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CARBONIFEROUS SPHINCTOZOA FROM THE CANTABRIAN MOUNTAINS, SPAIN

BY

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ABSTRACT

In Westphalian strata of the Cantabrian Mountains, northern Palencia, Spain, the sphinctozoan sponges *Amblysiphonella* and *Cystauletes* are quite common; *Sollasia* is much rarer. This is the first occurrence of *Cystauletes* in Europe. The great variability of *Amblysiphonella barroisi* and *Cystauletes mammilosus* is demonstrated with abundant material. One new species *Cystauletes maior* is described. All three genera are associated with Dasycladaceae, which indicates a very shallow water environment.

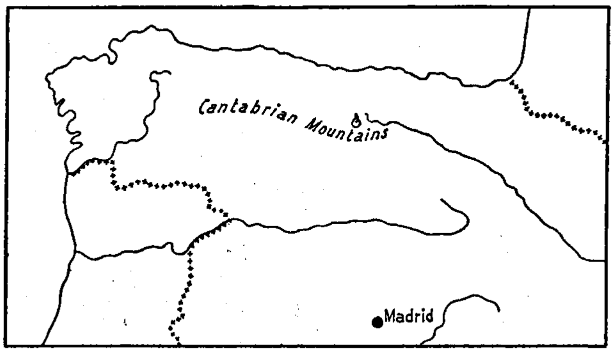
INTRODUCTION

In 1882 Steinmann described three sphinctozoan sponges from the Lena beds near Sebarga (Asturias). Since that time no report of other occurrences of these sponges in Spain, has been made.

In the Westphalian strata of the Pisuerga area, on the southern flank of the Cantabrian Mountains, these sponges, however, are fairly common in some limestones and calcareous shales. Especially one locality in the Sierra Corisa, north of the village of Vergaño (fig. 1), yielded a large number of *Amblysiphonella* and *Cystauletes*.

The age of the shallow water deposits in which they occur, is considered by van Ginkel (1965) and Rácz (1966) to be Upper Moscovian, i.e. Westphalian C—D.

Although *Amblysiphonella* and *Cystauletes* have also been found at other localities in the provinces of Palencia and León, only the Sierra Corisa locality yielded more than a few fragments and only this material is, with some exceptions, described in detail. Unfortunately I have not been able to visit Sebarga, where Barrois (1882) found Steinmann's specimens, to collect material for comparison. Van Ginkel (1965) dated the Lena Formation near Pola de Lena as Lower Moscovian (Kashirian). The ages he gives for the Piedras Luengas and Perapertu Limestone Members are Upper Vereyan and Lower Vereyan respectively. The Sierra Corisa locality itself yields fusulinids of an Upper Moscovian (Myachkovian) age. This means that the stratigraphic range of *Amblysiphonella barroisi* and *Sollasia ostiolata* in this region covers the whole of the Moscovian. *Cystauletes* has not yet been found in strata of an age other than Upper Moscovian.



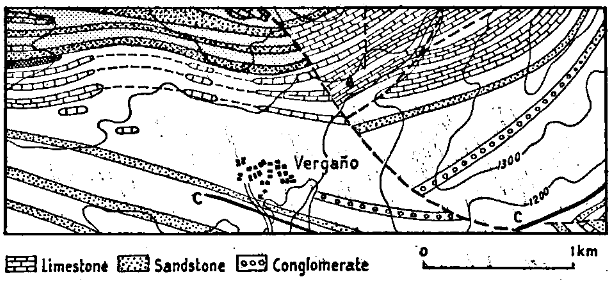


Fig. 1. Situation map of the Sierra Corisa locality (after De Sitter & Boschma, 1966).

Paleoecology of Amblysiphonella, Cystauletes and Sollasia

At the Sierra Corisa locality Finks's inferences (1960, p. 14—34) as to the paleoecology of these sponges are fully confirmed. The sediment in which the sponges are found, varies from calcareous, silty shales to poorly sorted, calcareous sandstones. Although a few discrete sandstone layers are present, little or no trace of the original depositional structures and textures has been preserved. The whole sediment has been intensively bioturbated and in polished sections it has a mottled appearance.

Apart from the sponges this locality yields a fairly rich and diverse fauna which comprises the following groups: fusulinids and other foraminifera, rugose

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corals, bryozoa, brachiopods, gastropods, pelecypods(?), trilobites and crinoids. The sponges have in some cases been encrusted by cyclostomate bryozoa. I have been unable to ascertain whether this occurred before or after death of the sponge.
If one tries to establish the original environment, by far the most important fossils to consider are, however, dasycladacean algae which occur in close association with the sponges. These algae are preserved in situ and thus give a clear indication that water-depth cannot have exceeded a few tens of meters. Sedimentary structures from neighbouring outcrops confirm this. The above mentioned characteristics indicate a shallow, quiet, fully marine environment.
An important point is whether the sponges themselves are preserved in situ. None of the specimens has been found in an upright position. All were lying more or less horizontally and were often badly fragmented. These features indicate that the sponges are no longer in their live positions. No preferred orientation of the fragments in the horizontal plane was observed in the outcrop. Nevertheless it is quite improbable that large, branched specimens as shown on plate II, fig. 6 and plate V, fig. 4, have been transported over distances greater than a few tens of meters, without being completely broken. Such a transport may have been achieved by an occasional storm (Hayes, 1967).
Another possibility is that these tufts are lying essentially in place and have only been toppled over. In that case the fragmentation may be due to scavengers and/or ordinary water movement. An indication that this is the case, is provided by the specimen shown on plate III, fig. 1. This specimen consists of two individuals of which the older serves as an attachment base for the younger. As these sponges grew in a more or less upright position, it is very likely that the oldest individual had fallen over before the youngest was very tall or even before it started growing. Although the specimen may have been transported as a whole, it probably implies that the environment in which the fallen individual was deposited, was suitable for the same species to continue to grow. I.e. *Amblysiphonella*, *Cystauletes* and *Sollasia* have most probably not been deposited outside the quiet, shallow marine environment where they normally grew.

Preservation

The external shape of the sponges is usually well preserved, only in a few cases flattened or crushed specimens have been found. Specimens of *Cystauletes* have often been partly silicified during diagenesis, which feature is much less common in *Amblysiphonella*. In the latter only the chambers are sometimes filled with silica. Even if no diagenetic silicification took place, it is often difficult to recognize the fine structures of the walls, because of recrystallization. Nevertheless it has been possible to confirm Steinmann's descriptions of the wall structures.

SYSTEMATICS

Introduction. — Steinmann's (1882) classification of the Sphinctozoa, which was amplified by Girty (1908b), was changed considerably by de Laubenfels (1955) who introduced a number of new names for the higher taxonomic units. Seilacher (1961) in his review of the Sphinctozoa re-established most of the old names that de Laubenfels had abolished and introduced one family and two superfamily names. Seilacher's classification is adhered to in this paper.
Seilacher also pointed out that many species of the Sphinctozoa, especially of *Amblysiphonella*, are insufficiently known to warrant their status as a separate species. This opinion is completely confirmed by the list of measurements on *Amblysiphonella* presented in table 1.

Suborder	SPHINCTOZOA	Steinmann, 1882
Superfamily	APORATA	Seilacher, 1961
Family	CELYPHIDAE	De Laubenfels, 1955
Genus	SOLLASIA	Steinmann, 1882

Genotype: Sollasia ostiolata Steinmann, 1882

Diagnosis. — Catenulate stems which are crypto- (or pseudo-) siphonate. Chambers hollow or with vesiculae. Wall is pierced by several ostia.

Sollasia ostiolata Steinmann, 1882

Plate I, fig. 2, plate II, fig. 5, 6, 7, plate IV, fig. 4.

Diagnosis. — Chambers are hollow and have a doubled floor; they are connected by a 1 mm wide osculum. The chamberwall consists of two layers and is pierced by four to six(?) spouted ostia. The chambers are clearly visible from the outside.

Material. — Three fragments; the measurements of the two larger specimens are given in millimeters.

length	nmb.chamb.	ø base	ø top
25	10	3,5	3,5
16	4	3	5

height chamb.	ø oscul.	ø ostia	d wall
2—3	0,8—0,9	0,3	0,3—0,4
3—5	0,9—1,0	0,2—0,4	0,5—0,6

Wall structures. — In the first specimen recrystallization has obliterated every trace of the two-layer structure of the wall. In the second one it is still visible. Besides, in this specimen a peculiar structure is visible in one of the ostia (plate II, fig. 7). A cone shaped tube, which has a number of rings on its outer surface, forms the wall of this ostium. Its diameter decreases from inside to outside from 0,27 to 0,19 mm, while its length is 1,4 mm. The rings on the outer surface are spaced at a distance of 0,13 mm and are

0,01 mm high. To visualize it, one should think of a tentaculite. In none of the other ostia a comparable structure has been found and its function is a complete puzzle to me.

Occurrence. — *Sollasia ostiolata* has been found at the Sierra Corisa locality and also in a small limestone lens about 850 m due south of Tremaya (Palencia). This limestone is of Upper Moscovian, i.e. Westphalian C-D age.

Superfamily PORATA Seilacher, 1961
Family SEBARGASIIDAE Girty, 1908
Genus AMBLYSIPHONELLA Steinmann, 1882
Genotype: Amblysiphonella barroisi Steinmann, 1882

Diagnosis. — Catenulate stems with a retrosiphonate osculum. Stems are cylindrical or (inversely) conical, and may be branched. Chambers are hollow or with vesiculae. Pores of osculum often larger than pores of external wall.

Amblysiphonella barroisi Steinmann, 1882

Plate I, fig. 5, 6, 8, 9, 10, plate II, fig. 2, 3, 4, plate III, fig. 1, 4, 6, plate IV, fig. 9, 10, plate V, fig. 4.

Diagnosis. — The diameter of the, often branched, stems probably varies between 0,5 and 2,5 cm. The diameter of the osculum is about 1/10 to 1/3 of the diameter of the stem. The diameter of the pores, which may be forked, varies normally between 0,05 and 0,6 mm, with the larger pores in the wall of the osculum. Wall thickness varies between 0,5 and 1,5 mm. In tangential sections of the wall the pores are surrounded by thin dark lines which produce a honeycomb pattern.

Material. — About 90 fragments, varying in length from 0,5 to 20 cm, of which some 60 were well enough preserved to permit detailed measurements of external and internal features. Some 25 peels and thin sections were made to study the microscopic structure and texture of the walls.

Wall structures. — From the peels and sections it appeared that the wall consists of two layers of which the outer one is characterized by the above mentioned honeycomb pattern and the inner by the lack of it (plate IV, fig. 9). On the inner side of the walls a third layer consisting of sparry calcite, may be present. The crystals of this layer are orientated perpendicularly to the wall. Its surface is normally quite irregular and also its thickness is variable. Nevertheless it seems to be a primary structure as it is crossed by the pores and more important because the vesiculae, which are undoubtedly primary, use it as a base (plate IV, fig. 10). This layer mainly occurs in the lower parts of the stems (like the vesiculae; see plate I, fig. 6) and its function was probably the strengthening of these basal parts.

A spicule-like structure is present in one specimen that has been cut at the joint of two chambers (plate II, fig. 2). As I have only found one example of this, I have been unable to establish its true nature.

Discussion. — The specimens represented in table 1 were selected from the collection because of their greater length and they are representative of the other specimens. As in table 2 all measurements are given in millimeters.
The measurements of the known genera of *Amblysiphonella* which are also shown in this table, were partly taken from the original descriptions, partly from later descriptions if the original ones were not available to me, and partly from the figured specimens if the descriptions were incomplete.
The measurements of the studied specimens clearly indicate the fairly great range in which the measured parameters of *Amblysiphonella* can vary. As the specimens at hand are only fragments of still larger tufts it is obvious that the variability of the different features in one specimen is still greater than is shown. If we take into consideration intraspecific variation, which can be quite large as Ziegler (1965) showed, it seems most likely that the specimens of table 1 represent only one species as it is impossible to divide this list into two or more groups with clearly distinct dimensions. As the dimensions of *A. barroisi* Steinmann are in agreement with those of the two completest specimens in the present collection, I conclude that all the studied material belongs to this species.
If the known species of *Amblysiphonella* are compared with my material, it is obvious that several species fall inside the variability range of what I consider to be *A. barroisi.* I suggest therefore that *A. asiatica, A. (Sebargasia) carbonaria, A. chinense,A. clathrata, A. dichotoma, A. merlai, A. sarytchevae* and *A. sikokuensis* should be carefully re-examined as they are quite likely identical to *A. barroisi.* Another such a group which probably should be considered as one species is constituted by *A. lörentheyi, A. multilamellosa, A. radicifera* and *A. vesiculosa.*

Occurrence. — Apart from the Sierra Corisa locality, *A. barroisi* has been found in the Piedras Luengas, Perapertu, Agujas and Abismo Limestone Members in the province of Palencia. Slumped limestone blocks on the Coriscao near the Puerto de San Glorio, the Mesao Limestone Member near Prioro and the limestones NW of Riaño also yielded some specimens of *Amblysiphonella.* All three localities are in the province of Léon. The mentioned limestones are shown on the maps by de Sitter (1962) and de Sitter & Boschma (1966). Their age, as is indicated by fusulinids, is Moscovian.

Genus CYSTAULETES King, 1943
Genotype: Cystauletes mammilosus King, 1943

Diagnosis. — Glomerate stems with a retrosiphonate osculum. Stems are cylindrical or (inversely) conical

TABLE 1 AMBLYSIPHONELLA, STEINMANN 1882			length	nmb.seg.	ø out.b.	ø out.t.	h.bot.	h.top.	ø inn.b.	ø inn.t.	ø osc.b.	ø osc.t.	ø out.p.	ø inn.p.	ves.p.b.	ves.p.t.	ves.p.o.
A. asiatica	Yü, 1935	P	70	16	21		4		19		4		0,3	0,5	–	–	×
A. barroisi	Steinmann, 1882	C	14	5	12	14	5		9	11	2,5	3	0,15	0,15	×	×	–
A. (Sebargasia) carbonaria	Steinmann, 1882	C	26	8	8	9	3,5	5	6	8	1,5	1,5	0,1		–	–	–
A. chinense	Hayasaka, 1918	P		6	14		4		12		2 – 3		0,15	0,5	×	×	–
A. clathrata	Parona, 1931	P	35	4?	14				12		5				×	×	–
A. dichotoma	(Yabe) Hayasaka, 1918	P	60	8?	13 – 14		5 – 7		12		3		0,25 – 0,3	0,25 – 0,3	×	×	×
A. guadalupensis	Girty, 1908	P	38		16						4				–	–	–
A. irregularis	Wilckens, 1937	T			55		8 – 9				4		0,5	0,15	–	–	–
A. lörentheyi	Vinassa, 1901	T	90		35						20				–	–	–
A. mabuchii	Yabe & Sugiyama, 1934	P	70	14	20		4 – 5		20 – 25		3				×	×	–
A. merlai	Parona, 1931	P	100		12		4		14		3				–	–	×
A. multilamellosa	Waag. & Wentz., 1887	P			30						13				×	×	–
A. planorbis	Hayasaka, 1918	P			11		2				3		0,2		–	–	–
A. prosseri	Clarke, 1897	C	59		15 – 18						3 – 5				×	×	–
A. radicifera	Waag. & Wentz., 1887	P	100		36						10				×	×	–
A. sarytchevae	Zhuravleva, 1965	P	70		30								0,2 – 0,3		×	×	–
A. sikokuensis	Yabe & Sugiyama, 1934	P	90	15	16		6 – 8				5		0,15 – 0,25	0,15 – 0,25	×	×	×
A. socialis	Waag. & Wentz., 1887	P			33						7				–	–	–
A. (?) timorica	Vinassa, 1915	T	50	11	18 – 24		1 – 3				5 – 9				–	–	–
A. vesiculosa	Waag. & Wentz., 1887	P	150		55						13				–	–	–
specimen number: 7			150	30	12	12		5	9	10	2,5	4	0,15 – 0,4	0,15 – 0,5	×	–	–
1			115	17	10	17	7	7	9	14	1,5	4,5	0,1 – 0,3	0,1 – 1	×	–	×
25			70	11	10	14	5,5	7,5	7	11	2	3	0,1 – 0,2	0,15 – 0,4	×	×	–
54			67	9	14	12	6	6	12	11	4	4	0,2	0,15 – 0,3	×	×	–
52			51	9	14	19	5	6	11	14	5	6	0,15 – 0,2		–	–	–
24			44	8	8	15	5	7	9	12	2	3,5	0,15 – 0,3	0,15 – 0,3	×	×	×
27			43	8	10	11	5	5	8	10		3	0,15 – 0,3	0,15 – 0,3	×	×	×
28			43	7	12	12	6	7	10	12	3	4,5	0,2	0,15 – 0,4	×	×	×
58			42	7	8	9	6	6	7	8	1,5	2	0,15	0,2 – 0,3	×	×	×
51			38	7	9	10	4		5	8	1		0,15 – 0,3	0,15 – 0,3	–	–	–
10			35	8	8	7	4	5	6	6	1,5	2	0,05 – 0,15	0,15 – 0,3	–	–	–
61			34	8	8	10	4	4	6	8	2	3		0,15 – 0,3	–	–	–
13			32	6	10	5	5	2	8	5	2	2	0,2 – 0,4	0,2 – 0,3	–	–	–
29			32	6	9	12	3	6	7	9	3	3	0,15 – 0,2	0,15 – 0,2	×	–	–
34			32	8	9	9	4	5	7	7	3	3	0,15	0,2	×	–	×
55			32	7	8	9	4	4		7	2	3	0,15 – 0,3	0,15 – 0,35	–	–	–
57			32	7	8	10	6	4	5	8	2	2		0,15 – 0,3	–	–	–
68			32	7	9	11	4	6	7	9	1	2	0,15	0,15 – 0,3	×	×	–

length : length of specimen
nmb.seg. : number of segments
ø out.b. : outer diameter of stem at the base
ø out.t. : outer diameter of stem at the top
h.bot. : height of segment at the base
h.top. : height of segment at the top
ø inn.b. : inner diameter of stem at the base
ø inn.t. : inner diameter of stem at the top
ø osc.b. : diameter of osculum at the base
ø osc.t. : diameter of osculum at the top
ø out.p. : diameter of pores in outer wall
ø inn.p. : diameter of pores in osculum
ves.p.b. : vesiculae present at base (x)
ves.p.t. : vesiculae present at top (x)
ves.p.o. : vesiculae present in osculum (x)
T : Triassic
P : Permian
C : Carboniferous

and may be branched. One layer of chambers (cysts), which are more or less spirally arranged, surrounds the osculum. The chambers are hollow or with rare vesiculae. The normally branched pores are surrounded by the same honeycomb pattern as in *Amblysiphonella*.

Cystauletes mammilosus King, 1943

Plate I, fig. 3, 4, 7, plate II, fig. 8, plate III, fig. 2, 5, plate IV, fig. 2, 3, 5, 7, 8, plate V, fig. 1, 2.

Diagnosis. — Slender, branched stems that increase in diameter towards the top. The number of cysts that is cut through by a transverse section probably varies from 4 at the base to about 20 at the top. The diameter of the osculum seems to vary from 1/8 to 1/3 of the diameter of the stem, which ranges at least from 0,5 to 2,8 cm. The inner diameter of the cysts, which are more or less spherical, varies from 1 to 7 mm. The pores are between 0,08 and 0,7 mm in diameter. The pores of the osculum seem to be more widely spaced than those of the external walls.

Material. — About 100 fragments, ranging in length from 0,5 to 20 cm, were available for this study. Some 70 specimens were well enough preserved to permit detailed measurements of the different features. In addition about 30 peels and thin sections were made to study the microscopic features of the walls. In silicified specimens, however, polishing gave more information. Treatment with HCl proved to be quite unsatisfactory because of incomplete silicification; nevertheless a few specimens treated in this way gave good results.

Wall structures. — From the peels and sections it appeared that the wall structures are identical to those of *Amblysiphonella* as described above, with the exception of the innermost layer which is much rarer than in *Amblysiphonella*. In some silicified specimens it could be observed that the very fine tubes in the center of the cells of the honeycomb pattern have an anastomosing appearance.

Discussion. — The specimens represented in table 2a were chosen from the studied material because they show the characteristic features of this species best. As in *Amblysiphonella barroisi* variability of the measured parameters is quite great, even in one specimen. Especially specimen 29 (143328) shows this clearly. In none of the specimens the branching of an osculum was observed; the possibility of this occurring can, however, not be excluded. The same applies to *A. barroisi*.

Occurrence. — *Cystauletes mammilosus* has been found at the Sierra Corisa locality, in the Abismo Limestone Member, and, according to Mr. A. van Loon, Leiden, in de Mesao Limestone Member.

Cystauletes maior van de Graaff, sp. nov.

Plate I, fig. 1, plate II, fig. 1, plate III, fig. 3, plate IV, fig. 1, 6, Plate V, fig. 3.

Diagnosis. — Branched (?) cylindrical (?) stems, which vary in diameter from 2,7 to 4 cm. The osculum varies from about 1/8 to 1/3 of the total diameter of the stem. The number of cysts cut by a transverse section ranges from 3 to 6. The greatest horizontal dimension in transverse section of the more or less spheroidal cysts, varies from 0,8 to 3,4 cm. The axis perpendicular to this in the same plane ranges from 0,6 to 1,3 cm. The pores are of about the same size as in *C. mammilosus.*

Material. — 5 fragments which are up to 20 cm long. Two of the fragments were found in close contact with each other. About 15 peels were prepared to study the finer structures.

Wall structures. — The wall structures are identical to those of *C. mammilosus.* In one specimen (plate V, fig. 3), however, it can be observed that the outer part of the wall shows a lamination which is strongly reminiscent of algal stromatolites. About its nature I can only say that it seems to be a primary layer and not a later encrustation of the sponge. It is probably due to exceptionally good preservation that this feature can be observed, as a faint trace of a similar layer is present in one specimen of *C. mammilosus.*

Differences with related species. — *Cystauletes maior* differs from the only other species in this genus, in that in a transverse section only a small number of cysts, in relation to the diameter of the stem, are cut. If for instance the measurements of specimen 29 (deposited under number 143328) are extrapolated, for a specimen about 3 cm in diameter we would expect about 20—25 cysts in transverse section, whereas we see only 6. All the other features seem to be quite similar.

Discussion. — Owing to scanty material the diagnosis given above has to be incomplete and the measurements given in table 2a do not show the full variability range.

Occurrence. — *Cystauletes maior* has only been found at the Sierra Corisa locality.

Derivatio nominis. — maior — the bigger one.

TABLE 2a CYSTAULETES MAMMILOSUS KING, 1943

no	length	ø stem	ø oscul.	nmb.cysts	h. cysts	d. cysts	d. wall	ø wall	ø oscul.
29	201	9 − 16	1,5 − 6	5 − 13		1,5 − 4	0,5 − 1	0,15 − 0,3	0,15 − 0,3
29a		9 − 15	1,5 − 4,5	5 − 10	3 − 4	1,5 − 3	0,5 − 1,5	0,15 − 0,55	0,15 − 0,4
32	140	7 − 28	2 − 8	5 − 13		2 − 4	0,5 − 1	0,08 − 0,15	0,15 − 0,3
33	86	22	9	14 − 15		3 − 5	0,5 − 1	0,15 − 0,3	0,15 − 0,3
10	70	19 − 23	5	± 9	3 − 6	5 − 7	0,5 − 1	0,15 − 0,7	0,15 − 0,3
65	62	12 − 21	4	± 10		2 − 5	0,5 − 1	0,1 − 0,2	0,15 − 0,2
47	60	13 − 16	2 − 5	7 − 8		2 − 6	0,5 − 1,5	0,15	0,1 − 0,3
15	57	17 − 22	6 − 8	10 − 12		3 − 4	0,5 − 1	0,15 − 0,3	0,15 − 0,4
42	52	9 − 13	3	5		1,5 − 3	0,5 − 1	0,15	0,1 − 0,3
39	48	16 − 17	5 − 7	9 − 13		3 − 4	0,5 − 1,5	0,15 − 0,3	0,15 − 0,3
16	44	15 − 17	4 − 5	± 8	3 − 6	4	0,5 − 1	0,15 − 0,4	0,15 − 0,3
48	43	15 − 18	6 − 7	11		2 − 5	0,5 − 1	0,05 − 0,2	0,15 − 0,2
62	43	17	4 − 5	13		2 − 3	1 − 2	0,15	0,1 − 0,3
11	41	9 − 11	3	± 9	1 − 2,5	2	0,5 − 1	0,15 − 0,3	0,15 − 0,2
66	41	14 − 16	5 − 6	11		2 − 4	0,5 − 1	0,1 − 0,5	0,15
19	39	16 − 21	5 − 6	8 − 10		4 − 5	1 − 1,5	0,05 − 0,55	0,15 − 0,5
35	34	16 − 19	3 − 7	8 − 13		2 − 4	0,5 − 1	0,15 − 0,3	0,15 − 0,3
23	33	12 − 17	2 − 5	± 10	3	3	1	0,15 − 0,3	0,15 − 0,4
45	27	17	5	13		2 − 4	1 1,5	0,15	0,15 − 0,3
64	27	5 − 10	1 − 2	± 8	2 − 3	1 − 2,5	0,5 − 1	0,1 − 0,3	0,1 − 0,15
38	24	10	2	6		0,5 − 3,5	1	0,15 − 0,2	0,1 − 0,2
King 1943	20	9 − 18	3 − 8,5	± 10 − 12		2,5 − 5	0,3 − 0,5	0,3	0,3

TABLE 2b CYSTAULETES MAIOR VAN DE GRAAFF, SP. NOV.

no	length	ø stem	ø oscul.	nmb.cysts	h. cysts	d. cysts	d. wall	ø wall	ø oscul.
2	200	35 − 45	?	?		?	1 − 1,5	?	0,15 − 0,4
3	101	27 − 40	5 − 15	3	4 − 13	6 − 13	1 − 1,5	0,15 − 0,3	0,15 − 0,7
4	65	38	8 − 11	6		9 − 12	1 − 2	0,15 − 0,3	0,15 − 0,7
1	41	31	5 − 10	4		8 − 12	1	0,15 − 0,4	0,15 − 0,4

no: collection number
length: total length of specimen
ø stem: external diameter of stem
ø oscul.: internal diameter of osculum
nmb cysts: number of cysts cut by a transverse section
h. cysts: height of cysts cut by an axial section
d. cysts: inner diameter of cysts measured from wall of osculum to external wall
d. wall: thickness of walls
ø wall: diameter of pores in external wall
ø oscul.: diameter of pores in osculum

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PLATES

The figured specimens and those represented on the tables have been deposited in the collections of the Rijksmuseum van Geologie en Mineralogie (National Museum of Geology and Mineralogy), Leiden, under the numbers RGM-St. 143284 to RGM-St. 143344 (both numbers included).
Unless stated otherwise the figured specimens have been found at the locality indicated on fig. 1. The photographs have been made by Mr. W. C. Laurijssen. The small triangle on the photographs points towards the upper part of the stem.

PLATE I

Fig. 1. *Cystauletes maior* spec. nov., paratype
Axial section; same specimen as in plate II, fig. 1; no: RGM-St. 143316; x 1,1

Fig. 2. *Sollasia ostiolata* Steinmann, 1882
Longitudinal section; same specimen as in plate IV, fig. 4; Tremaya; no:RGM-St. 143285; x 10

Fig. 3. *Cystauletes mammilosus* King, 1943
Axial section of branched specimen; note that the oscula are not directly interconnected; no: RGM-St. 143342; x 2,6

Fig. 4. *Cystauletes mammilosus* King, 1943
Transverse section of the lower part of a stem; fragment of the specimen shown in plate III, fig. 2; no: RGM-St. 143328; x 5,4

Fig. 5. *Amblysiphonella barroisi* Steinman, 1882
Axial section of branched specimen, the oscula are possibly directly interconnected; no: RGM-St. 143294; x 2,7

Fig. 6. *Amblysiphonella barroisi* Steinmann, 1882
Axial section; no: RGM-St. 143286; x 1

Fig. 7. *Cystauletes mammilosus* King, 1943
Axial section; same specimen as in plate IV, fig. 7; no: RGM-St. 143321; x 1

Fig. 8. *Amblysiphonella barroisi* Steinmann, 1882
Axial section of the uppermost part of a stem; no: RGM-St. 143292; x 1,6

Fig. 9. *Amblysiphonella barroisi* Steinmann, 1882
Axial section; note the abundant vesiculae; no: RGM-St. 143293; x 2,4

Fig. 10. *Amblysiphonella barroisi* Steinmann, 1882
Nearly axial section; no: RGM-St. 143298; x 1,2

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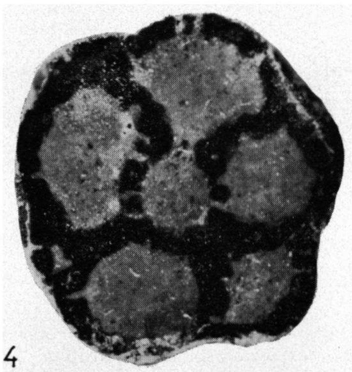

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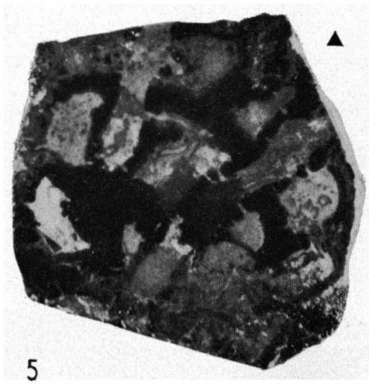

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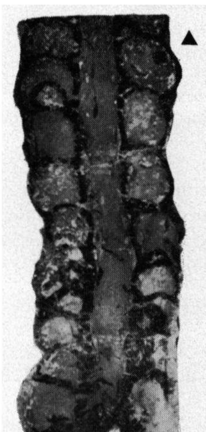

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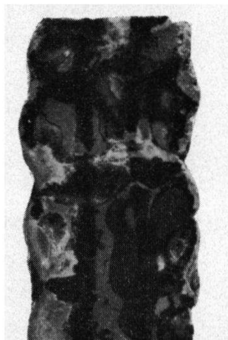

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PLATE II

Fig. 1. *Cystauletes maior* sp. nov., paratype
Longitudinal section; same specimen as in plate I, fig. 1; negative print of peel; no: RGM-St. 143316; x 1,5

Fig. 2. *Amblysiphonella barroisi* Steinman, 1882
Transverse section at the contact between two chambers; note the spicule-like structure in the outer wall; no: RGM-St. 143295; x 31

Fig. 3. *Amblysiphonella barroisi* Steinmann, 1882
Transverse section at the contact between two chambers; note the honeycomb pattern; no: RGM-St. 143311; x 25

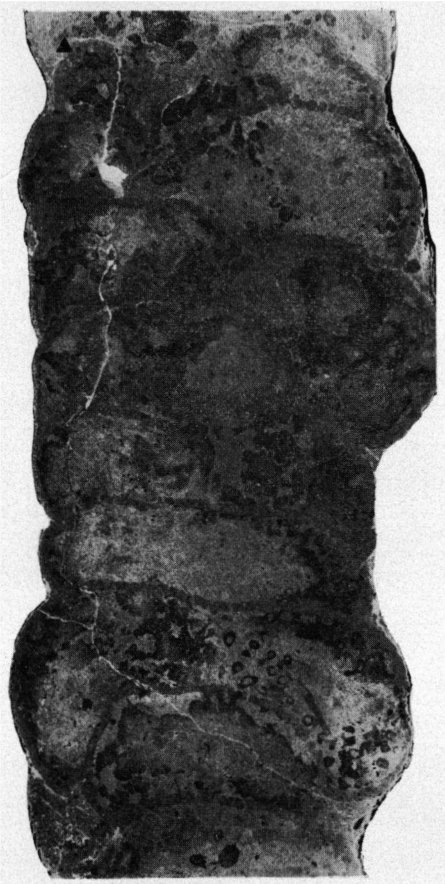
Fig. 4. *Amblysiphonella barroisi* Steinmann, 1882
Nearly axial section of branched specimen; the oscula are not directly interconnected; no: RGM-St. 143296; x 1,8

Fig. 5. *Sollasia ostiolata* Steinmann, 1882
No: RGM-St. 143284; x 4,5

Fig. 6. *Sollasia ostiolata* Steinmann, 1882
Axial section of the same specimen; no: RGM-St. 143284; x 5

Fig. 7. *Sollasia ostiolata* Steinmann, 1882
Enlargement of the rectangle in fig. 6 (see page 240); no: RGM-St. 143284; x 48

Fig. 8. *Cystauletes mammilosus* King, 1943
Transverse section, showing the honeycomb structure of the walls surrounding the larger pores; positive print of thin section; no: RGM-St. 143344; x 4



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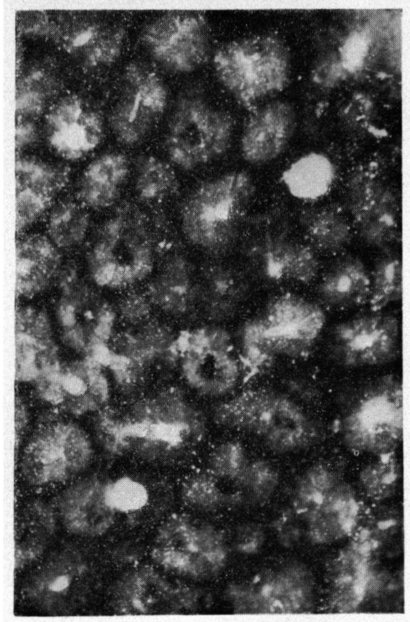

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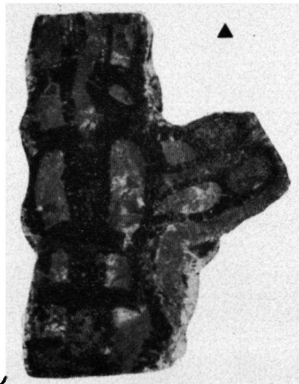

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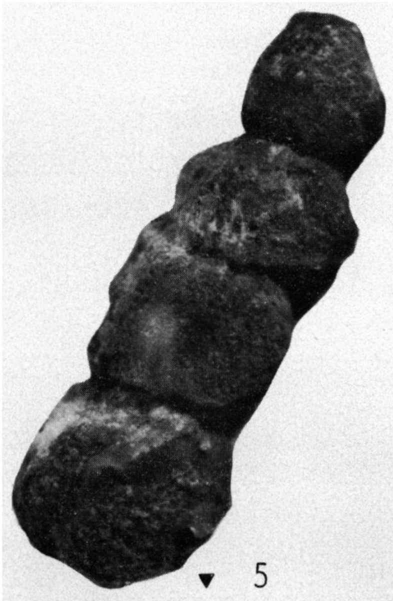

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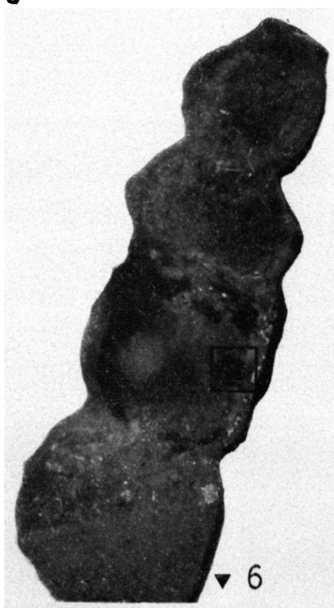

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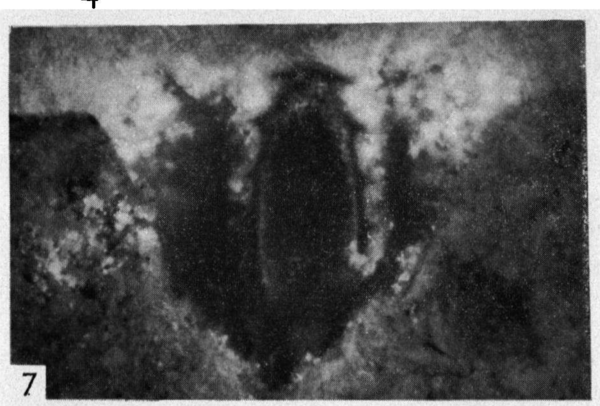

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PLATE III

Fig. 1. *Amblysiphonella barroisi* Steinmann, 1882
The specimen at the left consists of two individuals (see page 241); from left to right no: RGM-St. 143287, 06—68—0005, RGM-St. 143289; x 0,55

Fig. 2. *Cystauletes mammilosus* King, 1943
Note the branching of these fragments of one large specimen; no. RGM-St. 143328; x 0,47

Fig. 3. *Cystauletes maior* sp. nov., paratype
Nearly transverse section; negative print of peel; no: RGM-St. 143314; x 1,3

Fig. 4. *Amblysiphonella barroisi* Steinmann, 1882
Specimen etched HCl, the pore infillings are preserved; no: RGM-St. 143297; x 2,5

Fig. 5. *Cystauletes mammilosus* King, 1943
Partly silicified specimen etched with HCl to show the outer surface; no: RGM-St. 143326; x 2,6

Fig. 6. *Amblysiphonella barroisi* Steinmann, 1882
Large tuft, showing clearly the internal structures; no: RGM-St. 143288; x 0,7


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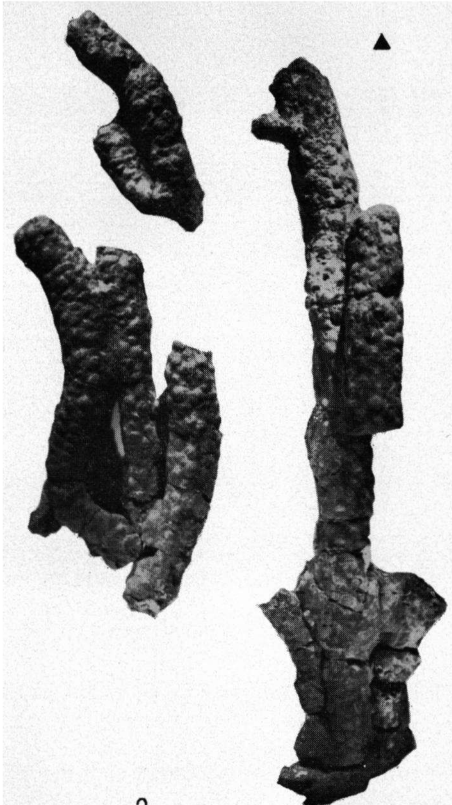
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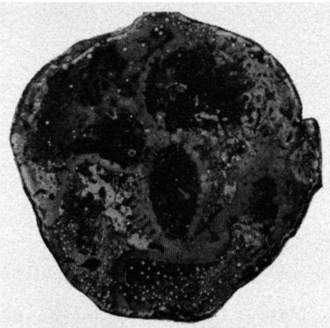
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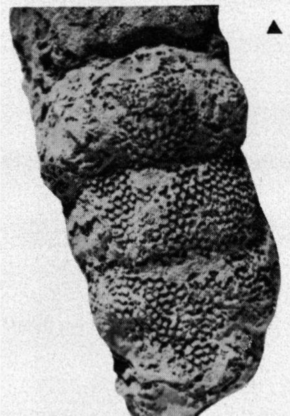
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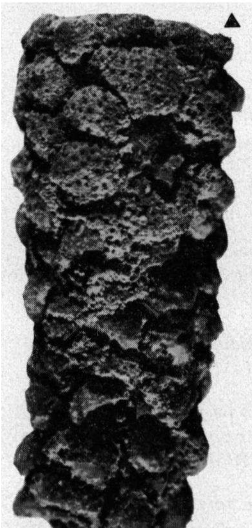
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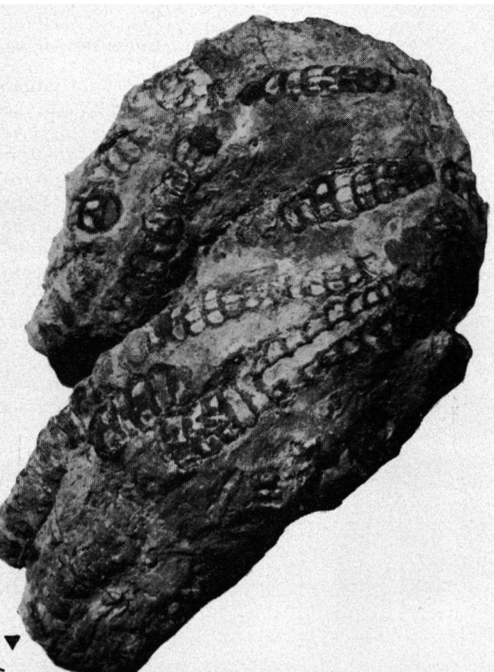
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PLATE IV

Fig. 1. *Cystauletes maior* sp. nov., paratype
Slightly crushed specimen; no: RGM-St. 143315; x 0,5

Fig. 2. *Cystauletes mammilosus* King, 1943
Longitudinal section; no: RGM-St. 143319; x 1,2

Fig. 3. *Cystauletes mammilosus* King, 1943
Axial section; no: RGM-St. 143324; x 2,5

Fig. 4. *Sollasia ostiolata* Steinmann, 1882
Longitudinal to axial section; same specimen as shown in plate I, fig. 2; Tremaya; no: RGM-St. 143285; x 4,5

Fig. 5. *Cystauletes mammilosus* King, 1943
Transverse section; no: RGM-St. 143319; x 2,5

Fig. 6. *Cystauletes maior* sp. nov., holotype
Nearly transverse section; no: RGM-St. 143318; x 1,4

Fig. 7. *Cystauletes mammilosus* King, 1943
Longitudinal section of the same specimen as shown in plate I, fig. 7; no: RGM-St. 143321; x 0,95

Fig. 8. *Cystauletes mammilosus* King, 1943
Transverse section; no: RGM-St. 143320; x 2,2

Fig. 9. *Amblysiphonella barroisi* Steinman, 1882
Oblique section showing the wall structure; partly encrusted by cyclostomate bryozoa; positive print of thin section; no: RGM-St. 143312; x 5

Fig. 10. *Amblysiphonella barroisi* Steinmann, 1882
Nearly transverse section showing that the vesiculae can have their base on a seemingly secondary part of the wall (see page 241); no: RGM-St. 143313; x 5,5

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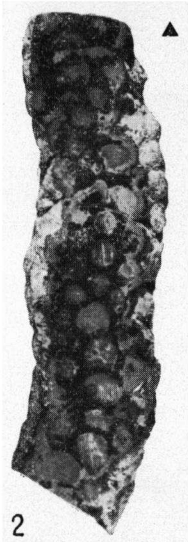

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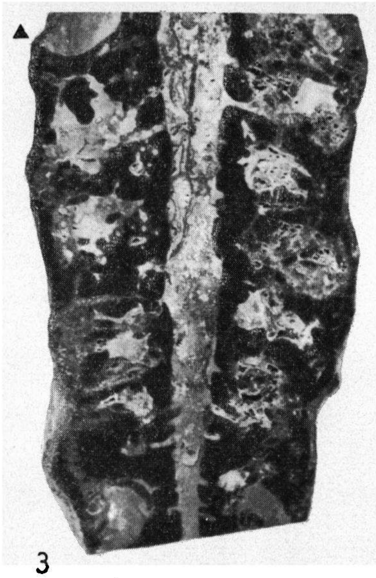

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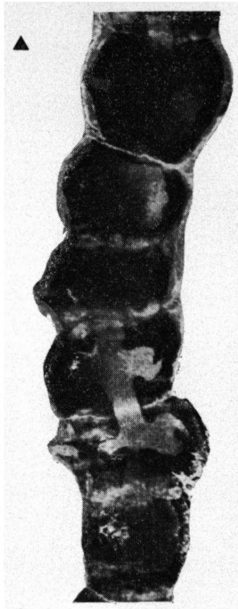

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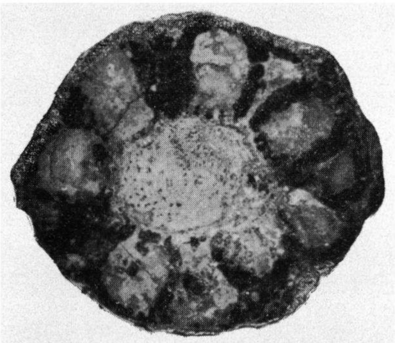

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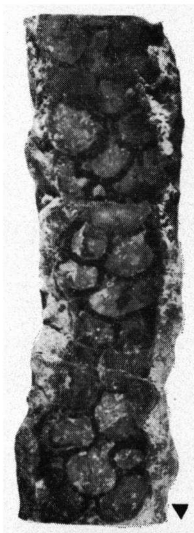

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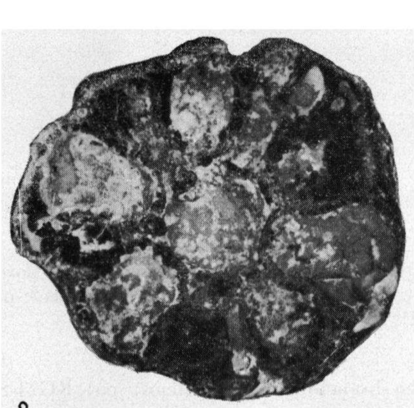

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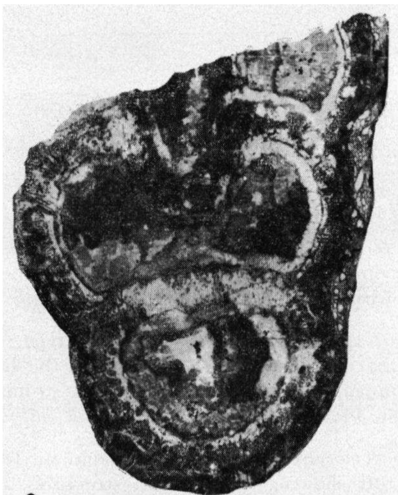

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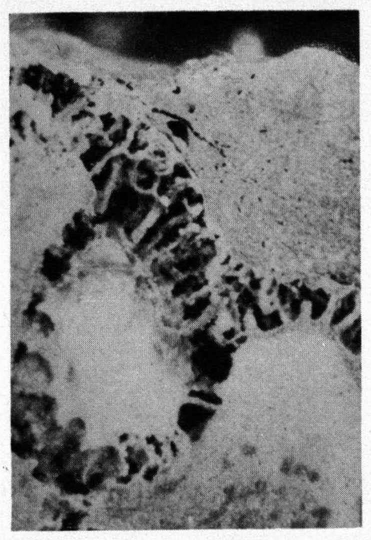
PLATE V

Fig. 1 & 2. *Cystauletes mammilosus* King, 1943
Stereoscopic pair of photographs, showing the pore infillings of the outer wall of a specimen etched with HCL; no: RGM-St. 143343; x 8

Fig. 3. *Cystauletes maior* sp. nov., paratype
Tangential section of one cyst showing the honeycomb pattern surrounding the larger pores. In the upper part of the photograph the 'stromatolitic' layer is visible; positive print of peel; no: RGM-St. 143317; x 6,6

Fig. 4. *Amblysiphonella barroisi* Steinman, 1882
Large tuft showing the internal structures and the branching of the stems; no: RGM-St. 143290; x 0,7



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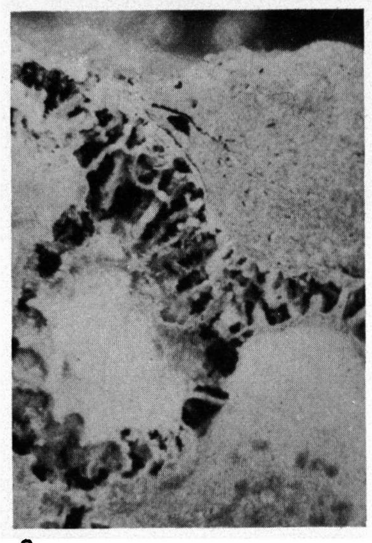

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