
Carcinophyllum (Axolithophyllum) quiringi (Weiss.)
Arachnastraea molli (Stuck.) *dilatata* subsp. nov.
Lithostrotionella maccoyana (Edw. & Haime)

Apparently, part of the fauna of the Vañes sea returned with the transgression of the Cotarraso sea. *Lithostrotion reticulatum* (Fom.) and *Corwenia longiseptata* (Fom.) disappeared, however, and a few new elements are introduced. *Arachnastraea molli* (Stuck.) is in the Cotarraso limestone also represented by the variety *delicata*. Another new element is *Carcinophyllum (Axolithophyllum?)* aff. *cylindricum* (Dobr. & Kab.).

According to fusulinid determinations by Van Ginkel, Nederlof (1960) correlates the Verdiana limestone and the Peña Tremaya limestone with the Cotarraso limestone. The corals from the Verdiana limestone have been described as follows:

Cyathaxonia cornu Mich. var. *cantabrica*
Stereostylus (?) sp. ex gr. *newelli* (Jeffords)
Carcinophyllum (Axolithophyllum) quiringi (Weiss.)
Corwenia symmetrica (Dobr.)
Arachnastraea molli (Stuck.) *dilatata* subsp. nov.
Arachnastraea molli (Stuck.) var. *delicata*

This fauna has several elements in common with the Vañes formation, as well as with the Cotarraso limestone. The presence of both *A. molli dilatata* and *A. molli* var. *delicata* may be seen as supporting evidence for correlating the Verdiana limestone with the Cotarraso limestone.

From the Peña Tremaya limestone only one species has been described:

Ivanovia freieslebeni (Stuck.)

This species is also recorded from the Peña del Moro limestone, together with:

Amygdalophylloides ivanovi (Dobr.) [1])

These species are not with certainty known from other limestones in the area.

Nederlof (1960), after data by Van Ginkel, tentatively correlated the Abismo-Diablo-Peña Tejedo limestones with the Sierra Corisa limestone. Further investigations of the fusulinid fauna led Van Ginkel to the conclusion that these limestones are to be paralleled with the Cotarraso limestone (pers. comm.).

The Peña Tejedo limestone has yielded the following corals:

Carcinophyllum (Axolithophyllum) quiringi (Weiss.)
Arachnastraea molli (Stuck.) var. *delicata*
Lonsdaleoides hispanicus spec. nov.

The occurrence of the first two species might indicate a relation with the fauna of the Cotarraso limestone. *Arachnastraea molli* var. *delicata*, however, is also present in the Celada limestone, which is an equivalent of the Sierra Corisa limestone.

From the Diablo limestone breccia, two non-dissepimented solitary corals have been described as:

Polycoelia cantabrica spec. nov.
Lophophyllidium sp.

The latter species is also recorded from the lower part of the Sierra Corisa limestone.

Other non-dissepimented solitary corals have been found in the biostromal limestone, developed between the Perniana- and Por-si-acaso coalseams. From its stratigraphical position, above the Perniana coalseam, which probably corresponds to the San Cebrián formation, the limestone is thought to represent another equivalent of the Cotarraso limestone. The corals found in it belong to the species:

Plerophyllum (Ufimia) alternans spec. nov.
Stereostylus sp.

Specimens of *Ufimia alternans* have also been met with in the lower part of the Sierra Corisa limestone.

[1]) *Amygdalophylloides ivanovi* is listed in Table I, together with the nondissepimented corals, on account of its small size and the late development of its narrow dissepimentarium.

From the limestone outcrop NW of Cotarraso have been collected:

Carcinophyllum (Axolithophyllum) quiringi (Weiss.)
Arachnastraea molli (Stuck.) *dilatata* subsp. nov.
Corwenia cantabrica spec. nov.

This association might be expected in the Vañes formation, but also in the Cotarraso limestone. The latter assumption appears more likely.

The corals, collected from the limestone outcrop NE of Cotarraso belong to the species:

Carcinophyllum (Axolithophyllum) quiringi f. *major*
Corwenia symmetrica (Dobr.)

Specimens of *Axolithophyllum quiringi* f. *major* have further been found in the Sierra Corisa limestone and in the Verdeña limestone, which, according to Nederlof (1960) corresponds in age to the Sierra Corisa limestone. *Corwenia symmetrica*, on the other hand, is also recorded from the Verdiana limestone, which is paralleled with the Cotarraso limestone. The occurrence of these two coral species gives no information concerning the stratigraphic position of this limestone outcrop.

Sierra Corisa limestone

The corals from the Sierra Corisa limestone have been chiefly collected in the light-coloured shales and marls, intercalated between the limestones. They have been found in situ or as erosional residue, when the soft shales are weathered away. The shale levels are locally developed, they are not horizontally continuous.

The non-dissepimented solitary corals belong to the following species:

Rotiphyllum exile spec. nov.
Rotiphyllum aequabile spec. nov.
Bradyphyllum oppositum Fomichev
Bradyphyllum? sp. no. 1 and 2
Amplexocarinia wagneri spec. nov.
Sochkineophyllum corisense spec. nov.
Plerophyllum (Ufimia) alternans spec. nov.
Cyathaxonia corisensis spec. nov.
Cyathaxonia sp. no. 2
Lophophyllidium breimeri spec. nov.
Lophophyllidium minus spec. nov.
Lophophyllidium sp.
Zaphrentites paralleloides spec. nov.
Zaphrentites clithria spec. nov.
Euryphyllum hispanicum spec. nov.

Except for *Bradyphyllum oppositum*, a species which has been reported from the Lower Moscovian and the Kasimovian of the Donetz basin, all species are new.

Most of the genera represented, except *Rotiphyllum*, *Cyathaxonia* and *Zaphrentites*, occur mainly in the Late Carboniferous and the Permian. The polycoeliids are sparsely represented in the Dinantian; *Bradyphyllum* and *Amplexocarinia* are recorded from the Mississippian.

The dissepimented solitary corals of the Sierra Corisa limestone belong to the genera *Bothrophyllum* and *Koninckophyllum*. *Bothrophyllum*, of which only a few specimens are present in the collections from Palencia, is abundantly represented in the Moscow basin and not uncommon in deposits of the same age in the Donetz basin and in the Ural mountains.

Koninckophyllum histiophylloides spec. nov. may have developed from earlier representatives of *Koninckophyllum*, found in this area.

Colonial corals have not been discovered in the Sierra Corisa limestone. A number of massive corals has been found in the Celada limestone, which, according to Van Ginkel (in Nederlof, 1960), corresponds in age to the Sierra Corisa limestone. The Celada limestone must have been deposited under different environmental conditions, favourable for the growth of colonial corals (a.o. shallower part of the basin, less argillaceous content). The species recognized are:

Arachnastraea molli (Stuck.) var. *delicata*
Lonsdaleia portlocki (Stuck.) *densiconus* subsp. nov.
Lithostrotionella celadensis spec. nov.
Lithostrotionella (Hillia) cantabrica spec. nov.

The coral fauna of the Cotarraso-Sierra Corisa limestones and their equivalents, seen as a whole, has eight species in common with the Myachkovian of the Moscow basin. These are:

Amygdalophylloides ivanovi (Dobr.)
Bothrophyllum pseudoconicum Dobr.
Carcinophyllum (Axolithophyllum?) cylindricum (Dobr. & Kab.)
Corwenia symmetrica (Dobr.)
Arachnastraea molli (Stuck.)
Lonsdaleia portlocki (Stuck.)
Lithostrotionella maccoyana (Edw. & Haime)
Ivanovia freieslebeni (Stuck.)

Massive corals, as the last named four species, are in the Moscow basin almost exclusively present in the Myachkovian. Locally they may occur in lower substages of the Moscovian, but with a limited horizontal distribution (Ivanova & Khvorova, 1955). According to Dobrolyubova (1935, p. 40), the Moscow basin reached in the Myachkovian optimum conditions for the development of massive colonial corals: the basin must have been shallow enough to let currents and waves reach the bottom, and the sea water was nearly free from clayey material. The other substages of the Moscovian and the Kasimovian are developed in a predominantly clayey facies.

The development of the Donetz basin was quite different. It is directly comparable with that of the Cantabric-Asturian area in its succession of terrestrial and marine deposits. Rotay et al. (1960, p. 9) state that the Middle Carboniferous of the Donetz basin "consists chiefly of terrigenous rocks ... with subordinate intercalations of limestones and coals".

The following species from the Moscovian and Kasimovian of the Donetz basin have been recognized in the Cotarraso-Sierra Corisa limestones:

Bradyphyllum oppositum Fomichev
Carcinophyllum (Axolithophyllum) quiringi (Weiss.)
Corwenia symmetrica (Dobr.)
Arachnastraea molli (Stuck.)
Lithostrotionella maccoyana (Edw. & Haime)
Ivanovia freieslebeni (Stuck.)

These species do not occur together in a particular substage, but appear at various levels of the stages mentioned. The first two species are reported from the Lower Moscovian, but they are also represented in the Kasimovian. *Lithostrotionella maccoyana* is restricted to the Lower Moscovian. *Corwenia symmetrica* and *Arachnastraea molli* are present in the Upper Moscovian and the latter persists in the Kasimovian. *Ivanovia freieslebeni* is characteristic for the Kasimovian. Apparently, opportunities for the development of massive corals arose oftener than in the Moscow basin.

The Carboniferous coral fauna of Palencia compares most closely with that of Russia. Late Carboniferous and Early Permian coral faunas have further been described from Central Europe. The best known is that from the Carnic Alps (Heritsch, 1936a a.o.). This fauna belongs to the Gzhelian and Artinskian, and so is younger than that of Palencia. For comparison with other Central European Permo-Carboniferous coral faunas not enough data are available.

It is interesting to note that the Carboniferous coral fauna of northern Palencia has twelve species in common with the fauna of the Moscovian of Russia. The conclusion seems warranted, that during the Moscovian there was a direct or indirect connexion between the Spanish and the Russian basins, which made migration of coral species possible. There is no evidence to show that this was also the case in the Bashkirian. Bashkirian corals have so far not been recognized in Palencia, although deposits of Bashkirian age are present, as shown by Van Ginkel on fusulinid evidence (see above, Santa María limestone and part of the Perapertú formation). Future investigations are needed to correct this impression.

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PLATES

PLATE 1

Figs. 1, 2 *Rotiphyllum exile* spec. nov.
Sierra Corisa limestone, coll. R. H. Wagner, loc. 58.
Fig. 1 holotype RGM no. 112501. a-c transverse sections, neanic and adult stages, 5 ×; d, transverse surface, calyx region, 3 ×.
Fig. 2 paratype RGM no. 112502. a-c transverse sections, neanic and adult stages, 5 ×; d, transverse surface, calyx region, 3 ×.

Figs. 3, 4 *Rotiphyllum aequabile* spec. nov.
Sierra Corisa limestone, coll. R. H. Wagner, loc. 58.
Fig. 3 holotype RGM no. 112511. a, transverse section, neanic stage, showing counter pseudofossula, 5 ×; b-d transverse surfaces, neanic stage to calyx region, 3 ×.
Fig. 4 paratype RGM no. 112513. a-c transverse sections, neanic and adult stages, 5 ×.

Fig. 5 *Bradyphyllum oppositum* Fomichev.
Sierra Corisa limestone, coll. R. H. Wagner, loc. 58, RGM no. 112514. a, b, transverse surfaces, neanic and adult stages; c, transverse section, slightly below calyx, 3 ×.

Fig. 6 *Bradyphyllum* (?) sp. no. 1.
Sierra Corisa limestone, coll. R. H. Wagner, loc. 58, RGM no. 112515. a-c transverse sections, late neatic and adult stages, 3 ×.

Fig. 7 *Bradyphyllum* (?) sp. no. 2.
Sierra Corisa limestone, coll. R. H. Wagner, loc. 58, RGM no. 112516. a, b, transverse sections, neanic and adult stages. a 5 ×; b 3 ×.

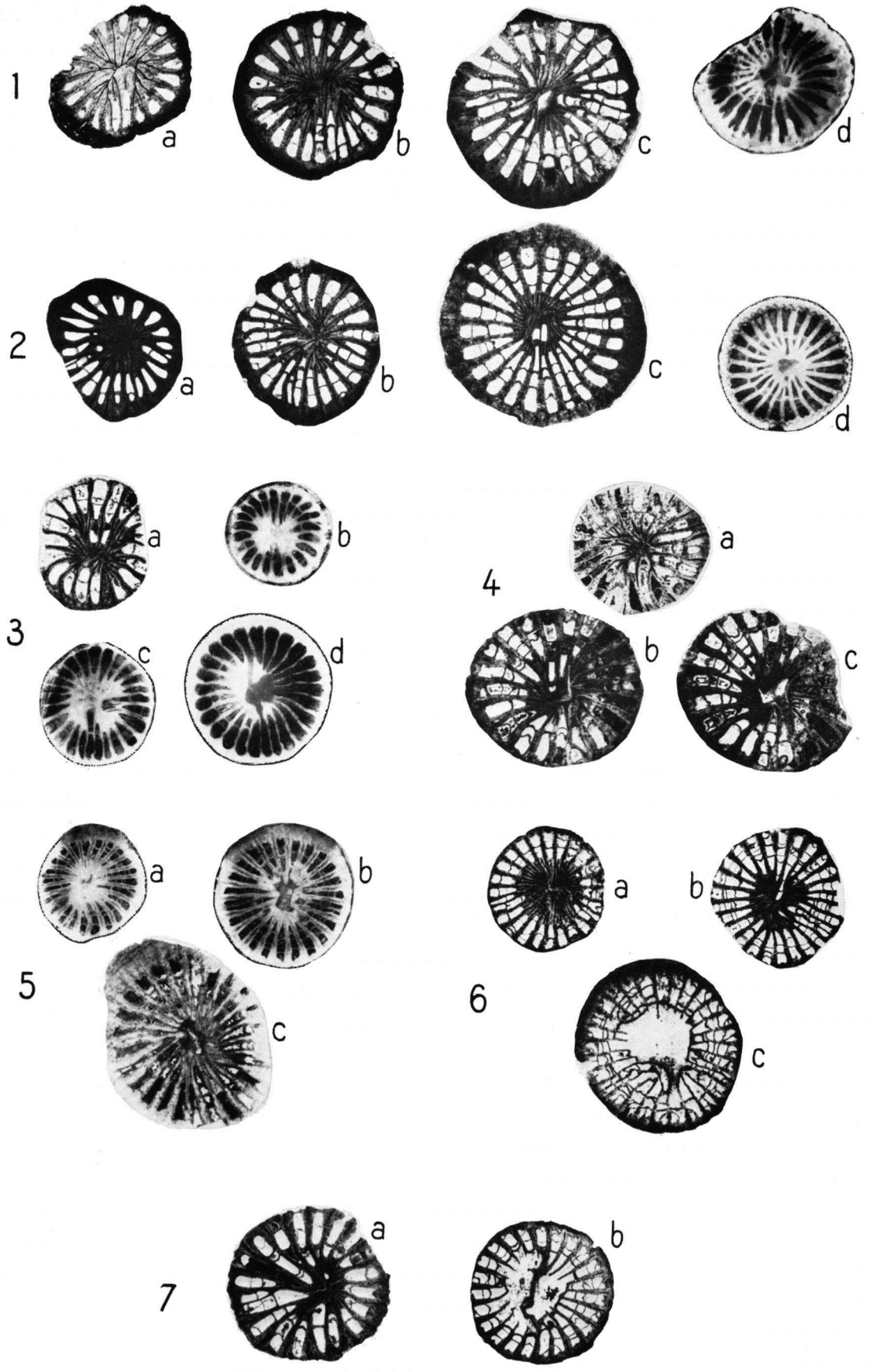
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PLATE 2

Figs. 1—3 *Amplexocarinia wagneri* spec. nov.
Sierra Corisa limestone, coll. R. H. Wagner, loc. 58.
Fig. 1 holotype RGM no. 112517. a, transverse section; b, longitudinal section, 3 ×.
Fig. 2 RGM no. 112522, specimen with strong peripheral stereozone. a, b, transverse sections, a, taken along tabular plane, 3 ×.
Fig. 3 RGM no. 112530 aberrant form, transverse section, 5 ×.

Fig. 4 *Polycoelia cantabrica* spec. nov.
Diablo limestone breccia, coll. M. M. Fischer, loc. 80, holotype RGM no. 112531. a, b, transverse surfaces, late neanic and adult stages, 5 ×; c, transverse section, adult stage, 3 ×.

Figs. 5, 6 *Sochkineophyllum corisense* spec. nov.
Sierra Corisa limestone, coll. A. Breimer.
Fig. 5 holotype RGM no. 112532. a, b, transverse sections, neanic and adult stages. a 5 ×; b 3 ×.
Fig. 6 paratype RGM no. 112533, transverse surface, adult stage, 3 ×.

Figs. 7—10 *Plerophyllum* (*Ufimia*) *alternans* spec. nov.
Fig. 7 holotype RGM no. 112535, Sierra Corisa limestone, coll. C. H. T. Wagner-Gentis, loc. 72. a-d transverse sections, neanic and adult stages. a, b 5 ×; c, d 3 ×.
Fig. 8 paratype RGM no. 112536, same locality as preceding, transverse section, neanic stage, 5 ×.
Fig. 9 paratype RGM no. 112538, limestone between Perniana and Por si acaso coal-seams, coll. M. H. Nederlof, loc. 17. a, b, transverse sections, adult stage, 3 ×.
Fig. 10 paratype RGM no. 112539, same locality as preceding, transverse section, early adult stage, 3 ×.

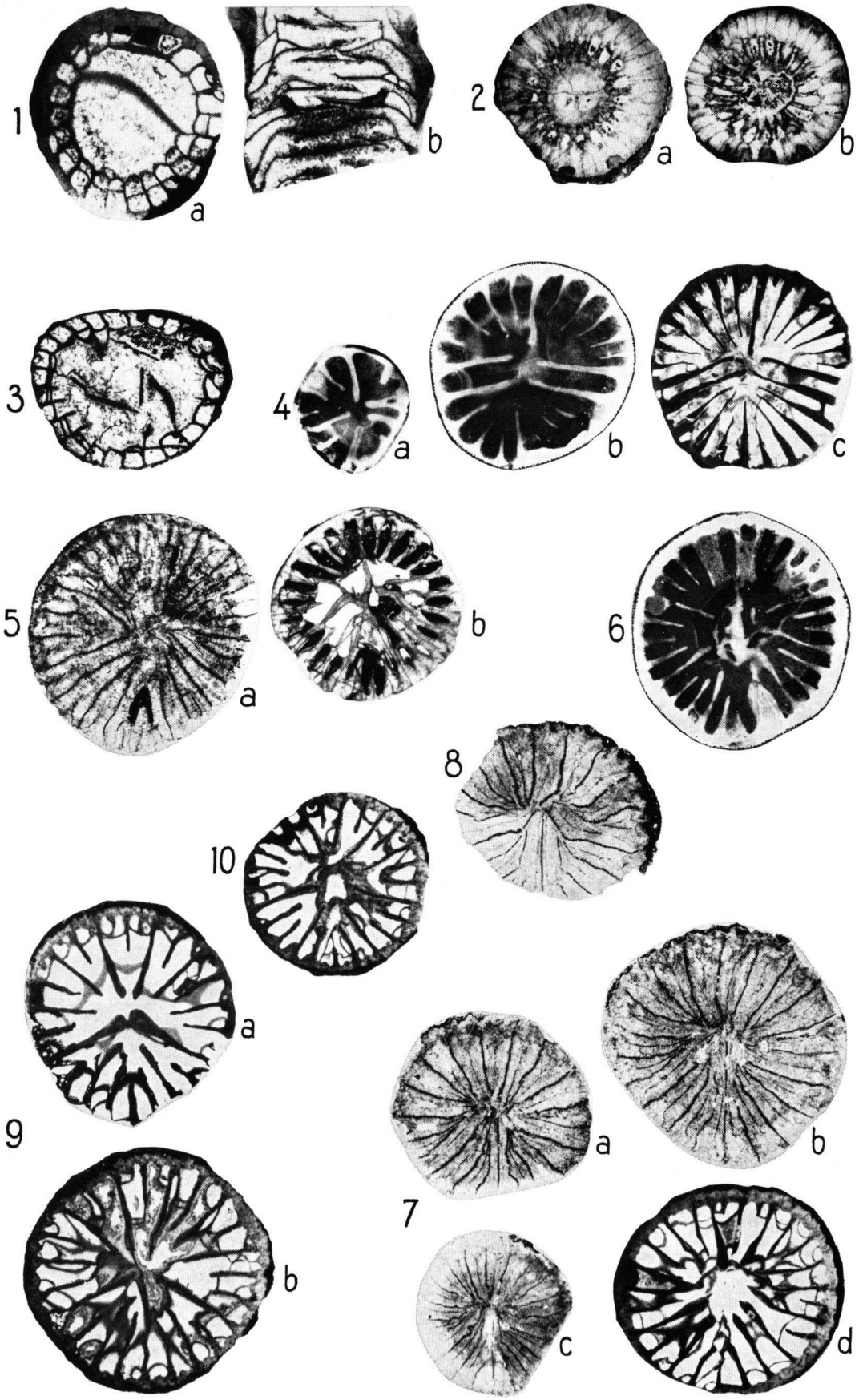
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PLATE 3

Figs. 1, 2 *Cyathaxonia cornu* Michelin var. *cantabrica.*
Fig. 1 RGM no. 112540, Perapertú formation, coll. R. H. Wagner, loc. 31, transverse section, showing septa with "carinae", 5 ×.
Fig. 2 RGM no. 112542, Vañes formation, coll. C. H. T. Wagner-Gentis, loc. 38, transverse section, 5 ×.

Fig. 3 *Cyathaxonia* aff. *cornu* Michelin.
Perapertú formation, coll. C. H. T. Wagner-Gentis, loc. 84, RGM no. 112544 transverse section, 5 ×.

Figs. 4, 5 *Cyathaxonia corisensis* spec. nov.
Sierra Corisa limestone.
Fig. 4 holotype RGM no. 112545, coll. C. H. T. Wagner-Gentis, loc. 74, transverse section, 5 ×.
Fig. 5 paratype RGM no. 112549, coll. G. E. de Groot, loc. 102, transverse section, 5 ×.

Fig. 6 *Cyathaxonia* sp. no. 2.
Sierra Corisa limestone, coll. R. H. Wagner, loc. 69, RGM no. 112552, transverse section, 5 ×.

Figs. 7—9 *Lophophyllidium breimeri* spec. nov.
Sierra Corisa limestone, coll. A. Breimer.
Fig. 7 holotype RGM no. 112553. a-d transverse sections, neanic to adult stages; e, transverse surface, calyx region. a-c 5 ×; d, e 3 ×.
Fig. 8 paratype RGM no. 112557. a, b, transverse sections, late neanic and adult stages, 3 ×.
Fig. 9 paratype RGM no. 112558, transverse section, adult stage, 3 ×.

Fig. 10 *Lophophyllidium minus* spec. nov.
Shales below Sierra Corisa limestone, coll. C. H. T. Wagner-Gentis, loc. 71, holotype RGM no. 112562. a, b, transverse sections, neanic stages, 5 ×; c, transverse surface, calyx region, 3 ×.

Fig. 11 *Stereostylus* sp.
Limestone between Perniana and Por si acaso coal-seams, coll. M. H. Nederlof, loc. 17, RGM no. 112568. a-c transverse sections, neanic stage to calyx region, 5 ×.

Fig. 12 *Stereostylus* (?) sp. ex gr. *newelli* (Jeffords).
Verdiana limestone, coll. R. H. Wagner, loc. 75, RGM no. 112569. a, b, transverse sections, adult stages, 5 ×.

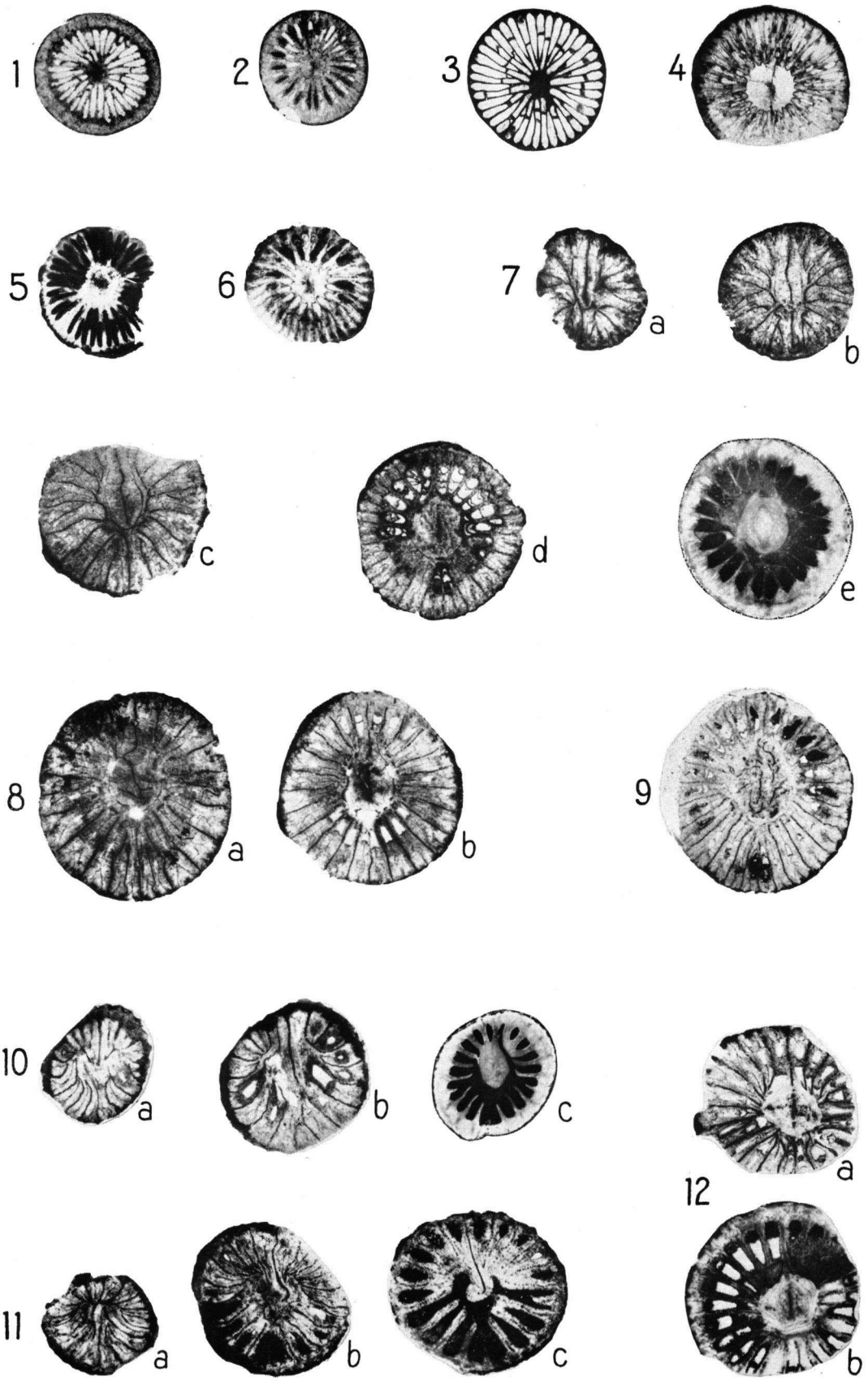
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PLATE 4

Figs. 1—5 *Zaphrentites paralleloides* spec. nov.
Sierra Corisa limestone.
Fig. 1 holotype RGM no. 112570, coll. G. E. de Groot, loc. 102. a-d transverse surfaces, neanic stage to calyx region, 5 ×.
Fig. 2 paratype RGM no. 112571, same locality as preceding. a, b, transverse sections, adult stages, 5 ×.
Fig. 3 paratype RGM no. 112576, coll. C. H. T. Wagner-Gentis, loc. 74, transverse section, late neanic stage, 5 ×.
Fig. 4 paratype RGM no. 112577, same locality as preceding, transverse section, late neanic stage, 5 ×.
Fig. 5 paratype RGM no. 112575, coll. G. E. de Groot, loc. 103. a, b, transverse sections, neanic stages, 5 ×.

Figs. 6, 7 *Zaphrentites clithria* spec. nov.
Sierra Corisa limestone.
Fig. 6 holotype RGM no. 112580, coll. G. E. de Groot, loc. 102. a, b, transverse sections, neanic and adult stages, 5 ×.
Fig. 7 paratype RGM no. 112581, coll. C. H. T. Wagner-Gentis, loc. 74, transverse section, near base of calyx, 3 ×.

Fig. 8 *Duplophyllum*? sp.
Perapertú formation, coll. A. Breimer, Rabanal, RGM no. 112584, transverse section, 5 ×.

Figs. 9—11 *Euryphyllum hispanicum* spec. nov.
Sierra Corisa limestone.
Fig. 9 holotype RGM no. 112585, coll. R. H. Wagner, loc. 69. a, b, transverse sections, late neanic and adult stages, 3 ×.
Fig. 10 paratype RGM no. 112586, same locality as preceding. a, b, transverse sections, neanic stages, 5 ×; c, transverse surface, adult stage, 3 ×.
Fig. 11 paratype RGM no. 112587, coll. A. Breimer, transverse surface, adult stage, 3 ×.

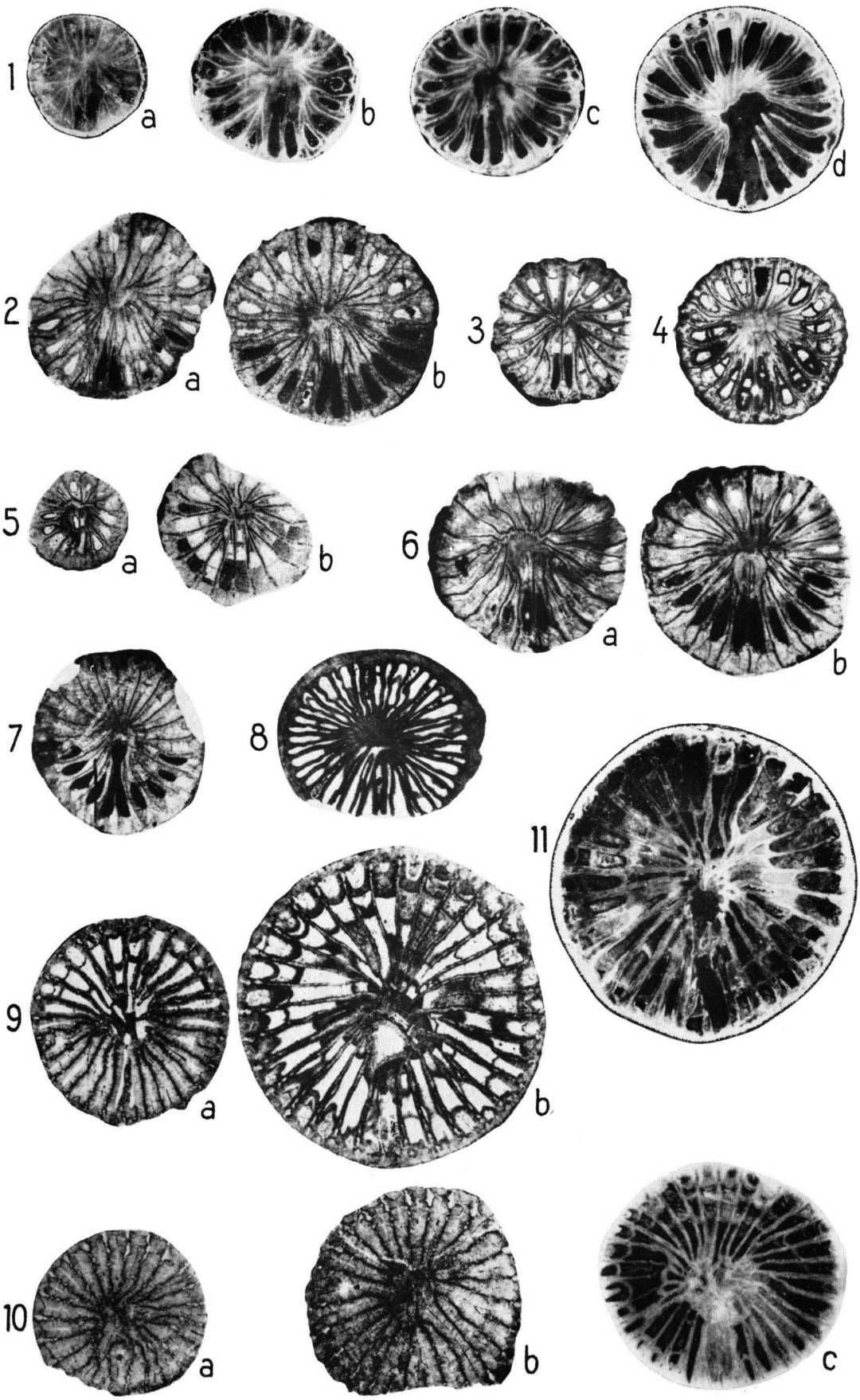
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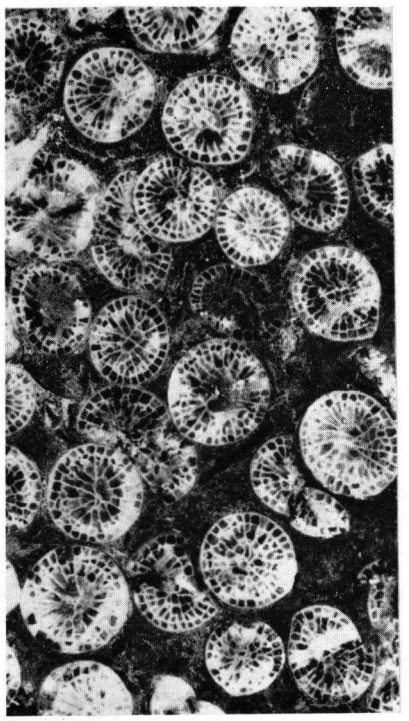
PLATE 5

Figs. 1, 2 *Lithostrotion reticulatum* (Fomichev).
Fig. 1 RGM no. 112589. Perapertú formation, coll. A. Breimer, Rabanal. a, transverse surface; b, longitudinal section, showing interrupted columella; c, longitudinal section, showing persistent columella.
Fig. 2 RGM no. 112598. Vañes formation, coll. C. H. T. Wagner-Gentis, loc. 59. a, transverse section, showing several diphyphylloid corallites; b, c, longitudinal sections.

All figures three times natural size.



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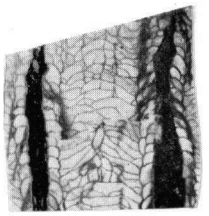

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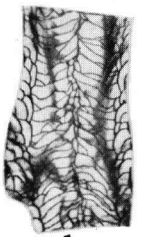

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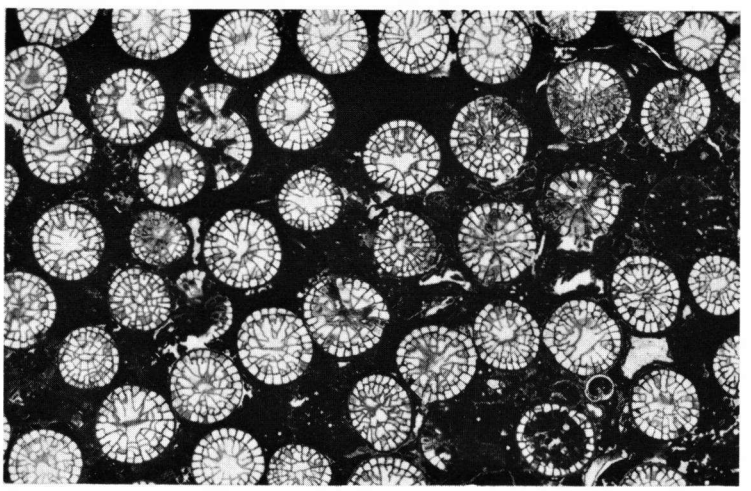

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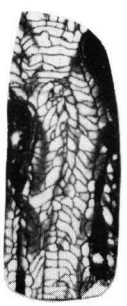

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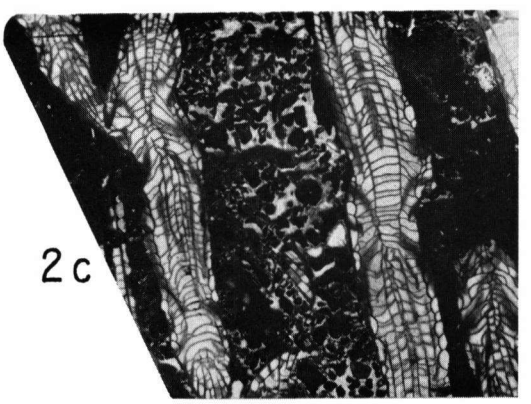

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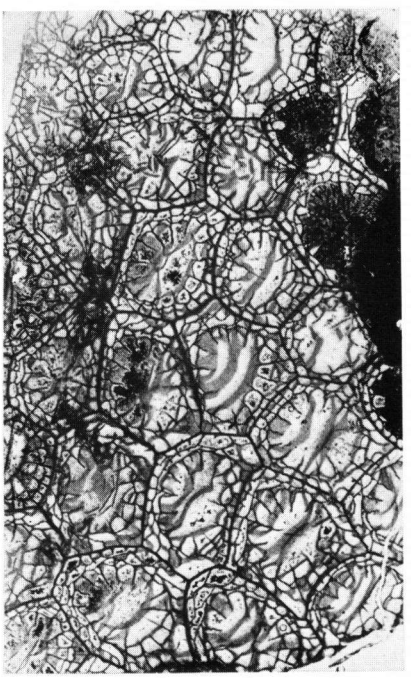
PLATE 6

Figs. 1, 2 *Lithostrotion* [*Stylastraea*] [*Thysanophyllum*] *trimorphum* spec. nov.
Perapertú formation, coll. R. H. Wagner, loc. 35.
Fig. 1 *Lithostrotion trimorphum* spec. nov., holotype RGM no. 112599. a, transverse section; b, longitudinal section of parent corallite with offset, showing locally diphyphylloid development.
Fig. 2 *Stylastraea* [*Thysanophyllum*] *trimorpha* spec. nov., RGM no. 112600. a, b, transverse sections; c, longitudinal section of parent corallite with offset, showing discontinuous columella.

All figures three times natural size.



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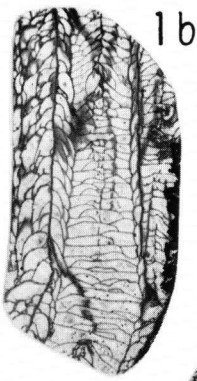

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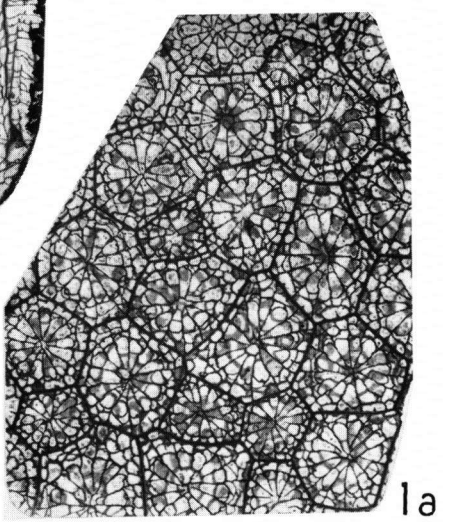

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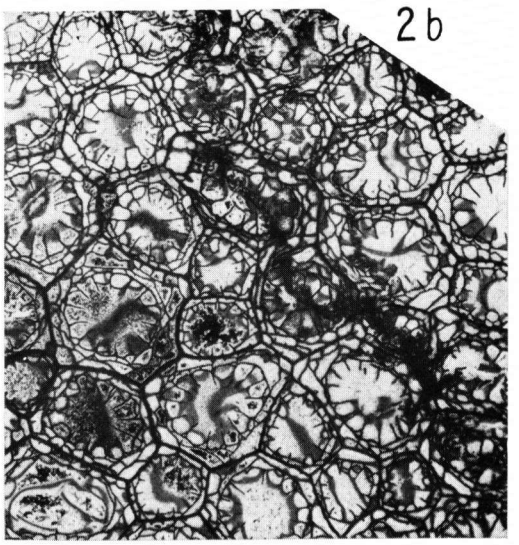

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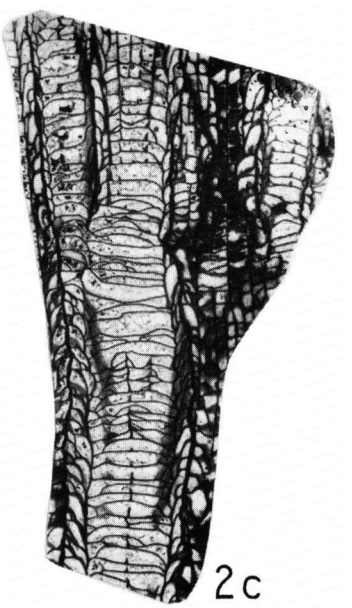

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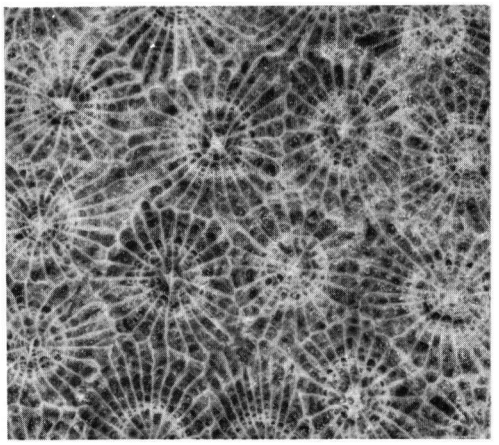
PLATE 7

Figs. 1—3 *Arachnastraea molli* (Stuck) var. *delicata*.
Fig. 1 RGM no. 112601, Celada limestone, coll. G. E. de Groot, loc. 28. a, transverse section; b, c, longitudinal sections.
Fig. 2 RGM no. 112606, Cotarraso limestone, coll. R. H. Wagner, loc. 65, transverse surface.
Fig. 3 RGM no. 112608, Peña Tejedo limestone, coll. M. H. Nederlof, loc. 22. a, transverse section; b, longitudinal section.

Fig. 4 *Arachnastraea molli* (Stuck.) *dilatata* subsp. nov.
Fig. 4 holotype RGM no. 112609, Vañes formation, coll. C. H. T. Wagner-Gentis, loc. 59. a, transverse surface; b, longitudinal section.

All figures three times natural size.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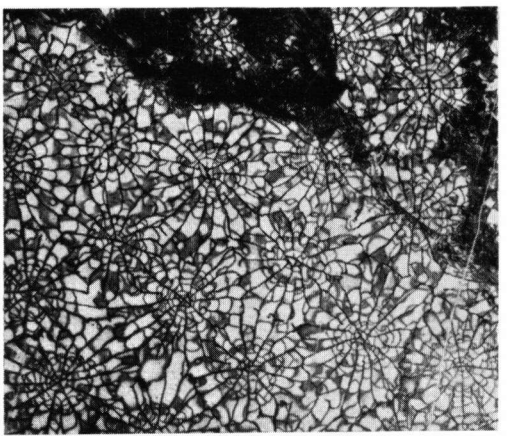
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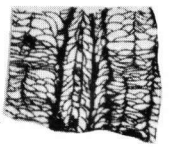
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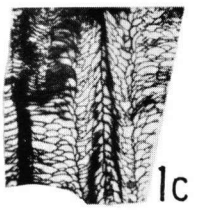
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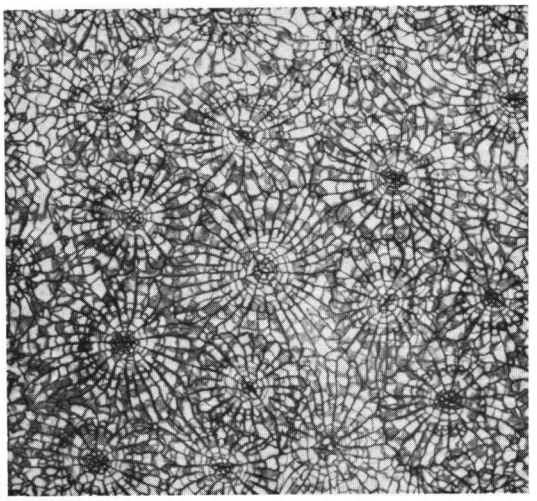
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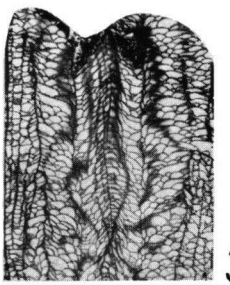
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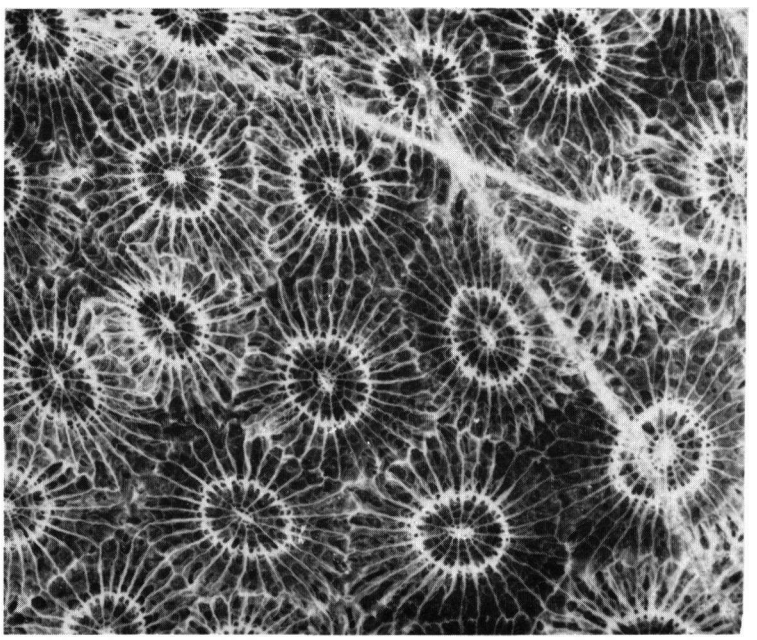
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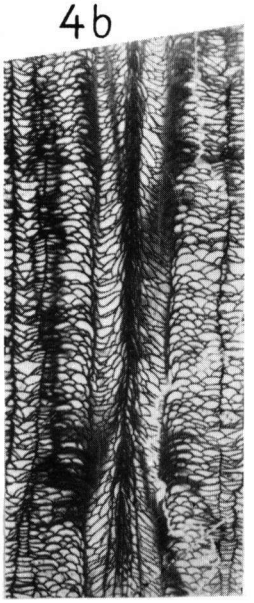
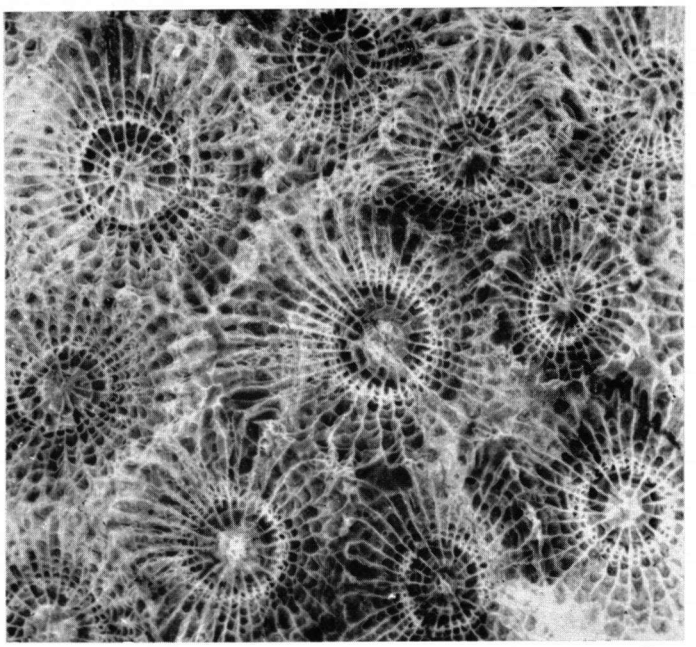


PLATE 8

Figs. 1, 2 *Arachnastraea molli* (Stuck.) *dilatata* subsp. nov.
Fig. 1 paratype RGM no. 112610, Vañes formation, coll. C. H. T. Wagner-Gentis, loc. 54, transverse surface, taken at the edge of the corallum.
Fig. 2 paratype RGM no. 112615, limestone outcrop NW of Cotarraso, coll. R. H. Wagner, loc. 66, transverse section.

Figs. 3, 4 *Arachnastraea orboensis* spec. nov.
Orbó limestone, coll. R. H. Wagner, loc. 105.
Fig. 3 holotype RGM no. 112618. a, transverse surface; b, transverse section.
Fig. 4 paratype RGM no. 112619, longitudinal section.

All figures three times natural size.



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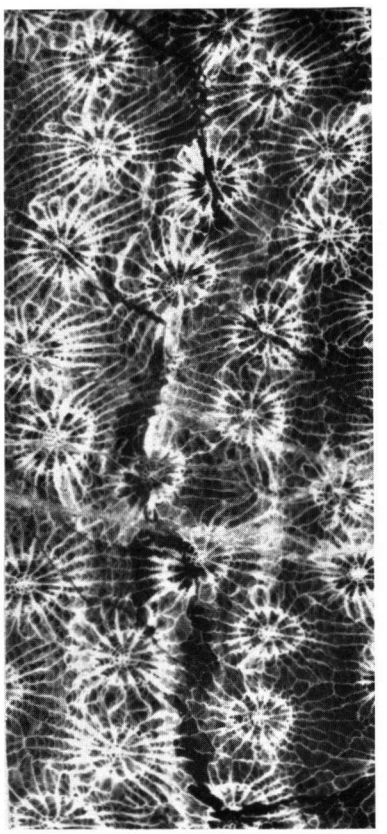

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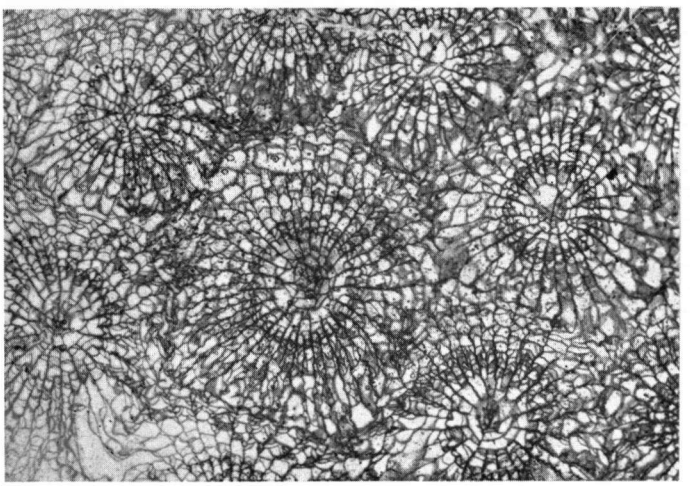

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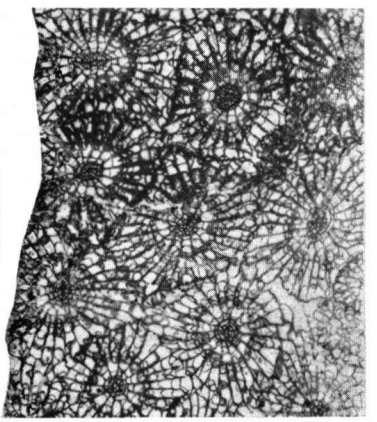

PLATE 9

Fig. 1 *Clisiophyllum* sp. no. 1.
Perapertú formation, coll. R. H. Wagner, loc. 39, RGM no. 112620. a-d transverse surfaces and e, transverse section, showing changes in the structure of the axial column, natural size.

Fig. 2 *Clisiophyllum* sp. no. 2.
Orbó limestone, coll. R. H. Wagner, loc. 105, RGM no. 112621. a, transverse section; b, longitudinal section, 3 ×.

Figs. 3, 4 *Dibunophyllum* sp.
Fig. 3 RGM no. 112622, Santa María limestone, coll. R. H. Wagner, loc. 21. a, b, transverse sections, showing "disappearance" of major septa and changes in the development of the axial column, a 3 ×, b 2 ×; c, longitudinal section, 2 ×.
Fig. 4 RGM no. 112623. Perapertú formation, coll. R. H. Wagner, loc. 43, longitudinal section, 2 ×.

Figs. 5—7 *Koninckophyllum multilamellatum* spec. nov.
Perapertú formation, coll. R. H. Wagner, loc. 44.
Fig. 5 holotype RGM no. 112624. a-c transverse surfaces, neanic and adult stages, a, b 3 ×, c 2 ×; d, longitudinal section, showing degeneration of axial column, 2 ×.
Fig. 6 paratype RGM no. 112625, transverse section, 3 ×.
Fig. 7 paratype RGM no. 112628. a, distal surface of halved fragment, showing a fairly completely developed axial column; b, longitudinal surface of the fragment, showing regeneration of axial column in the distal, slightly conical part; c, proximal surface of the fragment, showing a degenerate axial column, 2 ×.

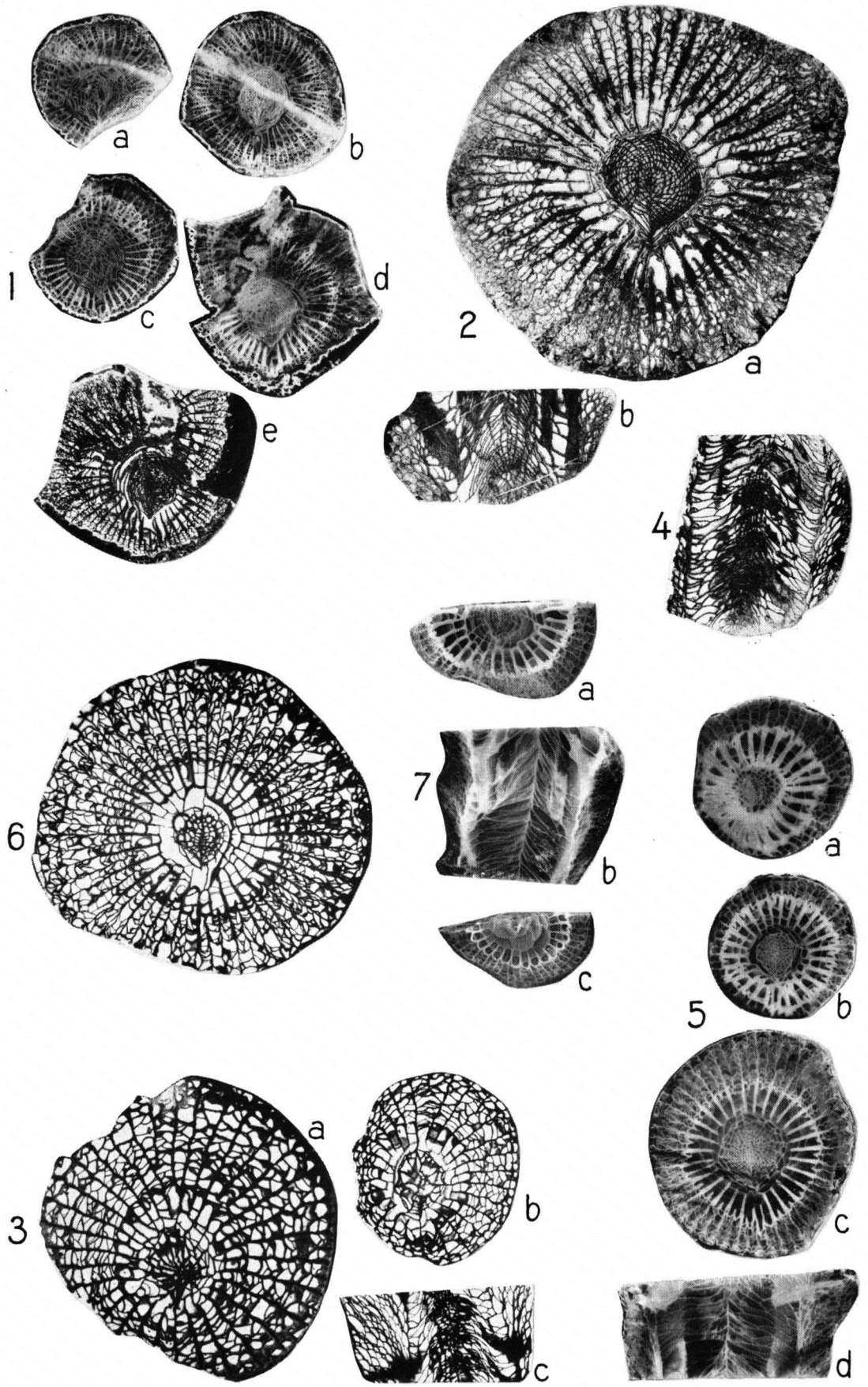
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PLATE 10

Fig. 1 *Koninckophyllum multilamellatum* spec. nov.
Perapertú formation, coll. C. H. T. Wagner-Gentis, loc. 75, paratype RGM no. 112634. a, transverse surface; b, longitudinal surface, 2 ×.

Figs. 2—3 *Koninckophyllum gentisae* spec. nov.
Vañes formation, coll. C. H. T. Wagner-Gentis, loc. 54.
Fig. 2 holotype RGM no. 112640. a, transverse surface, late neanic stage, 2 ×; b, transverse section, 3 ×; c, transverse surface, adult stage, during rejuvenation, 1½ ×.
Fig. 3 paratype RGM no. 112641. a, transverse section, late neanic stage, 3 ×; b, transverse surface, adult stage, 1½ ×; c, longitudinal section, showing koninckophylloid tabularium, 1½ ×.

Figs. 4—7 *Koninckophyllum gentisae* f. *minor*.
Vañes formation.
Fig. 4 RGM no. 112643, coll. C. H. T. Wagner-Gentis, loc. 54. a, b, transverse sections, neanic and adult stages, a 3 ×, b 2 ×; c, longitudinal section, showing inconstant development of axial column, 2 ×.
Fig. 5 RGM no. 112647, same locality as preceding. a-c transverse surfaces, a 3 ×, b, c 2 ×.
Fig. 6 RGM no. 112649, coll. C. H. T. Wagner-Gentis, loc. 56. a, transverse section, adult stage; b, longitudinal section, 3 ×.
Fig. 7 RGM no. 112650, coll. C. H. T. Wagner-Gentis, loc. 55, transverse section, 2 ×.

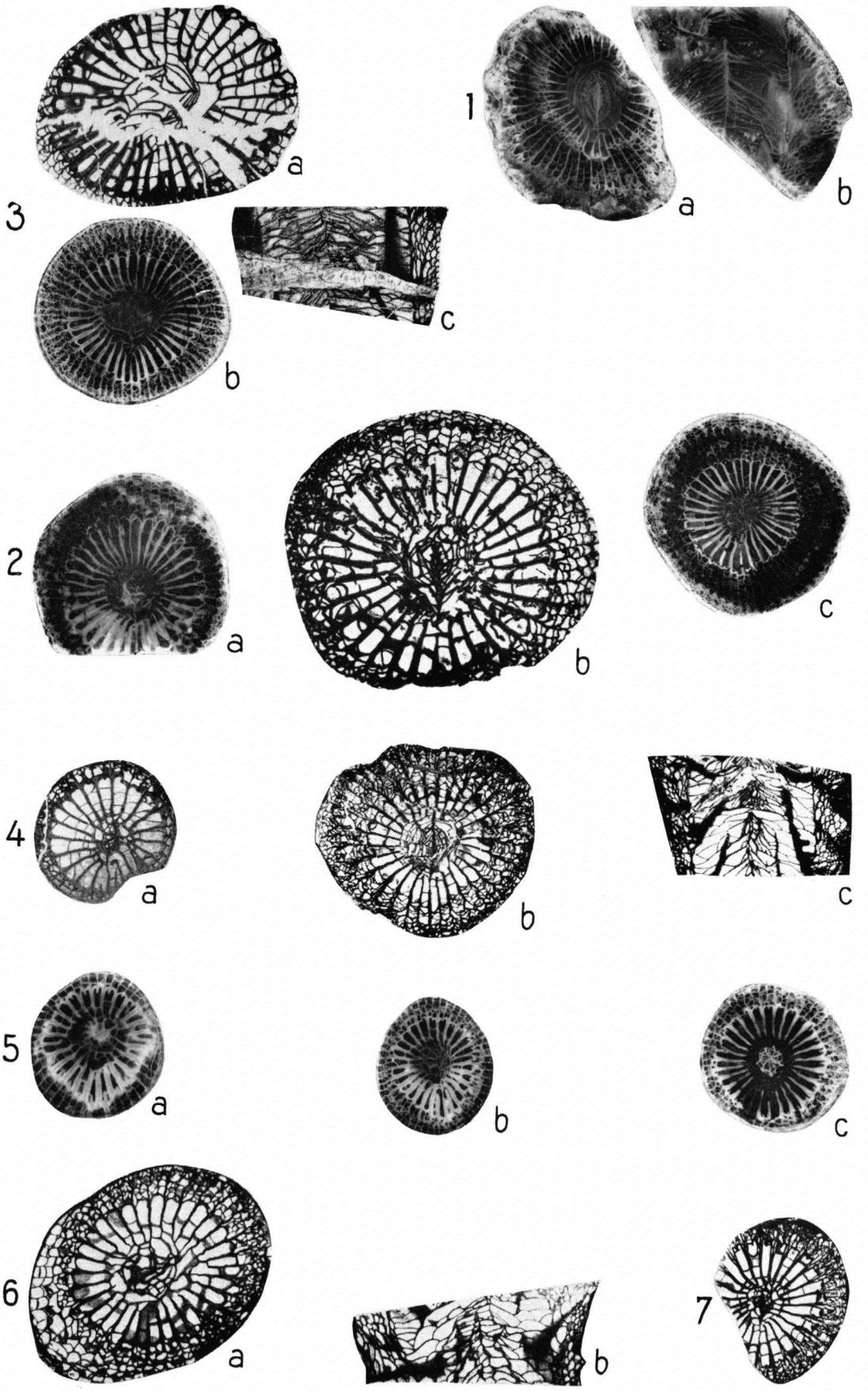
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PLATE 11

Figs. 1—4 *Koninckophyllum histiophylloides* spec. nov.

Fig. 1 holotype RGM no. 112652, Sierra Corisa limestone, coll. R. H. Wagner, loc. 58. a, transverse surface, late neanic stage, 3 ×; b, c, transverse sections, adult stages, 1½ ×; d, e, longitudinal sections, showing changes in development of axial structure, 1½ ×.

Fig. 2 paratype RGM no. 112653, same locality as preceding. a, transverse surface, middle neanic stage, 3 ×; b, c, transverse sections, late neanic to early adult stages, 2 ×; d, transverse surface, adult stage, 2 ×; e, longitudinal section, 2 ×.

Fig. 3 paratype RGM no. 112655, Sierra Corisa limestone, coll. G. E. de Groot, loc. 102, transverse section, late neanic stage, 3 ×.

Fig. 4 paratype RGM no. 112657, Celada limestone, coll. M. H. Nederlof, loc. 20. a, b, transverse sections, adult stages, a 2 ×, b 1½ ×; c, longitudinal section, 2 ×.

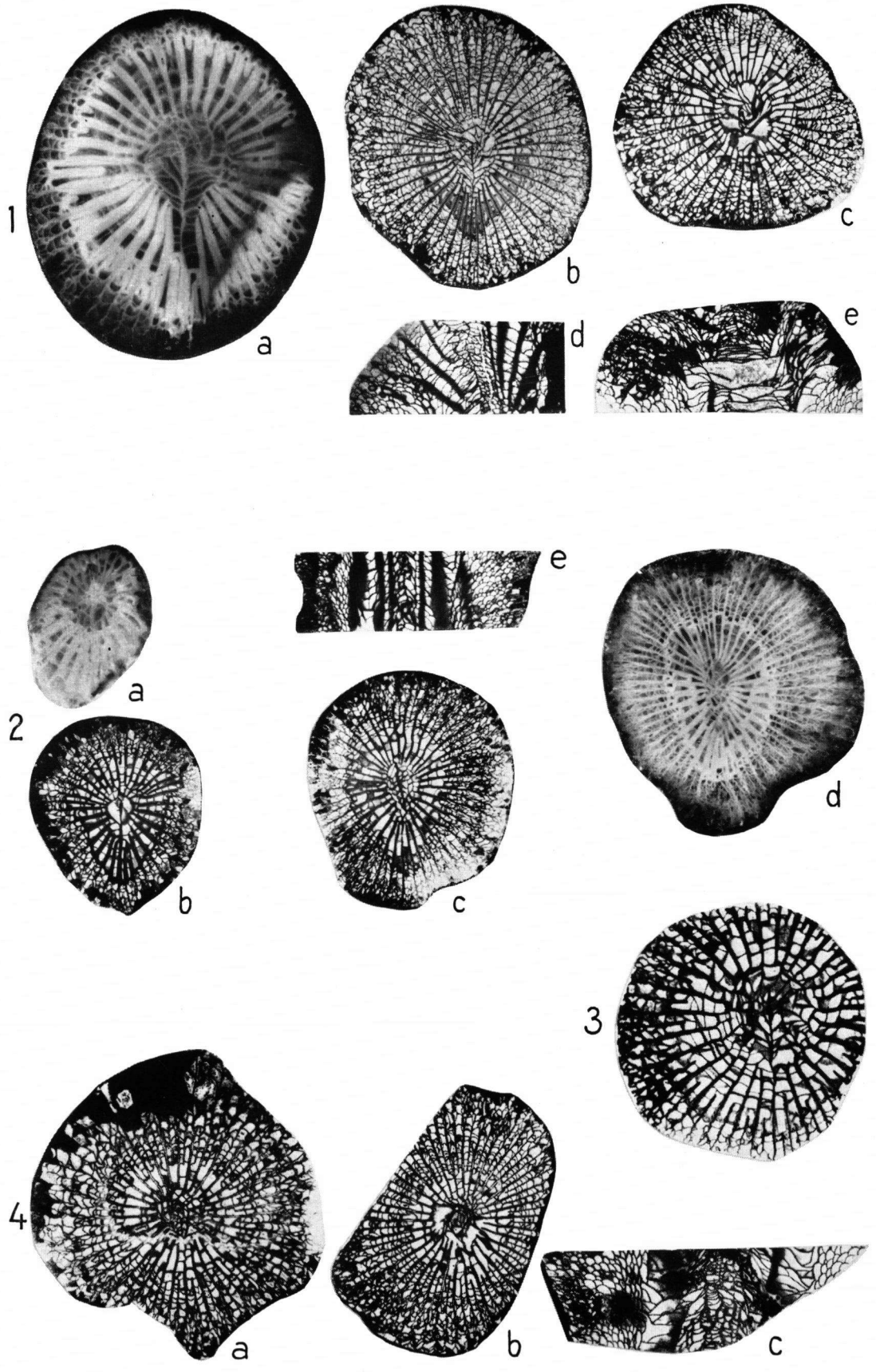
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PLATE 12

Figs. 1—3 *Corwenia symmetrica* (Dobrolyubova).
Limestone outcrop NE of Cotarraso, coll. R. H. Wagner, loc. 72.
Fig. 1 RGM no. 112658. a, transverse surface; b, transverse sections.
Fig. 2 RGM no. 112659, external view of corallum-fragment, showing fasciculate form, natural size.
Fig. 3 RGM no. 112660, longitudinal peel section.

Figs. 4—9 *Corwenia longiseptata* (Fomichev).
Vañes formation, coll. C. H. T. Wagner-Gentis, loc. 54.
Fig. 4 RGM no. 112663, transverse section.
Fig. 5 RGM no. 112665, transverse surface.
Fig. 6 RGM no. 112666. a, b, transverse sections.
Fig. 7 RGM no. 112670, transverse surface of offset.
Fig. 8 RGM no. 112667, longitudinal section, taken at alar plane.
Fig. 9 RGM no. 112676, longitudinal section, taken at countercardinal plane.

Fig. 10 *Corwenia cantabrica* spec. nov.
Limestone outcrop NW of Cotarraso, coll. R. H. Wagner, loc. 66, holotype RGM no. 112678. a, transverse surface; b, transverse section, showing several offsets; c, longitudinal section.

Except fig. 2, all figures three times natural size.

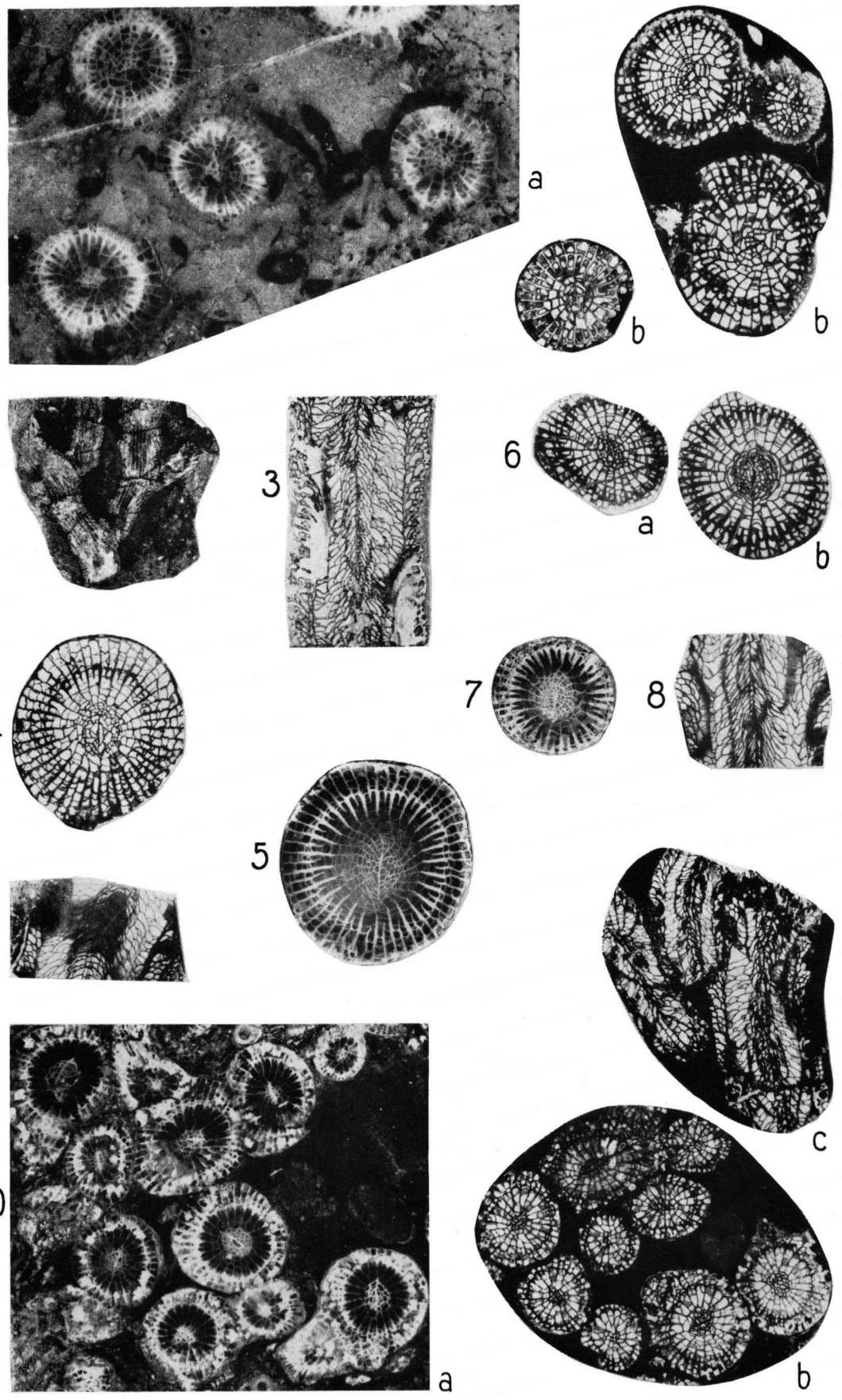
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PLATE 13

Figs. 1—5 *Pseudozaphrentoides rabanaliensis* spec. nov.
Perapertú formation, coll. A. Breimer, Rabanal de los Caballeros.
Fig. 1 holotype RGM no. 112679. a-d transverse surfaces, late neanic to adult stages. a, b 2 ×; c 1½ ×; d natural size.
Fig. 2 paratype RGM no. 112684. a-c transverse surfaces, neanic to adult stages. a 3 ×; b, c natural size.
Fig. 3 paratype RGM no. 112688. a, transverse surface, adult stage; b, longitudinal surface, natural size.
Fig. 4 paratype RGM no. 112701. a, transverse surface, neanic stage, 2 ×; b, transverse section, late neanic stage, 1½ ×; c, transverse surface, early adult stage, 1½ ×.
Fig. 5 paratype RGM no. 112703. a-c transverse surfaces, neanic to late neanic stages, a 3 ×, b, c 2 ×; d, transverse section, late neanic stage, 1½ ×.

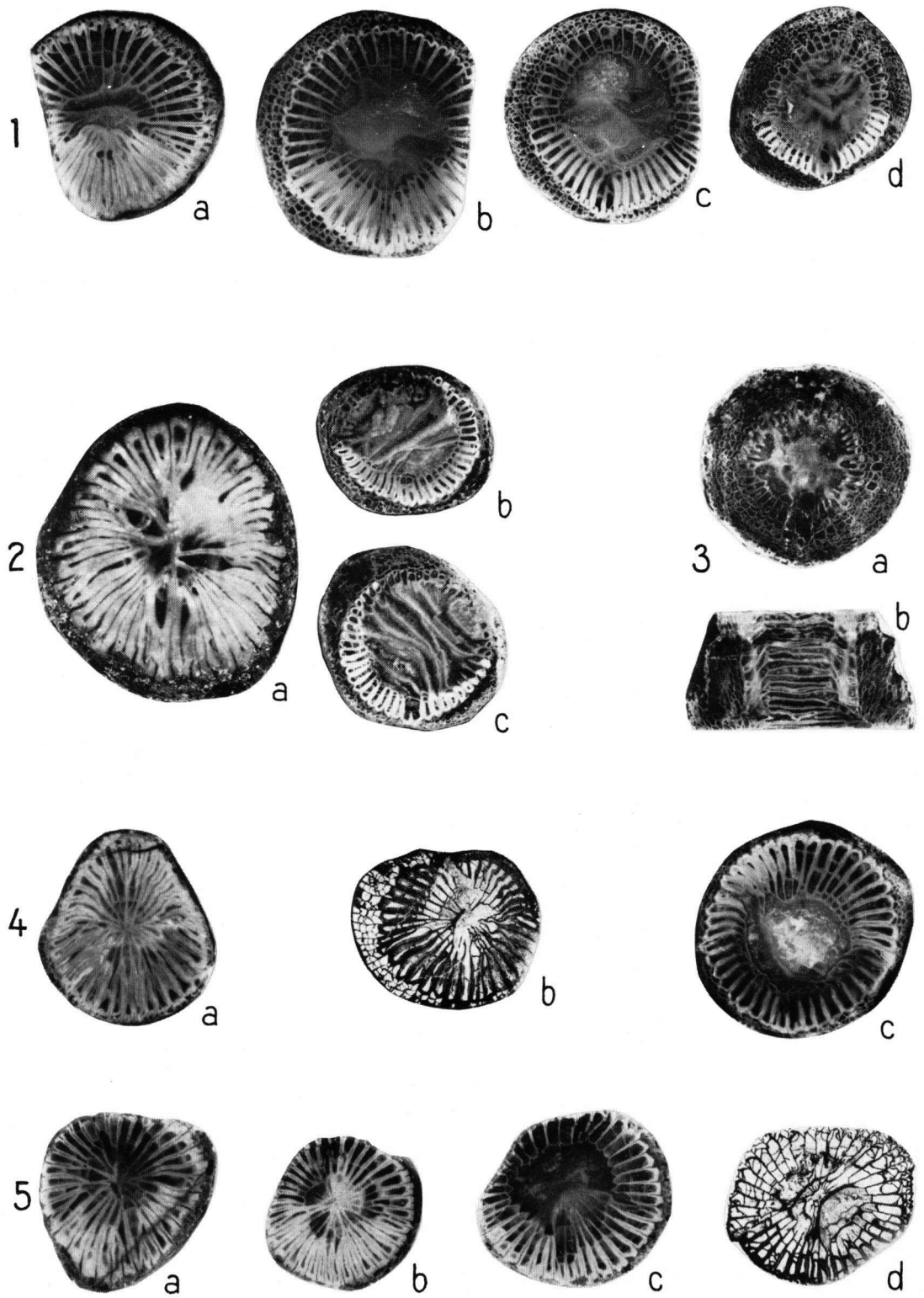
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PLATE 14

Figs. 1, 2 *Pseudozaphrentoides rabanaliensis* spec. nov.
Perapertú formation, Rabanal de los Caballeros.
Fig. 1 paratype RGM no. 112680, coll. G. E. de Groot. a, b, transverse surfaces, neanic and late neanic stages, a 2 ×, b 1½ ×; c, transverse section, early adult stage, natural size; d, transverse section, adult stage, natural size.
Fig. 2 paratype RGM no. 112710, coll. A. Breimer. a-c transverse surfaces, late neanic to adult stages. a 1½ ×; b, c natural size.

Fig. 3 *Bothrophyllum* cf. *pseudoconicum* Dobrolyubova.
Sierra Corisa limestone, coll. G. E. de Groot, loc. 160, RGM no. 112717. a-c transverse surfaces, neanic to adult stages, a 3 ×, b 2 ×, c 1½ ×; d, longitudinal surface, showing interrupted axial structure, 1 ½ ×.

Fig. 4 *Bothrophyllum*? sp.
Sierra Corisa limestone, coll. C. H. T. Wagner-Gentis, loc. 74,
RGM no. 112718. a-c transverse surfaces, adult stages; d, longitudinal surface, 1½ ×.

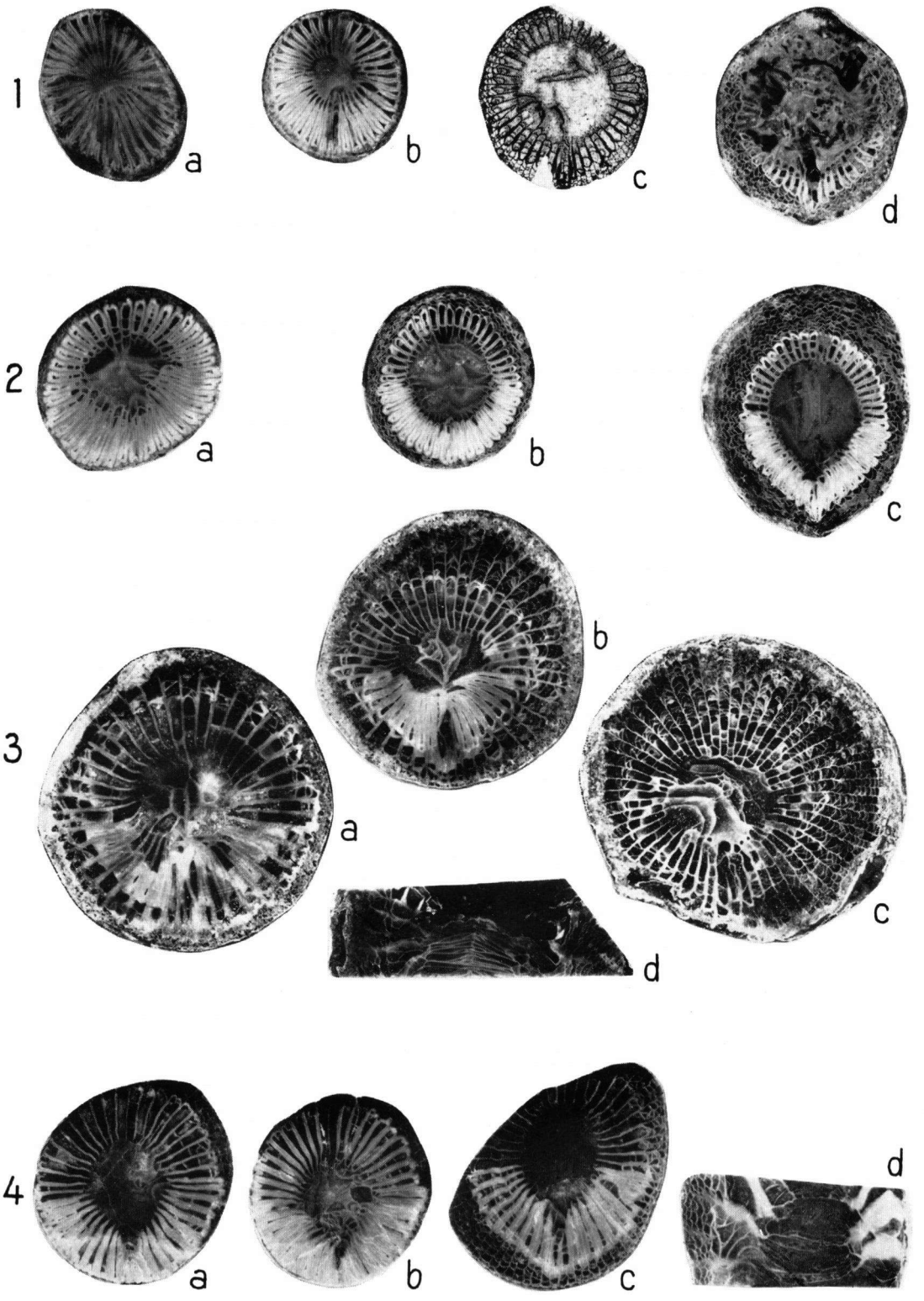
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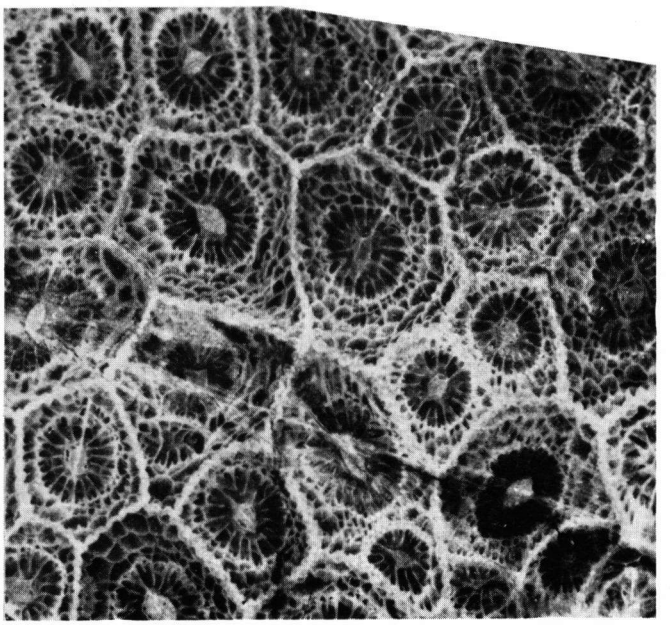
PLATE 15

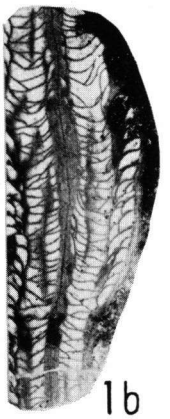
Fig. 1 *Lonsdaleia portlocki* (Stuck.) *densiconus* subsp. nov.
Celada limestone, coll. G. E. de Groot, loc. 29, holotype, RGM no. 112719.
a, transverse surface; b, longitudinal section.

Fig. 2 *Lithostrotionella celadensis* spec. nov.
Celada limestone, coll. J. A. van Hoeflaken, loc. 30, holotype, RGM no. 112720.
a, b, transverse sections; c, d, longitudinal surface and section, showing occasional development of axial tabellae.

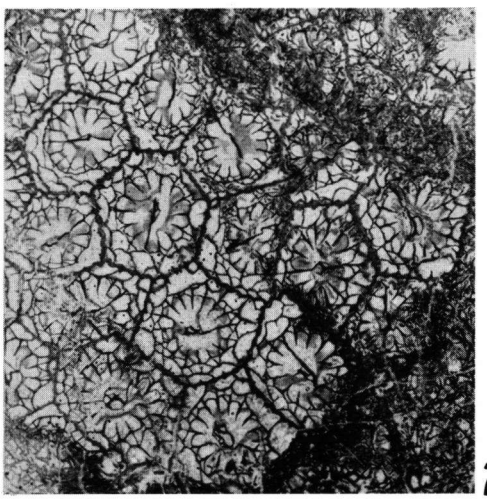
All figures three times natural size.



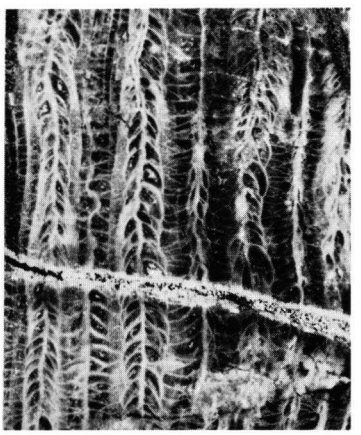
1a



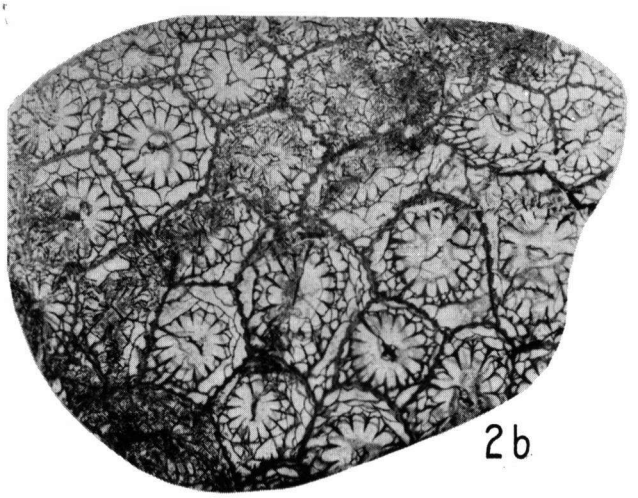
1b



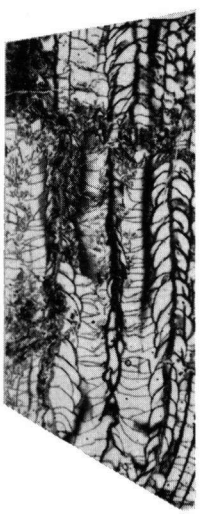
2a



2c



2b



2d

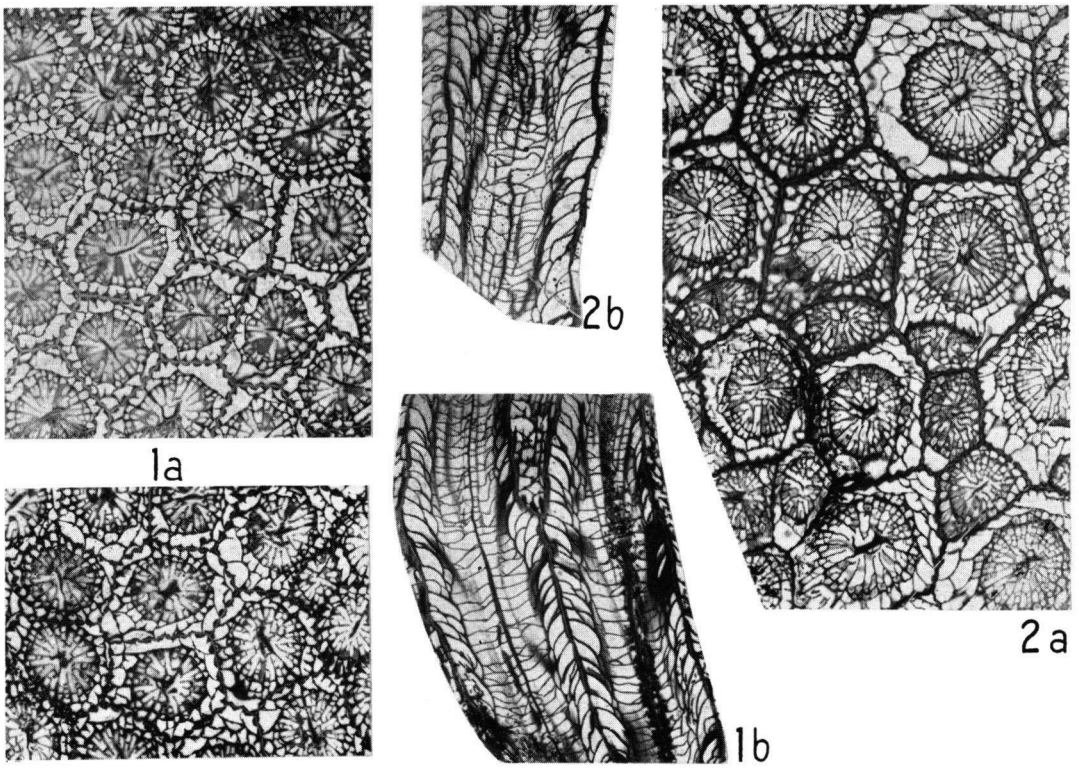
PLATE 16

Fig. 1 *Lithostrotionella maccoyana* (Edwards & Haime).
Vañes formation, coll. C. H. T. Wagner-Gentis, loc. 54, RGM no. 112721.
a, transverse section; b, longitudinal section.

Fig. 2 *Lithostrotionella maccoyana* (Edw. & Haime) f. *major*.
Vañes formation, coll. C. H. T. Wagner-Gentis, loc. 7, RGM no. 112726.
a, transverse section; b, longitudinal section.

Figs. 3, 4 *Lithostrotionella sexangula* spec. nov.
Orbó limestone.
Fig. 3 holotype RGM no. 112727, coll. R. H. Wagner, loc. 23. a, transverse section; b, c, longitudinal sections.
Fig. 4 paratype RGM no. 112728, coll. R. H. Wagner, loc. 140. a, transverse section, showing several corallites with uninterrupted septa; b, longitudinal section.

All figures three times natural size.


1a
2b
1b
2a

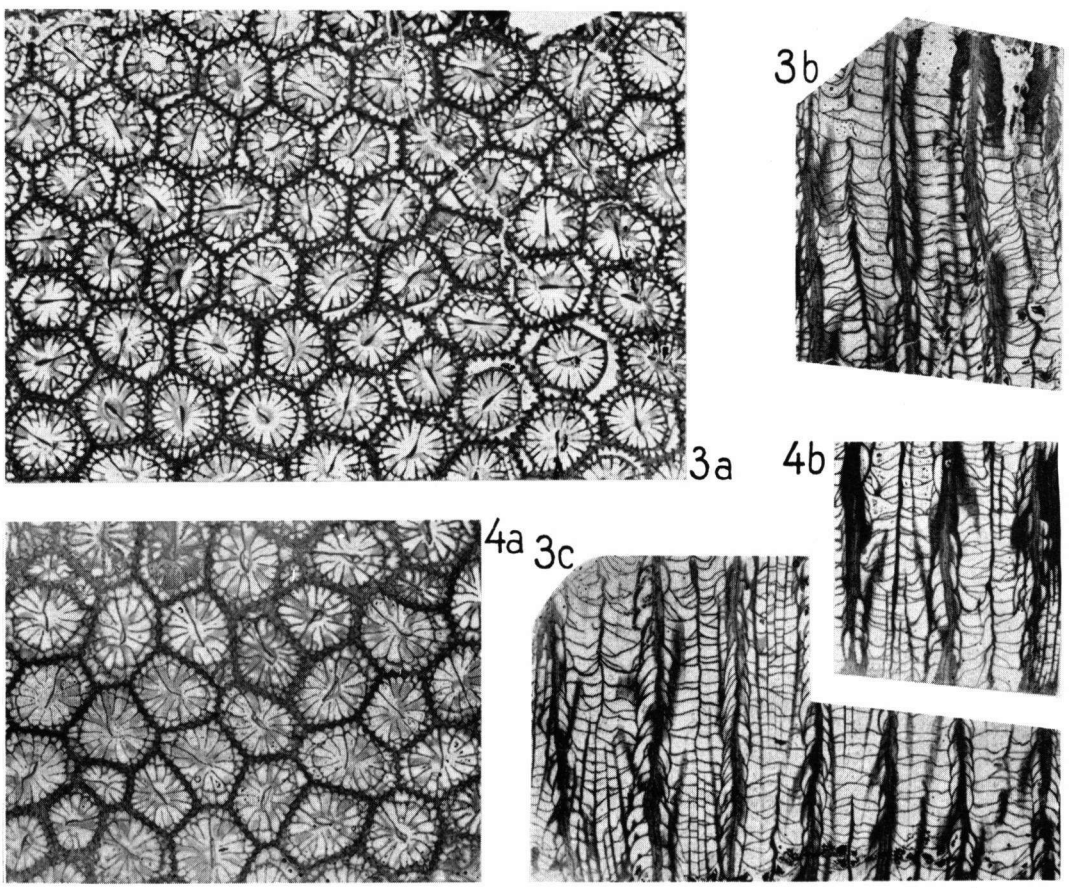
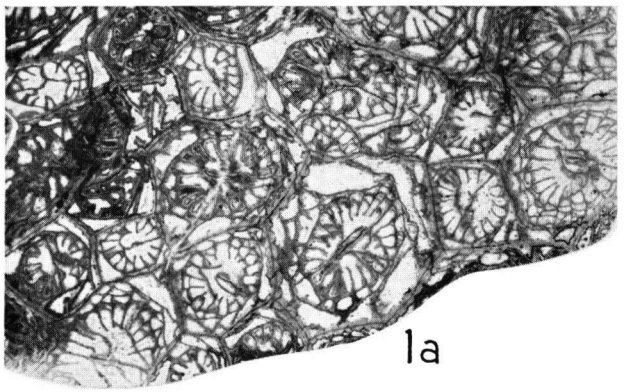

3b
3a
4b
4a
3c

PLATE 17

Fig. 1 *Lithostrotionella monocyclica* spec. nov.
Santa María limestone, coll. R. H. Wagner, loc. 21, holotype RGM no. 112731.
a, b, transverse sections; c, longitudinal section.

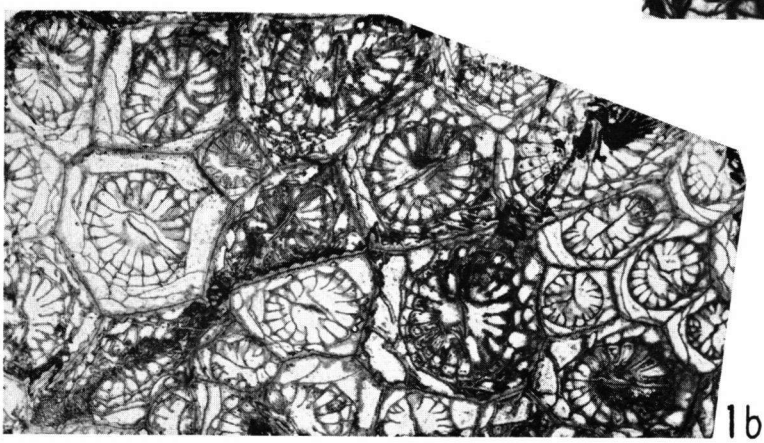
Fig. 2 *Lithostrotionella orboensis* spec. nov.
Orbó limestone, coll. R. H. Wagner, loc. 105, holotype RGM no. 112732.
a, transverse section; b, d, longitudinal sections.

All figures three times natural size.

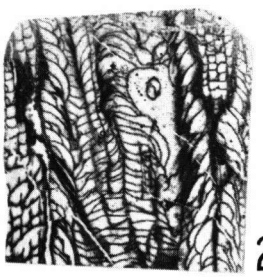


1a

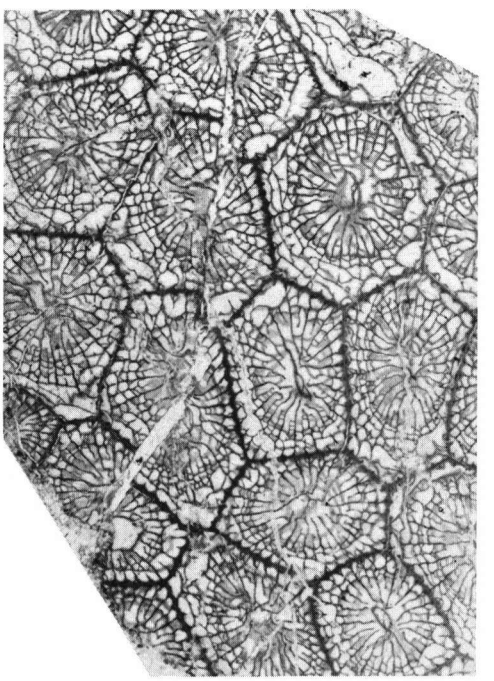
1c



1b



2b



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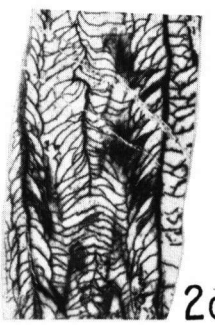
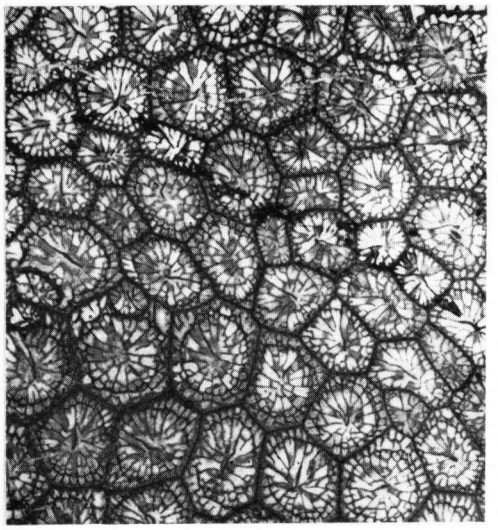


2d

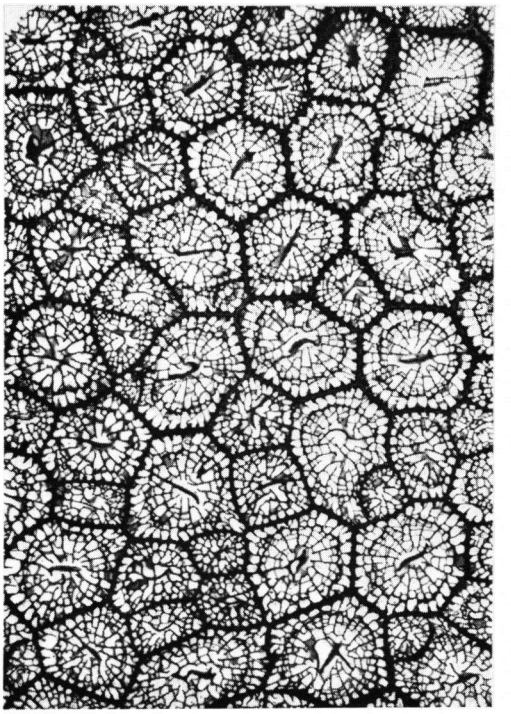
PLATE 18

Figs. 1—3 *Lithostrotionella* (*Hillia*) *wagneri* subgen. et spec. nov.
Perapertú formation.
Fig. 1 holotype RGM no. 112734, coll. R. H. Wagner, loc. 35. a, transverse section; b, c, longitudinal sections.
Fig. 2 paratype RGM no. 112742, coll. R. H. Wagner, loc. 47, transverse section.
Fig. 3 RGM no. 112738, in which dissepiments are sparsely developed, coll. R. H. Wagner, loc. 35. a, transverse section, showing corallite(s) in which two columellae are observed; b, longitudinal section.

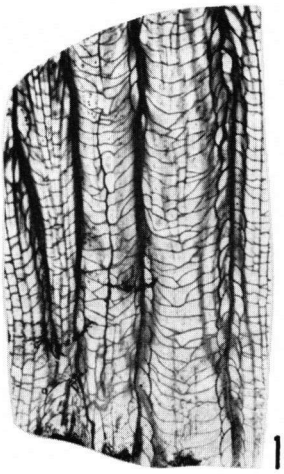
All figures three times natural size.



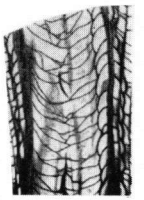
1a



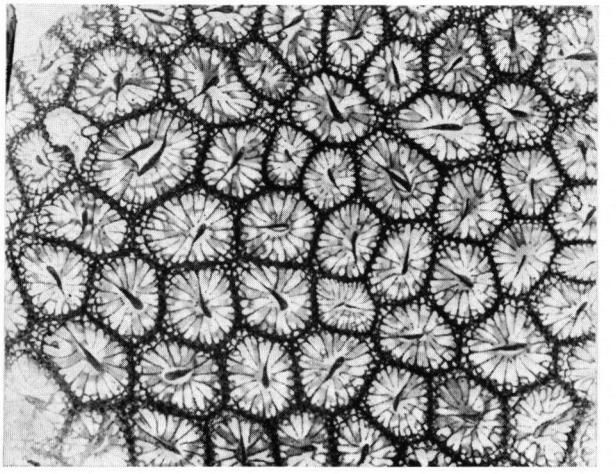
2



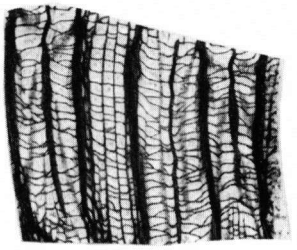
1b



1c



3a

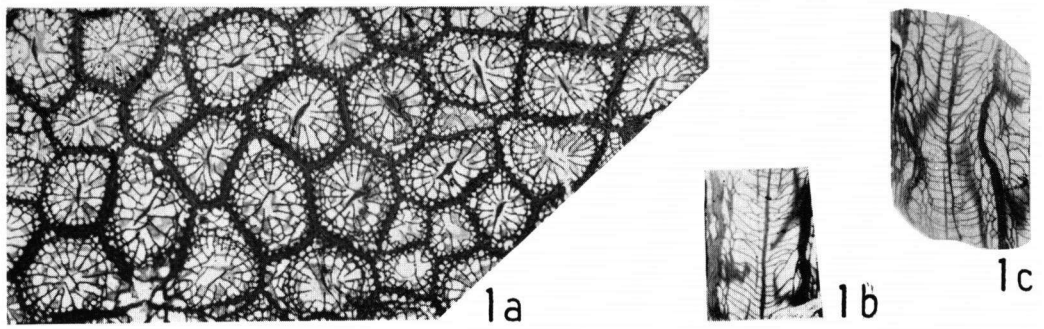


3b

PLATE 19

Figs. 1, 2 *Lithostrotionella* (*Hillia*) *perapertuensis* subgen. et spec. nov.
Perapertú formation.
Fig. 1 paratype RGM no. 112744, coll. A. C. van Ginkel. a, transverse section; b, c, longitudinal sections.
Fig. 2 holotype RGM no. 112743, coll. R. H. Wagner, loc. 49. a-c transverse sections, showing differences in development of marginarium; d, longitudinal section, showing clinotabellae.

All figures three times natural size.


1a
1b
1c

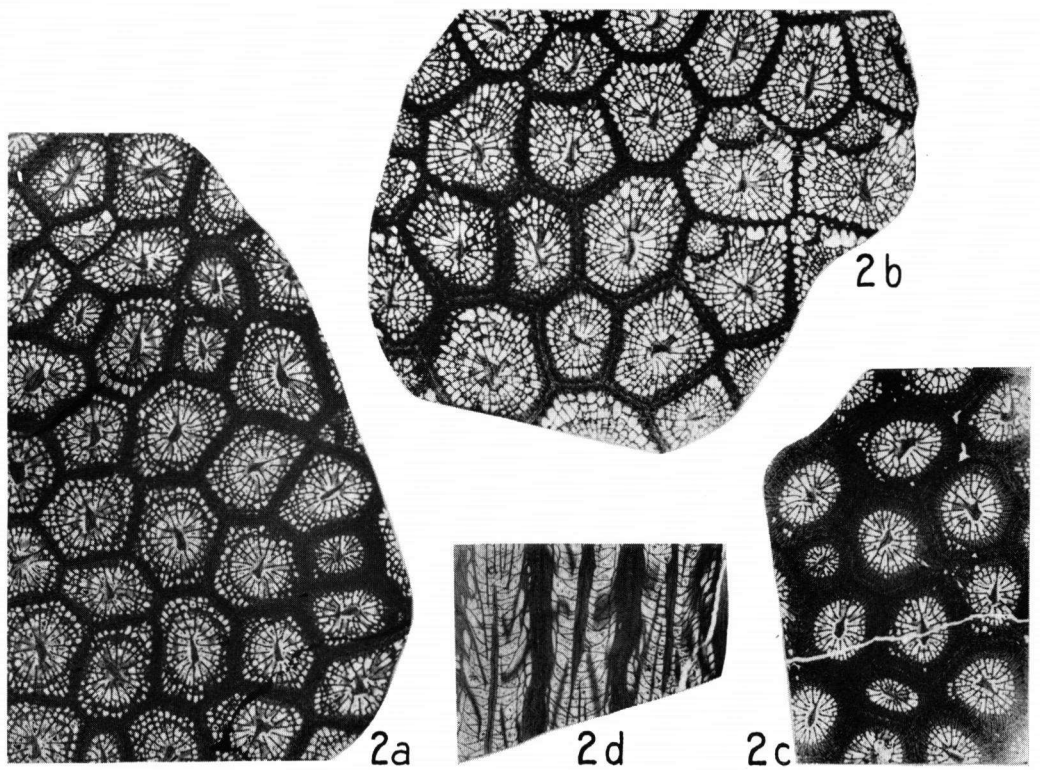
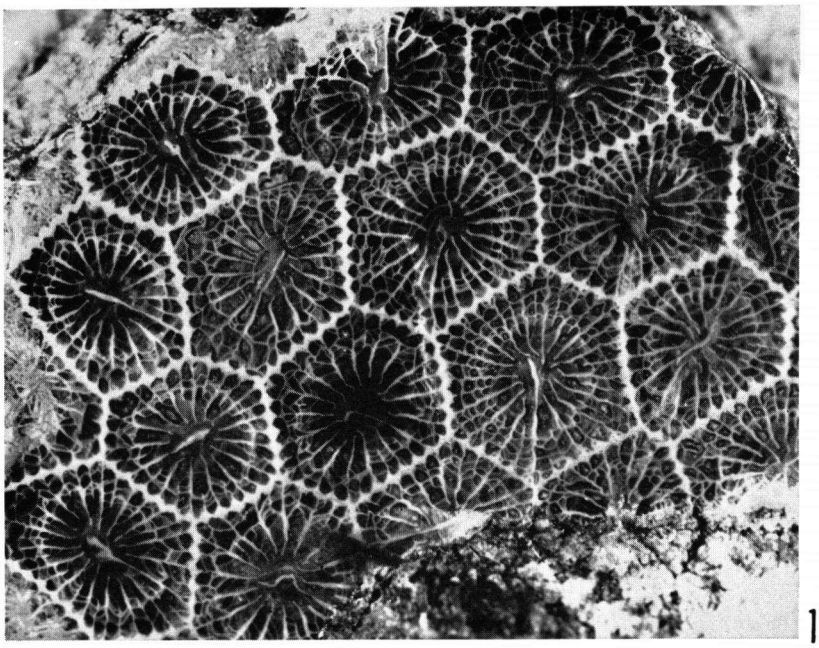

2a
2b
2c
2d

PLATE 20

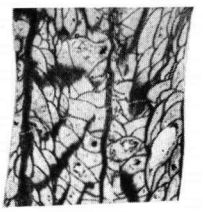
Fig. 1 *Lithostrotionella (Hillia) radians* subgen. et spec. nov.
Perapertú formation, coll. R. H. Wagner, loc. 35, holotype RGM no. 112746.
a, transverse surface; b, c, longitudinal sections.

Figs. 2, 3 *Lithostrotionella (Hillia) intermedia* subgen. et spec. nov.
Perapertú formation, coll. R. H. Wagner, loc. 44.
Fig. 2 holotype RGM no. 112748. a, transverse section; b, longitudinal section.
Fig. 3 paratype RGM no. 112749, transverse section.

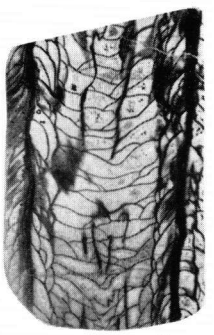
All figures three times natural size.



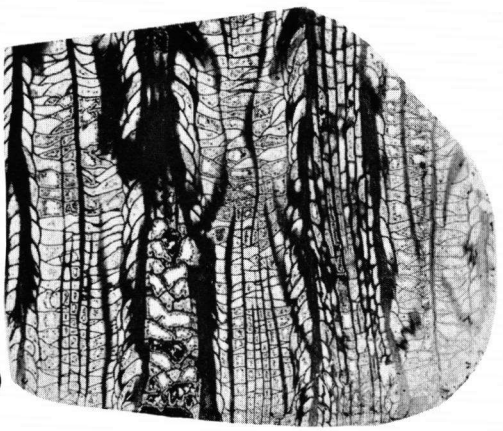
1a



1b

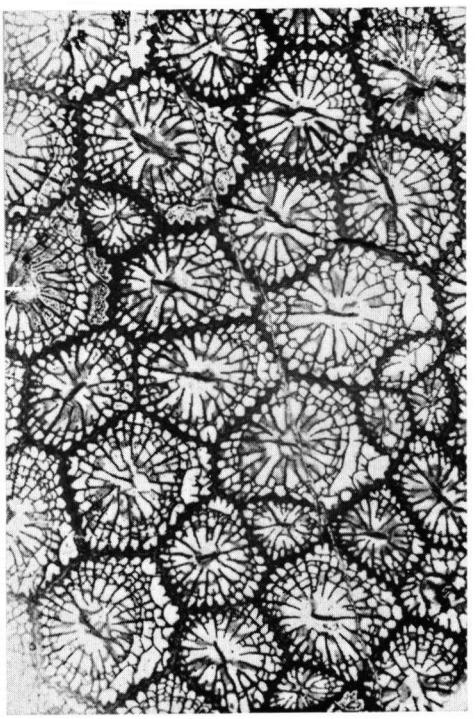


1c



2b

2a



3

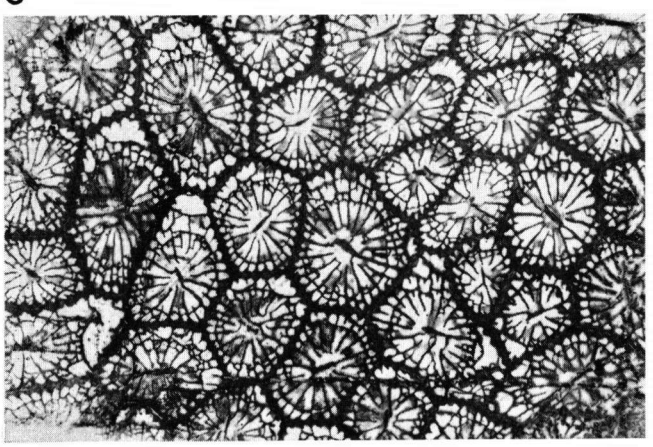
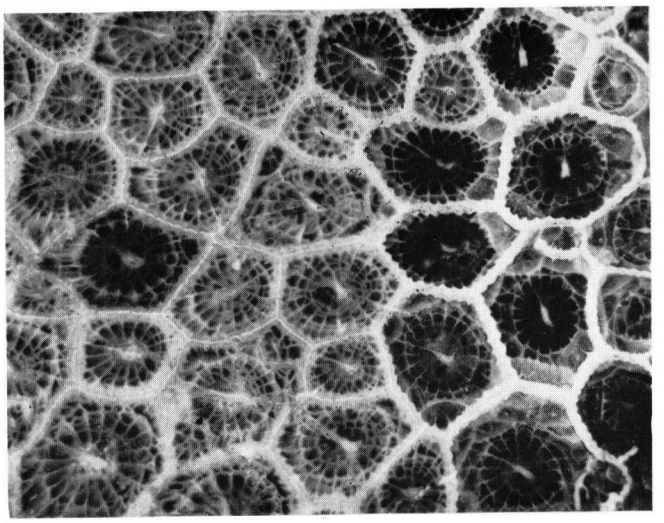


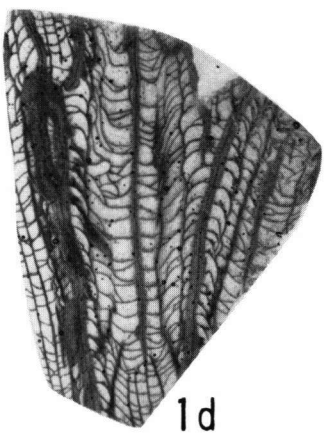
PLATE 21

Fig. 1 *Lithostrotionella* (*Hillia*) *santaemariae* subgen. et spec. nov.
Santa María limestone, coll. R. H. Wagner, loc. 21, holotype RGM no. 112751. a, transverse surface, taken at the edge of the corallum, where the corallites have a non-septate dissepimentarium; b, c, transverse sections; d, e, longitudinal sections.

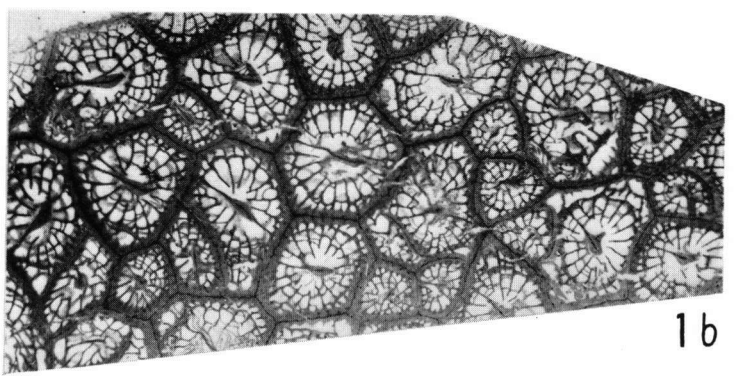
All figures three times natural size.



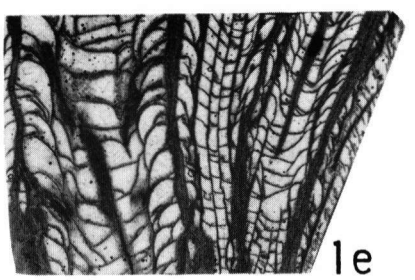
1a



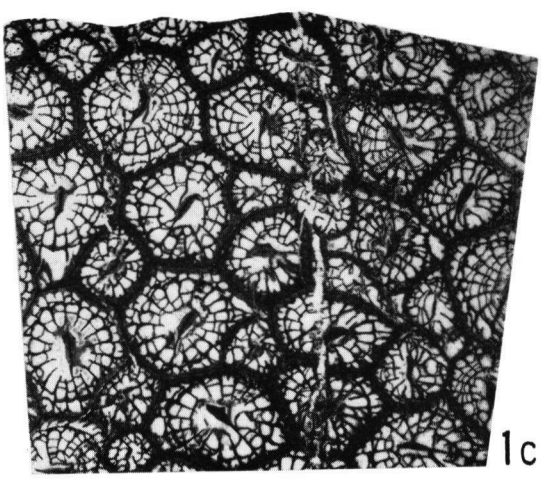
1d



1b



1e

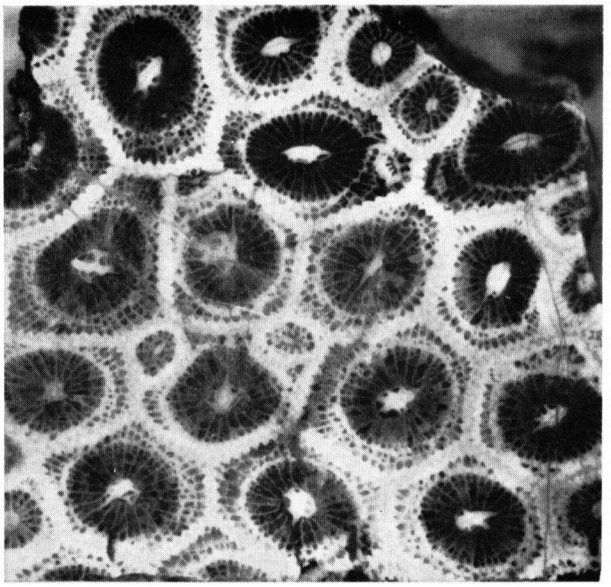


1c

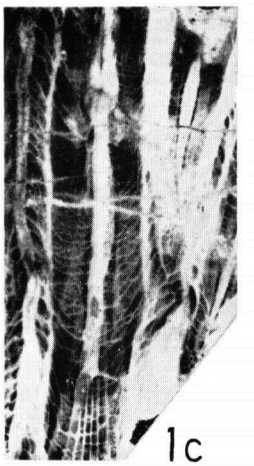
PLATE 22

Figs. 1—4 *Lithostrotionella* (*Hillia*) *cantabrica* subgen. et spec. nov.
Fig. 1 holotype RGM no. 112752, Santa María limestone, coll. R. H. Wagner, loc. 21. a, b, transverse surface and section; c, d, longitudinal surface and section.
Fig. 2 paratype RGM no. 112754, Perapertú formation, coll. C. H. T. Wagner-Gentis, loc. 84. a, transverse section; b, longitudinal section.
Fig. 3 RGM no. 112755, specimen with smaller corallites, same locality as preceding. a, transverse section; b, longitudinal section.
Fig. 4 paratype RGM no. 112757, Celada limestone, coll. G. E. de Groot, loc. 28, transverse section, showing corallites with non-septate dissepiments.

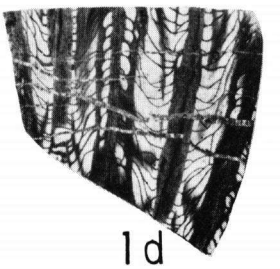
All figures three times natural size.



1a

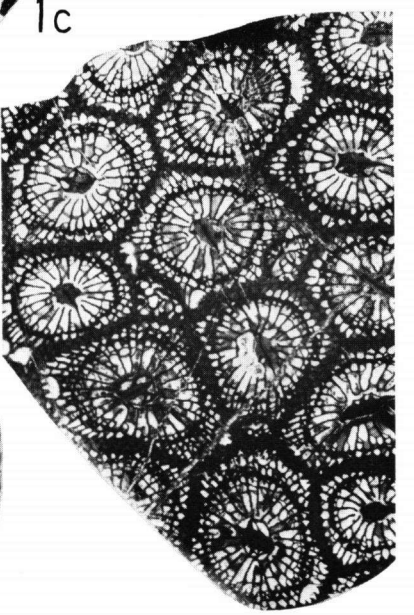


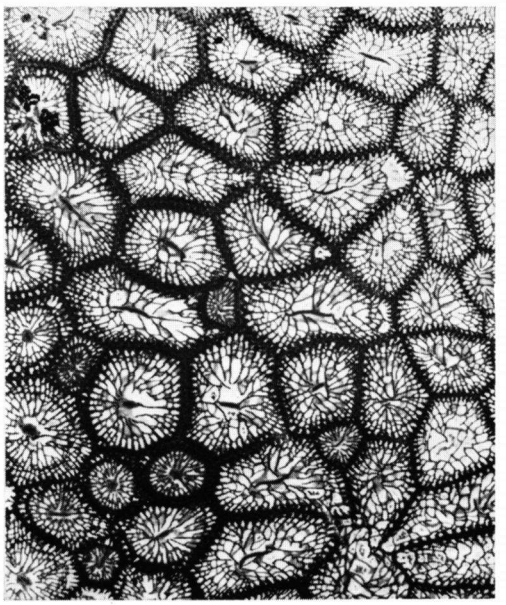
1c



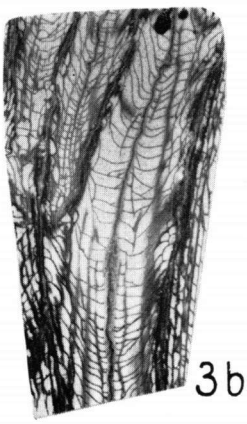
1d

1b



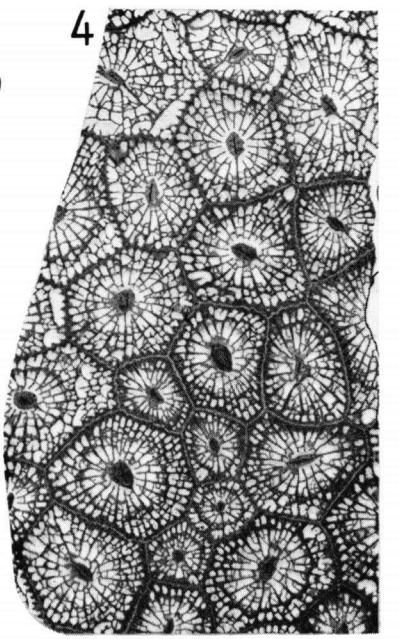


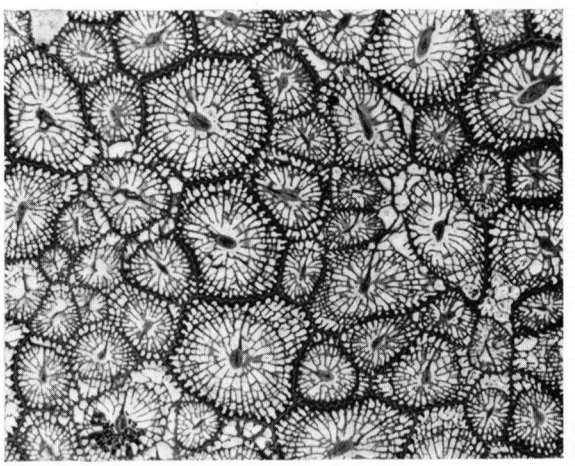
3a



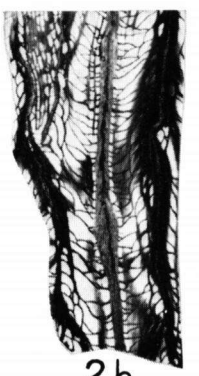
3b

4





2a



2b

PLATE 23

Fig. 1 *Koninckocarinia concinna* spec. nov.
Perapertú formation, coll. R. H. Wagner, loc. 48, holotype RGM no. 112758. a-c transverse sections, late neanic and adult stages; d, longitudinal section, somewhat off centre. a, b, d 2 ×; c 1½ ×.

Figs. 2—5 *Carcinophyllum wagneri* spec. nov.
Perapertú formation.
Fig. 1 holotype RGM no. 112759, coll. R. H. Wagner, loc. 31. a, transverse section, adult stage; b, longitudinal surface, showing clinotabellae at right hand side, 3 ×.
Fig. 3 paratype RGM no. 112761, coll. R. H. Wagner, loc. 32, transverse section, 3 ×.
Fig. 4 paratype RGM no. 112762, same locality as preceding. a, transverse section, taken near base of calyx, 3 ×; b, tangential section, taken near the epitheca, 1½ ×.
Fig. 5 RGM no. 112763, coll. R. H. Wagner, loc. 40. a, transverse surface, late neanic stage; b, transverse section, adult stage; c, longitudinal section, 3 ×.

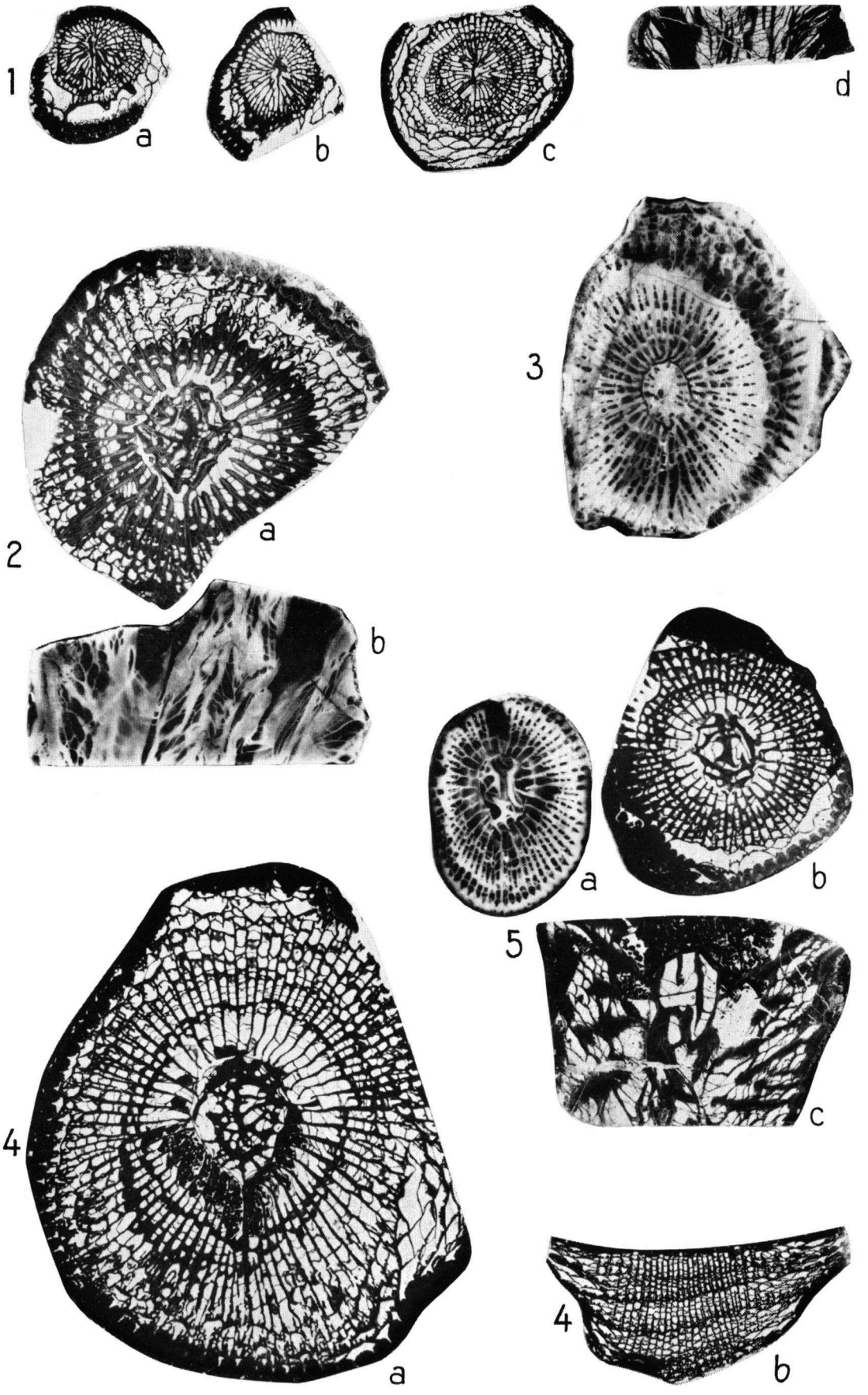

1
a
b
c
d
2
a
b
3
a
b
4
a
5
c
4
b

PLATE 24

Fig. 1 *Carcinophyllum* (?) sp.
Perapertú formation, coll. C. H. T. Wagner-Gentis, loc. 40, RGM no. 112770. a, transverse section, taken just below the calyx; b, c, transverse surfaces, calyx region, 3 ×.

Figs. 2, 3 *Carcinophyllum* (*Axolithophyllum*) *quiringi* (Weissermel).
Vañes formation, coll. C. H. T. Wagner-Gentis, loc. 54.
Fig. 2 RGM no. 112771. a-c transverse sections, neanic and adult stages; d, transverse surface, calyx region; e, longitudinal section, 3 ×.
Fig. 3 RGM no. 112774, longitudinal surface, 1½ ×.

Figs. 4—6 *Carcinophyllum* (*Axolithophyllum*) *quiringi* (Weiss.) f. *major*.
Fig. 4 RGM no. 112783, Sierra Corisa limestone, coll. C. H. T. Wagner-Gentis, transverse section, taken just below the calyx, 1½ ×.
Fig. 5 RGM no. 112784, Verdeña limestone, coll. M. H. Nederlof, loc. 14, transverse section, 1½ ×.
Fig. 6 RGM no. 112785, limestone outcrop NE of Cotarraso, coll. R. H. Wagner, loc. 72. a, transverse section; b, longitudinal section, 1½ ×.

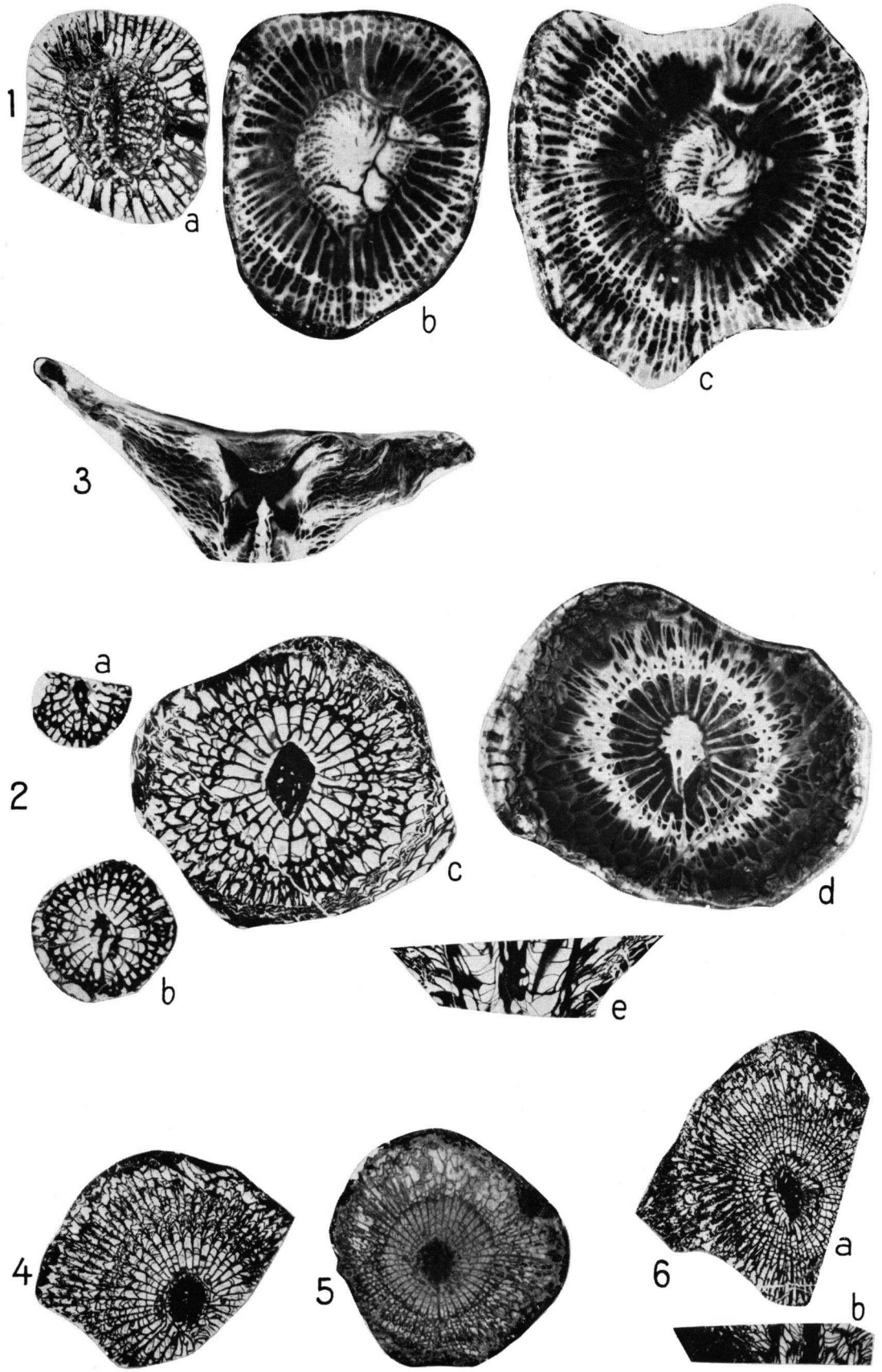

1
a
b
c
3
2
a
b
c
d
e
4
5
6
a
b

PLATE 25

Fig. 1 *Carcinophyllum* (*Axolithophyllum*?) aff. *cylindricum* (Dobr. & Kab.).
Cotarraso limestone, coll. C. H. T. Wagner-Gentis, loc. 47, RGM no. 112787.
a, transverse section; b, longitudinal section, 3 ×.

Figs. 2—5 *Lonsdaleoides hispanicus* spec. nov.
Peña Tejedo limestone, coll. R. H. Wagner, loc. 73.
Fig. 2 holotype RGM no. 112788. a, b, transverse surface, 3 ×.
Fig. 3 paratype RGM no. 112789. a-c transverse sections, showing variation in the development of the marginarium, 2 ×.
Fig. 4 paratype RGM no. 112790, longitudinal section, 2 ×.
Fig. 5 paratype RGM no. 112791, longitudinally fractured corallite, 2 ×.

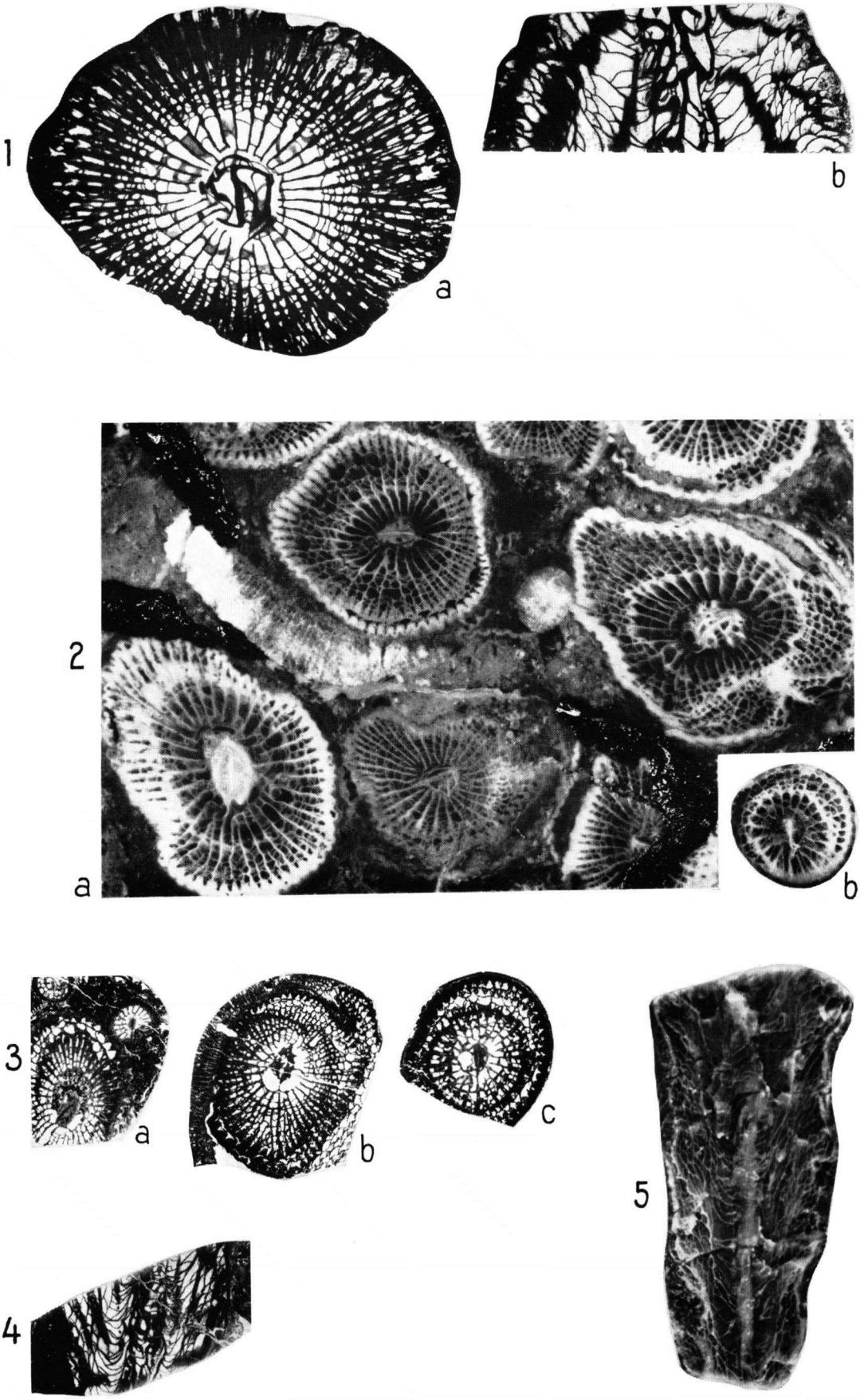
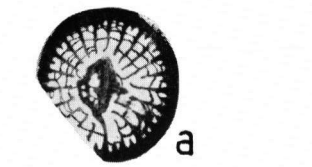

1
a
b
2
a
b
3
a
b
c
4
5

PLATE 26

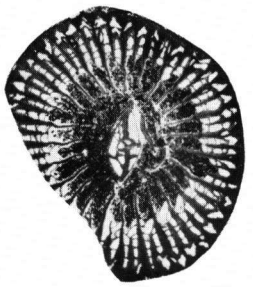
Fig. 1 *Amygdalophylloides ivanovi* (Dobrolyubova).
Peña del Moro limestone, coll. M. H. Nederlof, loc. 28, RGM no. 112795. a, transverse section, late neanic stage; b, transverse section, calyx region; c, longitudinal section.

Figs. 2—4 *Ivanovia freieslebeni* (Stuckenberg).
Fig. 2 RGM no. 112796, Peña del Moro limestone, coll. M. H. Nederlof, loc. 28. a, transverse surface; b, longitudinal surface.
Fig. 3 RGM no. 112799, Peña Tremaya limestone, coll. M. H. Nederlof, loc. 64. a, transverse section; b, longitudinal section, showing epitheca and columella locally interrupted.
Fig. 4 RGM no. 112798, Peña del Moro limestone, coll. M. H. Nederlof, loc. 28. a, longitudinal section, showing axial tabellae; b, longitudinal section, showing much thickened columella.

All figures three times natural size.

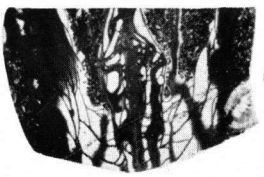


a

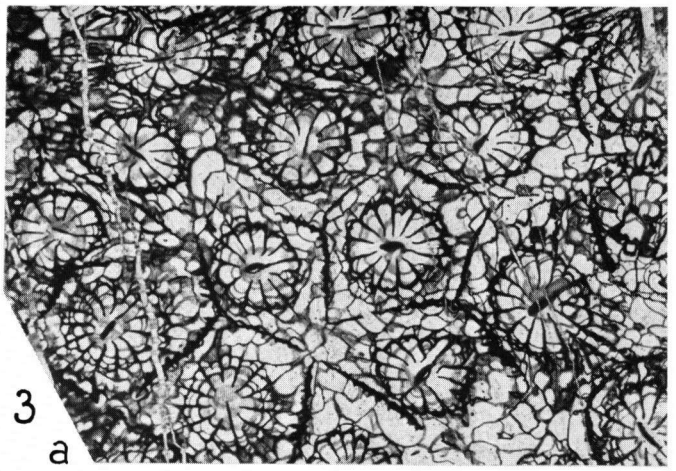


1

b



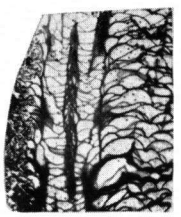
c



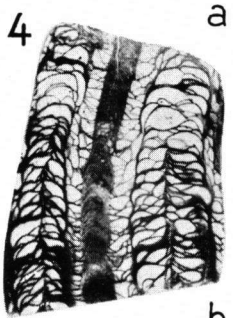
3

a

b

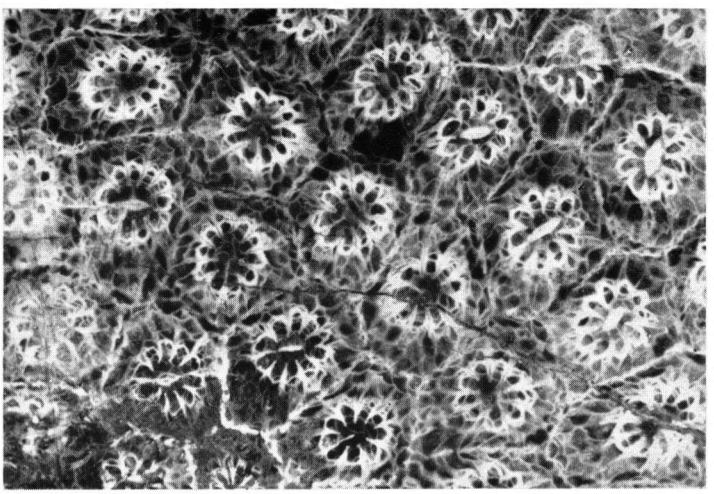


a



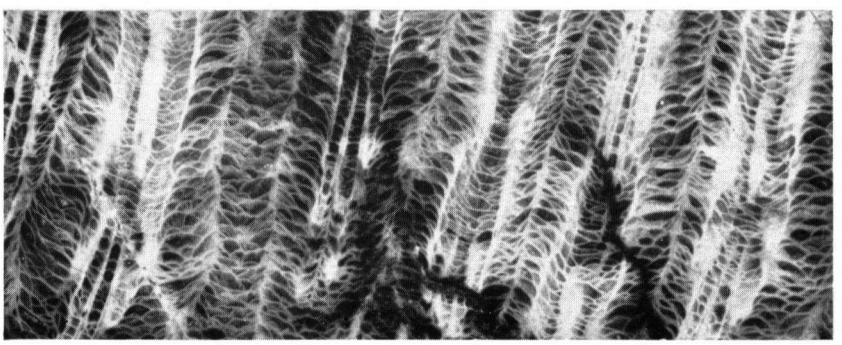
4

b



2

a



b