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REMARKS

ON

THE HELIOLITIDÆ

BY

G. LINDSTRÖM

WITH TWELVE PLATES

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ERRATA.

Page	11	line	18	from top,	The statement concerning the aculæ is rather to be corrected by what is said at page 87 in description of Plasmopora? reticulata.		
»	37	»	12	»	for	*Subfamily* read	*Family*.
»	41	»	6	»	»	1819 . »	1818.
»	41	»	18	from bottom	»	*macrostylis* »	*macrostylus*.
»	41	»	18	»	»	133 »	135.
»	54	»	8	from top	»	1833 »	1834.
»	60	»	5	from bottom	»	*interstinctus* »	*intricatus*.
»	70	»	12	from top	»	family »	tribe.
»	70	»	18	»	»	1861 »	1867.
»	93	»	6	»	»	1819 »	1818.

The printing of this memoir was commenced January 24th and finished April 20th 1899. When the thirteenth sheet was ready to be printed, April 7th, I received a work written by Dr KIÆR, partly treating of the same subject and then just published.

Introduction.

The purport of this memoir is chiefly to review the Swedish species belonging to the palæozoic corals of the family of the Heliolitidæ, also paying due attention to several species from other regions, which give good illustrations of the structure and the development. To the genuine Heliolitidæ I append the Coccoseridæ, which in some instances have been described as Heliolitæ and which I consider to be a group nearly related to them.

The material for attaining this scope has been derived chiefly from the island of Gotland, being very rich in such fossils, but also from other places in the mainland of Sweden, as well as from all other countries where Silurian and Devonian formations exist, excepting Australia.

My thanks are due to many naturalists, some now deceased, for valuable contributions to my work, through sending me with great liberality specimens and much useful information. I am thus under great obligations to Signor G. DE ANGELIS D'OSSAT in Rome, to the late Mr BILLINGS, Professors DOUVILLÉ, FRECH, Mr J. E. GRAY, late of Hagley, Dr J. W. GREGORY, the late Dr J. HALL of Albany, Drs HEAD (Chicago), HINDE, HOLM, Professors THS. M'KENNY HUGHES, INOSTRANZEW, VON KOCH, VON KOENEN, LAUBE, MALAISE, ALPH. MILNE-EDWARDS, NICHOLSON, M. D. OEHLERT, Dr PENECKE, Prof. POČTA in Prag, Prof. FERD. ROEMER, Dr ROMINGER, Prof. SCHLÜTER, Akadem. FR. SCHMIDT, Prof. HJ. THÉEL, Drs TÖRNQUIST, WENTZEL, WIMAN, and H. WOODWARD.

It has been the more welcome to receive such friendly assistance as the identification of many species is very difficult through unsatisfactory descriptions and bad or incomplete figures. Through the scients above mentioned I have received for inspection several critical specimens which have formed the basis for descriptions by previous authors. It is, of course, most important to examine such specimens and compare them with others because there may, especially in respect to the oldest descriptions, be some uncertainty of what forms were kept in view.

With very few exceptions, especially mentioned, a great number of specimens have in each species been examined, in some instances more than hundred, and studied in transparent sections.

The state of conservation of the specimens is naturally of the utmost importance. The originally calcareous coralla have in some strata been silicified and consequently their structure is often totally lost or destroyed. But even in those which have retained the calcareous constitution it happens that the older portions have been subject to chemical transformations during their long enclosure in the rocky strata, and the sceletal elements been, as it were, blotted out during that long enduring process. The aspect of the septa and the outlines of the calicles are blurred and evanescent. Such specimens would be highly misleading if more perfect specimens were not at hand. But even in well preserved specimens there may sometimes be features and structures, which can be in a certain way described, but, at present at least, baffle all attempts to declare or explain their real meaning, as for instance what has been called the formation of fasciæ in certain Heliolitæ.

Generally specimens found in situ are well preserved, especially in limestone or marly strata, those, again which are found detached on the shores or on the fields, derived or *remaniés* from older strata are more or less altered, silicified, changed into dolomite and weathered.

In a great number of specimens it is almost impossible by the exterior appearance to distinguish the species from each other. Apparent similarity of the surface may hide the greatest dissimilarity of the interior structure. No true knowledge of these corals can be gained without sections in thin, transparent slices, transverse and longitudinal, and chiefly such will give the best results. Tangential ones are also sometimes of value. In some instances it is quite necessary to take a series of many sections along the same line at different depths, as for instance in order to gain a true insight into the phases of the gemmation.

It is in the deciphering of these microscopic objects of importance not to be deceived by false appearances, caused by strange infiltered inorganic matter, by diminutive crystals of manganous or ferric oxide hydrate or of arragonite etc. in dispersed individuals or heaped in druses. Below, in the special descriptions, instances will be given how such extraneous matter has been mistaken for sceletal structures and described as such.

Owing to the great plasticity of these, as well as of so many other corals, it is extremely difficult to draw neatly the lines of distinction between the different species, as they seem to be, as it were, confluent with each other and combined by numerous gradations in character. In the descriptions of supposed new species too much stress has been laid upon the size of the calicles, their distance from each other or the amount of the interposed coenenchyma, as being characteristic differences. But who ever has examined a great number of specimens soon has been aware that such characters are of very little value, if any, as large and small calicles may often be found placed at much varying distance from each other on the same colony. In one specimen of Heliol. interstinctus, for instance, the calicles vary in size from 1 mm. to 0,5 mm. Of widely greater importance not only for specific, but even for generic differentiation are such sceletal elements as the septa, their shape and size, the structure of the coenenchyma, and the dissepiments as seen in longitudinal and transverse sections. The manner in which the coral has grown may sometimes be of value, especially for singling out local varieties.

In the following I have given, first an account of the general structure of the whole family, which being thus ascertained, serves as a basis for secondly to eliminate all those heterogenous fossils, corals and bryozoa, which have for so long time been, according to my opinion, wrongly associated with the Heliolitidæ. Next I shall give a notice of the geographical and geological distribution. At last these introductory remarks are followed by the detailed descriptions of all genera and species which I have been able to examine.

In respect to that encumbrance which is called »List of synonyms», I have tried to make it as complete as possible. I have, however, excluded »*nomina nuda*», or mere catalogue names, unaccompanied by descriptions, comments or figures, unless being quite sure of the identity, as for instance in regard to Swedish species, through examination of specimens or by reliable references. Even if an author has identified his specimens with previously decribed species, there is no certainty of the validity of this determination, unless there has been made by him a thorough research of the original specimens. Hence it is necessary to accept a great many synonyms with caution and reserve.

At last I may be permitted to express my deep gratitude to the Royal Swedish Academy af Sciences for defraying the expenses of publishing this memoir. I have also to tender my thanks to Herr G. Liljevall, who with the utmost care and with his well known artistic skill has drawn the plurality of the figures placed on the annexed plates, and given me much valuable assistance in preparing specimens and in clearing up some obscure features of structure. I am, however, afraid that the manner of the reproduction of his drawings is not, at least in some instances, doing full justice to them.

Remarks upon the general Structure of the Heliolitidæ.

The coenenchyma is the most prominent feature of the Heliolitidæ. Numerous are the names which have been bestowed upon that part of the composed corallum in this family and others, and quite as much varied have been the interpretations concerning its true nature.

Linnæus spoke about »pori minimi» between »pori magni», Hisinger says »massa porosa cellulis interjecta», James Hall »spaces between the openings», Dana »interstitial space», Phillips »intervalls filled by polygonal openings», M'Coy »polygonal tubes», Lonsdale »interstices» or »interstitia porosa». German authors as Schlottheim say »Zwischenräume», Quenstedt »Zwischenmasse» or »Grundmasse», Vogt »Zwischensubstanz» and most recently von Koch »Zwischengewebe».

In this state of an unstable and ever changing terminology, it was most welcome, when Milne-Edwards and Haime in their grand works on the structure of the Corals put an end to the confusion by giving the questionable structure a new definition and denomination. In their first memoir [1] they have called it peritheca. Identical is probably also the »tissu commun des Astrées» which they called »exothèque [2]. The term »coenenchyma» appears for the first time in their monographic descriptions of the Astræidæ [3]. It is there stated that »ces côtes réunies entre elles par des traverses nombreuses, forment tout autour de la muraille des divers individus une masse celluleuse plus ou moins épaisse, d'où résulte un coenenchyme [4] ou tissu commun dont le développement est souvent très-considérable».

The best definition is that given by the same authors in the »Introduction to the British Fossil Corals» (1850 p. vi). It is according to them the calcified derm which extends »exteriorly without constituting distinct costæ, and forms a dense or reticulate tissue, which in certain aggregate corals, is nowhere referable to any individual polyp and produces a sort of intermediate mass or true coenenchyma». Intercostal dissepiments also assume »the appearance of a coenenchyma, or common tissue».

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[1] Ann. Sci. Nat. Zool. 3:e Série, vol. IX, p. 49.
[2] l. c. p. 84.
[3] Ann. Sci. Nat. 3:e Série, X, p. 213. 1848.
[4] Derived from κοίνος, common, and ἔγχυμα, properly somewhat that is poured out into something, but here meant as an expansion or efflucnce.

By the latter passage, compared with the former statement, and also by others in their works may be seen that they had in view different sorts of coenenchyma, so amongst others a false one or a peritheca as in Galaxea, with which also the perithecal secretions in the palæozoic genera Syringophyllum and Pholidophyllum may be compared.

Since MILNE EDWARDS and HAIME had published their memoirs on the structure of the corals the term coenenchyma was almost generally accepted by authors writing on Anthozoa. But there has, of course, been great difference of opinion concerning its nature and some have even interpreted it in a sense contrary to the meaning of those first authors. In all variance of opinion is to be found a tendency to regard as coenenchyma all interspace between not too closely set calicles. In this wide conception it is, of course, evident that the denomination coenenchyma must embrace a great multiplicity of highly different structures. The coenenchyma in the Antipatharia cannot of necessity bear the slightest resemblance to that of the Madreporaria. It may then be justly said that it exists as many kinds of coenenchyma as there exist groups or large divisions of genera. DUNCAN [1] was right when he said that all sceletal structures outside the true theca were to be called exotheca, but when he continues that this was of two kinds 1) coenenchyma and 2) peritheca, a difficulty arises to discern between them. It might be said that the peritheca is without any intimate connection with the calicles, lies outside them, as in Galaxea, the coenenchyma again is in intimate connection with the calicles or indeed only a part of them.

As to the coenenchyma of the Heliolitidæ, the particular objects of this my memoir, the following most important interpretations of its nature have hitherto been given. One of the most remarkable opinions is that advanced by NICHOLSON. Probably the singular tubular composition of the coenenchyma in the genus Heliolites has given the first impulse to his views.

The first origin of this hypothesis can be traced to a paper, read by him [2] March 1875 and published in the same year. He there, treating of the calicles and the coenenchymal tubes of the genus Heliolites and its palæozoic allies says that »the question arises .... whether these (coenenchymal) tubuli are to be regarded as constituting a proper coenenchyma, or whether they are not really of the nature of aborted or rudimentary corallites». And he thinks that several facts not nearer mentioned favour the latter view. Not long afterwards MOSELEY sent to the Royal Society a paper on Heliopora [3] in which he expressed nearly the same opinion, without, of course, being aware of NICHOLSON's shortly before published views. In this paper MOSELEY compares the polyp animals of Heliopora with those of Sarcophyton, in which Alcyonarian there exists a dimorphism of two different sets of polyps: sexual animals and zooids, which latter are by far more numerous than the former. MOSELEY thought [4] it »by no means improbable that the coenenchym

[1] Revision p. 202.

[2] On the mode of growth and increase amongst the Corals of the Palæozoic Period. Transact. R. Soc. Edinb. vol. XXVII pt. III, p. 248.

[3] Structure and Relations of the Alcyonarian Heliopora coerulea etc. receivd by the R. Soc. Sept. 28th, read Novemb. 25th 1875 and published 1876 in vol. 166 pt. 1 of Trans. R. Soc. This paper was published again, a little enlarged, in the »Report on the Corals» in the »Results of the Challenger Expedition, Zoology» pt. VII of vol. II.

[4] l. c. p. 119.

here (in Heliopora) is composed of the tubes of absorbed polyps and zooids». Accepting the affinity of the Heliolitidæ with Heliopora, as given by MILNE EDWARDS, MOSELEY concluded, that all Tabulata were Alcyonarian and consequently that the Heliolitidæ were dimorphic. The contents of this first memoir was in the main reproduced in the Challenger Report. He there[1] proposed the terms »autozooids» for the sexual polyps and »siphonozooids» for KÖLLIKER's zooids. These suggestions of MOSELEY were eagerly accepted by NICHOLSON, who 1878 in his »Silurian Fossils of Girvan»[2] says: »In view of the researches of MOSELEY upon Heliopora we shall consider the smaller tubes (in the coenenchyma) to be really of the nature of corallites, tenanted, probably, in the living condition by a peculiar kind of zooids». In his work on the Tabulata (1879) he calls the different sets larger and smaller corallites and he changed later[3] these terms in accordance with MOSELEY into Autozooids and Siphonozooids of which the former correspond with what I would call the interior area of the calicles and the latter with the coenenchymal tubuli. In this respect a few authors, as WAAGEN, SARDESON and the anonymous translator of ZITTEL's Text-book in English, have followed NICHOLSON. I shall revert to this below.

Of the latest authors WENTZEL is almost the only one who has paid some closer attention to the structure of the Heliolitidean coenenchyma[4]. He in the main accepts my views as published several years ago and establishes two types af coenenchyma, of which he calls one, my vesicular coenenchyma, for costal coenenchym and the second which he does not distinguish by a separate name is identical with my tubular coenenchyma. One of the conclusions to which he has arrived[5] is, that the coenenchymal tubuli are not to be considered as a peculiar structure, independant of the septa, but as originated through their furcation, coalition and again repeated furcation.[6]

The Heliolitidæ display in the most evident manner the two elements out of which the sceleton in most corals is constructed, the vertical and the horizontal. The vertical element reveals itself as theca, septa with septal spines, tubuli and various detached formations in the coenenchyma; the horizontal element again is observed as tabulæ and various other sorts of dissepiment. Out of variations of both these elements the coenenchyma is composed.[7] In the Heliolitidæ together with the Coccoseridæ it is of essentially four different kinds. These are 1) the tubular coenenchyma, 2) the vesicular, 3) the bacular and 4) the compact coenenchyma.

1. The **tubular** coenenchyma which prevails in the genera Heliolites, Cosmiolithus and Proheliolites consists of narrow, mostly polygonal tubes enclosed within polyëdric thecæ and divided by regular horizontal tabulæ (dissepiments or traverses) more numerous or closely set than in the adjoining calicles. They increase by fission.

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[1] p. 121.
[2] Pt. I, p. 53.
[3] Manual of Palæontology 3d Ed. 1889, p. 335.
[4] Zur Kenntniss der Zoantharia tabulata, 1895, pag. 3, 7—12.
[5] l. c. pag. 11.
[6] WEISSERMEL (Zeitschr. deutsch. Geol. Gesellsch. 1898, p. 56) has also treated of the sceletal parts and given good information.
[7] There is a decided difference in colour between the two kinds of elements when seen in transparent light; the vertical being pale straw-coloured, the horizontal black or grey, an outward difference, which may indicate some intimate difference in texture or chemical composition.

2. The **vesicular** coenenchyma is proper to the corals of the tribe Plasmoporinæ and is composed of a great number of thin, convex lamellæ, equivalent to the horizontal traverses or dissepiments of Heliolites. Through covering each other nearly as tiles they enclose an empty loculum below themselves and these locula become large or dwindling to microscopical littleness according to the much varying size of the lamellæ. In this same way a tissue is formed which also is common for so many corals belonging to widely different families or without any relation or affinity, as for instance Galaxea and Cystiphyllum. In its simplest and purest condition it appears in the genus Propora in such species as Pr. conferta (Pl. IX fig. 12, 18) and var. minima (Pl. IX fig. 24). Now, in others, there have arisen accessories of the vertical element, which are entirely wanting in the Proporæ just cited. In Propora tubulata, for instance, (Pl. VIII fig. 14) or still better in Plasmop. scita (Pl. VII fig. 8, 11) diminutive, vertical stylets sit on the superior surface of the convex lamellæ. I propose for them the term **aculæ** derived from **acula**, a little needle. No doubt they cover the whole surface, as can be learnt from the transverse sections (Pl. VIII fig. 12, 15) and the same are also scattered on the surface of the convex lamellæ in Pl. VIII fig. 8, 11, though looking more blunt, like wartlets, perhaps through weathering or not having grown out. They can be very irregularly distributed as in section pl. VIII fig. 19, often wanting and then reappearing. In Plasmopora? reticulata pl. VII fig. 36 they are no longer free and without connexion with each other, they have combined and form a reticulate web (fig. 35) giving the surface of the coral very much the appearance of the tubular coenenchyma. By this combination they have originated short tubuli intermingled with the convex laminæ.

These aculæ again are arranged in another fashion, having grown in longitudinal rows or series following exactly in the same line above each other as seen in Pl. VII fig. 10. There they are still without connection in a longitudinal direction, but in another specimen of the same species a junction is attained and the convex laminæ of the coenenchyma are, as it were, pierced by narrow rods or rather thecal elements, which somewhat disturb the formation or regular growth of the convex lamellæ that nevertheless tend to maintain their regular shape though they are pressed in between these rods and in shape approach the Heliolitidan horizontal tabulæ. What these strings really are, becomes evident on inspection of transverse sections as in pl. VII fig. 7, 9. They form a coenenchyma of irregular tubes, which, however, do not continue downwards, but are interrupted. Further modifications of this kind of coenenchyma, somewhat related to that of Heliolites, are described in detail under the different species of Plasmopora. It only rests to signify a coenenchymal formation peculiar to this genus. Around the calicle (Pl. XI fig. 36, 37) is placed an area formed of twelve radii or costæ, as they also may be named as they are a direct continuation of the septa, outside the calicular theca, and it might be said that the whole is a sort of reduplication of the calicle as these radii are linked together at their exterior ends through a sort of theca, being composed of angular lines of the vertical element which continue nearly uninterrupted downwards and in a longitudinal section are seen to encircle the calicular tube on all sides as a zone, broader than the irregular coenenchymal tube. I propose to call this fine structure **aureola**, which is entirely wanting in the other genera of the Plasmoporinæ. It may be somewhat difficult to find it so clear and evident in

all as in Plasm. stella, the species which shows it most perfectly. It may be larger than the diameter of the calicle and it may dwindle away to the smallest dimensions as in Plasm. heliolitoides, but upon closer inspection it may always be detected.

A different vertical structure occurs in the genus Propora. If sections as fig. 16, 17, 18 etc. pl. x are compared we find that amongst the coenenchymal lamellæ vertical rods are embedded, tapering at both ends, narrow, without any perceptible, microscopical structure. These rods may be named **bacilli** in contradistinction to another class, the **baculi,** about which further on. These bacilli are always solitary and do not unite, as seen in the transverse section of them (fig. 16, 17) where they stand out as black, widely separated points and their tops project above the natural surface of the corallum (fig. 12). The **baculi** again (pl. IX fig. 42, 44, 46, pl. x fig. 3, 4, 5) are stouter, short and have a distinct microscopical structure. They are, to wit, composed of diminutive fibrillæ, which stand out on all sides, directed upwards from a central axis, which in some is visible as a white line, but generally is wanting and really imaginary as these fibrillæ radiate from a common starting point which has no peculiar structure, being only the interior extremities of the fibrillæ. In longitudinal sections, where they are so common, they have a pinnate appearance, the fibrillæ standing out on both sides like the beard of a feather. They are dispersed among the convex lamellæ of the coenenchyma, remote from each other (pl. x fig. 5) and their superior ends project as tubercles on the surface of the coral (pl. x fig. 3). I am not prepared to say that these bacilli and baculi are to be considered as spicula, but it is evident that they share their intimate structure with the thecal and septal sceletons of the plurality of recent and fossil corals.

Amongst the Plasmoporinæ the genus Diploëpora occupies a peculiar position. In the oldest strata or in the youngest stages of growth the coenenchyma is of the distinctest vesicular nature, quite as in the most simple Proporas, consisting only of convex lamellæ. But during the continued growth of the polypary (Pl. XI fig. 4) this sort of coenenchyma is supplanted by a quite dissimilar one, a dense stratum of baculi, closely packed together and of the same pinnate structure as the solitary baculi just described. Though sharing for the rest all the particulars of the other Plasmoporinæ it really forms a transition to the next category of coenenchyma.

3. The **bacular** coenenchyma. The small tribe of the Coccoseridæ has its coenenchyma composed of baculi (Pl. XI f. 33, Pl. XII f. 6) also of the general pinnate structure.

4. The **compact** coenenchyma. In the genus Pycnolithus (Pl. XI fig. 8, 9) the coenenchyma is a dense, homogenous mass, a little granular, longitudinally permeated by white lines being vestiges of the replenished tubuli.

In order to demonstrate the development of the coenenchyma of Heliolites and to explain its nature I have had recourse to initial stages of colonies which have only a few millimeters in length. Also a peculiar manner of gemmation of calicles on the surface of the polyparies has given good information. I have as yet not succeeded in finding a single polypierite, just in its initial stage, but, as shown pl. I fig. 25, one sufficiently small incipient colony gives good idea of the first beginning. It consists of the initial polypierite and of two others which have budded out from the coenenchyma.

The initial or parent polypierite has a length of 0,6 millimeters from the tip to the upper edge of the calicle and also a diameter of 0,6 mm. of the calicle. It is cornet-shaped [1] gaining rapidly in width from the obtusely pointed apex and is with its whole length affixed to the theca of a rugose coral. A blackish, glossy epitheca covers the outside, finely transversally wrinkled. It is evident that this young polypierite besides the epitheca, if there is any, consists of a comparatively thick theca and that in the beginning there are no septa. This is quite in accordance with the development of other Silurian corals, as I have described elsewhere [2] and as I hope to describe more in full at another occasion. In these the sceleton also is an empty tube without any traces of septa, which appear only a little later one by one. When VON KOCH says [3] that the theca probably always develops out of the septa, which unite with their exterior ends, he apparently only had the recent corals in view, being not aware of the proceedings amongst the palæozoic ones.

The smallest specimen of Hel. interstinctus which I have found with septa was a little above one millimeter in length and had five septa developed on one side of the nearly circular outline (Pl. 1 fig. 30). The tabulæ, in the beginning much concave, are not seen until higher up in the tube (Pl. 1 fig. 28). By longitudinal sections and also by direct observation on such specimens as figured on Pl. 1 figs. 25—28, is seen that the coenenchyma is commencing to develop only when the young primary polyp has gained somewhat in length and after the first septa have been secreted. It is to be remarked that this reticulate tissue in its beginning never is formed on the exterior or upper side of the polypierite but always on the lower edge of the calicle — that side on which it during the first stage of growth is reposing, affixed to a substratum. After a while the coral has abandoned the rampant mode of growth and continues in an erect direction.

Further to elucidate the formation of the coenenchyma we have to contemplate a peculiar variety of calicinal gemmation, which occurs on the surface of mature colonies of Heliolites and other genera of the family. In the figures 34 I—IV pl. 1, a series of sections is represented from one and the same calicle of Heliol. interstinctus showing its gradual transformations, of which more in detail below. Suffice here to say, that out of the tubular calicle, which has raised itself above the coenenchyma, a new coenenchyma has grown around its theca and that this coenenchyma becomes also circumscribed by a theca so that in this stage the corallum has two thecas, one interior and one exterior theca. The exterior theca through the increasing growth of the polypary envelops at last a great number of calicles with their surrounding coenenchyma and coincides or is identical with the thin film which generally has been called epitheca, but for which I would rather propose the name **coenotheca** as it is the common integument or wall of all calicles in a compound Heliolitidean coral.

[1] BERNARD, Journ. Linn. Soc. Zool. pt XXVI, 1898, p. 498, calls this initium of Alveopora an epithecal cup, but it is probable that this, like Heliolites and others, consists not only of epitheca but of several thin linings within the epitheca.

[2] Ueber die Gattung Prisciturben KUNTH 1889 Bihang. Vet. Akad. Handl., Bd 15 Afd. IV n:r 19 p. 4; and Beschreibung einiger Obersilurischen Korallen etc. 1896 p. 8, Taf. I fig. 9, 10, also p. 49, Taf. VIII fig. 110.

[3] Biol. Centralblatt II[r] Bd p. 588.

By these two different modes of growth we learn, first that the calicle of a Heliolitidean does for some time exist without any coenenchyma and secondly that this structure is a secondary growth and developed either from one side of the initial polypierite or all around a calicle, which by rising as a tube above the parent coenenchyma introduces the intracalicinar gemmation and thus for a time exists as a portion of a solitary individual. Consequently it belongs not exclusively to a compound coral. It acquires its character of a coenenchyma only when it embraces more calicles than the first, when such have been produced by it through gemmation. Before this happens it is something else.

It can be shown that the perfect homology to it is found in corals which never form compound corals, but continue single through their life. The figure 25 pl. XII represents the calicle of a Thecopsammia enlarged. The exterior ends of the numerous septa are dissolved into the dense, spinous and porous tissue which like a broad frame surrounds them and the interior of the calicle. This outer zone has been called wall by DUNCAN but I think that it is a structure quite out of the category of a wall. It is in intimate connection with the septa and there is moreover outside this zone an epitheca or rather a thin wall, because there seems indeed to be no real difference between these two names and I do not think that any one has really seen an epitheca covering a theca, so as to make out the difference between the two in juxtaposition. The calicle of many corals, recent and fossil, belonging to widely distant families, is in the same manner as this Thecopsammia provided with a broad marginal, flat plane from which the septa radiate towards the centre of the calicle. I have formerly [1] called this expansion »Gebräme», which word may be rendered in English with *border* or border-zone. I can not decide whether it in some way is identical with the often employed term »Randplatte», but I should think that it is not.

In several corals, as the palæozoic Ptychophylla which resemble Fungia, the septa are considerably dilatated exteriorly and form one of the largest borders. In the »Perforates» the outer ends of the septa vanish in the border zone as in Thecopsammia and Balanophyllia. If now a solitary coral of such a growth increases in width and then propagates through gemmation, this latter procedure will take place on the border. A new calicle is budding out of this spongy, loose substratum, is surrounded by a quite similar porous border and when at last several calicles have become placed in the same way near each other, they coalesce with their borders to a common mass, in which the calicles project from the now fully developed coenenchyma. This consequently arises from the coalesced borders of the calicles. It is the same with the Heliolitidæ.

In the figure 26 pl. XII a young colony of a Turbinaria is delineated growing on the surface of a dead coral of the same species. It is evident that the larger calicle has sometime been alone, surrounded only by its reticulate and spiny border, out of which later, when expanded sidewards, a new calicle has budded.

To apply this to the coenenchyma of the Heliolitidæ let us recapitulate and finish the description of the structure of an individual polypierite in that family. Its component parts are enclosed within a solid, imperforated wall. There cannot be the least doubt that the theca is the first formed part and that it for a while alone constitutes the whole

[1] RICHTHOFEN's China, Bd 4, p. 59.

sceleton of the polyp. It is quite certain that in the majority of the palæozoic corals and chiefly amongst the Rugosa[1] the theca is secreted before any septa are formed. The same is the case in composite colonies of Heliolitidæ, for instance in Diploëpora, where young calicles just beginning to sprout forth from the coenenchyma on the top of the branches show a narrow, smooth edge forming the circular wall without the least traces of any septa. By and by there are formed faint infoldings in the margin, becoming more and more distinct and assuming the shape of well developed septa with spiny edges. Pl. x fig. 32—35.

There are true septa, in no way homologous with the pseudosepta of Heliopora. They are without exception always and constantly twelve. They may be more or less perfectly developed or even totally wanting in some varieties as Heliol. decipiens, though their presence in some calicles of the same specimen indicates that they may have been present in all, but have been absorbed. In the pl. II figs 3—6 an illustration is given of this condition from several closely set calicles on the same surface of a Heliolites. The calicle, fig. 3, with complete septa, meeting in the centre, is evidently one of the oldest, being smaller, next, fig. 4, one with somewhat lesser septa, then, fig. 5, one with much reduced septa like those common in Heliol. interstinctus and at last, fig. 6, a calicle, like the plurality of the other calicles on the same surface, without any septa at all and giving the characters of Heliol. decipiens.

In some species of the genus Heliolites there are septa of alternating size (pl. II f. 29, Hel. porosus), as if indicating a tendency to form two cycles of six septa each. But we have as yet no evidence that the six longer septa have originated earlier or prior to the shorter ones, nor does the development, at least as seen in the coenenchymal gemmation, confirm this supposition.

The shape of the septa varies much as to the different tribes. Common to them all is that they are thin laminæ, intimately composed of minute, microscopic fibrillæ directed upwards and inwards. Pl. II fig. 35, pl. III fig. 2. They have consequently quite the same microscopical structure as the septa of almost all other corals and even concordant with the structure of all other vertical elements both of the Heliolitæ and others. In a longitudinal section of Heliol. porosus (pl. II fig. 35) this is very distinctly seen, where a calicular theca meets a theca of a coenenchymal tube and between them the dark line, which Miss Ogilvie calls centre of calcification, but the true nature of which is not explained by her suggestions. Next we have two figures (pl. II fig. 34, pl. III fig. 1) of transverse sections representing parts of calicles with septa and coenenchymal tubes. Each tube has a theca well circumscribed through a dark line, dividing it from the surrounding thecas. The theca and the septa of the calicle are coherent as a whole and separated from the coenenchyma through the dark line. The true colour of this line, in

[1] There is no valid reason, as it seems to me, at least in the present provisional state of our knowledge of the fossil corals, to abandon this name for those corals, which later authors have called Tetracorallia or Pterocorallia. The former name is not borne up by the structure, as the arrangement of the septa according to four primary ones is visible only in a few species. The denomination Rugosa again is most characteristic pointing to one of the chief distinctions of this group. There exist in none of them costæ, but the exterior longitudinal foldings of the wall coupled with the peculiar initial stages of growth separates them from all posterior corals.

all fossil and recent corals known to me is white or creamcoloured and it looks black only when seen through transmitted light.

The septa consist of two moieties with fibres tending in different directions and a narrow whitish partition line. If it is borne in mind that in most palæozoic corals the septa are secreted later than the theca and by the evidence given by the transverse sections figs. 33—34 pl. II and figs. 1, 23 pl. III it seems that it must be concluded that the septa of the said corals are dependencies of the calicular theca and offshoots of it and not *vice versa* that the septa form the theca. The smallest septum seen in fig. 33 pl. II, is without dividing line and has particularly the appearance of having originated from the theca. Sections of the septa nearly resembling those on my plates have been figured by SARDESON (Tabulaten p. 267) and by WEISSERMEL (Zeitschr. deutsch. Geol. Ges. p. 61, 63 fig. 3 & 4.) The latter author has given valuable remarks on the structure of the Heliolitidæ, some of which coincide with mine.

On the interior edge of the septal laminæ spines of unequal size are often formed growing in the same direction as the elementary fibrillæ and probably owing their origin to lacunæ left in the tissue of the septal laminæ.

In the Plasmoporinæ the laminæ are much reduced and consist chiefly of a series of spines and when these, as often happens, have been destroyed the interior side of the calicle has a fluted appearance through the twelve narrow longitudinal ridges, which serve as the basis of the septa. In some species, as in Propora conferta, the septa have been invested with a multitude of microscopic crystals of infiltred manganous or ferric oxide hydrate giving them a false and deceptive appearance. Such crystals also cover the upper surface of the tabulæ in several corals as for instance in Propora conferta (pl. VIII fig. 34). It is in some instances difficult to decide whether one sees organic structures, as aculæ, or crystals.

The longitudinal angular curves of the theca which stand out between the infoldings of it, give to weathered calicles, which like those of »Lyellia», project free from the coenenchyma, an aspect like the rugæ on the outside of the Rugosa and like the rugæ they have also been called »costæ» or »pseudocostæ» by some authors. Their position in relation to the septa is perfectly the same as in the Rugosa, the septa alternating with these rugæ. It must he left as an open question whether this similarity is a sign of relationship between the two groups or not. These rugæ of the Heliolitinæ can not be confounded with true costæ, as such really occur amongst the Plasmoporinæ.

In the centre of the calicle of Heliolites interstinctus a columella is sometimes formed. It is an isolated narrow, twisted plate. It is, however, not constant, but may dissappear for a while and then again is formed anew. A longitudinal section (pl. I fig. 15, 23) shows such changes.

The size of the calicular areas varies between 4 millimeters and a little less than 0,5 millimeter. Their shallowness presupposes a very small amount of animal tissues to fill them and probably the living mass covering the whole sceleton has been very thin.

The dissepiment of the calicles consists in all genuine Heliolitidæ of horizontal tabulæ, regularly distantiated or more or less crowded, horizontal or concave, seldom interlaced or crossing each other. At their point of contact with the theca sometimes a

sort of septal grooves is formed, very small and shallow, nearly reminding of those which are seen in some Favositidæ (pl. IX fig. 4).

The genus Camptolithus makes it evident that the convex lamellæ of the coenenchyma in the Plasmoporinæ are identical with the tabulæ of the calicular tube, by showing how the remarkably convex tabulæ of the calicle of that genus are transformed into the same sort of convex lamellæ as in the coenenchyma (pl. X fig. 29, 30).

To complete the description of the different parts of a single polypierite, amongst the Heliolitidæ, we may only remind of the above described coenenchyma and how it in the beginning of its formation is a »border-zone» around the solitary calicle, as the case is in the intracalicinal gemmation. Here it must, however, be remarked that Thecopsammia and Turbinaria, above given as instances, have only one theca enclosing both the border-zone and calicle together.

Now this condition of two thecas in Heliolites is very much in analogy with what obtains in solitary polypierites of several other palæozoic corals for instance in the genus Acervularia where a central area is enclosed within an interior theca[1] and around this a flattened border-zone contains the septal ends and the interposed dissepiment. That interior wall is formed by dilatations of the sides of the septa, in such a way that the dilatations from contiguous septa meet and join, thus building up a well marked annular area, enclosing the central ends of the septa. The exterior theca or the theca proper which, although very thin, envelops every individual polypierite in a compound Acervularia, clearly indicates that the exterior area can by no means be considered as extracalicinal or as an exotheca, it is indeed an endothecal structure.

Besides Acervularia we find other corals with a similarly formed interior theca, as Pachyphyllum and Smithia, but in these there exists no exterior limitation or exterior theca between the different polypierites and where the septa of neighbouring calicles meet they are confluent without boundaries and consequently form a coenenchyma between the central areas of the calicles. It may be said that a coenenchyma originates as soon as in a compound coral all exterior thecas which else separate the polypierites in a colony, have vanished.

In Acervularia there is no coenenchyma, as we have seen, because every polypierite has its own exterior theca. In such genera again as Arachnophyllum, Pachyphyllum and Smithia and several others there is a true coenenchyma in the same conception as in Heliolites. In such genera the coenenchyma must be strictly regarded as endothecal or calicinal. What in Heliolites from the beginning was the calicle proper has by the exorbitant development of the border-zone become but the central area of the polypierite. It ought then properly be called the interior area of the calicle, when the surrounding coenenchyma is the exterior, but for conveniences sake I have in the descriptive part of this memoir retained the name of calicle to designate it.

Hinde has objected[2] to my views on the analogy between the »cylindrical corallite», as he says, in Heliolites and Acervularia. In the former, he writes, the wall is too distinct and well defined to be compared with the »pseudowalls» of Acervularia. This

[1] Muraille intérieure H. Milne-Edwards.
[2] Geol. Mag. 1883 p. 87.

objection aims only at relative distinctions, at a quantitative degree of development and does not affect the quality. The comparison can be held up, whatever the affinities of Heliolites may be. It is moreover very easy to find in longitudinal sections of Acervularia that the interior theca is more strongly built than that of Heliolites. HINDE also says that there is no evidence that the tubules in Heliolites are produced by the extension outwards of the ends of the septa of the coral. Not to forget the evidence given by the intracalicinal gemmation and the statements of WENTZEL above referred to nothing is more fit to prove that extension than the conditions in the Plasmoporinæ. In almost all species of Plasmopora, for instance Plasmopora stella, Pl. XI, fig. 36, the septa continue in the most distinct manner outside the interior theca as costæ and often, as also in Propora, join the septa or costæ from surrounding calicles.

The view that the coenenchyma of the Heliolitidæ is an endothecal structure, although no exterior theca for every single polypierite is developed in the compound corals, is strengthened by what follows. It is a most important fact, that in some Heliolitidæ the confines of the individual polypierites are most distinctly conspicuous, though the exterior theca is wanting. The figure (pl. VI, fig. 23) of Plasmopora calyculata may be consulted for this feature. There the coenenchyma is partitioned off into regular polyedric spaces through softly elevated ridges, also of coenenchymatous structure, thus forming well circumscribed calicular areas having the small central area (h. e. the calicle proper) with the inner theca in the middle and a portion of coenenchyma around it. In some of the Heliolitæ from Gotland faint traces of dividing lines are discernible on the coenenchyma. In another way, as in some specimens of Heliol. interstinctus (decipiens) pl. II fig. 11, the areas of the single polypierites are well seen as small cones separated from each other through shallow grooves. LONSDALE has described[1] specimens of »Porites pyriformis» (= Hel. porosus) figs 4, 4*a* with regularly circumscribed calicular areas. It is also possible that Palæopora? favosa M'COY figs 3*c*, 3*d* pl. 1C of »Palæozoic Fossils» represents a Heliolites with distinct calicular areas. These figures belong to another specimen than that figured on the same plate as figs 3, 3*a*—*b*, which represent the genuine Heliol. interstinctus. In SALTER'S »Catalogue of the Cambridge Fossils» p. 104 a variety of a Heliolites is mentioned with »sunk pores» and also a »Heliol. variety with depressed areas at the cell mouths».

As a conclusion based on the above given statements and facts I cannot find how NICHOLSON'S hypothesis of the dimorphism of the Heliolitidæ is to be upheld. I have attempted to demonstrate that the coenenchyma, strictly considered, is the integral part of every calicle in a compound coral, as is most evidently shown by Plasmopora calyculata and that Propora, the near affinity of which with other Heliolitidæ cannot be denied, has a coenenchyma which lends no support to the hypothesis of Siphonozooids. Still more convincing proofs of the impossibility of this hypothesis are given below in treating of the coenenchymal gemmation.

Modes of growth of the coralla. The composite corals are much variable as to their shape. In some species it is constant, in others again much depending on now

[1] Notes on the age of the limestones of South Devonshire, p. 721 of Transactions Geol. Soc. London, vol. V, 1840, pl. 58, fig. 4, 4*a*—*f*.

unknown local circumstances, thus giving origin to local varieties, but for the rest coinciding in essential characters with other specimens of the same species.

The most common forms are the *discoid* and the *hemisphærical*, more or less vaulted on the superior, corallite bearing surface and with a flat basis. Near to this is the *lamellar* colony, forming thin, incrusting or free plates, as in several of the Coccoseridæ. Then *sphæroidal*, *globular*, *sub-globular* and irregularly *globular*, *tuberose* colonies, these varieties bearing calicles on all sides, without any epitheca. A few are *dendroid* or *arborescent* with flatly compressed or tumid branches, as Diploëpora. There are also some *pyriform* or *mushroomlike* colonies. A peculiar manner of growth is remarked in several discoid species of Heliolites and especially amongst the Coccoseridæ: as it were, superimposed tiers growing in such a manner that a part of a colony has been arrested in growth, the other mass continuing to grow and spreading sideways covers the extinct part, leaving however a free space between.

The epitheca which is chiefly developed in discoid varieties, is a very thin, blackish, often glossy coating, grown in concentric rugosities and in some instances with a structure of its own as in Acantholithus.

The size of the polyparia or colonies is much variable. At the largest I have found specimens measuring 30 centims. in diameter; but generally they are smaller. Some may have grown much larger, as may be seen from fragments. In the strata of Stora Carlsö they lie in their natural position, as they once lived on the bottom of the Silurian Sea, with the flat epitheca as basis.

Propagation. It is evident that the small colonies, consisting of a primary polypierite with beginning coenenchyma, described above, must have led their origin from an ovum, which being developed into a free, swimming larva affixed itself and secreted a polypary.

The propagation through *gemmation* is by far more frequently observed. There are in the Heliolitidæ three different kinds of it, viz. 1. **Coenenchymal** gemination. 2. **Intracalicinal** gemmation, and 3. **Epithecal** (or coenothecal) gemmation.

1. **Coenenchymal** *gemmation* (Pl. I fig. 32, I—IV, fig. 33, pl. II fig. 37, I—VII, pl. III fig. 27 I—IV, pl. V fig. 29 I—VII.)

The best instance of this has been found in Heliol. porosus, the procedure of which, as well as of other species, is given in detail further on in the descriptions. This procedure is by no means so schematically regular as BOURNE has stated.[1] He says »that the constant number of twelve pseudosepta in Heliolites is the necessary result of the formation of the calicles by the suppression of a group of seven central coenenchymal tubes and the arrested growth of the adjacent walls of the twelve cells surrounding the group». But even if it were so, this is not valid for the Plasmoporinæ, where, and more so in Propora, no reduction can take place in the coenenchymal tubuli as such do not occur, at least not so pronounced as in Heliolites. In the Plasmoporinæ the twelve septa are entirely new structures formed out of the coenenchymal lamellæ, I suppose nearly in analogy with the gemmation in Galaxea. In a certain way there is reduction, but not

[1] Heliopora coerulea p. 463 pl. 11 fig. 9.

to that extent as BOURNE postulates. There is reduction *and* new growth. The septa are not a result from the arrested growth of twelve environing tubuli, but from the altered growth of the central tubuli and they are not formed all at once. In stage III there are seven and in stage IV nine. Moreover in Heliol. interstinctus there are only nine tubuli in the beginning partaking of the gemmation.

Most interesting and remarkable is to find in the same specimen of Hel. porosus the seven stages of the progress of the gemmation and side by side with it a fully developed calicle which is changing step for step in a quite opposite direction or decaying, dying out by being by degrees changed again into coenenchyma, out of which it had originated, in the same way as the budding new calicle beside it. The particulars are given in the description of Heliol. porosus.

If meeting with a calicle like the left one in section five (pl. II fig. 37) alone, without connection with any precedent or subsequent stage, it must indeed be very difficult, if not impossible to decide whether it is a calicle in progress or in regress, so nearly do both these changes resemble each other. We can consequently say that a Heliolitidean calicle originates from the coenenchyma but also in decaying returns to coenenchyma.

In a manner quite contrary to the generating agency, as a destructive one, the coenenchyma invades the calicles immersed in it. Through its exuberant growth it sometimes encroaches upon the calicles, covers them and kills them. (See pl. I fig. 20, 21.) The struggle between the coenenchyma and the calicle is to be seen in such longitudinal sections as figured on plate IX f. 24 or more strange on pl. X fig. 23, where, if I understand it rightly, calicles have been overwhelmed by the coenenchyma twice and new calicles grown up as many times. If it be so, it is a new and curious instance of the observations that a part of an organism can subdue and annihilate a more important and central part. Generally the coenenchyma has been regarded as something alien to the calicles, as without any connexion with them. But we now see them in a continuous intercourse, in reciprocal action, the coenenchyma is an outgrowth from the calicles and the calicles on the other hand bud out from the coenenchyma.

This kind of propagation forms one of the most serious objections which militate against accepting the hypothesis of dimorphism in the Heliolitidæ, so eagerly contended for by NICHOLSON and his followers. Long before 1883 when my observations on the coenenchymal gemmation were first published in abstract,[1] I had seen this mode of propagation in Heliolites and Plasmopora and already in 1876 the first figures representing this process were drawn. During the voyage of »Challenger» MOSELEY in 1875 discovered a similar mode of gemmation in Heliopora and his observations were published the following year.[2] He says that »new calicles are developed by the arrest of growth of one or more cells (= coenenchymal tubuli) . . . . which . . . . form a central floor in the calicle». The appertaining figure (pl. 9 f. 17), however, shows, as it seems, in the bottom of the calicle several *intact* coenenchymal tubuli. In turning to specimens of Heliopora to consult them in this case, it is very easily seen that the calicles originate from the

[1] Obersilurische Korallen von Tshau-Tiën, in RICHTHOFEN's China. Bd 4, p. 50.
[2] On the structure of the Alcyonarian Heliopora coerulea etc. p. 99 & 120 in Philos. Tr. R. Soc. 1876.

coenenchyma. There are small shallow pits in its mass, with some three or five tubes in the bottom, of which one or two are of more considerable size than the rest. There is, no doubt, arrested growth of a few as MOSELEY says, while the surrounding tubuli continue to grow upwards around them, and in Heliolites again there is continued growth and great changes in the bottom of the new calicle. In my paper I said that »aus diesem (the coenenchyma) knospen neue Kelche hervor .... indem der neue Kelch sich aus mehreren Coenenchymröhren ausbaut.» I was however not quite exact in saying that it went on in the manner described by MOSELEY nor is the illustration, which was given there of plate VII fig. 9 to the point, as it is questionable whether this is not rather a decaying calicle or one overwhelmed by coenenchymatous growth as above described. Instead I hope that the sections given on plate II of this memoir will be more convincing. If now, as NICHOLSON pretended, Heliolites is a dimorphous colony with sexual and asexual individuals and that the latter form the coenenchyma, the strange and abnormal fact would here prevail, that a new sexual individual is budding out from the body of as many as nine or more asexual individuals, which all build it up. Not to further speak of the paradoxical of such a supposition it is enough to remind, that there does not exist in the whole animal kingdom any instance at all, that a single individual is formed as a direct offspring from several others, the bodies of which entirely contribute to its formation.

In the same year as I published my views in RICHTHOFEN's China, though somewhat later, VON KOCH in his memoir »Ungeschlechtliche Vermehrung Palæozoischer Korallen» expresses himself very cautiously about this question and does not with a single word mention my observations on what he later calls »Cönenchymknospung». What he says[1] is: »Gegen diese Ansicht (NICHOLSON's) hat Lindström verschiedene Gründe geltend gemacht, von denen mir einer, die Entstehung eines Hauptkelches aus einer grösseren Anzahl von rudimentären Polypen, als der wichtigste erscheint». Now this is somewhat ambiguously expressed. The origin of a calicle from a great number of rudimentary polyps was not one of my reasons, on the contrary I contested NICHOLSON's views on the ground that it was impossible to accept such a supposition.

In the »Zoologischer Anzeiger vol. I p. 103, 1878 (not 1881 as VON KOCH himself wrongly writes in »Ungeschlechtl. Vermehrung» p. 10) in a paper, intitulated »Notiz über die Zooide von Pennatula» he says »Ich habe nun bei der Betrachtung einer Anzahl von Exemplaren der Gattung Pennatula die Bemerkung gemacht, dass sich manchmal einzelne dieser Zooide wie in jeder Beziehung normale Polypen entwickeln». This observation was, as we shall see, most welcome to the adherents of the hypothesis of dimorphismus in Heliolites and they did not care for, that VON KOCH himself in his paper[1] expressly had said that the circumstance that the Siphonozooids of the Pennatulids many times change into genuine polyps is an objection against the dimorphismus, and likewise also the anatomy of Heliopora.

WAAGEN, no doubt seeing the impossibility of reconciling the view of the dimorphismus, to which he adhered, with the observations on the coenenchymal gemmation tried

[1] Ungeschlechtl. Vermehrung p. 10.

to evade this dilemma by a suggestion[1] which he deduced from VON KOCH's above mentioned observation on the transformation of the siphonozooids and he was supported by NEUMAYR.[2] WAAGEN says that the siphonozooid in transforming into an autozooid required much more room and »it might then well be imagined . . . . that . . . to make room for the new individual thus formed, the surrounding siphonozoids die and that the first sign of this beginning decay is just the thickening of the outer walls, which are destined to form together the wall of the new autozooid». Does this mean that the tubuli around the new autozooid are absorbed and that only their outer walls remain to form the theca of the new calicle?

For the rest the thickening of the theca, of which WAAGEN speaks, is by no means the beginning of the change in the coenenchyma, but on the contrary the last act of it. And if it were as WAAGEN says, we should see only one of the »siphonozooids» enlarge and most naturally the central one within the area affected. Instead, the tubuli there continue for a while of the same size, and then it may be two or three contiguous ones in the periphery which have grown larger.[3]

At last NICHOLSON, who in his works previous to the third edition of his Manual of Palæontology, published in 1889, does not make any mention of the coenenchymal gemmation, seems there, p. 334, hesitate to accept fully the interpretation of MOSELEY of what may be called polygenesis as he says that the conversion of a group of imperfect polyps into a single polyp is a »remarkable» phenomenon. Then he continues in the same manner as WAAGEN, that it is only a single siphonozooid which becomes converted into an autozooid.

There is now not much need to confute these statements since BOURNE, VON KOCH and others have demonstrated that there are no siphonozooids existant in Heliopora. BOURNE has,[4] though assuming the affinity of Heliopora with Heliolites, shown, as it me seems, upon clear evidence, that the coenenchymal coeca of Heliopora »are not of the nature of degenerate siphonozooids». Consequently no single autozooid could here develop out of one, still less of a plurality siphonozooids. Moreover, on account of its sceleton Heliopora must be considered as a highly aberrant member of the Alcyonaria.

2. *Intracalicinal gemmation.* Of this I have above at page 13 given notice and below in the description of Heliol. interstinctus (pl. I fig. 34, 35 and also pl. IV f. 15, pl. VIII fig. 28) all particulars. In a certain way it is a variety of the coenenchymal gemmation, as no new buds arise before the coenenchyma has been sufficiently developed around the raised calicle. And both sorts of gemmation have the common feature of originating out of the border zone. Its difference from coenenchymal gemmation consists in its originating first a coenenchyma within the tubularly elongated calicle, then out of this new calicles.

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[1] Palæontologia Indica, Sect. XIII, Productus limestone Fossils p. 906.

[2] Thierstämme p. 331.

[3] I cannot find how my observation that the polypierite and the calicle proper in incipient colonies are formed before the coenenchyma can not the least, as WAAGEN seems to think, support a supposition of his that the coenenchymal tubes (= »mesopores») are the first and that the »large tubes» in Fistulipora are developed out of them. I did not occupy myself with the Fistuliporæ and the reality in Heliolitidæ is in direct contradiction to what he says.

[4] Structure and Affinities of Heliopora coerulea, 1895 p. 472—473.

3. *Epithecal* (or coenothecal) *gemmation.* As an indication of the propagating faculty of the epitheca I would consider such features as shown on pl. VII f. 11, pl. VIII f. 17, in which calicles go out directly from the epitheca on which they are based. The integument which once covered and secreted the epitheca, also through its vitality procreated independant calicles. These are as if truncated at their starting point and of the same width as the rest of the calicinal tube.

The natural limits of the Heliolitidæ.

Having in the preceding section characterized the Heliolitidæ I will now review such genera which by some authors have been from time to time ranked amongst them, stating my arguments for not considering them as members of this family of corals. In thus eliminating them from the Heliolitidæ I will examine these genera one by one, taking them in alphabetic order.

Great confusion has arisen because superficial analogies or presumed identity of quite different structures have been considered as homologies. Thus, to give one instance, Bryozoans like Monticulipora, Fistulipora and others, Favositidæ and several other corals have been stated to be nearly related to the Heliolitidæ or to belong to their family. It is necessary to bear in mind, that these form a well defined and clearly circumscribed group of fossils. Of very little value as a distinction are the tabulæ, these partitions which occur in widely different groups of animals. Cephalopoda, Gastropoda, Conularidæ, Annulata, Bryozoa and Foraminifera share this structure with the Corals. There are, however, slight variations, which make it possible to distinguish between the tabulæ of the Corals and those of the Bryozoa, of which particulars will be given below.

Axopora M. Edw. & Haime, H. N. Cor. III p. 243 by them placed amongst their Milleporidæ, next to Lyellia as occurring in the Eocene formation near Paris and London. It is said that the coenenchyma is reticulated and spongy and that the septa are rudimentary. In the detailed description of the two principal species again it is said, that there are no septa at all. Some years later Duncan in Supplem. to Brit. Foss. Corals described two species and these have absolutely no septa. Zittel (Palæozoologie I p. 288) has placed it amongst the genuine Milleporidæ and this seems to me to be its true affinity.

Battersbyia M. Edw. & Haime from the Devonian of England, which by these authors was classed as one of the Heliolitidæ, has through the researches of Duncan [1] been recognized to be one of the *Astræidæ*, the supposed coenenchyma being only a parasitic incrusting Stromatopora. Ferd. Roemer [2] again regards it as a Rugose Coral. At all events there is nothing to justify its being ranged with the Heliolitidæ.

Calapœcia Billings (derived from *καλός*, beautiful and *ἀποικία* colony, consequently not to be written as Calopœcia or Calapæcia as some authors do). Through examination

[1] Philos. Transact. vol. 157 p. 648.
[2] Leth. palæoz. p. 415.

of original specimens I am convinced that the genera Columnopora NICHOLSON, Houghtonia ROMINGER and probably also Lyopora NICHOLSON & ETHERIDGE are identical with this genus and consequently superfluous. ZITTEL and SARDESON have numerated it amongst the Heliolitidæ.[1] I do not think that it belongs there in spite of some superficial similarity. As it is provided with a perforated theca, with an unstable number of septa, twenty or more and less, and a quite different sort of coenenchyma, I cannot regard it as one of the Heliolitidæ according to my conception of this family. It reaches from the highest Lower Silurian to the lowest beds of the Upper Silurian and has a very wide geographical distribution from Canada and North America, England, Norway, Dalecarlia and Gotland in Sweden, Esthonia to the middle Tunguska river in Sibiria.

Columnopora, see Calapœcia.

Cyrtophyllum, LINDSTRÖM, Silurische Korallen aus Nord-Russland und Sibirien in Bihang till Svenska Vetensk. Akad. Handl. Bd 6, N:o 18 p. 17, fig. 1—2. SARDESON (Tabulaten page 276) has, inadvertently calling it Cyathophyllum, placed it with Plasmopora from which genus, as well as from all other Heliolitidæ it is widely different through its numerous, about forty septa, through its peculiar and characteristic tabulæ. I have placed it as nearest to Acervularia. The outlines of the polypierites are very clear and defined and there is seldom much coenenchyma between them.

Fistulipora. Concerning this, as well as other fossils, rather to be regarded as Bryozoa, I have given some details below in treating of the affinities of Heliol. decipiens.

Haimeophyllum BILLINGS. ZITTEL (Palæozoologie I, p. 213) enumerates this devonian genus amongst the Heliolitidæ. On examination of specimens, which BILLINGS himself once sent me, I can not find the least to justify its affinity with Heliopora or Heliolites. There is no coenenchyma, there are about forty septa and the thecæ are perforated by oscula, like those of the Favositidæ. The calicles are filled with a dissepiment, like that in the Cystiphyllidæ.

The name of this genus ought not to be retained any longer as it is quite identical with Chonostegites M. EDW. & H., founded by them in 1850. Their Chon. Clappi is indeed the same fossil as Haimeophyllum ordinatum BILLINGS (first described 1859), as I have learnt by comparing specimens of both. It is not likely that it is related to Michelinia as some American authors think.

Halysites. In a paper in Annals and Mag. Nat. Sciences 1876 I placed this genus amongst the Heliolitidæ on account of the similarity in structure as observed in longitudinal sections. Further there is an apparent homology with the coenenchyma through the intercalicinal tubes. But as the mode of growth of the Halysitæ is so peculiar, it may at present be left as a type for itself.

Heliopora, BLAINVILLE. No other coral has been so often and so eagerly compared with Heliolites as this and yet, I think, that a closer investigation will prove, that there is very little of a real affinity between them. Too much stress, as to their differing,

[1] I myself also in a paper on the Tabulata in Ann. mag. N. Hist. 1876 vol. II p. 16 ranged this genus with the Heliolitidæ along with Thecostegites, Halysites and with some doubt Thecia. But further researches have lead me to abandon this view.

may, however, not be laid on the total absence of all connecting links between these genera from the end of the middle Devonian to the Recent times.

Several fossil corals have been called Heliopora, which on closer inspection by no means can be considered as such. MILNE EDWARDS and HAIME referred to Heliopora two species from the Cretaceous strata of Gosau, which REUSS had described as belonging to his genus Polytremacis. They had better to be left there, as may be found by studying the beautiful figures of REUSS.[1] Whatever they may be, they are certainly no Helioporæ. The same is the case with Heliop. deformis MICHELIN, which fossildealers send under that name from the tertiaries of Auvers in France. QUENSTEDT[2] has described and figured a Heliopora bipartita from Berchtesgaden. From the figures to judge he has commingled two different species, none of them a Heliopora. In one (fig. 14) the two opposite septa of the first order, (because they must be genuine septa), have coalesced with a little columella in the centrum. The other form, Heliop. var. sparsipora (fig. 19), differs so completely that it must be assumed it belongs to another genus than the former. If there now is no evidence of fossil Heliopora we have to take the recent Hel. coerulea into consideration as the only species known.

Several authors, as HINDE, NEUMAYR, WENTZEL etc., have already denied all alliance between Heliopora and Heliolites.

As NEUMAYR has well pointed out there are no true septa. The short, blunt spines, which surround the edge of the calicle, are nothing else but the same sort of echinulations which stand up on the coenenchyma between its open tubes and are only continuations from the core or nucleus, the string which forms the centre of the rods, that make up the whole of the corallum. This central string which evidently is the oldest part of the rod, as it grows in advance of the ambient tegument, is of a splendid cream colour, which by transmitted light looks black. It is enclosed by a mass of pale, blue-greenish calcite fibrillæ, growing out from it upwards in an acute angle. These rods meet from opposite sides around the calicles and the coenenchymal tubes and at the meeting-point they have a jagged outline. A feature in Heliopora, which decidedly removes it far from the Heliolitidæ is the total want of a calicular theca. The pseudosepta or rather the tubercles around its rim are not in any way connected with each other, nor do they grow out from any theca as in the Heliolitidæ.

There is no ground for the statement that the calicles of Heliopora as a rule are surrounded by twelve such pseudosepta, as in Heliolites. In one and twenty calicles I found the number of the pseudosepta to be as shown in the annexed table.

Number of calicles	2	2	2	4	3	5	1	2
Number of septa in each . .	10	11	12	13	14	15	16	17

As BOURNE remarked before me fifteen seems to be the most prevalent number.

[1] Denkschriften der K. K. Akad. der Wissenschaft. vol. VII, pl. 24. — ZITTEL Palæozool. I, p. 212 also has given figures of »Heliopora» Polytremacis Partschi partly copied from REUSS and partly (f. 122 a) new, differing from the figures of the latter especially as to the coenenchyma. The longitudinal section clearly shows the difference from Heliopora.

[2] Petrefact. Deutschlands p. 154, pl. 149 fig. 14—19.

Every one of these pseudosepta is continued downwards by a narrow, not much prominent ridge, the interior wall of the calicle being consequently fluted, as it were, through quite as many grooves as there are ridges or pseudosepta round the aperture. The ridges are regularly provided with short knobs.

The tabulæ in the calicles, as well as in the coenenchymal tubes are by far not so numerous as one could think by the figures given by several authors. They are very thin, concave and situated at a great distance from each other and moreover often deficient in the most narrow coenenchymal tubes.[1]

Houghtonia, see Calapoecia.

Lyopora, see Calapoecia.

Millepora L. Much needs not to be said concerning this genus, since the discoveries of AGASSIZ and MOSELEY have shown that it is a Hydrozoon and their views have been accepted by all authors.

Polysolenia REUSS in »Reise der Novara. Geologischer Theil» 2r Bd, p. 172, Taf. 2, fig. 3. — This fossil coral, which ZITTEL regards as one of the Helioporidæ, and consequently according to his views as nearly related with Heliolites, was found in the tertiary formation of Java and by its founder compared with Polytremacis and Heliopora. The calicles have eight constant septa, seemingly in two cycles of four septa each, the coenenchyma consists of circular tubes with thick walls and are traversed by regular, horizontal, though scarse tabulæ. In the calicles, if I understand the section fig. 3*d* rightly, the tabulæ are more numerous and intersected by the septa. Thus far, as the figures show. In the descriptive letterpress, however, REUSS tells that there are no »Quersepta», and that the walls of the coenenchymal tubes are perforated through »Quercanäle» (traverse tubes). It seems, however, that he has mistaken the tabulæ for tubes and that he thinks the loculi between the septa to be the septa themselves. By what now has been stated, concerning its structure, sufficiently is shown that this genus by no means can be considered as related to the Heliolitidæ.

Polytremacis D'ORBIGNY. I cannot find that this author ever gave a clear definition of this genus. It seems that he considered Pol. Blainvilleana (Heliop. Blainvilleana MICHELIN Iconographie p. 27 fig. 6*a*—6*b* not fig. 8) as the type species as he mentions this first. MILNE EDWARDS & HAIME, who follow him, say that the septa in this genus are well developed and so large that they nearly meet in the centre of the calicles, but this is not the case in any of the species known, excepting that which REUSS, according to my view, wrongly called Pol. Blainvilleana and which if exactly figured can not possibly belong to this genus.[2] All the others have short septa and the surface is as in a Heliopora. That remarkable coral again has according to the figures of REUSS twelve regular, equalsized septa, stretching near to the centre surrounded by a tubular coenenchyma with horizontal tabulæ and the calicles have concave tabulæ, the whole thus giving a real Heliolitidean appearance. But when we turn to the printed description it is stated that

[1] BOURNE (Heliopora) remarks on the difference in the propagation of the coenenchymal tubes in Heliolites in opposition to that of Heliopora and Favosites. — Favosites can scarcely be brought in comparison with these as there is no coenenchyma.

[2] Wiener Denkschriften vol. 7 (1854) pl. 24 fig. 4—7.

the septa (»Radiarlamellen») are between 8—14. Evidently there are several quite different species and even genera commingled under the name of Pol. Blainvilleana. The other forms have short, numerous septa and the surface resembles that of Heliopora. MICHELIN's Hel. (Polytremacis D'ORB.) Blainvilleana can scarcely, if we may judge by his obscure figures, be identical with the homonym species of REUSS and they cannot be retained in the same genus. MICHELIN's species which is provided with a greater number of septa is probably identical with the Heliopora Blainvilleana of QUENSTEDT (Petref. Deutschl. p. 901, pl. 170 fig. 30) which this author also thinks is the same as REUSS' first species Polytr. Partschi. As I have not been able to examine their specimens, I must leave this for other authors to decide. It seems, however, doubtful whether Polytr. Partschi REUSS with its peculiar broad, collarlike circle of septa or pseudosepta and its starry coenenchyma can be identical with Polytr. Blainvilleana MICHELIN & QUENSTEDT. Polytr. macrostoma, the third species of REUSS may also be generically different from the others.

I have had some few specimens of two species kindly sent me from Dr LAUBE in Prag, one called P. Partschi REUSS,[1] the other P. Blainvilleana, none of them corresponding with the descriptions or figures of REUSS, though that which is denominated Pol. Blainvilleana comes near to Pol. Partschi of REUSS. Both have a great number of short pointed septa, amounting to between 30—40 in the larger calicles, and continuing outwards in connection with the coenenchyma. This is quite different in both: reticulate, open tubes, Heliolites-like in P. Partschi, spiny or warty in P. Blainvilleana. In a horizontal section of the latter small narrow tubes, somewhat arranged in lines or series lie imbedded in a thick mass, which in a longitudinal section is composed of rods, baculi, the former species has some scarce tabulæ in the narrow tubes. I have examined a specimen sent from the Geologische Reichs-Anstalt in Wien with the denomination Polytremacis Blainvilleana with the number of septa varying from eight to twenty; tabulæ in the calicles and the coenenchymal tubes; the coenenchyma on the surface with small points or also smooth.

To sum up, if a genus ever was in need of revision it is this, and untill this has been executed by somebody provided with sufficient material to accomplish the research, we may suspend our final opinion as to the systematic position of it and in the meanwhile keep it apart from the Heliolitidæ.

Stylophyllum REUSS is by ZITTEL enumerated as one of the Helioporidæ along with the Heliolitidæ. The description and figures of REUSS[2] show that it is a most abnormal coral, without any coenenchyma at all and with a great number of septal spines in irregular rows and vesicular tabulæ and that it consequently does not show any affinity with the Heliolitidæ.

[1] It may here be remarked that the figures of Heliopora Partschi, p. 212 ZITTEL Palæozoologie, belong to widely different species. Figure 122*b* is evidently a reproduction of fig. 7 pl. XXIV of REUSS' memoir in Wiener Denkschriften vol. 7 and by him intended to represent a longitudinal section of Polytrem. Blainvilleana. But this species, as stated above, more Heliolitidean than any, cannot be a Heliopora, nor a Polytremacis, and must form a new genus. A longitudinal section of Heliopora, as well as of Polytremacis is quite different. NEUMAYR in his »Stämme» pag. 305 has again reproduced the figure of ZITTEL and names it simply »Heliopora» and he describes it also as representing the living Heliopora, what is highly misleading. The fig. 122*a* should represent Heliop. (Polytremacis) Partschi, but the indistinctness of its execution allows no decisive opinion of what species it really is.

[2] Wiener Denkschriften, 1854 vol. 7 p. 132 pl. XXI fig. 1—3.

Tetradium, DANA. NICHOLSON[1] says that Tetradium presents a very striking resemblance to Heliolites in the form of the septa, which he considers as pseudosepta. On the same account many other corals, not so dubious as Tetradium, might also be classed as allies to Heliolites.

BOURNE[2] says that Tetradium minus resembles Heliolites in the »close approximation of its corallites, in the possession of tabulæ» and the pseudosepta. I cannot find that there is the least resemblance between these two genera in the position of the »corallites» (? = calicles), as in Heliolites the calicles are more or less distantiated through the intervening coenenchyma, in Tetradium, on the contary, the calicles are entirely contiguous without the least traces of any coenenchyma. The »possession of tabulæ» is a character which is shared by such a diversity of not else allied corals that it is of no value at all for pointing out any affinity between those two genera and the same is also the case with the septa. The regularity and the constancy of the twelve septa in Heliolites in contradistinction with the characteristic four septa in Tetradium must moreover exclude all ideas of any affinity between them.

Thecia, GOLDFUSS. As to the pretended affinity of this genus with Heliolites it may be enough to remind that the calicles have no interior theca and are confluent with each other, communicating through an abundant system of horizontal tubes lying in consecutive series above each other, in a longitudinal section giving the appearance as of oscula, like those in the walls of Favosites. The septa are irregular and of a varying number. The tabulæ are thin and scarce, sometimes arranged like those of Cystiphyllum, in a few instances regular. Consequently I cannot consider Thecia as a member of the Heliolitidæ.

Thecostegites, EDW. & H. Having lately through the kindness of M. D. OEHLERT been enabled so examine specimens of Thec. Bouchardi E. H., I have found that I formerly was mistaken in supposing its affinity with the Heliolitidæ (Ann. Mag. Nat. Hist. 1876, vol. II, p. 16). It has tabulæ as the Syringoporæ and a few tubelike connections between the calicles; the calicles are in many instances closed with a pseudooperculum as in several Favositæ and the connecting »plateaus» are not of the nature of a coenenchyma.

The now revised genera being, on reasons alleged, eliminated from the close affinity of the Heliolitidæ, this family consequently retains of the previously known genera only the following ones, viz.

Heliolites, DANA.

Plasmopora, MILNE EDW. & HAIME.

Propora, LONSD.

Diploëpora, QUENSTEDT.

Lyellia, M. E. & H. (if it really is an independent genus).

Further I have appended the family of the Coccoseridæ to the Heliolitidæ as nearly related on account of their regular and consimilar septal formation, their mode of

[1] Tabulate Corals p. 234.
[2] Heliopora p. 469.

gemmation, and also in some degree of their coenenchyma. They have indeed by some authors been mistaken for and described as true Heliolitidæ.

As to the affinities of these groups with other corals I cannot at present find any other palæozoic allies. In regard to the often pretended proximity of the Favositidæ and the Heliolitidæ I have tried to show further on, in the description of Heliol. decipiens that there exist fundamental dissimilarities between these two groups.

Distribution.

Geographical and geological.

The genera of this family have a world-wide distribution, as well as some of the species. In almost all countries where Silurian and Devonian strata have been searched for them, they have been found. Not to mention Europe and the United States of North America, they have been discovered in the farthest boreal parts of North America and Canada, in China, in Sibiria, in Niti in the Himalayan Mountains, in the Caucasian Alps and in Australia.

The space of time during which they existed, as far as at present known, extends between the uppermost beds of the Lower Silurian (none being found below the Bala beds of England or the Wesenberg strata of Estland), and the Lowest beds of the Upper Devonian formation, after which time all traces of them are lost and they have probably become extinct, and if, as I have stated above, the supposed allied corals in the cretaceous strata and the recent Heliopora do not link them together, there seems not much hope left to rely on the imperfection of the geological record for explaining their non presence. The Scalpella found in the Upper Silurian of Gotland having no direct relatives before the cretaceous times form a most striking instance of the validity of accepting such an imperfection. But it fails in regard to the Heliolitidæ. There is only according to Reuss' descriptions of the Gosau Corals a single species, his Polytremacis Blainvilleana, which in a most deceiving manner shows the characters of the Heliolitidæ. If this in reality is to be regarded as a survival of the Devonian Heliolitidæ or not, must at present be left undecided, as it seems to stand so isolated and as we must wait for more ample proofs.

As to the statement of Milne-Edwards and Haime (British Foss. Corals, Mountain limestone p. 152) of a Carboniferous Propora, some remarks are to be found in the end of the descriptions of that genus.

The Heliolitidæ are most numerous in the Upper Silurian strata and more so in the northern region of Siluria. In the Lower Silurian beds the Plasmoporinæ and the Coccoseridæ prevail, the Heliolitinæ proper thrived chiefly in the Upper Silurian times. The Coccoseridæ which are so nearly related to the Heliolitidæ are in the main confined to the Lower Silurian strata, and only a few remains have been discovered in the lowest Upper Silurians.

Some of the Lower Silurian Heliolitidæ have the distinguishing feature of a scarce coenenchyma and of closely placed calicles. This may perhaps, taken together with the development of the polypary of Heliolites, indicate a lost stage of early or ancestral forms of Heliolitidæ in which there was no coenenchyma at all developed and that this came in by and by.

The stratigraphical occurrence of the species is as follows, more detailed notes are given in the special descriptions.

Exclusively Lower Silurian.

Heliolites hirsutus n.
Proheliolites dubius Fr. Schmidt.
Propora bacillifera n.
Prop. cancellata n.
Coccoseris Ungerni Eichw.
» microporus Eichw.
» megastoma M'Coy.
» var. minor.
» micraster n.
Protaræa vetusta J. Hall.
Acantholithus lateseptatus n.

Common to Lower and Up. Silurian.

Heliolites interstinctus L.
Hel. parvistella F. Roem.
» var. intricatus.
Propora tubulata var. Lonsd.
» conferta E. H.
Acantholithus asteriscus F. Roemer.

Only Upper Silurian.

Heliolites Barrandei var. spongodes.
» fasciatus n.
» repletus n.
» Liljevalli n.
Cosmiolithus ornatus n.
» halysitoides n.
Plasmopora petaliformis Lonsd.
» foroensis n.
» calyculata n.
» var. tuberosa n.
» scita E. H.
» follis E. H.
» stella n.
» scala n.
» rosa n.
» suprema n.
» rudis n.
» heliolitoides n.
» reticulata n.
Propora tubulata Lonsd.
» conferta var. minima n.
» euryacantha n.
» speciosa Billings.
» compacta n.
» ambigua n.
Camptolithus papillatus Roming.
Diploëpora Grayi E. H.
Pycnolithus bifidus n.

Common to Upper Silurian and Devonian.

Hel. interstinctus L.
Hel. Barrandei Penecke.

Only Devonian.

Heliolites porosus Goldf.

In this memoir fourty-six species and varieties have been described, but of course this does not comprise all hitherto known of which several must be classed as synonyms to older. Nevertheless the following list of the distribution of the Heliolitidæ must of necessity be very incomplete in as far as it treats of other countries than the northern and no doubt a greater number is to be found in extra European countries, of which I have had no notion.

Sweden.

Scania.

Heliolites interstinctus-decipiens M'Coy.

Westergötland.

Propora conferta E. H.

Isle of Öland.

Heliolites hirsutus n.
Propora conferta E. H.
Propora bacillifera n.
Propora sp.
Coccoseris megastoma var. minor.

Östergötland (Borenshult).

Propora speciosa BILLINGS.

Isle of Gotland.

Heliolites interstinctus L.
» Barrandei PENECKE.
» var. spongodes n.
» parvistella FERD. ROEM.
» var. intricata n.
» fasciatus n.
» repletus n.
» Liljevalli n.
Cosmiolithus ornatus n.
» halysitoides n.
Plasmopora petaliformis LONSD.
» foroensis n.
» calyculata n.
» var. tuberosa n.
» scita E. H.
» stella n.
» scala n.
» rosa n.
» suprema n.
» rudis n.
» heliolitoides n.
» ? reticulata n.
Propora tubulata LONSD.
» euryacantha n.
» conferta E. H.
» var. minima n.
» speciosa BILLINGS.
» ? ambigua n.
Diploëpora Grayi E. H.
Pycnolithus bifidus n.

Dalarne (Dalecarlia).

Proheliolites dubius F. SCHM.
Propora conferta E. H.
» bacillifera n.
Coccoseris micraster n.
Protaræa vetusta J. HALL.
Acantholithus asteriscus FERD. ROEMER.

Jemtland.

Heliolit. interstinctus L.

Norway.

Heliolites interstinctus L.
» parvistella FERD. ROEM.
Plasmopora stella n.
Propora bacillifera n.
Prop. conferta E. H.
Coccoseris Ungerni EICHW.

These species I have examined myself in original specimens and besides KIÆR in his »Faunistische Uebersicht des norwegischen Silurgesteins» enumerates the following species, some still undescribed and possibly identical with some of the above enumerated.

Plasmopora primigenium K.
» ramosa n.
Proheliolites dubius F. SCHM.
Plasmopora parvotabulata K.
Plasmoporella convexotabulata K.
» connexotabulata K.
Heliolites intricatus var. lamellosus LM.
Plasmopora stellata K.
» intercedens K.
» Andersoni NICH. & ETH.

England.

Heliolites interstinctus L.
» porosus GOLDF.
» parvistella F. ROEM.
Plasmopora petaliformis LONSD.
» calyculata n.
» scita E. H.
» stella n.
Propora tubulata LONSD.
» speciosa BILL.
Diploëpora Grayi E. H.
Coccoseris megastoma M'COY p. p.

Estland (Esthonia).

Hel. interstinctus L.
» parvistella F. ROEM.
» hirsutus n.
Proheliolites dubius FR. SCHM.
Propora tubulata LONSD. var.
» conferta E. H.
» cancellata n.
» bacillifera n.
Diploëpora Grayi E. H.
Coccoseris Ungerni EICHW.
» microporus EICHW.
Protaræa vetusta J. HALL.
? Acantholithus lateseptatus n.
» asteriscus F. ROEM.

Bohemia & Austria.

Hel. interstinctus L.
» parvistella F. ROEM.
» Barrandei PEN.
Propora tubulata LONSD.

Germany.

Hel. porosus GOLDF.

France.

Hel. porosus GOLDF.
» interstinctus L.

Italy (Alpi carniche).

Hel. porosus GOLDF.
» interstinctus L.

Belgium.

Hel. porosus GOLDF.

United States (N. Am.).

Heliolites interstinctus L.
» Barrandei PEN.
» parvistella F. ROEM.
Plasmopora scita E. H.
» follis E. H.
Camptolithus papillatus ROMING.
Protaræa vetusta J. HALL.

Canada.

Propora conferta (= affinis BILL.).
» speciosa BILL.
Protaræa vetusta var. major.

Arctic regions N. Am.

»Heliolites porosa», »Hel. megastoma», both probably Hel. interstinctus.

North Russia.

Hel. interstinctus L.
Propora compacta n.

Caucasus.

Hel. porosus GOLDF.
» solidus & concentricus ROMANOWSKY probably synonyms to the former.

Siberia.

Hel. interstinctus L.
Propora conferta var.
» compacta n.

China.

Hel. interstinctus L.
Propora conferta var.

Himalaya (Niti).

SALTER, in Palæontology of Niti 1865, p. 51 has a Heliol. depauperata Pl. 5 f. 5 which is an imperfect fragment with some calicles, uncertain whether a Heliolites at all.

Australia (N. S. Wales).

Heliolites Daintreei ETH.
Heliolites plasmoporoides described by R. ETHERIDGE jr. I am not sure of their affinities as I have not seen them. De KONINCK in his »Recherches sur les fossiles paléozoïques de la N. Galles du Sud» enumerates the following species.
Heliolites porosa GOLDF.
Heliolites megastoma MAC COY.
Hel. Murchisoni E. H.
Propora tubulata E. H.
Plasmopora petaliformis LONSD., but there is no evidence that the identification is justified.

A systematic Synopsis of the species described.

Fam. Heliolitidæ.

The corals appertaining to this family as well as the nearly connected one, the Coccoseridæ, are chiefly distinguished by their twelve regular septa, by the individual polypierites composed of an interior area enclosed within an inner theca and of an exterior area without any separating wall for each polypierite and forming a differently shaped coenenchyma

Of systematic essays published in the latest years upon the Heliolitidæ may be mentioned first that of SARDESON in his memoir »Beziehungen der fossilen Tabulaten zu den Alcyonarien» p. 353. His Suborder Helioporidæ embraces the families Heliolitidæ, Plasmoporidæ and Halysitidæ. Of these the first corresponds with my Heliolitinæ if Polytremacis, Heliopora and Sarcophyton be excluded. With my Plasmoporinæ his Plasmoporidæ agree in so far as the genera Plasmopora and Propora are concerned. Lyellia, Pinacopora and Houghtonia are to be removed as they partly are synonyms with other genera and partly belong to other families. His third family has certain features resembling those of the Heliolitidæ but the homology is not ascertained.

The latest attempt towards a systematic arrangement of this group is by Prof. FRECH in »Neues Jahrbuch für Mineralogie» etc. 1897 p. 214. We there have the order Heliolithoidea with the families Heliolitidæ, Plasmoporidæ and Fistuliporidæ.

I propose to subdivide the Heliolitidæ and the Coccoseridæ in the following manner.

Tribus I. **Heliolitinæ.**

Septa thin, coherent lamellæ, coenenchyma of polygonal tubes.

Genus 1. *Heliolites*. DANA.

Coenenchyma monomorph.

Species 1. interstinctus L.
- 1 *a*. var. decipiens MAC COY.
2. porosus GOLDFUSS.
3. Barrandei PENECKE.
4. var. spongodes n.
5. parvistella FERD. ROEMER.
6. var. intricatus n.
7. hirsutus n.
8. fasciatus n.

Species 9. repletus n.
10. Liljevalli n.

Genus 2. *Cosmiolithus* n.

Coenenchyma dimorph, thick walls, narrow tubes.
Species 11. ornatus n.
12. halysitoides n.

Genus 3. *Proheliolites.* KIÆR.

Coenenchyma scarce, septal spines directed downwards.
Species 13. dubius FR. SCHMIDT.

Tribus II. **Plasmoporinæ.**

Coenenchyma vesicular, theca thick.

Genus 4. *Plasmopora.* E. H.

Calicle with an »aureola», coenenchyma in its structure intermediate between vesicular and tubular.
Species 14. petaliformis LONSDALE.
15. foroensis n.
16. calyculata n.
17. var. tuberosa n.
18. scita E. H.
19. follis E. H.
20. stella n.
21. scala n.
22. rosa n.
23. suprema n.
24. rudis n.
25. heliolitoides n.
26. ? reticulata n.

Genus 5. *Propora.* E. H.

Coenenchyma chiefly vesicular, no aureola.
Species 27. tubulata LONSD.
28. euryacantha n.
29. conferta E. H.
30. var. minima n.
31. cancellata n.
32. speciosa BILLINGS.
33. compacta n.
34. bacillifera n.
35. ? ambigua n.

Genus 6. *Camptolithus* n.

Instead of tabulæ the calicles are provided with a vesicular tissue like that of the coenenchyma.

Species 36. papillatus ROMINGER.

Genus 7. *Diploëpora*. QUENST.

Coenenchyma partly vesicular, partly bacular.

Species 37. Grayi E. H.

Tribus III. **Pycnolithinæ.**

Genus 8. *Pycnolithus* n.

Coenenchyma dense or compact, of granular texture.

Species 38. bifidus n.

Subfamily **Coccoseridæ.**

Septa short, thick, central area of the calicle filled with columnar baculi the pointed tops of which form papillæ on the bottom of the calicle. Coenenchyma bacular with no or narrow tubes, in which few tabulæ.

Genus 1. *Coccoseris*. EICHWALD.

The sclerenchyma entirely composed of baculi, no tabulæ.

Species 1. Ungerni EICHW.
2. microporus EICHW.
3. megastoma M'COY.
4. var. minor n.
5. micraster n.

Genus 2. *Protarœa*. E. H.

Thin, incrusting coral, sclerenchyma much resembling that of the preceding genus, though more incoherent as to the septa, and with a very scarce coenenchyma.

Species 6. vetusta J. HALL.

Genus 3. *Acantholithus* n.

Septa thin, but built upon the same plan as in Coccoseris, coenenchyma with a few tabulated tubes.

Species 7. latesceptatus n.
8. asteriscus FERD. ROEMER.

Descriptions of Genera and Species.

Tribus I. **Heliolitinæ.**

This tribe comprises those genera which as a rule have twelve septa in the calicular area, being coherent lamellæ, more or less spiny on their margin. Regular tabulæ in the calicular tubes as well as in the tubes of the coenenchyma, which latter have a polygonal shape. According to the structure of this coenenchyma joint with other differences, as closer indicated in the descriptions further down, three genera may be discerned.

1. *Heliolites*, DANA, with monomorphous coenenchyma or all its tubes equalsized and polygonal.

2. *Cosmiolithus* nov. gen. with dimorphous coenenchyma or tubes of two different kinds.

3. *Proheliolites*, KIÆR, with very scarce coenenchyma, septal spines, unlike all others in this family, bent downwards. Coenenchymal gemmation from single tubes.

Genus *Heliolites*, DANA.

Synonyms.

1745. Millepora p. p. L. Cor. balt. p. 30.
1767. Madrepora p. p. L. S. N. ed. XII p. 1276.
1826. Astræa p. p. GOLDFUSS. Petref. Germ. p. 64.
1833. Heliopora p. p. STEININGER. Mém. Soc. Géol. de France p. 346.
1839. Porites p. p. LONSDALE. Sil. Syst. p. 686.
1845. Explanaria GEINITZ. Grundriss d. Verstein. p. 568.
1846. Heliolites DANA. Zoophyta, Un. St. Expl. Exp. p. 541.
1849. Lonsdalia D'ORB.[1] Note sur les polyp. foss. p. 12.
1850. Fistulipora p. p. MAC COY. An. Mag. N. H. Ser. 2, vol. 6, p. 285.
1850. Palæopora p. p. MAC COY. Ibid. 285.
1850. Geoporites D'ORBIGNY.[1] Prodrome, p. 49.
1895. Stelliporella WENTZEL. Zur Kenntniss der Zoantharia tabulata p. 27.
1895. Pachycanalicula ID. Ibid. p. 27.

DANA is the real author of this genus, but the name had been used long before by GUETTARD. This author, however, in his »heliolithe» joined a great number of dissimilar and not at all congeneric forms. The conception which DANA gave of the genus is the only true one.

Of the name Heliolites, from which also that of the family has been formed, as from the longest known and the most typical of all its congeners, I cannot find any earlier notice before GUETTARD employed it in 1770 in his »Mémoires sur différentes parties des Sciences et Arts», vol. 2 p. 284, where he says that he has »adopté le mot d'heliolithe» for such stones which have »des rayons comme le soleil». He evidently therewith meant to say, that he had adopted an earlier name, the more so as he in

[1] According to MILNE EDWARDS & HAIME. D'ORBIGNY's descriptions are too insufficient to find what he intended.

another place says that it has been already employed as »Heliolithos variorum autorum», I have in vain made a search for these authors, but the name has indeed, written in this manner, a classical form and in accordance with such ancient mineralogical names as Tecolithos, Hexacontalithos etc., which occur in PLINIUS Hist. Nat. Lib. 36, Cap. 19. It seems, however, that GUETTARD by some inadvertence left the true track and in his Mémoires, vol. 2 p. 419 created the name »Heliolithes», »Heliolithe», for his new »Genre XV» and thus imitated the many names ending on — *ites*, as *hæmatites* and others, which invariably are of the masculine gender, while those ending on — *itis*, being altogether gems, are of the feminine gender. It would have been more convenient, if he had transscribed Heliolithos into Heliolithus, as PLINIUS also uses similarly composed names for minerals, as Chrysolithus for instance.

Now to change the old, often and universally employed word Heliolites[1] and to transform it to what it ought to have been, would cause too much confusion and might certainly be approved by only very few, if any authors. Consequently it is better to keep it as it is. Again, on the contrary, for the new genera which may be created within this family, it seems advisable to form their names according to the Plinian rules. Thus, for instance, Acantholithus.

The corals which belong to this genus generally have grown in diskshaped, flat or slightly hemisphærical polyparies, on the inferior or basal surface covered with a thin, finely wrinkled epitheca. In some which are globular or slightly branching, calicles are formed on all sides and consequently without any epitheca.

The calicle has regular septa which sometimes have been entirely reduced so as to give the interior side of the theca a completely smooth surface. When they meet in the centre they may form various sorts of network or even columellalike structures. A little, transverse columellar protuberance often occurs in the middle of the calicle of Hel. interstinctus. Commonly the septa in this genus are entire lamellæ and not only spinous projections from the theca, as in the Favositidæ or even in other Heliolitidæ. But in Hel. Barrandei the edges of these lamellæ are serrated by long, curved spines.

The coenenchyma is generally composed of regularly polygonal tubes, which multiply through fission of their area by transverse sclerenchymatous partitions, that have developed across the aperture of a tube, from one wall to the other and thus dividing a tube into two. Every tube is circumscribed by its own wall; hence the dividing ridge between two adjoining tubes is a double wall.

The intimate structure of their longitudinal walls is of the fibrous nature as described above (p. 15) in the same way as the septa and the theca of the calicle, which are coherent. There is some good evidence of a direct continuation or prolongation of the septa out in the coenenchyma as is so manifest amongst the Plasmoporinæ; but there is no sign of an aureola, though specimens of Hel. porosus may indicate some approximation to it, as shown by WEISSERMEL's figure 3.[2] The dissepiment of the calicles consists of regularly horizontal tabulæ; in some of the oldest specimens from the Arach-

[1] This name must be written without *h* in accordance with the other words ending in *ites*, as not derivate from *lithos*.

[2] Zeitschr. deutsch. geol. Gesellschaft 1898 p. 61.

nophyllum stratum (*a*) of Gotland they are concave. The dissepiment of the coenenchyma is also composed of regular, though much more densely crowded tabulæ.

The gemmation has been observed to be of two different kinds viz. 1. *Coenenchymal* and 2. *Intracalicinal*, both as described above at p. 19, 22. Some differences of a specific nature are mentioned below under the species.

Very small polyparies, affixed to other corals or shells, consisting of an initial polypierite and a few, three or four, which have sprouted from it, testify to the development out of ova. The young, of necessity free swimming larva or further developed young polyp had fixed itself and secreted the wormlike tube, the first beginning of the polypary as stated more in detail above.

The geological distribution of the species of this genus, which are described below, is seen from the next table.

	Lower Silurian.	Upper Silurian.							Devonian.		
	Uppermost beds.	Arachnophyllum.	Llandovery.	Wenlock shale.	Wenlock limestone.	Ludlow.			Lower.	Middle.	Upper.
		a	b	c	d	f	g	h			
Heliolites interstinctus L.	*	*	*	*	*	*	*	*	*		
var. decipiens Mac Coy		*	*	*	*	*	*	*	*		
Hel. porosus Goldfuss									*	*	
Hel. Barrandei Penecke		*			*	*	*	*	*	*	
var. spongodes n.			*	*							
Hel. parvistella Ferd. Roemer	*	*	*	*	*	*	*	*			
Hel. parvistella-intricatus				*							
Hel. fasciatus n.		*									
Hel. repletus n.			*	*							
Hel. Liljevalli n.		*									
Hel. hirsutus n.	*										

As here shown this genus at first appears, though scantily represented, in the uppermost beds of the Lower Silurian, from the Leptæna limestone of Dalecarlia in Sweden, and in the detached limestone blocks at Sadewitz in Silesia, which seem to be derived from the »Lyckholmer Schicht» of Estonia and also in these. It occurs in great richness of varieties and specimens in the Upper Silurian of Sweden, England, Russia, Bohemia, North-America, China and Australia and continues through the Lower Devonian to the lower division of the Upper Devonian, as mentioned above at p. 31, after which time it seems to have become extinct. It is found in the Devonian strata of Russia, Austria, Germany, Italy, France and England.

One species, Hel. Barrandei, is common to both the Upper Silurian and Devonian formations and the same is probably the case with Hel. interstinctus.

Heliolites interstinctus. L.

Plate I figs. 1—36, Pl. II f. 1—2. Pl. III f. 1—2.

Syn.

1745. Millepora subrotunda, poris minimis, confertis, majoribusque crenatis remotis, L. Corallia baltica, p. 30 N:o XIII, fig. XXIV.

1749. » » » » L. Amoen. Acad. I, 99.

1767. Madrepora interstincta, L. p. p. Syst. Nat. ed. XII, p. 1276.

1819. Madreporites interstinctus, WAHLENBERG. Petref. Svec., p. 98. A short description intended to embrace the Linnean form.

1828. Astræa stellulata, HIS. Anteckn. IV, p. 241.

1831. Astræa interstincta, ID. p. p. Anteckn. V, p. 127 and Esquisse, p. 26. The collections of HISINGER preserved in the State Museum of Natural Hist. at Stockholm contain under the varying names of Astræa porosa and Astræa interstincta a number of different Heliolitidæ.

1838. Astræa porosa, ANGELIN. Mus. Palæont. Svecicum, N:o 5.

1839. Porites pyriformis, LONSDALE. Sil. Syst., p. 686, pl. 16, fig. 2*c*, 2*d*, 2*e*. Figs. 2*a*, 2*b* belong scarcely to the same species, possibly it is a variety with small calicles.

1841. Astræa porosa, HISINGER. Förteckning, p. 58.

1845. Porites pyriformis, LONSD. in Murchison Russia, vol. I, p. 625.

1846. Porites interstincta, KEYSERLING. Beobacht. auf einer Reise in Petschora Land, p. 175.

1851. Palæopora interstincta, M'COY. Brit. Palæoz. Fossils, p. 15.

1851. Palæopora ? favosa, M'COY p. p. Ibid. p. 15. This species is evidently composed of incongruous elements and, amongst the figures on pl. IC, the fig. 3*b* entirely coincides with the Gotland specimens.

1851. Heliolites subrotundus, SALTER, in MURCHISON Silurian Rocks of Scotland, Qu. Journ. Geol. Soc. vol. 7, p. 171 and also p. 144, pl. IX, f. 9. It is possible that this may be identical with this species, but there is no description, and the figure of a cast leaves the identity undecided. It might as well be an impression of a Coccoseris. Salter adopted the species name »subrotundus» from the second word of the description in Cor. Balt., erroneously attributing it to FOUGT.

1852. Heliolites macrostylis, HALL. Pal. N. York II, p. 133, pl. 36*A*, fig. 2*a* is probably identical with this species, not Hel. pyriformis HALL.

1854 ? Heliolites interstincta, EDW. H. p. p. Brit. Foss. Cor. p. 249, pl. 57, fig. 5*b*. This fig. is the only one of all given that can be identified with ours. The descriptions given in the various works of these authors are not so consistent which each other that they can be regarded as aiming at the same species. In Polyp. palæoz. there is given as a character »douze cloisons assez bien développées», in Brit. Foss. Cor. again the figure cited above shows short equal sized septa.

1854. Heliolites interstinctus, SALTER in Siluria, 1:st ed. p. 120, f. 3, 4, 5, pl. 39, f. 2—2*e*. Fig. 3 called Hel. megastoma. The same figs. recur in the later editions of Siluria.

1856—57. Heliolites porosa, HAUGHTON. Geol. Notes & Illustrations, Appendix to M'CLINTOCK, Reminiscenses of Antarctic Ice Travel in Journ. R. Dublin Soc. vol. I, p. 183, pl. X, fig. 5, 5*a*, bad figures and incomplete description. Worn specimen, but probably of this species.

1862. Porites megastoma, M'COY. Sil. foss. of Ireland p. 62, pl. IV, f. 19. The MS of this work was finished already in 1846, but was not printed before 1862. In British Pal. Foss. p. 16, the first part of which was printed 1851, he refers to this work, when describing a different coral, being a Coccoseris, with the same denomination.

1876. Heliolites megastoma, ROMINGER. Geol. Survey of Michigan, vol. III, pt. II, p. 11, pl. 1, f. 3. I have received specimens from the late Dr ROMINGER, found at Point Detour, Michigan, which quite correspond with the variety from the highest Gotland strata with large calicles.

1878. Heliolites megastomus (!) R. ETHERIDGE Sr. Palæontology of the coasts of the Arctic Lands etc. Qu. Journ. Geol. Soc. vol. 34, p. 581. Belongs possibly to this species, but the description is too short.

1878. Heliol. interstincta, QUENSTEDT. Petref.-Kunde Deutschlands 1e Abtheil. 6r Bd, p. 142, pl. 148, fig. 25.

1879. Hel. megastoma, NICHOLSON. Tabulate Corals p. 244, pl. XII, f. 2, 2*a*.

1880. Hel. interstincta, NICHOLSON & ETHERIDGE p. p. Sil. Foss. Girvan p. 254, pl. XVI, fig. 4 cet. exclusis.

1882. Heliolites interstinctus, LDM. Sil. Korall. aus N. Russland und Sibirien, p. 19.

1883. » » ID. Obersilur. Kor. von Tshau-Tiĕn in RICHTHOFEN China Bd IV, p. 54, pl. V, f. 7.

1883. » » FERD. ROEMER p. p. Lethæa geogn. p. 506. Several species seem to have been classed together. The figures in the Atlas, published 1876, also represent dissimilar forms.

1883. » » J. COLLET. 12th Ann. Rept. Indiana, p. 252, pl. 2, figs. 1, 2, 3.

1885. » » DAVIS. Kentucky Foss. Corals, Pt. II, pl. 1, fig. 3. It is uncertain whether fig. 4 also belongs to this species as stated by the author.

1888. » » LDM. Upper Sil. Foss. of Sweden, p. 21.

1889. » » TOLL. Die palæozoischen Versteinerungen der Insel Kotelnoy. Mém. Ac. Sc. de Russie T. 37, p. 47.

1889. » » LESLEY. Pennsylv. Geol. Rept. pt. 4, Dictionary Foss. Penn. p. 273, figs. 1—3.

1895. » » LDM. On the Corallia baltica of Linnæus. Öfvers. Vet. Akad. Förhandl. p. 636.

1895. » » WENTZEL. Zoantharia tabulata. Denkschr. Wiener Akad. d. Wissensch. p. 506 (30 in Separ.) pl. 1, f. 1—7.

There cannot exist the least doubt that LINNÆUS did not intend to enclose all Gotland Heliolitæ under this one. But to judge from the type specimen drawn and described in his »Corallia Baltica» it was this he had in view as the type. The reference of LINNÆUS to BROMELL (Lithogr. Suecana) identifying the »Porus tuberiformis» of the latter with Millepora interstincta is not corroborated by the obscure description and figure of BROMELL. NICHOLSON and ETHERIDGE who have ranged a number of disparate Heliolitæ under the denomination of Hel. interstinctus, say[1] concerning the original type of LINNÆUS: »On this point we have nothing to guide us but the statement of MILNE EDWARDS and HAIME (Pol. Foss. Terr. Pal. p. 214) that the septa in Hel. interstincta are »assez bien développées». But it may be remarked, that the last mentioned authors express their own opinion and that they do not say anything at all about LINNÆUS' type. Consequently it is difficult to find how their words could guide us to find what LINNÆUS had himself meant. For further particulars I may refer to my paper on LINNÆUS' »Corallia baltica» and also on the Corals in RICHTHOFEN's China vol. 4, where I have tried to prove that the species described by LINNÆUS is just this Hel. interstinctus.

Perhaps no other species of the genus Heliolites has been so often mistaken for others as this. So for instance FERD. ROEMER in his Silur. Verstein. von Tennessee p. 23 pl. II f. 5, 5*a* described a diskshaped fossil with rather small calicular openings without septa as Hel. interstinctus, in his »Sadewitz» again p. 24 pl. IV f. 4 a still more narrow-

[1] Fossils of Girvan p. 258.

tubed Heliolites with crenulated calicinal margin and twelve well developed septa reaching nearly to the centre has the same name. In his Lethæa geognostica, last edition, pl. 9 fig. 3*a*, he has copied the figure of Hel. interstinctus of M. Edw. and at last in the »Lethæa erratica», pl. v fig. 7, there is a new form without septa and nearly related to the first mentioned. Not one of these, which represent at least three different species, can be regarded as identical with Linnæus' type and must be removed from the list of the synonyms of Hel. interstinctus. We must not be led astray by the circumstance that Linnæus in subsequent editions introduced foreign and recent corals under the same specific name. There exists indeed none besides the fossil Gotland form, which is to be described below, to which the words »poris majoribus crenatis» and »marginibus aliquantum crenato, crenis circiter duodecim» can be applied.

In »Obersilurische Fauna des Timan» Herr N. Lebedeff[1] has at p. 13 described a coral, which he calls Hel. interstincta. But the description is so incomplete that the identity must be doubted. Lebedeff's figures[2] on pl. 1 fig. 3 do not show the real characters.

Hel. interstincta Weissermel 1894 Korallen .... Preussens, p. 666 cannot be a true interstinctus as he tells about »Zwölf wohl entwickelte Septen».

As very doubtful forms of this species I regard the following.

Porpital Madreporite, Parkinson. Org. remains II, p. 69, tab. vii f. 2, 4, 5.

Sarcinula punctata, Fleming. Hist. of Brit. Animals p. 508.

Porites favus Barrande MS from Tachlowitz.

Hel. subtubulata, M'Coy. Palæoz. Foss. p. 16 pl. 1C f. 2.

Geoporites intermedia, D'Orbigny. Prodr. I, p. 49, according to M. Edw. & H. identical with this species, but as D'Orbigny does not give any characteristics, I cannot find if he is right.

Geoporites americana, D'Orb. Prodrome p. 108 much uncertain = Hel. parvistella F. Roemer ?.

Hel. megastoma, Eichwald. Lethæa rossica I,1 p. 453.

Hel. interstincta, Nicholson & Etheridge. Girvan p. 57.

A so common and so widely spread coral as Hel. interstinctus must already *a priori* be expected to offer a great number of variations and mutations. And so it in reality turns out to be. But in all this variability there is something in common and this will serve to establish the specific description.

The form of the polypary. As a rule the polypary has grown in flat or slightly vaulted disks, in undulating placentoid pieces, plane or a little excavate below. A local variety from the stratum *d* along the shore of Wisby, there very common, forms compressed, broad branches bearing calicles on all sides. From the edges and the surface there project finger- or hornlike prolongations, which when detached or broken might be mistaken for independant polyparies. There are also irregularly globular or pyriform polyparies, but by far not so common as the others.

[1] Mémoires du Comité géologique (de Russie) vol. XII, N:o 2. 1892.

[2] There is in the explanation of the figures a confusion of the numbers, giving f. 3 for Propora tubulata and f. 4 for Hel. interstinctus instead of *vice versa*.

Epitheca. In the disciform polyparies there is an extremely thin, in a section scarcely perceptible film, transversaly wrinkled and longitudinally finely striated. In the branching and globular polyparies there is of course not much of an epitheca. It there never forms a coherent covering on the surface, it occurs only in narrow irregular stripes forming zones, as it were, between the calicles. It must be the common, coenenchymal tissue which has secreted this fragmentary epitheca, probably at intervals when the living surface of the coral had retired within narrower boundaries and the surface outside it was dead. It must be borne in mind that this epitheca is the common exterior wall of all polypierites, corresponding to the simple wall which envelops the first or initial and single polypierite, from which the other have budded. It is an amplification from this secreted by a multiplicity of individuals placed along the borders of the polypary.

The calicle. The range of variability in regard to the size and the proximity of the calicles is very wide. The diameter ranges from 3 mms to 1 mm. or a little less. In length one and the same calicular tube has been found to reach a length of 15 mms and probably was still 10 mms longer as it was hidden in its lowest part. Those found in the youngest strata, the limestone beds signed as *f—g—h*, have in the rule the largest calicles, closely set and consequently a scanty coenenchyma. They are very shallow, generally only 0,5 mm. deep and consequently the living animal tissue cannot have been of any considerable thickness.

Septa. The circular margin of the area is often slightly exsert and, what is most characteristic, wrinkled with twelve short ingoing angles, in fact the twelve septa which continue downwards into the calicular tube as faintly prominent, straight ridges, so that the interior side assumes a fluted appearance. In some more perfect specimens the septa form extremely thin and short lamellæ with entire margin. In others again they are nearly evanescent so as to approach to the variety called Hel. decipiens, which actually, as will be shown further on, is nothing but a peculiar manner of growth of H. interstinctus. As PENECKE observed in his H. Barrandei that the septa have disappeared in deeper situated portions of the polypary may also be seen in Hel. interstinctus, as for instance in the peculiar specimen drawn Pl. 1 fig. 20 of which fig. 24, a section deeper down, exhibits quite empty calicles. This change is no doubt usually due to the fossilisation, but it may there also sometimes have been an original defect of septa. In some specimens as in one from the lowest beds there are in the youngest areas longer septa which later are shortened.

Columella. The centre of the calicles is almost without exception provided with a columellar protuberance of a variable shape, styliform, lamellar, straight or bent so as to form an angular lamella. (See pl. 1 figs. 9, 11, 12, 13, 14, 15, 20.) It may he branching (f. 14, 20) and occupy a larger space. As to its origin the figures 11 and 13 may give some explanation. In the specimen, fig. 11, which evidently is a calicle not quite mature, the septa on the right are longer than those at left, which are of the ordinary size. One of the lefthand septa reaches to the centre and as a continuation of it and in connexion with it lies the columella, also united with two other septa. In fig. 13 an earlier stage of development is represented. There are twelve septa of which a couple, lowest down, still show the vestiges of their origin out of the coenenchyma. They are else all large

and reach to the centre where they are united with some rests of as yet unchanged coenenchyma out of which later the columella develops. This central part remained isolated as columella, when the septa are shortened to their normal size. The top of the columella, in the large variety of figure 20, as represented in section fig. 22, is divided into tiny spines, else generally smooth. As is evident by many longitudinal sections, figs. 8, 15, 23, the columella has not been formed continually during the whole life of the polyp, its growth has been interrupted and continued anew (figs. 2, 8). It can be followed as a long whitish line in the centre of the calicular tube (fig. 15) and then again ceases. In fig. 2 it has a peculiar appearance, disconnected on two of the lowest tabulæ and again reappearing on one of the uppermost.

Tabulæ. They are in the rule horizontal, four on a length of one millim. They occur densely crowded near the top of the calicular tube (figs. 22—23) as to form large horizontal bands. This must depend on some abnormity, on an excessive or sickly secretion, an accelerated growth. Near the theca the tabulæ are sometimes wavy or provided with a sort of grooves, especially where they meet the septa (fig. 29). These remind a little of those which are seen in several species of Favosites and may have the same sort of origin as these but do not occur regularly.

Coenenchyma. The tubes of the coenenchyma are in the rule polygonal, five or six-sided, the dividing walls thick, as in specimen fig. 9, or threadfine as in fig. 20. The line which divides the walls of two contiguous tubes, can be discerned in specimens as fig. 9 and 13. There are closely set, regularly horizontal tabulæ, five on a length of one millim. or even more. The tubes augment by fission. A small partition wall grows out from the wall into the tube (many instances fig. 20), meets a similar from the opposite side (f. 13) or even four meet (f. 9) and form like a Tetradium four new tubes. In the coenenchyma between the second and third calicular tube at left in fig. 31 there is at first a single coenenchymal tube, which divides into two, and these again at a short distance again in two, so that four new have been produced out of one.

At times there has been a singular invasion of the coenenchyma over the calicles. It is as if an exuberant growth had forced it to cover these areas partially or completely and thus to extinguish or alter the life-organs there existing. Instances of this phenomenon are delineated in figs. 20, partial destruction, and in fig. 21, complete destruction of two calicles, in one of which the columella is still visible.

Propagation. 1. Through ova. That this has taken place is evident through the many small incipient polyparies consisting of a few polypierites, which have sprung out from a single primary one. (See figs. 25—27). This must of necessity have originated out of an ovum, passed through a larva stage and then fixed itself, secreting an epithecal envelope around itself. It has the form of a cornet, rapidly increasing in breadth, the theca is blackish, glossy and transversally finely striated. In a section, about one millim. above the initial tip (f. 30) only three small septa have been developed, and these are situated on that side of the polypary on which this lies fixed to the shells (fig. 26—27). And there is in the beginning no sign of any coenenchyma. This develops on the bottom side, the upper side left without any (fig. 25—27) and out of this new calicular

areas arise, as it seems in a quincunxial arrangement $\begin{smallmatrix} 3\,3\,3 \\ 2\,2 \\ 1 \end{smallmatrix}$ (see figs. 25, 27), which, however, soon is disturbed through the enlargement of the polypary with a great number of new calicles. Tabulæ have been secreted at an early period, almost immediately after the wall (fig. 28), thus appearing before the septa.

Gemmation. This is of three different sorts: 1. *Coenenchymal*, 2. *Intracalicinal*, 3. *Epithecal.*

1. *Coenenchymal* (pl. 1 figs. 32, 1—IV and fig. 33). The series of sections, representing this change, has been obtained by scraping down with a knife the little calicle and cautiously observing every change. It embraces only a depth of one millim. ere unaltered coenenchyma was reached. Beginning from below (fig. 32, 1) some nine coenenchymal tubes are seen to have assumed a deeper colour than the surrounding tubes and a reduction has set in at the lowest right corner. Next, as seen in the bottom of section II, which actually includes two stages, the walls of several tubes have been reduced or absorbed at the right hand while they are still complete on the upper side at left. In sect. II proper all tubes have vanished and an open area is created. Then the new septa begin to grow out irregularly, of unequal size, being already twelve in section III. In the last stage figured, sect. IV, they have grown still longer, tending towards the centre of the calicle. The completion of this, other specimens taken in consideration, seems to be, that the new formed septa attain the centrum, that a columella is formed by their union, that a new reduction in size sets in and the normal structure of the species is attained. In a longitudinal section representing the coenenchymal gemmation (pl. 1 f. 33) we also see how the coenenchyma gradually is dissolved, how the tabulæ are deranged, how soon a large calicular tabula is formed still interrupted by some irregular, remaining tubular walls, till at last the calicular tube is ready formed with its regular tabulæ.

2. *The intracalicinal gemmation* (pl. 1 figs. 34, 1—IV and 35). The notion of its various phases has been obtained in the same way as in the previous case. A regular calicle, at the same level as the surrounding coenenchyma (sect. 1) half and half of interstinctus and decipiens type, as so often occurs, with eight short septa on one side, and none on the other begins to raise its margin (sect. II), which thus becomes osculating and rises more and more above the coenenchyma so as to assume the shape of a little erect tube. In this stage there has been formed all around the septa, which now are distinctly twelve, between them and the theca a zone of coenenchymal tubes. This new theca, which of course did not exist before the calicle began to grow upwards, has originated at the same time the rising took place, and in sect. II we find its presence by the two small tubuli of incipient coenenchyma at the lowest, left corner. In the third stage III the coenenchymal ring has widened and been finished all round with its own strong and well marked theca. There are now two thecæ, an *interior* one from which the septa start, being the primitive calicular theca from which the septa emanate and an *exterior* one, enclosing both coenenchyma and calicle. The calicle and the septa have changed their aspect during this procedure, the septa are twelve, but irregular, broad, ingoing folds. The newformed coenenchyma is evidently an outgrowth from the interior theca, because the walls which divide its tubuli, regularly proceed from the angles between the septa towards the exterior theca.

The last stage of this instance, the tube which grew on the surface of a polypary (sect. IV) bears clearly the signs of degeneration, the coenenchyma so promising in the previous stage is nearly gone, the theca and the septa are, as it were, shrivelled up. This bud thus never attained to the perfection which is seen in many other small colonies which have grown up on the surface of larger polyparies. An instance of this on a small scale is given by the little colony in figure 35, where a similar tubular polypierite with irregular coenenchymal tubuli has procreated a smaller calicle.

3. *Epithecal gemmation.* Though of an excessive thinness the epitheca must possess strong vital functions where at its formation it is covered by a diminutive lining of living organic matter spred out from a polyp. I think that in no other way, than as originating directly out of the epitheca, can be interpreted such a section as that shown in figure 12. There it seems to have been a little coenenchymal basis from which the regular calicinal tube arose.

Geological and Geographical Distribution.

This species already appears in the Lower Silurian Strata of Russia. A specimen, belonging to the Museum of Reval, by Dr KIÆR signed as Hel. parvistella ROEMER, has been found in the Lyckholmer Schicht of the Island of Worms and it is a variety with small calicles. The same Museum also contains a specimen with uncommonly small calicles only 0,8 mm. in diameter from Hohenholm, Isle of Dagö. From the Upper Sil. of Norway in Malmö near Christiania the State Museum preserves specimens. In the Upper Silurian of the Asiatic Russia at the Lower Tunguska and Olenek it has been found by Russian explorers.[1] RICHTHOFEN found it in China at Tsiën-shui.[2] It was found in North Russia at Petschora.[3] I have specimens from the U. Silurian of Bohemia (étage e^2) at Kotzel, from Dudley in England, from North America, Niagara formation, and sent from Prof. JAMES HALL as Hel. megastoma, from Drummond Isl., Michigan. It also passes up in the Devonian formation, in the Middle Devonian of the Alpi carniche of Italy and also according to MILNE EDWARDS and HAIME in France at Néhou.

In Sweden it occurs only in the Upper Silurian and in the Island of Gotland it is one of the most common corals. The »Riks Museum» of Sweden is in possession of specimens from the following localities.

a. From the oldest stratum of Gotland, the Arachopophyllum stratum in detached pieces, broken up from the beds, which lie below the following strata.

bc. From the next shale beds, the shores north and south of Wisby to Halls huk and to Gnisvärd, Westergarn, Djupvik in Eksta, Lerberget in Stora Carlsö, Hablingbo, Östergarn, Lau (lower beds), Djupdya in När, Dember in Fårö, Kyrkbacken Fårö.

In the stratum *d* at Bunge Fårösund, Lansa Fårö, Ryssnäs Fårö, Kyrkbacken Fårö, Tjelders Boge, the shore of Boge, Kulshage kanal Hangvar, the hills at Kålensqvarn, Wisby and almost everywhere north and south of the town in the peculiar variety mentioned above on p. 43, at Lau, Enviken in Hamrà and at the hill of Hoburg.

[1] LINDSTRÖM, Sil. Korallen aus N. Russland und Sibirien p. 9.
[2] RICHTHOFEN, China vol. 4, p. 54.
[3] KEYSERLING, Wissensch. Beobacht. p. 175.

In the uppermost strata, signed *f*, *g*, *h*, from Mannagårda in Lye, Lill Rone in Lye, Sandarfve kulle *f*—*h*, Lindeklint, Mallgårdsklint, Klinteberg, Lummelunds kanal, Follingbo, Hörsne, Bara hill, Simunde in Bara, Gothems hammar, the limestone between Bäl and Slite, Tjelders in Boge, the hills of Slite, Enholmen, Klints and Samsugn in Othem, Bunge and Fårösund.

In the other silurian strata of Sweden it has been found only in the province of Jemtland in the coralline limestone of Norderön.

Some remarks on Heliolites decipiens. Mac Coy.

Pl. II figs. 3—22.

I cannot have the least doubt that Mac Coy's Fistulipora decipiens[1] is identic with a greath number of Gotland specimens, which I have temporarily named Heliolites decipiens or Hel. interstinctus-decipiens, the more so, since through the kindness of Professor Th. Mac Kenny Hughes I have received a cast of Mac Coy's original specimen, preserved in the Woodwardian Museum at Cambridge. It has been partially figured plate II figs. 21, 22, and may be compared with the Gotland specimens figured on the same plate. Mac Coy himself says about his specimen: »So exactly does this resemble the Palæopora interstincta that I have little doubt it has often been confounded with it... I have seen this coral also in large masses in the Upper Silurian limestone of Gothland. Chief character wabes smooth within, perfectly destitute of lamellæ». Also Milne Edwards & Haime, who had examined M'Coy's specimen, say[2] that it much resembles a Heliolites and »the coenenchyma does not present the vesicular tissue, which is characteristic of the genus Fistulipora». Neither these authors nor anybody else seem ever to have reexamined the original or typical specimens of M'Coy's first described[3] species of Fistulipora, which occur in the Carboniferous formation of England and which ought to have been a leading norm for introducing new species into that genus. These type species, to judge by the descriptions and figures, widely differ from the same author's Fistulipora decipiens. Subsequent authors continued to join with these the most heterogenous forms. Assuming a certain similarity with Fist. decipiens, Billings in 1857 described a new species, named Fistulipora canadensis.[4] But already in 1862 Rominger[5] had found its real nature as being a true Favosites, which he in his last work[6] called Fav. canadensis and still later Nicholson[7] has confirmed this conclusion. I have been able to examine several specimens

[1] Ann. & Mag. Nat. Hist. 2d Series vol. 6, 1850, p. 285.

[2] Brit. Foss. Corals p. 298.

[3] Ann. Mag. Nat. Hist. 2d Ser. vol. III, p. 130. 1849.

[4] Geol. Survey of Canada, Report 1857 p. 165, and Canadian Naturalist and Geologist vol. III p. 420, also »Fossil Corals of Canada West» in Canadian Journal 1859, p. 98 fig. 1.

[5] On Calamoporæ in gravel deposits near Ann Arbor. Sillim. Journal 2d Ser. vol. 34, p. 397 as Calamopora canadensis.

[6] Geol. Survey of Michigan, vol. III, part II, p. 30, pl. VIII fig. 4.

[7] Structure and Affinities of the Genus Monticulipora 1881, p. 94.

of this coral, which were sent to me from Mr BILLINGS, as well as from ROMINGER together with others and I can with certainty affirm the results both of ROMINGER and NICHOLSON.[1] My specimens of which I have given a couple of figures on plate II, figs. 23—26 distinctly present the tabulæ and the oscula of the thecæ which, however, are only visible in such calicles that have not been completely silicified. On the other hand I never, even in the best preserved specimens, have been able to see »the cycle of twelve rows of horizontal squamæ» of which ROMINGER speaks and I cannot understand what he means. Moreover he talks about »the radiated structure of the tubes». In the first description (l. c.) he writes about »twelve distinct longitudinal ridges» in the larger tubes and also of longitudinal striæ in the smaller tubes. Even if there are such, this does not militate against the Favosite-nature. There is, moreover, nothing that could be interpreted as coenenchyma. There are larger and smaller calicles, quite as in other palæozoic, especially Silurian Favositidæ. I have, on plate II fig. 28, given a figure of a Gotland Favosites, where the surface has an appearance nearly alike that of Fav. canadensis.

There are amongst the species of the genus Favosites two distinct groups, one with angular, polygonal calicles, all of nearly equal size, the other with one set of large calicles with circular aperture, surrounded by a great number of smaller, both polygonal and circular calicles of unequal size, intervening as a sort of quasi-coenenchyma between the large calicles. There are several transitions from such corals, where the larger, circular calicles not are so prominent, to others where they are placed at regular intervals from each other. Instances of this may be seen on the plates of DAVIS' Corals of Kentucky. Even in Favos. canadensis this irregularity may be remarked and it may be regarded as an extreme development of the tendency seen in some Favositidæ to have two sets of calicles. In these there exists no coenenchyma, there is not the least homology with the Heliolitidæ and there is no reason with NEUMAYR to say that »offenbar in naher Beziehung zu den Fistuliporen steht die im Silur und Devon verbreitete Familie der Heliolithiden».[2] This is quite in conformity with the views of DANA as expressed in Synopsis of the Report on Zoophytes 1859 p. 104 where the Heliolitidæ are enumerated in the subfamily of the Helioporinæ and Family of Favositidæ. In spite of the clear evidence given by ROMINGER and NICHOLSON NEUMAYR persisted in the view of the relation of F. canadensis with Heliolites and went so far as to say: »Wir haben in Fistulipora canadensis ein klares Bindeglied zwischen Favositiden und Heliolithiden vor uns». WENTZEL already in 1895 criticized this view in his Memoir on the Tabulata (p. 23). Through some notion of NEUMAYR's views probably an unpublished Museum name, Heliolitina canadensis, occurs in American collections as a synonym to Favosites canadensis. The high authority which NEUMAYR still after his decease deservedly enjoys amongst many of his followers for his researches on the fossils of the mesozoic strata might contribute to perpetuate this evident error and I shall in the following table try to give an idea of the fundamental differences between the two groups named.

[1] NICHOLSON in »Tabulate Corals», p. 289, when speaking of Fistulipora canadensis represents me as having in my paper of 1876 stated that it belongs to the Bryozoa, but I do not there mention it at all.

[2] NEUMAYR, Stämme des Thierreichs, p. 320.

Heliolitidæ.	Favositidæ.
1. Coenenchyma.	1. *No* coenenchyma.
2. Twelve regular, coherent septal lamellæ.	2. No coherent septal lamellæ, only septal spines of irregular number, 20 or 30, never regularly twelve. ?
3. Imperforate theca.	3. Perforate theca with numerous oscula.
4. Coenenchymal and *intra*calycinal gemmation.	4. *Inter*calycinal gemmation. ?
5. Tabulæ without fossulæ.	5. Tabulæ with fossulæ.
6. No epithecal coverings over the calicles, nor false opercula.	6. Epithecal coverings and false opercula.
7. Calicle preserving the same size during its lifetime.	7. Calicles increasing in size during continued growth.
8. Theca having a microscopic structure of fibrillæ directed obliquely upwards.	8. Thecæ of minute threadlike vertical elements.

After a long and continued examination of numerous specimens I have come to the conclusion that the fossil corals, which I of late have named Heliolites decipiens are nothing else but a phase or modification of the growth of Hel. interstinctus. A colony of this may for a time grow quite regularly, showing the twelve septa as described above, and then assume the appearance of decipiens. But there are also specimens where both sorts of calicles may be found alongside on the same surface. In one specimen, where the decipiens character predominates, there are, as figured pl. II figs. 3—6*a*, few calicles of which one, probably the youngest, has large unequally developped septa, irregularly curved, another fig. 4 where they are quite regular and equal, reaching far inwards, then there is one, fig. 5, with septa in the regular interstinctus-fashion, and at last fig. 6 we have the decipiens stage without the least traces of any septa.

Having thus duly considered the value of the innumerable gradations in conformation merging into each other, I cannot avoid the conclusion that Heliolites decipiens must be united with H. interstinctus as a variety, or perhaps rather more properly be regarded as a transient state in the growth, changing again into the typical shape. But this modification can also be stable a long while or during the whole existence of the colony and thus gain a certain appearance of independant specific value. It is questionable whether not other species than Hel. interstinctus may have had a »decipiens» stage, depending on the reduction of the septa. So I have found from the Middle Devonian of Eifel a large polyparium with calicles, in which no septa are visible. This might possibly be a transformation of Heliolites porosus. Pl. II fig. 20.

It must also be taken in consideration that a false appearance of a decipiens-stage can originate in the interior of all species through metamorphic changes in the fossilised structures, of which PENECKE has given good information.[1] Close beside quite intact

[1] Ueber die Fauna .... einiger paläozoischen Korallriffe der Ostalpen, Zeitschr. deutsch. geol. Gesellsch. 1887 p. 267, Taf. XX f. 3.

septal areas lie others with partly destroyed or as it were dissolved septa and again further on calicles without any septa at all, that is to say, as decipiens. Such changes make the determination and distinction very difficult or almost impossible and necessitate a series of transverse sections for comparison.

There may have been very slight exterior impulses to modify or alter and give a multiplicity of deviating characters to some polyparies which fundamentally or by descent are of the same stock.

A list of synonyms now follows enumerating the various forms which I consider as identical with Heliolites interstinctus-decipiens, thus completing the list of synonyms given above as pertaining solely to the typical form.

1837. Astræa porosa, HISINGER. Lethæa Suecica p. 98, pl. XXVIII, fig. 2.
1850. Fistulipora decipiens, MAC COY. Ann. Mag. Nat. Hist., 2[d] Ser., vol. VI, p. 285.
1851. » » ID. Palæozoic Fossils p. 11, pl. IC, fig. 1, 1*a*, 1*b*.
1854. Heliolites Murchisoni, M. EDW. & H. p. p. Brit. Foss. Cor., p. 250, pl. 57, fig. 6*a*, 6*b*. Only the figures cited, not the description, indicate the identity.
1854. Heliolites megastoma, M. EDW. & H. p. p. Brit. Foss. Cor., p. 251, pl. 58, figs. 2, 2*a*, 2*b*. The figs. 2*c*, 2*d* belong to a Lower Silurian species of Coccoseris, of which see below. There are no septa in the calicles, only in those of the Coccoseris figures, which may have caused the authors to speak of »twelve small septa». I have examined the original specimens which are preserved in the Museum of Jardin des Plantes in Paris and these do not present the least trace of septa and correspond to the figures.
1854. Fistulipora decipiens, M. EDW. & H. Brit. Foss. Cor., p. 298.
1854. » » M'COY. Contrib. Brit. Palæontol., p. 172.
1860. Heliol. interstincta, FERD. ROEMER, Tennessee, p. 23, Taf. II, fig. 5, 5*a*. The enlarged figure, 5*a*, clearly shows the identity.
1873. Fistulipora decipiens, I. W. SALTER. Catal. Foss. Cambr. p. 103.
1878. Heliol. interstincta, QUENST. Petrif. p. 143, pl. 148, fig. 25 (enlargement of coenenchyma falsely drawn).
1878. Heliol. megastoma, ID. Ibid. p. 143, 144, pl. 148, fig. 27, 30, 31.
1880. Heliol. Murchisoni, NICHOLSON and ETHERIDGE, Girvan p. 244. They say that it is closely allied to Hel. porosus and nevertheless they describe it as wanting septa.
1880. Heliol. interstincta, ID., ibid. pl. XVI fig. 3, 3*a*, 4, 4*a*.
1883. Heliol. decipiens, LINDSTRÖM in RICHTHOFEN's China, Bd IV, p. 56, pl. V, fig. 6.
1885. Heliol. pyriformis, DAVIS, Kentucky Fossil Corals, pl. I, fig. 5, 6.
1885. Heliol. subtubulatus, ID. Ibid. pl. I, fig. 7—8.
1888. Heliol. decipiens, LINDSTRÖM, List of U. Sil. Foss. of Sweden, p. 21.
1891. Fistulipora decipiens, WOODS, Catal. Type Spec. Cambridge, p. 18.
1895. Heliol. decipiens, WENTZEL. Zoanth. tabulata p. 33, Tab. IV, fig. 2—9.
1895. Heliol. bohemicus, ID. Ibid. p. 31 Tafl. I, f. 8—9, Tafl. II, f. 1—4.
1895. » » var. major, ID. Ibid. p. 33, Tafl. III, f. 8—9, Tafl. IV, fig. 1.

There are local varieties in great abundance. From the stratum *c* of Tofta Gotland we have semiglobose colonies with calicular openings rather more distant than else. The circular, non indented wall raised a little above the coenenchyma, which is faintly elevated all around it or rather there is a minute mound of the coenenchyma with the calicle on the top.

From the Arachnophyllum stratum near Wisby there is a variety, growing in disks of the vertical thickness of 25 mm. The calicles are small, circular, distant, 4—5 millims apart and 0,5 mm. in diameter. The abundant coenenchyma is very finely reticulated, with tubuli of regular sixsided shape.

There are in all at least five variations.

1. Interior side of the theca quite smooth and small calicles.

2. Quite smooth inside, calicles large, densely placed. From the Ohhesaare pank in Ösel I have seen a variety between 1 and 2 in the Museum of Reval.

3. Small indentations in the theca, calicles small, much distantiated from each other.

4. Large calicles, closely set, indications of septa, coenenchyma partly irregular. To this belongs Heliol. bohemicus of WENTZEL. I cannot but find that it is only a variety of interstinctus or intermediate between this and the genuine decipiens. I have had Bohemian specimens for examination. WENTZEL admits in his description the great variability in size and in the thickness of the theca. The chief difference from decipiens lies according to him in »das Coenenchym ist sehr unregelmässig ausgebildet». The size of the calicles is of no account at all as specific character, as in many instances has been shown, that the same surface bears calicles of greatly deviating size. Moreover, I have specimens presenting on one side the »bohemicus» feature, on the other side the regular interstinctus coenenchyma. This variety also occurs at Taggamois, Undwa, stratum I of the Island of Ösel.

5. Large calicles, closely set, indications of septa and regular coenenchyma. To this variety belongs the Eiflian specimens, mentioned above. All these five varieties have been found in the Gotland strata. I have also received specimens from Chicago by Dr HEAD, from Louisville Kentucky, named Hel. subtubulatus and even Plasmopora follis, from Ta-pa-shan, Schenzi China by Baron RICHTHOFEN. In Sweden it also occurs in Norderön, Jemtland and the »Riks Museum» is in possession of specimen from the upper-silurian of Öfveds kloster in Scania. Some calicular tubes attained a great length, one holding 56 millim. all along with or breadth of 2 mm.

Much on account of the pretended affinity with MAC COY's Fistulipora and still more through a false appearance of coenenchyma in such genera as Callopora, Dybowskiella, etc. a supposition of affinity between these and the Heliolitidæ has been most positively maintained by several authors, especially by DYBOWSKI, WAAGEN, NEUMAYR and with some hesitation also by NICHOLSON. Here is not the place to enter into any lengthened discussion upon this point, as it will require a most detailed research of longer duration of time than I now can dispose of, nor is it at present much need of it, since of late several authors, as for instance ROMINGER, JAMES, ULRICH, SAMPSON and GREGORY, have definitely ranged amongst the bryozoa nearly all those fossil species which the former insisted upon to regard as corals.

The principal questionable forms have been referred to Monticulipora, Callopora, Fistulipora and so forth. But there prevails a great confusion as to the limits and names of several of them. What WAAGEN has called Dybowskiella is Lichenalia for the American

authors and Fistulipora according to NICHOLSON.[1] The chief differences in structure which make it impossible to see affinities between the Heliolitidæ and the above mentioned genera may here be enumerated.

1. Amongst the Heliolitidæ we do not find the least traces of acanthopores so significant to palæozoic bryozoa.

2. There are on the surface of the Heliolitidæ never any »maculæ» nor »monticuli».

3. Their calicular apertures are never closed by false »opercula».

4. The intimate microscopical structure is in both groups dissimilar. In the Heliolitidæ it agrees with that which is seen in most recent or fossil corals, consisting of diminutive fibrillæ, which are directed upwards from their starting point, while those of the bryozoa are directed downwards. See numerous instances in the works of NICHOLSON, DYBOWSKI and others where sections of bryoza are given.

5. In the bryozoans there have never been discovered the least traces of any structure at all to be regarded as homologous with septa. In Dybowskiella (= Lichenalia) for instance, which according to WAAGEN, is a true coral and nearly related to Heliolites, he states that there are two septa.[2] But these so called septa are nothing else but the »lunarium» or »lunula» so characteristic for many both palæozoic, mesozoic and probably also recent bryozoa. This structure occurs in the palæozoic genera Lichenalia (= Dybowskiella), Fistulipora, Coscinium, Ceramoporella and many others, in the mesozoic (jurassic) Chilopora, in Salicornia from the Oligocæne formation, in Lepralia from the Crag and recent seas. It is a crescentic plate or incrassation below the aperture of the zooœcium formed by its peristome and of course of variable shape in the different genera, but all homologous and referable to the same type. In some of the sections figured by WAAGEN it seems to have been detached from the peristome lying loose beside it and has probably been altered through pressure in the rock.

6. The bryozoa have no coenenchyma in the same sense as Heliolites and the interspace or tubes between the zooœcia are now considered as absorbed zooœcia and termed mesopores. There are also »intravesicular tissues». WAAGEN has not given decisive proof that what he calls coenenchymal gemmation in Dybowskiella proceeds in the same manner as in Heliolites.

7. There is a decided dissimilarity between the interior structure of the bryozoa and the Heliolitidæ, many of the former having imperfect diaphragms, and they are provided with the characteristic cystophragms.

Heliolites porosus. GOLDFUSS.

Pl. II figs. 29—37. Pl. III figs. 3—7.

1770. Héliolithe pyriforme GUETTARD. Mémoires sur différentes parties des Sciences et des Arts, vol. 2 p. 429 pl. 22 f. 13—14, vol. 3 p. 454. Specimens from Eifel. He considers Madrep. interstincta of LINNÆUS as identical.

[1] Tabulate Corals pl. XV, f. 3*a*.

[2] Palæont. Indica, Foss. Productus-limestone XIII, p. 917 etc., pl. CII, fig. 3.

1805. In HÜPSCH's »Naturgeschichte des Niederdeutschlands, Zweiter Theil, Vorläufige Abbildungen», containing only plates without any descriptive letterpress, as it was edited after the decease of HÜPSCH by the Raspesche Buchhandlung in Nürnberg, the figures 49—52 represent this species in natural and enlarged size, without giving any denomination.

1820. Madreporites stellatus SCHLOTHEIM, Petrefaktenkunde I, p. 362.

1826. Astræa porosa GOLDFUSS, Petref. Germaniæ, p. 64, pl. 21, fig. 7.

1833. Heliopora pyriformis STEININGER, Observations sur les Fossiles du Calcaire intermédiaire de l'Eifel. Mém. Soc. Geol. de France I, p. 346.

1834. » » BLAINVILLE, Manuel d'Actinologie, p. 392.

1837. Heliopora interstincta BRONN, Lethæa Geognostica, p. 48, pl. V, fig. 4*a*—*b*. Several species mixed.

1840. Porites pyriformis LONSDALE apud SEDGWICK and MURCHISON, Physical Structure and older stratified Deposits of Devonshire, Transact. Geol. Soc., II[d] Ser., V, p. 697, pl. 58, fig. 4, 4*a*—*f* and Explan. of figures.

1841. » » PHILLIPS, Palæozoic Foss., p. 14, pl. 7, fig. 19*a*—*c*.

1843. Porites porosa F. A. ROEMER, die Versteiner. des Harzgebirges, p. 4, Taf. II, f. 9*a*—*b* (mala).

1844. Porites pyriformis, FERD. ROEMER, Das rheinische Uebergangsgebirge, p. 58.

1848. Heliopora piriformis BRONN, Index palæont. Nomenclator, p. 574.

1850. Geoporites Boloniensis D'ORB. Prodrome, p. 108 ?.

1850. Geoporites Phillipsi D'ORB. Prodr., p. 109.

1851. Heliolites porosa M. EDW. & H. Pol. palæoz., p. 218.

1851—56. » » SANDBERGER, Verstein. Rhein. Schichtensystems, p. 407, pl. XXXVII, fig. 1, 1*a*, 1*b*. Specimen interiorly crushed.

1851. Palæopora pyriformis MAC COY, Brit. Palæozoic Foss., p. 67.

1853. Heliolites porosa M. EDW. & H. Brit. Foss. Corals, p. 212, pl. 47, f. 1—1*f*.

1860. » » IID. H. Nat. Cor. III, 235.

1876. Heliolites porosus FERD. ROEMER, Lethæa geognostica Atlas, Taf. 26, f. 2*a*, 2*b* (mala). The descriptive letterpress is of later date, 1883, 1[r] Bd 2[e] Lief., p. 509. In the same he gives, p. 504, a figure (120*b*) of Heliol. megastoma, which, however, seems to belong to Hel. porosus. The description also contradicts this figure as there is stated that »die 12 Sternlamellen *wenig* entwickelt». Moreover it is quite impossible to coordinate the longitudinal section in fig. 120*c*, with the transverse section in *b*, as of necessity the well developed septa must be seen in the former.

1876. Heliol. porosa ZITTEL. Handb. der Palæont., Abth. 1, Bd 1, p. 213, fig. 123*a*—*c* (original).

1878. » » QUENST. Petrefaktenkund. Bd I, p. 138, pl. 148, f. 15—22, fig. 24 scarcely belongs to this species.

1879. » » NICHOLS. & ETH. Corals of N. Queensland, Ann. Mag. N. H. Ser 5, vol. 4, p. 223.

1880. » » IID. Silur. Foss. Girvan, p. 244.

1880. » » GOSSELET. Esquisse Géol. du Nord de la France, pl. III, fig. 15, 15*a*.

1883. Heliol. porosus VON KOCH, Ungeschlechtl. Vermehrung palæoz. Korallen. Palæontogr., XXIX, p. 333, pl. 43, fig. 1—11.

1885. Heliol. porosa MAURER, Fauna von Waldgirmes, Abhandl. Hessischen Geol. Landesanstalt, p. 79.

1889. Heliol. interstincta CH. BARROIS, Faune calcaire d'Ebray, p. 30, pl. III, fig. 6*a*—6*b*.

1889. Hel. porosus NICHOLSON, Palæontology, I, p. 336 f. 217, *C*, *D*.

1890. Hel. concentricus ROMANOWSKI, Materiali geologie Turkestan etc., p. 7, Tab. VII, f. 3, 3*a*.

1890. Hel. solidus ID. Ibid., p. 6, pl. VII, f. 2, 2*a*, pl. XIV, f. 3.

1894. Hel. porosa PENECKE, Grazer Devon, Jahrb. k. k. Geol. R. Anst. Bd XLIII, p. 591.

1895. Heliol. pyriformis WENTZEL, Tabulaten, p. 28.

1896. Heliol. porosus SARDESON, Tabulaten, N. Jahrb. f. Min., p. 263, fig. 7—10.

This since long times known coral, so often described and figured, might seem to have no need of further investigation. Still there are some points in its structure and development which may be a little closer ransacked.

Form of polypary sphærical or tuberous, covered with calicles and coenenchyma everywhere and consequently with no or very little epitheca.

Calicles. Perhaps in no Heliolitidean there exists so great a difference in size between the calicles as in this species, as MILNE EDWARDS and HAIME already have stated in their Brit. Foss. Corals pl. 47, figs. 1*a*, 1*b*, 1*c*, all from the surface of the same specimen. They vary from 2 mms. to a little less than one millimeter. The theca or inner wall is remarkable for its thickness, being somewhat exsert, and contrasts in this respect with the interior theca of Heliol. interstinctus, which is thinner and deeper indented.

Septa. The size of the twelve septa is also much variable. Seldom they are so long and attenuated as in pl. II fig. 30 or as also SARDESON figured them. Even in the same polypary all gradations may be seen (pl. III figs. 5—6) from those which nearly meet in the centre, ending in a sharp point (never, however, uniting so as to form such an intricate network so characteristic for the nearly allied Heliol. parvistella) to such which stretch only halfways from the interior wall and leave a nearly circumscribed area enclosed in the centre between their ends. And lastly there are septa (pl. II fig. 32, pl. III f. 5 the right calicle) that almost remind of those in Heliol. interstinctus. In the last mentioned species the septa are equalsized, but in Heliol. porosus they often are regularly alternating short and long. Pl. II fig. 29. It is as if they, like »Hexacoralla», had two cycles, each of six septa of different orders, but there is no cause to assume that they are not coëval. We have no indication of only six septa in the young polypierite. As a further distinction from Heliol. interstinctus may be mentioned that H. porosus never bears the columella-like protuberance, which adorns the centre of the calicle in the former.

The septa are no mere septal spines, as so often has been asserted, but are coherent lamellæ, having their edges obtusely denticulated, as shown in the fig. 36 pl. II. But they may also (pl. III f. 7) have the margins fringed with slender curved spines or cusps reaching not quite to the centre.

The *tabulæ* are generally regular, but also often distantiated and deviating from the horizontal.

The *coenenchyma* has polyedric tubuli with rather thick walls and of small diameter.

The intimate microscopic structure (pl. II figs. 33, 34, 35) consists of three strata, a very narrow, central one enclosed within two larger, of similar structure, on each side.[1] The central stripe is of white colour, in transparent light looking black, quite as is the case of what I formerly have called the primary streak or primary septum, with which

[1] Already QUENSTEDT, Petrefaktenkunde 1, p. 138 pl. 148 fig. 15*y*, had observed what he calls the double wall and its dividing line in Hel. porosus. SARDESON, Tabulaten p. 267 fig. 10 has seen the stripe only in the theca and regards it as a dividing line of the double wall. The fibrillæ he calls a »krystallinische Structur». WEISSERMEL, Deutsche Geol. Gesellsch. 1898, p. 61 and 63, fig. 3 & 4, has seen the »Primärstreif» both in the theca, the septa and the coenenchyma in Hel. porosus, and as he says in Hel. interstinctus from Gotland, which probably not is interstinctus on account of the long septa, the fibrillæ were not clearly seen by him.

I regard it as homologous, as well as with Miss OGILVIE's centres of growth. I have not been able to detect any structure in this central stratum, it seems to be homogenous. The two lateral strata consist entirely of minute fibrillæ, which in a longitudinal section are directed upwards from their basis, be it on the exterior or the interior side of the theca. The septal lamellæ consist of such, as well as the coenenchymal tubuli. But there is no double wall to the calicle for itself, it shares the outer moiety with the adjacent tubuli, which also share their walls with the adjacent ones. The median stripe is common to them all, radiating without interruption between all calicles and all tubuli, it is, as it were the primary sceleton of the polyparium. Only the septa, which present themselves as direct offshoots from the interior stratum of the theca and entirely dependant of this, consist of two strata, indistinctly divided by a white stripe which apparently communicates with the central stripe. To judge by this, joint with the observations of the small initial polypierite, the usual rule, that it is the septa which form the wall by uniting their exterior parts, does not hold good here and it is on the contrary the wall or theca, which is the primary part from which the septa grow out as well as the coenenchyma. The distinct strawcolour or pale yellow which characterizes all the vertical constituents of the polyp sceleton in Heliolites viz., thecæ, septa, septal spines and walls of the coenenchymal tubuli, testifies to the common origin of all.

Gemmation. The only one which I have been able to observe in this species is the coenenchymal. The seven sections pl. II fig. 37, I—VII, represent the successive changes of two calicles, by a happy coincidence actually found beside each other. This series of sections was obtained by cautiously rubbing down from the surface a portion of an Eifliau specimen having the aspect as presented in fig. 37, sect. VII. The entire length thus abraded from VII to I amounts to 1,2 millim. In the deepest section I, to begin from the beginning, we find to the left a perfect, fully developed calicle and at right the common coenenchyma, of which, however, two or three tubuli seem affected, having a deeper tinge. As the changes in these two series of calicles are diametrically opposite we leave the left one, to continue with the budding one. In section II seven tubuli are affected, of them the two lowest, the same as in I, have grown larger; six are grouped round a central one. They grow still more in size, sect. III, and the central one as well as the two tubuli right of it are much changed, the walls between them partially broken and vanished, reduced in size, dwindling to threadlike thinness from at first being thick. The first indication of septa is visible on the right side in a bifurcation which in the next stages has grown out into two septa. A step further in sect. IV, all walls towards the centre, where it is an open space, have been absorbed, there is free intercommunication between all seven tubuli now changed into open compartments between their lateral thecæ, changed into narrow, irregular septa eight or nine, and the whole is surrounded by an incrassated border, the first irregular indication of the future theca, partly formed of the remaining fragments of tubular thecæ, but, however, not regularly circular. Two more tubuli, one in the uppermost left corner, one in the lowest, have been attracted within this sphære of change and out of these have, sect. V, been formed two new loculi and the number of septa is complete, though they are of much unequal size owing to their successive appearance. Some are formed out of old tubuli walls, others, the smallest, are formed anew and grown out of the theca. In VI the new

calicle is nearly ready, the shape of its theca is not circular and the septa are irregular in their size and direction. In VII we have the calicle fully developed and regular. The lacuna on the left side is incidental.

The description given by VON KOCH of the coenenchymal gemmation in Heliolites porosus does not agree with my observations. He says that about twelve tubuli covering a circular surface *at once* and at *the same time* arrest their growth and cover themselves with a common tabula and instead of them a calicle appears *directly* built in the normal manner. I suppose he has been misled by such sections as those represented on his pl. XLIII figs. 7 & 8. Nor can I find how the figs. 9—11 could show the gemmation. If f. 11, according to him, is the oldest and fig. 9 the uppermost or youngest, there is rather the contrary of the gemmation or a destruction of the calicle through change back again into coenenchyma as I am going to describe a few lines below and have delineated on pl. II fig. 34. It is evident that NICHOLSON's representation of calicular gemmation in Hel. porosus (page 336 Man. Palæont. 3[d] Ed. fig. c *au'*) is nothing else but the same deterioriation of the calicle. The theca is too perfect to belong to a budding calicle on that stage. Compare pl. II fig. 37, sect. V to the left in my memoir.

We have now contemplated how a new calicle originates, let us now turn to see how a mature calicle degenerates and again turns into coenenchyma from which it was derived. In sections I and II there is no change in the regular shape. The change sets in in III by disorderly growth of some septa at right, as if they were affected by the alterations going on next it, where the first new septa begin to appear. They acquire a new shape or coalesce and so it continues in IV till in V the right moiety is completely destroyed and transformed into a reticular tissue of tubuli which have grown out of the altered septa and it has been converted into coenenchyma. At the left side five or six septa are still visible, but have grown longer and coalesced with each other and formed tubuli. In VI the whole has turned into coenenchyma of an irregular appearance, and at the surface, of the corallum, VII, it is changed into a regular coenenchyma where all vestiges of the lower buried calicle are effaced.

Both these parallel, collateral series of sections were taken at a distance of 0,1 mm. from each other. The distance between sections VI and VII is 0,6 millim.

In figs. 3—4 pl. III another instance is given of this selfdestruction of the calicles. In fig. 3 the calicle has proceeded far in the coenenchymal metamorphosis, the fig. 4 showing the appearance of the same calicle a little below the former. This change is in contradistinction to another of the same effect, when the coenenchyma incroaches upon the calicular area and destroys it by overwhelming it.

Metamorphic agencies have been at work in the interior of the polyparia. As it is possible by degrees to follow the alterations, no mistake can be made to attribute to organic structure what is in fact inorganic destruction. Thus in a transparent section at one side where the structure is intact the calicles have their twelve septa. In an intermediate patch between this and the metamorphosed region the calicles have partly lost some septa and the rest is mutilated, while on the metamorphosed side they are like the calicles of Hel. decipiens. The regular outlines of the calicles and the normal form of the septa left in situ on the one side prove, however, sufficiently that this change is caused by other than organic changes.

This species ranges widely from the Alpi carniche in Italy to France, Ebray, St. Germain de Fouilloux in Mayenne, Belgium (Petigny), England Torquay in Devonshire, Germany in many places of its western countries, especially Eifel, but also in Nassau, Westphalia and the Harz mountains.

Its geological horizon is Lower and Middle Devonian in which it is found as high up as in the Stringocephalus beds.

Heliolites Barrandei. PENECKE.

Pl. III figs. 8—12, 17—27.

1887. Hel. Barrandei (R. HÖRNES nomen nudum) PENECKE. Fauna . . . paläozoischer Korallriffe der Ostalpen. Zeitschr. d. deutschen Geol. Gesellsch. Bd 39, p. 271. Taf. XX, fig. 1—3.
1888. » » FRECH. Ueber die Altersstellung des Grazer Devon. Mittheil. d. NW. Vereins Steiermark, p. 6.
1894. » » PENECKE. Das Gratzer Devon. Jahrb. k. k. Geol. R. Anst. Bd XLIII, p. 591.
1895. Pachycanalicula Barrandei WENTZEL. Tabulaten p. 23.

Mode of growth. This very common species has grown in large, flat or slightly domeshaped disks with a thin, wrinkled epitheca on the inferior surface.

Calicles generally small, at the highest attaining only one millimeter in diameter, those from the oldest strata only 0,5 millim. Their theca does not project above the surface of the corallum or only very little; it is regular and not much indented.

Septa well developed, rather thick and short, at their interior end they send off thick, blunt spines upwards and the centre of the calicle is occupied by the tops of lower situated septal spines, which sometimes cause a false appearance of a columella. The longitudinal sections fig. 12, 16, show how they continue upwards and fill the central space of the calicle. These numerous septal spines, issuing from the margins of the septa (fig. 20), are of an irregular growth, but always tending in a bow upwards from their basis, sometimes meet in the central axis of the calicinal tube, where they form an intricate tissue. Some, especially the younger varieties of the Upper Silurian and the Devonian ones, have a slight swelling in the apex like a little globule.

Tabulæ. These are rather scarce and much distantiated, surrounding the large spines, which have grown in advance of them. They are else regularly horizontal.

Coenenchyma. Its tubuli are upon the whole more regularly polyedric than in the former species, though in some of the varieties from the higher Upper Silurian strata and the Devonian polyedric tubes are mixed with rounded or irregular ones (pl. III, fig. 22 & 24). Dr PENECKE has stated that the walls in these tubuli are of great thickness. The sections which PENECKE has figured in his above cited paper seem to me to have been derived from specimens which have been subject to much pression and thence assumed their peculiar oblique aspect. The calicles in these are ovale or oblique, deviating from the regular circular shape in some specimens. In others again, which I owe to the liberality of Dr PENECKE the regularity is predominant. I have given a figure of such, pl. III f. 24—25, showing quite regular coenenchymal tubuli. A longitudinal section (pl. III f. 25) has by no means thicker walls than the Swedish specimens and the thick ones seen in fig. 25 are entire

walls of the theca, lying parallel with the surface of the section, and consequently not cut but seen »en face». This partial dilatation of the tubuli walls caused WENTZEL to create a new genus Pachycanalicula for these forms. I do not think that this can be considered as a so fundamental diagnostic, as to be adduced for basis of a new generic division. If so it should be a permanent feature in the structure of the coral, not a transient or mutable one.

The tabulæ are rather more scarce and more distantiated than in the other species. In several specimens they are both on the superior and inferior surface covered with a dense coating of minute blackish crystals (pl. III fig. 26) probably of pyrite, and the thin tabula shines in the middle between them as a white streak. It may be this circumstance that has occasioned an opinion expressed by some author that the tabulæ consist of two layers and the white line (the true tabula) to be their dividing line.

The distinction in colour between the septal and dissepimental elements are much clearly seen in the longitudinal sections, perhaps more so than in other forms. The longitudinal thecæ, septa, spines inclusive, are of a pale strawcolour, the tabulæ black in transparent light, white in reflected light. This points to some chemical or even structural (histological) fundamental, difference, between these two elements.

The microscopic structure (transverse section, pl. III f. 23) consists of the fibrillæ on both sides of the white streak, and they stand forth as integral parts of the theca without sign of any dividing line.

Propagation. The only manner I have observed is the coenenchymal gemmation, as delineated in pl. III; fig. 27, sections I—IV. It proceeds nearly in the same manner as in the other Heliolitæ. In II three new septa are already formed and part of the theca out of the walls of the surrounding tubuli, in III there are septa and scattered fragments all round in the well circumscribed calicle. In IV it is nearly complete, but of oval outline.

This species ranges from the lowest Upper Silurian into the Upper Lower Devonian of Austria. It has been found copiously in the Silurian strata of the Isle of Gotland from those signed *a.* to *f.* inclusive. There is some little dissimilarity between the specimens from the oldest beds and those from the top, the latter having larger calicles, but it is of slight signification.

It has been found at the following Gotland localities. In the Arachnophyllum stratum, *a*, near Wisby. In the stratum *bc* at Atlingbo canal, Stora Carlsö, Skäret in Fröjel, Gnisvärd and Vägume vik, Petesvik Habblingbo.

In the stratum *d.* at Lansa, Alnäse, Dember and Ryssnäs in Fårö, Wisby, Dalhem, Klef in Sundre.

In the stratum *f.* at Sundre, Hoburg, Sandarfve kulle, Löjsta klint, Mallgårds klint, Lilla Carlsö, Follingbo, Bara backe, Gothem, Tjelders in Boge, Slite, Wägume vik, Longume and Pafvals in Lärbro, a quarry near Lärbro church, Helvig on fields, near Bunge church, Alnäse in Fårö. At Lau, Bondarfve backe in Burs, Klinteberg.

Through the kindness of the late Prof. JAMES HALL I have received specimens from the Falls of Ohio.

I have also examined specimens from the »Oberes Unter-Devon: Zone Heliolites Barrandei» near Graz in Austria.

Heliolites Barrandei, varietas *spongodes* n.

Pl. III fig. 13—16, pl. IV, f. 1.

1880. Heliolites micropora NICHOLSON & ETHERIDGE. Girvan p. 245. This is identical with my var. spongodes, which I formerly had confounded with Heliol. micropora EICHWALD and sent to Prof. NICHOLSON under that denomination. Having through the kindness of Prof. INOSTRANZEW been able to examine the original specimen of EICHWALD, preserved in the Museum of the University of St. Petersburg, I have found that this is a Coccoseris, which has been described further on in this memoir.

Mode of growth. Polypary grown in spongelike, irregularly lobate masses expanding from a narrow basis, having short fingerlike processes from the rounded edges, and with calicles on all sides. There are only a few undulating stripes of epitheca formed by and by as the coral has advanced upwards and covering the older calicles.

The *calicles* are extremely small, scarcely 0,5 millim. in diameter. Their theca is slightly prominent, very little indented.

The *septa* are of unequal size, some reaching to the centre, where a few detached tubercles fill the space, being the ends from lower situated septal spines. The septal laminæ are, quite as in the typical species, split up in narrow, upwards curved spines, enclosed by the horizontal and distantiated tabulæ.

The *coenenchyma* consists of very small and narrow polygonal tubes.

This very characteristic and distinct local variety occurs only in the strata *b*—*c* in the Wisby region, seldom in the lowest beds of *d*, and ranges from Wible, past Wisby, Snäckgärdet towards Likkershamn. Only one specimen has been found in the stratum *c* at Djupvik in Eksta and nowhere else.

Another variety of a singular mode of growth has been found in the uppermost strata of Sandarfve kulle. Pl. IV, fig. 1. It has grown in narrow branchlets of a width of 4—5 millims. The calicles are totally concordant with those of the genuine Heliolites Barrandei and occur on all sides of the polyparium. It reminds somewhat of Heliolites inordinatus LONSDALE (British Fossil Corals, p. 253, pl. 57, fig. 7) but this has more slender, regularly cylindrical branchlets and the calicles have, to judge by the figures, longer and more regular septa.

Heliolites parvistella. FERD. ROEMER.

Pl. III f. 28—31, pl. IV f. 2—9.

1861. Hel. parvistella FERD. ROEMER. Sadewitz, p. 25, Tab. IV, f. 6.

1878. Hel. conf. Murchisoni QUENSTEDT. Petrefaktenkunde, p. 143, pl. 148, fig. 29. The appearance of the calicles make it probable that this is identical, but a longitudinal section is wanted to make it certain.

1880. Hel. interstincta NICHOLSON & ETHERIDGE. Girvan, p. 254, pl. XVI, fig. 1*a*, 2*a*—2*b* cet. excl.

1880. Hel. interstinctus, var. lamellosus LINDSTR. Fragmenta Silurica, p. 32, Tab. I, fig. 5.

1883. Hel. parvistella FERD. ROEMER. Lethæa geogn., p. 506.

1888. Hel. inordinatus LINDSTR. Fossil Faunas of Sweden, II, p. 21.

1895. Stelliporella lamellata WENTZEL. Tabulaten, p. 34, Tab. IV, fig. 10—12.

1895. Heliol. parvistella ID. Ibid., p. 29.

At present it must be left undecided whether the following names belong to this species or not.

1860. Hel. interstinctus EICHWALD. Lethæa rossica I, 1, p. 453. His description »12 lames verticales pénétrant jusqu'au centre» shows that his specimen cannot be H. interstinctus, but possibly belongs to this species.
1876. Hel. interstincta ROMINGER. Corals of Michigan, p. 12, pl. 1, fig. 1.
1885. » » FERD. ROEMER. Lethæa erratica, p. 78, Tab. V, fig. 7.
1885. Hel. megastoma DAVIS. Kentucky Corals, pl. 1, fig. 1.
1885. Hel. interstinctus ID. Ibid., pl. 1, fig. 4.

Mode of growth. The polyparium is discoid or lamellar, the larger polyparia with protuberances from the superior or calicle bearing surface, no doubt originated through the intracalicular gemmation. These lamellæ are often very thin, having a vertical thickness of only three or four millimeters. The epitheca is finely wrinkled and glossy.

The *calicles* are at widest 2 millims. The theca forms outgoing angles between the loculi and ingoing angles opposite the septa, in consequence of what the whole assumes the shape of a star and the outline of the calicle more or less deviates from the circular.

The *septa* are long, stretching in some specimens quite to the centre of the calicle, in others forming in the centre an irregular network by combining, as it were, with their ends. In the former calicles (pl. III, figs. 28, 30, and pl. IV, fig. 2) there is also at the meeting of the septa an indication of the same reticulation through the curving and interlacing of their ends. Sometimes they are longitudinally bent in zigzag and with small spinules on the sides. In consequence of their meeting with their interior edges in the central axis of the calicular tube and because they there coalesce with each other no marginal spines have room for developing. For the same reason the *tabulæ* have rather the character of a dissepiment and they are not stretching in coherent lamellæ uninterrupted over the whole calicle, but are subdivided in the loculi and bent a little upwards or even downwards or as a convex lamella (figs. 29, 31, pl. III). Owing to this subdividing of the tabulæ in the loculi and to the prominence of the septal lamina in a longitudinal section it is very difficult in such a section to distinguish the calicular tube from the surrounding coenenchymal tubuli. In these, however, the dissepimental laminæ are most regularly horizontal. For the rest these tubes are regularly polygonal with very thin walls.

In many sections (figs. 3, 9, pl. IV) there is seen a very distinct difference in colour between the septa or longitudinal walls and the dissepiments or tabulæ, the former having in transmitted light a paler, nearly strawcolour and the latter being dark or black.

On the plates III and IV specimens from different localities have been figured to be compared with the original specimen of FERD. ROEMER (pl. III, f. 28). There is a specimen from the Upper Silurian of Oesel (pl. III, f. 30), one from Louisville in America (pl. IV, f. 2), one from Kozel in Bohemia (pl. IV, f. 5) and one from the Upper Silurian of Gotland (pl. IV, fig. 8). In respect to their structure, as revealed in longitudinal sections, there reigns the most complete conformity. Again in viewing the calicles on the surface or in a transverse section there seems at first to exist a great dissimilarity between them

for instance between figs. 28, 30, pl. III, f. 2, pl. IV on the one side and figs. 5 and 8, pl. IV on the other. But now calicles of the first type may be found on the surface of the same polyparium together with calicles of the second type, in which also the reticulation is more or less complicated or in other words variable. So in the Bohemian, as well as in the Gotlandic specimens. I therefore cannot agree with WENTZEL in considering the reticulated specimens as so highly differentiated as to justify their being removed into a separate generic type, called Stelliporella. As the chief and only distinguishing character of this genus can be shown to be highly variable and as for the constituting of a new genus must be wanted more than a single character and that too of constant value, I should at the highest attribute a varietal value to the Stelliporella-specimens.

From Heliolites Barrandei, the only one, with which it could be confounded, it is distinguished in the following manner.

Hel. Barrandei. PEN.	*Hel. parvistella.* F. ROEMER.
Septa not attaining the centrum of the calicle, at the edges bent upwards in spines.	Septa long, meeting in the centre of the calicle, where they intercross and form a more or less complicated reticulation.
Tabulæ regular, horizontal but scarce.	Tabulæ irregular, as it were, broken up between the loculi and curved upwards or convex.

Distribution. In Gotland it is one of the most common species and has been found in all strata. In the bed *a*, the Arachnophyllum stratum near Wisby, though not so common there as in the next superjacent beds *bc*, from Stora Carlsö, Westergarn, Petesvik in Hablingbo, Sproge, Stenbro å, Djupvik in Fröjel, the canal from Wisne myr in Fardhem, Asarfve in Hemse.

In the stratum *d* at Wisby, Stjernarfve in Eksta, Östergarn, Ryssnäs in Fårö. In the stratum *f* at Lau, Burs, Klinteberg, Sandarfve kulle, Fröjelklint, Lilla Carlsö, Follingbo, Wisby, the hill of Bara, Simunde in Bara, Slite, Klints in Othem, the shore of Boge, Tjelders in Boge, Kylley, Hidevik, near Bunge church. Also found in the Leptæna limestone of Dalecarlia in a few specimens at Östbjörka.

Its geographical distribution out of Sweden is also wide. The Swedish State Museum is in possession of specimens from the isle of Malmö near Christiania in Norway, from Kozel in Bohemia, from Dudley in England, from Louisville and the falls of Ohio in N. America, and from Pattakumäggi in the Island of Oesel, Russia. F. ROEMER found it in erratic blocks at Sadewitz in Silesia, which are derived from the uppermost beds of the Lower Silurian of Esthonia.

Heliolites parvistella, var. *intricata* n.

Pl. IV, figs. 10—19, pl. V, fig. 3.

Mode of growth. The corallum is arborescent or tuberous and there is scarcely any epitheca seen.

The *calicles* are, when fully developed, nearly circular with lobate edge through the indentations in the wall opposite the septa and very thin. The twelve threadfine septa are sinuous, some coalescing before they reach the centre of the calicle where they all join in an irregular net. The tabulæ are, as in the former, much broken up and hemmed in between the septal laminæ.

The *coenenchymal* tubuli vary much; they are regularly polyedric or they are of very different size (pl. IV, f. 11, 13, 14) many of them with small ribs or costæ shooting out into the tube (pl. IV, f. 11). They may also be much irregular, assuming all sorts of shapes (pl. IV, f. 13), meandring and curved.

Propagation. The coenenchymal gemmation may be observed on the surface of the polyparia as well as through transverse sections deep below the surface. Fig. 11, pl. IV represents the gemmation on the surface. It begins at first as a little shallow dimple pl. V, f. 3 all over covered by the meshes of the coenenchyma. In proportion as this shallow cup increases in size the meshes or tubes assume an irregular shape and when the incipient calicle has assumed a stellulate outline, as in the calicle farthest at left in fig. 11, most of the original tubuli have vanished, a few only linger still in the centre and from the lobate edge the beginning septa are directed centripetally. In the large calicle on the right, fig. 11, pl. IV, there are skeins of coenenchyma trending centripetally from the edges of the calicle, five or six on the right side. Between them a blank is left, a loculus, altogether six, or one between each skein. It is evident through the central calicle that these radiate accumulations of coenenchyma become transformed into septa, and they also make it manifest to us whence the sinuosity of the septa and their lateral thorns and ridges are derived, fig. 12, being in fact remnants of broken up coenenchymal tubuli. Thus it is also really evident that the central reticulations in the calicles of this species and so many others are actually coenenchymal tissue which has persisted unchanged there, while the other portions was metamorphosed into septa.

No law or rule common or equal for all Heliolitidæ in the manner of the coenenchymal gemmation can therefore be established. The suggestion that the formation of new calicles out of coenenchyma depends entirely on a reduction of several tubes, has only in a much restricted sense foundation in the natural procedure. On the contrary, as we have seen in this and in other instances, there is a formation anew and a transformation of preexisting parts into new ones.

Transverse sections at different depths of a polypary give, as seen in figs. 13, 14, 17, 18, pl. IV, various aspects of the calicles and the coenenchyma, unlike to that of the surface. Some as figs. 13, 17 remind of the coenenchymal gemmation and may also be such. A section fig. 19 of the base of the same specimen from which the other sections have been taken presents four calicles on different stages of development, not concordant

with that just described as occurring on the surface. This resembles rather more what obtains in the other species of Heliolites. We find by this that there are several modifications, even in the same species, of this mode of gemmation.

There is also evidence of intracalicinal gemmation in this species, as represented in fig. 15, pl. IV. The procedure seems to have been the same as described above in Hel. interstinctus, the median calicle being about to begin, the left one showing the next step and the right one being further advanced. In the central calicle a narrow belt of coenenchyma has been developed around the calicle. In the bottom of all these calicles, however, the coenenchymal tissue is still visible, and although not fully developed, they had already begun to bud.

This variety has been found chiefly in the shale beds (*c*) at Djupvik, Eksta, though there may be some specimens from a few other localities as at Lilla Carlsö, with a tendency to vary slightly towards the »intricatus»-type.

Heliolites hirsutus n.

Pl. XI, figs. 18—22.

It forms semiglobose masses with circular, densely crowded calicles having a diameter of 1,2 millimeters. The septa, as seen on the surface and in a transverse section, (figs. 18—19) have the short form as in Hel. interstinctus. Bases of spines are, however, observable as diminutive tubercles on their edge (fig. 18) and these are present in great numbers intact in the longitudinal sections (fig. 20) where they nearly fill the calicular tube, emanating from the narrow septal lamella and directed in a bow upwards and inwards, gradually tapering into a fine point. The thin *tabulæ* are in consequence of the numerous spines irregularly horizontal.

The scarce *coenenchyma* has the appearance common amongst the Heliolitæ though not so regularly polyedric and nearly only in one single row between the calicles. In a longitudinal section, owing to the preponderance of the calicles, it is difficult to find its tubes, but (fig. 22) they are narrow with distantiated, horizontal tabulæ. A remarkable feature, the same as observed in Proheliolites, is that a coenenchymal tube by degrees widens, is invested with septal spines and in fact is metamorphosed into a true calicle (fig. 22). This is a peculiar modification of the coenenchymal gemmation, as one coenenchymal tube is sufficient to perform this change.

This species shows affinities with Hel. Barrandei, but may be distinguished from it through the scarce and irregular coenenchyma, through the shape of the calicles and the spines, and moreover through its remarkable manner of budding.

It has been found in detached boulders at Hulterstad in Öland by J. G. Andersson and also at Skärlöf, the same island by Dr G. Holm. I have also had specimens from Worms, Piersal (F^1) and Hohenholm (Dagö) in Estland, Patakumäggi near Hapsal, Lyckholm, Kertel in Dagö, and a fragment also from Sandö north of Gotland. It is confined to the uppermost strata of the Lower Silurian of Sweden and Russia.

Heliolites fasciatus n.

Pl. IV, figs. 20—25.

Mode of growth. This species forms flat, discoid lamellæ attaining at the highest a thickness of 25 millimeters. The epitheca is finely striated by minute lines running parallel with the lines of growth.

The *calicles* are circular or nearly so, sometimes with thick, indented theca, only attaining 0,8 in diameter. The septa are thick, short, reaching only halfways to the centre (pl. IV, fig. 21); in the centre a sinuous columella-like protuberance. In a longitudinal section (f. 24) the septa are not visible. The irregularly distantiated tabulæ are more or less concave, but well developed. The columellar streak is partly visible, being present only at intervals.

The most peculiar feature is the banded appearance of the longitudinal section, some nine fasciæ, nearly parallel succeeding each other in a section (fig. 22). In fig. 23 a part of the coenenchyma is still more magnificd. These fasciæ are a sort of compression or, as it were, a condensation of the tabulæ, which have heaped themselves, so as to be five or six on a distance of only 0,2 or 0,3 millim. while on the same distance else in the section there are not more than one tabula. These bands have a white colour, in transparent light black, whence they in the drawings also are black. Whatever may have caused this tightening of the coenenchyma at the same level along the whole polyparium and at regular intervals, being oftener repeated, however, near the upper surface, it occurs in all specimens which have been found of this coral and thus acquires the value of a regularly occuring phenomenon during its growth. In these bands the tubuli have divided more frequently than on both sides below and above. In a transverse section (fig. 25) taken through a fascia, great irregularity reigns, the coenenchymal tubes having all sorts of forms, the septa, three or four crossing the calicle in sinuous lines.

This species has been found in several specimens in the Arachnophyllum-stratum near Wisby and also at Westergarn.

Heliolites repletus n.

Pl. IV, figs. 26—31, pl. V, figs. 1, 2.

Mode of growth. This corallum has grown in large disks or semiglobular masses.

The *calicles* have a size of 1,2 millims. and are perfectly circular when fully developed having an indented, slightly exsert margin.

The *septa*, threadfine and sinuous in a not fully developed calicle (fig. 28), are in a mature calicle (fig. 29) straight, stretching near to the centre, where a small protuberance forms a sort of columella. It seems, to judge by the sections, that during the growth of a calicular tube there may be septa present some time and then wanting. (Figs. 30—31, pl. IV). This may coincide with changes nearly resembling those in Hel. fasciatus or with a tightening of the coenenchyma so as to form horizontal fasciæ. The coenenchyma, which

during the normal state of the polypary has the appearance figured on pl. IV, f. 29, assumes, when this peculiar modification of the constitution of the polyp sets in, a quite different aspect as shown in pl. IV, figs. 27, 28, pl. V, figs. 1, 2. The whole arrangement of the tubuli (fig. 27) becomes irregular, their dividing walls are sinuous and crooked, or even dissolved between contiguous tubuli. On the inside of the walls they are covered (fig. 28) with numerous, minute thorns and asperities. They increase in thickness and irregularity and are as unlike common tubuli of a Heliolites as possible. The figs. 1—2, pl. V represent the coenenchyma in this state. It is this change which is visible in the middle of the longitudinal section pl. IV, fig. 30, where it forms a narrow fascia. The septa also partake and lose their normal character, become sinuous, intertangled, coalescing, but are always twelve (pl. IV, fig. 27). Sometimes, when the septa are much reduced, the structure reminds of that of Hel. interstinctus in which, however, the characters are constant.

This species has been found in the shale beds *b*—*c* near Wisby, one specimen has been brought up from a depth of 5 metres in the harbour of Wisby, detached from the shale beds, which form the bottom there.

Heliolites Liljevalli n.

Pl. IV, figs. 32—34.

Of this curious and very distinct species only a single specimen has hitherto been found. It is disciform with a thickness of 10 millims. The *calicles* attain scarcely one millim. in diameter. The theca is stelliform, the angles facing the septa as deep as in Hel. parvistella. The *septa* are long though not all of equal size and reach to the axis of the calicle, which is excentric or a little on the side of the centre, whence the septa nearest the lesser moiety of the calicle are shorter. The *tabulæ* are highly irregular, oblique, wavy, convex and they have on their superior surface rows of stout spines which chiefly are visible in the longitudinal section (fig. 34), where also the septal laminæ and their composition of oblique fibrillæ are evident. The *coenenchyma* consists of the most minute tubuli that exist in this genus. They are of irregular section, seldom polyedric, elongated, bent, of varying size, though all very small. Their walls are thicker than in any of the other species and the distantiated tabulæ are concave. But the most peculiar feature consists in the numerous short ridges which project from the walls of the tubuli into their lumen, generally one in each tube, in some as many as three. By growing they divide the tube and through this fission form one or more new coenenchymal tubes. But they may also be present and continue almost through the whole length of the tube without initiating any fission. In the longitudinal section fig. 34 they are seen in the tubes at left. What is more strange, they are also found in the two calicles represented in the transverse section fig. 33, where they stretch in a loculus of each like a little adventitious septum.

This species has been found in the stratum *a*, the »Red Stratum», near Wisby, which has proved very rich in new and interesting forms.

I dedicate this remarkable species to Herr GEORG LILJEVALL, who through his great and renowned skill as a draughtsman and the keen perception of his eye has rendered the science so many valuable services.

Besides the above described species of Heliolites and their synonyms enumerated, there are several other names mentioned, as belonging to that genus. Some of these, as »Hel.» dubius and Hel. Grayi will be met with again as synonyms in other genera. Some others may be independant species, but I cannot describe them in particular, as I have not seen specimens.

Such are: *Heliol. Daintreei* ETHERIDGE and NICHOLSON, Ann. Mag. N. Hist., v ser., vol. IV, p. 224.

Heliol. plasmoporoides E. & N. l. c. p. 225, both from N. Queensland, Australia.

Hel.? parasitica NICH. & ETHERIDGE, Girvan, p. 259.

Hel. foliacea NICH. & ETH. l. c. p. 261.

Hel. macrostylus and *H. pyriformis* J. HALL, Pal. N. York vol. II, p. 135, 1, are probably identical with some of the Silurian species described above, but I have not been able to identify them.

Heliolites placenta has been described by M. EDW. & HAIME as a Devonian species. Its synonymy is the following:

1826. Coscinopora placenta GOLDF. Petref. Germaniæ p. 31, pl. 9, fig. 18.
1850. Geoporites placenta D'ORBIGNY. Prodrome, I, p. 108.
1851. Hel. placenta EDW. & H. Pol. pal. p. 219.
1860. » » ID. Hist. N. Cor. III, p. 237.
1866. Receptaculites Neptuni FERD. ROEMER apud GIEBEL, Repertorium zu GOLDFUSS' Petrefakten Deutschlands p. 6.

Professor CL. SCHLÜTER in Bonn has kindly communicated, that GOLDFUSS himself already gave this fossil a new name in his museum as Receptaculites placenta and he adds that it actually is a Receptaculites and no Heliolites.

Porites discoidea LONSDALE Sil. Syst. vol. II, p. 688, pl. 16, fig. 1, later in Siluria, 4th Ed., p. 510, called Heliolithes discoideus, has long ago been shown to be one of the Stromatoporidæ, in 1870 by me in a paper on the »Anthozoa Perforata of Gotland» p. 11 (Svenska Vetenskaps-Akademiens Handlingar. Band 9. N:o 6) and in 1886 by NICHOLSON in his Monograph of the British Stromatoporoids, p. 6 (Palæontogr. Society) who identified it as Stromatopora discoidea.

According to GOSSELET[1] a species of Heliolites has been found in the upper division of the Devonian formation at Engis, which locality by the Belgian geologists is placed in the group of the »Calcaire de Fresne», forming the lowermost beds of the Upper Devonian. To judge by the short description annexed by M. GOSSELET it is not quite certain that the fossil mentioned is a genuine Heliolites, but it may belong to an allied genus.

A few other names of Heliolites recur in the list of synonyms amongst species of the Plasmoporinæ.

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[1] Le Calcaire de Givet, Ann. de la Soc. Géol. du Nord. Tome VI, p. 11.

Gen. *Cosmiolithus* n. gen.

(Κόσμιον, ornament.)

Coenenchyma composed of a medley of small and larger tubuli of circular section, the former surrounding the larger ones. Their walls are very thick and the lumen is narrow with scarce, concave or oblique tabulæ. The calicles have a complete set of perfect, narrow septa, somewhat irregularly sinuous and in the centre, where they meet, forming a reticular tissue with open meshes. Owing to the great development of the septa, the tabulæ are seen only as small horizontal lines between them. The septal lamellæ are contiuous in their whole length and consist of fibrillæ. Both species hitherto known have grown in thin lamellar expansions.

From the genus Heliolites, to which it is most nearly related, it differs through its peculiar coenenchyma and the uncommonly thick coenenchymal walls. In respect to the septa and their arrangement it has a great resemblance with Hel. parvistella, but their structure is upon the whole different. What upon the first glance distinguishes this genus is the uncommonly narrow tubuli of the coenenchyma, the largest of which do not attain more than 0,1 millimeter in width.

Cosmiolithus ornatus n. sp.

Plate V, figs. 4—11.

The polypary has grown in thin incrusting lamellæ, scarcely attaining two millims. in thickness, bearing calicles only on the superior surface, the inferior being covered with a concentrically wrinkled epitheca. In a section this epitheca (fig. 10) shows a peculiar lobate appearance, being comparatively more corrugated than the smoother epitheca in other Heliolitidæ.

The *calicles* attain only 0,5 mm:s in diameter and their edge is incised by the angles facing the septa and filled with minute tubuli of the coenenchyma.

The *septa* in the calicle proper are well developed, straight, narrow, thickening downwards and form in the centre a reticulated tissue where they meet and, as it were, intertwine with each other. This central reticulation is tubular and in a longitudinal section its tubes cannot as to their structure be discerned from the larger coenenchymal tubuli, it is only by their position in the middle of the calycinal section they are recognized. The tabulæ are around the central reticulation of the calicle curved in a small bow upwards and continue more horizontal within the central tubes of the calicle.

The *coenenchyma* consists of two sets of rounded tubuli, f. 7, one more than four times as large as the other, which surrounds the larger one. Both are very tiny, the larger attaining a diameter of 0,1 millim., the smaller only of 0,02 millims. Deeper down below the surface, as seen in sections, f. 8, they have much thicker walls than could be appreciated from the surface, and they are filled with rather scarce, concave tabulæ, f. 10. Their walls, as

well as those of the calicles show in some places the same microscopic structure of fibrillæ, directed obliquely upwards, as seen in other Heliolitidæ and Corals.

There are some slight variations in the size of the calicles and in the thickness of the coenenchymal walls as seen in specimens from Wisby and Klinte (figs. 5 and 11), though the character in other respects is constant.

This beautiful species occurs in Gotland in the red layer *a* near Wisby and in the strata *b*, *c*, *d* of the same place, in the stratum *c* at Fröjel and Mölners in Klinte.

Cosmiolithus halysitoides n. sp.

Pl. v, figs. 12—18.

Polypary growing in thin lamellæ of 5 millimeters or less, bearing calicles only on the superior surface, the inferior one covered by a thin wrinkled epitheca having, when seen in a longitudinal section, a finely serrated edge (fig. 16). Its mode of growth is peculiar. In a specimen from Roma myr there are seven thin lamellæ above each other, the thickest of 5 mm., but all taken together 45 mm. These lamellæ are separated from each other through interspaces now filled with rock. But of these four of the lowest are connected in such manner that the upper one has grown out of next subjacent, tending obliquely upwards and sending out a new lamella in the same direction. It cannot be doubted that the three uppermost lamellæ also were in this manner connected, but the specimen is broken at one end. Only the two uppermost are thus connected. The *calicles* which attain a diameter of 1 mm are stelliform, the exterior wall being indented and invaginated forming acute angles where it faces the septa. The *septa* are rather short, continue towards the centre, where they form a sort of an extensive columella of reticulated tissue. The septa are in some calicles sinuous or even as if composed of minute tubuli (fig. 13). In sections of the calicles (figs. 17, 18) the broad septal laminæ form an exterior zone, showing the oblique arrangement of the elementary fibrillæ (fig. 18) and also the scarse concave tabulæ which continue into the narrow tubuli formed by the central reticulate meshes. The *coenenchyma* consists of two sets of tubuli one larger, of irregular oval shape with dense walls, and in these walls there are immersed the smaller tubes often in a chainformed series, giving an appearance as of an Halysites. In a longitudinal section the very thick and dense walls of the coenenchymal tubes are very prominent, enclosing the usual dissepiment of narrow, concave tabulæ.

It is chiefly the organisation of the coenenchyma and the excessive growth of the columellalike reticulation in the calicle that distinguish this species from the preceding.

It has been found rarely in the stratum *a* at Norderstrand near Wisby and also near the Roma myr, Gotland, in a detached specimen.

Gen. *Proheliolites*. KIÆR.

1858. Heliolites FR. SCHMIDT. Untersuchung Silur. Estlands, Archiv, p. 228.
1897. Proheliolites KIÆR. Faunistische Uebersicht der Etage 5 des Norwegischen Silurgesteins, p. 10 (nomen nudum).

Corallum consisting of minute circular calicles with twelve septa, the basis of which resembles that of Heliolites, but the spines that are attached to them at regular distances are directed downwards, contrary to what is prevailing in all other Heliolitidæ. The coenenchyma is of the scarcest kind and only a few single tubes are found between the calicles. A single tube, which has the tabulæ more close than the calicles, can by expanding be changed into a calicular tube. Lower Silurian. As to its systematic place it ought perhaps on account of its great structural deviations from other corals form a family of its own, but it may stand as an appendix to the Heliolitidæ with which it else shows the greatest affinity.

Proheliolites dubius. FR. SCHMIDT.

Pl. XI, figs. 10—17.

1858. Heliolites dubia FR. SCHMIDT. Untersuch. Silur. Estlands, Archiv, p. 228.
1861. » » FERD. ROEMER. Sadewitz, p. 26, tab. IV, f. 5—5*a*.
1861. » » TÖRNQUIST. Lagerföljden i Dalarne, p. 19.
1873. Heliol. favosus LINDSTR. (nec M'COY). Svenska Undersil. Corall. p. 23.
1879. Hel. dubia DYBOWSKI. Chætetiden der Ostbaltischen Silurformation, p. 113, tab. IV, f. 2—2*a*.
1880. Heliol. dubius LDM in ANGELIN, Fragmenta Silur., p. 32, tab. I, figs. 1—4.
1880. Hel. dubia NICHOLS. & ETHERIDGE. Girvan, p. 250.
1883. Hel. dubius FERD. ROEMER. Leth. Geogn., p. 505.
1885. » » ID. Leth. erratica, p. 313, Taf. IV, fig. 13 *a*, *b*.
1888. » » LINDSTR. Fossil Faunas Sweden, I, p. 23.
1889. » » NICHOLSON. Manual Palæontol., I, p. 336, fig. 217 *A*, *B* (upside down).
1894. Hel. dubia WEISSERMEL. Korallen Silurgeschiebe Ost-Westpreuss., p. 666, pl. LIII, figs. 4*a*, 4*b* (these figures do not show the real characters).
1895. Heliolit. dubius WENTZEL. Zoanth. tabulata, p. 30.
1896. » » SARDESON. Foss. Tabulaten, p. 270, figs. 11—12, p. 285, fig. 19.
1897. Proheliolites dubius KIÆR. Faun. Uebersicht der Etage 5, p. 10 (without description).

The coral generally has grown in sphæroid and even semiglobose masses with a flat basis, in the former cases with calicles on all sides. A specimen from Lissberget in Dalecarlia measures 10,12 cm. by 9 cm. A characteristic feature in this species is that the small and as a rule perfectly circular calicles are so closely crowded that there is very little coenenchyma between them. They have a diameter of 0,8 millim. In some instances, even on polyparies, which for the rest have quite normal calicles, some of these (fig. 12) are irregular, almost polyedric, contiguous, without any coenenchyma.

The original form of the calicles is that delineated in fig. 16, being perfectly circular, with thin margin, without indentations as later acquired, fig. 11. There are twelve regular, equal, short septal laminæ with sharp, thin interior edge. At much regular distances (pl. XI, figs. 14, 17) short, thin spines go out from them, all directed downwards in a most characteristic manner, contrary to what obtains in all other Heliolitidæ. These spines (figs. 14, 15) are often incrusted with microscopic crystals of ferric oxide hydrate or manganous oxide hydrate which have occasioned some confusion in the descriptions by a few authors as if they were of organic origin. Such accumulations of crystals also occur in the coenenchymal tubes as seen in fig. 15. In some instances the septal spines are inclosed within a sheath of clear crystalline quartz all the way down, giving the spines in a transverse section a peculiar appearance.

The tabulæ are much distantiated, thin, oblique or horizontal. In the coenenchymal tubuli again (fig. 17) they are more frequent, even as many as four on the space between two of the calicular tabulæ. The narrow tubuli of the coenenchyma by and by expand or widen and are changed into real calicles, as SARDESON already has observed.[1] This is the same sort of coenenchymal gemmation which also occurs in Hel. hirsutus.

Several varieties of Chætetes and Monticulipora have sometimes been confounded with typical specimens of this coral, but they can be well distinguished upon closer examination. So the Heliolites dubius var. minima of FERD. ROEMER, as he named some specimens of a Monticulipora, distributed to foreign museums, but not described. It is to such that he alludes in the Lethæa geogn. I, p. 506, where he says that some specimens of Hel. dubius have maculæ quite as Monticulipora. But in reality such specimens are Monticuliporæ as I have assured myself through study of an original.

Proheliolites dubius is entirely restricted to the uppermost strata of the Lower Silurian formation. It is widely distributed in the Baltic provinces of Russia and dispersed in the diluvial beds of North Germany, where Sadewitz in Silesia is one of the most renowned localities. In Estland it occurs at Lyckholm, Kurküll, Worms, Pattuka near Worms and other places. In Sweden it has been found at Boda, Osmundsberg, Skatungbyn, Lissberget and Östbjörka, all in Dalecarlia in the stratum which the Swedish geologists have named »Leptæna Limestone», corresponding to the Lyckholm and Borkholm strata of Estland. It has also been found loose in a morainic accumulation on Gotland at Öjle myr, from where Dr C. WIMAN has dissolved out from the blocks by means of acids a large collection of fossils probably belonging to a passage bed between the Lower and Upper Silurian, older than the Arachnophyllum stratum on the coast near Wisby. The strata, of which these blocks are fragments, have not as yet been found *in situ*. The specimen delineated on pl. XI, figs. 16—17 has been kindly communicated by Dr WIMAN from the Öjle myr.

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[1] Tabulaten, p. 272.

Tribus II. Plasmoporinæ.

The most prominent, distinguishing feature of the genera composing this tribus is the constitution of their coenenchyma, almost entirely made up of thin, convex, minute lamellæ, which, superimposed upon each other, form a vesicular tissue. As may be induced from the coenenchyma of a few Plasmoporæ (Plasm. stella, Pl. scala, pl. v, f. 21, 28) where the Heliolitic type of coenenchyma is coordinate with the vesiculous, the convex lamellæ are undoubtedly homologous with the regular horizontal tabulæ in the coenenchyma of the genus Heliolites or, as it were, the convex lamellæ are convertible into horizontal tabulæ and *vice versa*. Another characteristic of the Plasmoporinæ consists in the presence of unconnected rods, slender rods (*bacilli*) or thick rods (*baculi*), standing erect or vertical in the midst of the vesicular tissue (pl. VII, f. 13, pl. x, f. 9, 18) as already has been mentioned above at pages 11, 12. To these may also be numbered the frequent, vertical aculæ which have grown on the convex lamellæ, either dispersed without order amidst these or being disposed in several coordinate or juxtaposite longitudinal rows (pl. VII, fig. 10), though without any connection with each other, but, as it were, foreshadowing the long, vertical bacillæ, which united alongside which each other, at last formed coenenchymal tubuli.

The septa have spiny margins or their laminæ are entirely dissolved into rows of spines, which are directed in the same way as the elementary fibrillæ, of which they in reality are compounds. The calicinal tabulæ are generally horizontal or concave as in the genus Heliolites.

The modes of reproduction are also identical.

Before giving a description of the genera composing this tribe it may be convenient to review the characters given by MILNE EDWARDS and HAIME to the three genera which they considered as most nearly allied and which also by later authors have been grouped together.

The following table gives a survey of the characters upon which the said authors based their new genera.

The characters which are stated to be peculiar to each genus are printed in italics.

Plasmopora.	Propora.	Lyellia.
1849. *Comptes Rendus*, tome XXIX, p. 262.		
Polypier libre, subhémisphérique, à plateau commun recouvert d'une épithèque plissée concentriquement. Cloisons *rudimentaires*. Planchers horisontaux. Murailles minces. Calices à bords *non saillants*. Les polypiérites sont unies par d'assez grandes lames verticales radiées, entre lesquelles s'étendent d'autres lames horizontales.	Diffère du genre précédant par des calices à *bords saillants*, des cloisons *plus développées* et qui se prolongent extérieurement sous forme de petites côtes.	

Plasmopora.	Propora.	Lyellia.
1850. *British Fossil Corals*, p. *lix.*		
Calices *immersed.* Septa *rudimentary.* Walls thin. Coenenchyma of large vertical, radiate laminæ united by smaller horizontal plates.	Calices with *exsert* margins. Septa *more developed*, extending outwards as to constitute small costæ.	
1851. *Polypiers terrains paléozoiques*, p. 221 and the following.		
Polypier massif. Calices circulaires *non saillants.* Murailles *minces* mais bien distinctes. Coenenchyme, *grandes lames verticales radiées representant côtes et unies par des traverses à peu près horizontales.* Douze cloisons bien développées en largeur. Planchers *sensiblement* horizontaux. Se distingue des autres par le grand développement de l'appareil costal.	Polypier massif. Calices circulaires à *bords un peu* saillants. Coenenchyme . . . une exothèque à cellules *inégales et assez irrégulières, mais dans laquelle les côtes ne se prolongent que peu ou point.* Douze cloisons assez étendues en largeur et qui se continuent extérieurement sous forme de rayons costaux. Planchers horizontaux ou un peu irréguliers.	Polypier massif. Murailles *épaisses* et *costulées.* Périthèque vésiculeuse et très abondante. Cloisons bien développées. Planchers un peu irreguliers.
1860. *Histoire naturelle des Coralliaires*, vol. III, p. 241.		
(Description exactly identical with that of 1851, excepting »cloisons bien développées en *longueur*» instead of »largeur», possibly through misprint.)	Calices circulaires à bords saillants. Coenenchyme médiocrement développé et constitué par des traverses nombreuses et subramifiées. Cloisons bien développées et s'étendant en dehors de façon à constituer de petites côtes.	Coenenchyme très développé entièrement vésiculeux rappellant tout à fait la périthèque des Galaxées.

If we now scrutinize the above given characteristics we shall find that in the earliest descriptions, of 1849 and 1850, there are some essential differences, which later in 1851 and 1860 are effaced, so as to make the distinctions not perceptible. So, for instance, it is at first said that in Plasmopora the septa are rudimentary and in Propora again more developed. In 1851 and 1860 it is said concerning both these genera that they

have »cloisons bien développées», and so forth. As to Lyellia there is only said that its »murailles» are »épaisses et costulées», in all other respects it coincides with Propora and scarcely not in that respect, as it is also stated that Propora has costæ. For the rest there are further down under the genus Camptolithus reasons adduced for not longer retain Lyellia as an independant genus. I think, that if there were no other differences found between Propora and Plasmopora than those adduced by MILNE EDWARDS and HAIME, there is no great cause to keep them apart and this was also the reason why I formerly united both under Plasmopora. But through later researches I have seen that there are actually differences of generic value. As to Plasmopora and Propora, having many features in common, there are still several points which are of value as distinction, thus for instance, that in Plasmopora there are in the coenenchyma large vertical laminæ. In Propora there is strictly only Propora tubulata with exsert calicles or with »bords saillants» and in Plasmopora also some species are provided with exsert calicular margins. There are Plasmoporæ, some with long and others with nearly rudimentary septa, but the generic distinction does not depend on this circumstance alone.

The characters of the Plasmoporine genera, according to my conception, are the following.

Gen. 1. *Plasmopora.* M. EDW. & HAIME.

Calicles surrounded by a stelliform space, formed by the continuation of the septa outside the theca and their union at the ends forming an area, called *aureola.* Coenenchyma of irregular, disconnected and interrupted tubuli, often changing into detached bacilli or even aculæ. The traverses are horizontal dissepiments as well as irregular convex laminæ, both sorts occuring in the same specimen.

Gen. 2. *Propora.* M. EDW. & HAIME.

Calicles without costæ or only very short ones, not forming an aureola. Septa consisting only of free spines not forming any lamellæ.

Coenenchyma entirely consisting of vesicular tissue without tubuli, with unconnected bacilli, baculi and aculæ.

Gen. 3. *Camptolithus* n. gen.

Tabulæ of the calicle convex, commonly short and intermingled as to form a vesicular tissue of small convex lamellæ, quite identical with that of the coenenchyma and also provided with aculæ and bacilli.

Gen. 4. *Diploëpora.* QUENSTEDT.

Calicles of varying shape according to their stage of development, with rows of spines instead of septal laminæ.

Coenenchyma of two different strata: the older and innermost vesicular, the younger and exterior of closely packed, straight baculi of a peculiar conformation.

I may here remark that SARDESON in his paper on the Tabulate Corals, p. 353, has established a Family of Plasmoporidæ in the Suborder Helioporidæ and includes in it, besides the two first above mentioned genera, also Pinacopora and Houghtonia. As to Houghtonia it is synonymous and identical with Columnopora, which latter was ranged by SARDESON with Michelinia as member of his new family Pleurodictyidæ, but both are synonyms and identical with Calapœcia, an older genus of BILLINGS, which according to the views I have represented above at page 24 has no connection with the Heliolitidæ. As to Pinacopora I cannot find it different from Propora, and it is probably only a variety of the common species Pr. conferta.

Plasmopora. MILNE EDWARDS & HAIME.

1839. Porites p. p. LONSDALE. Sil. Syst., p. 687.
1849. Plasmopora MILNE EDW. & H. Comptes Rendus, tome XXIX, p. 262.
1850. Astræopora D'ORBIGNY. Prodr. I, p. 50.
1851. Palæopora MAC COY. Brit. Palæoz. Foss., p. 17.

I some time, adhering too closely to the distinctive characters given by MILNE EDWARDS and HAIME in their fundamental works, held the opinion that the corals belonging to the genera Propora and Plasmopora could not be generically kept apart, but must be joined in a common genus, Plasmopora, to be retained as being the oldest. But since I have been able to examine a richer material of specimens I have found that both genera are very well distinguished from each other.

Plasmopora is well separated from all other genera by the following peculiarity. The calicle proper is surrounded by a more or less stelliform space or area, formed by the twelve prolongations of the septa which stretch outside the theca of the calicle and enclose longitudinal compartments and unite with each other through a curved lamina at the ends. This distinctive area, which is found in all species of this genus, I have called an *aureola*. A good specimen of it is to be seen on plate XI, fig. 36 and others. If the calicles are closely set, the aureola cannot expand as much as else and those of neighbouring calicles intermingle.

The septa are either coherent lamellæ of fibrous texture with spiny margins or, as it were, broken up, nearly entirely, in oblique, strong spines. The coenenchyma has irregular tubes, they are crooked and bent, their walls are discontinuous or the traverses mingle from different tubes. The traverses can be regularly horizontal, funnelshaped or obliquely intercrossing and besides in the same specimen the convex lamellæ can exist alongside with the former. The aculæ are present together with bacilli and it can actually be observed (pl. VII, fig. 10), how the latter have been formed out of the former. Coenenchymal gemmation has been observed in two species. From the septa and the aureolar radii being simple or barbed, from the different internal structure specific characters may be obtained.

This genus is at the earliest found in the lowest Upper Silurian beds continuing prolific in variable forms through the whole of that formation, but not higher, so that not a single specimen is known from the Devonian formation.[1]

In distinguishing and describing the species belonging to this genus or rather in trying to subdivide the various fossil forms pertaining to it, into distinct species great difficulties are to be encountered through their great variability and their similarity in many features. There are at least three groups of species. One contains Pl. petaliformis, foroensis, calyculata and scita with their large spiny septa, the sinuous barbed aureolar radii, the irreguliar coenenchymal tubuli, with spiny walls, and the coenenchyma composed both of convex lamellæ and aculæ, bacilli or irregular tubuli enclosing vesicular lengthened traverses. Another group is formed by Plasmopora suprema, rudis and heliolitoides with short, nearly evanescent septa, a narrow aureola, and peculiar funnelshaped and oblique traverses in the irregular tubuli. A third group consists of Plasmopora stella, scala and rosa with large, well developed aureola, simple straight septa and partly with nearly regular Heliolitidean coenenchyma. To these I have joined yet one species, the belonging of which to this genus may be contended, but I can at present not find it in greater affinity with any other genus.

The geological distribution of these species is the following:

	Uppermost strata of Lower Silur.	Arachnophyllum strat.	Llandovery.	Wenlock shale.	Wenlock limestone.	Ludlow beds.			
		a	b	c	d	e	f	g	h
Plasmopora petaliformis Lonsd.				*	*		*		
foroensis n.							*	*	*
calyculata n.			*	*	*				
var. tuberosa n.					*				
scita M. Edw. & H.			*	*	*				
follis M. Edw. & H.					*				
stella n.		*							
scala n.		*							
rosa n.							*		
suprema n.								*	*
rudis n.								*	*
heliolitoides n.				*					
? reticulata n.		*							

[1] On the pretended Devonian species see at the end of this genus.

Plasmopora petaliformis. LONSDALE.

Pl. VI, figs. 1—12.

1839. Porites petalliformis LONSDALE. Sil. Syst. II, p. 687, pl. 16, figs. 4, 4*a*.
1849. Plasmopora petaliformis EDW. & H. Comptes Rendus, vol. XXIX, p. 262.
1850. » » ID. Br. Foss. Cor. Introd., p. *lix*.
1851. Palæopora petalliformis M'COY. Brit. Palæoz. Foss., p. 17.
1851. Plasmopora petaliformis EDW. & H. Pol. pal., p. 221.
1854. » » ID. Brit. Sil. Cor., p. 253, pl. LIX, figs. 1, 1*a*, not fig. 1*b* which belongs to the new species Plasmop. stella.
1860. » » ID. Hist. Nat. Cor. III, p. 240.
? 1862. Porites petalliformis M'COY. Sil. Foss. Ireland, p. 62, uncertain whether identical.
1867. Plasmopora petaliformis LINDSTR. Nom. Foss. Gotl., p. 27.
1867. » (Heliolites) » DUNCAN. Siluria, pl. 39, f. 4.
1879. » » QUENSTEDT. Petref. Deutschlands, p. 152, Taf. 149, f. 11.
1880. » » NICHOLSON & ETHERIDGE. Girvan, p. 267, Fig. *A*, but not in »Tabulate Corals», pl. XI, f. 5 and pl. XII, f. 1, which differ in having no septa.
1883. » » FERD. ROEMER. Leth. Geogn., p. 510, fig. 121 *a—b*. The last figure is in so far inexact that the septal spines are not delineated.
1883. » » VON KOCH. Palæontogr., p. 334, pl. 43, figs. 12—15.
1885. » » LINDSTR. List. Foss. of Gotland, p. 18.
1888. » » ID. List. U. Sil. Foss. Sweden, p. 21.

The English specimens have grown in regularly semiglobular disks of circular circumference, with the superior surface convex, hollow or flattened on the basal side, which is concentrically, coarsely wrinkled by a thin epitheca. The Gotlandic specimens are more irregular, forming larger disks of moderate thickness.

The *calicles* have a diameter varying between two and one millimeter according to the specimens. The edge is rather oftener exsert than immersed.

The *septa* are variable in length (fig. 7), though usually long (fig. 10) and straight. In sections (figs. 1, 4) they are often destroyed and shortened. They have no large lamina (figs. 9, 12 etc.), are divided into spines, more or less curved, which do not reach to the centre of the calicle. The *tabulæ* are sparse, thin irregularly concave.

The *aureola* surrounding the calicle is of varying width, with radii as long as the diameter of the calicle or even only as half that size. The radii may be crooked or straight, often with barbs on both sides. The compartments between the radii are of the same width near the theca as at their outward edge, only a little widening. The coenenchymal tubes are much irregular, especially as to their size, and upon the whole they are rather scarce, as the space between the calicles is chiefly occupied by the aureolæ. It is difficult to find how this vertical part of the corallian sceleton is placed in relation to the vesicular tissue of the coenenchyma. There are aculæ, ordinate in longitudinal rows (figs. 5, 9), these have coalesced (fig. 12 at the right in the coenenchyma), forming two zigzaglines enclosing modified bladders, becoming nearly square or flattopped instead

of convex. Of this latter structure the section fig. 11 is almost entirely composed. In the English specimen, fig. 3, being the lowest part of the same as in figs. 1 & 2, the coenenchyma is nearly free from all vertical elements and composed of large, very convex laminæ. I suppose that the shaded portions of the coenenchyma, fig. 12, vertically streaked, are derived from the walls of the aureola or of the tubuli, occasionally sectioned in a parallel direction or alongside. The dark patches again seen in the transverse sections (fig. 1) and others are due to the convex laminæ.

As a variety of this species I regard a coral from Tjelders in Boge delineated pl. VI, figs. 13—15. The aureola is more richly developed with thick, branching radii, covered with larger and more numerous barbs, quite as long as the diameters of the calicle, the septa are nearly of the same conformation as in the former, the coenenchyma of the cancellate fashion which is so predominant in Plasm. follis. It cannot be denied that there exists a wide range of differentiation in this species, when for instance the section fig. 8 is compared with fig. 1 or fig. 10. The septa which are so long in fig. 10 have evidently been destroyed in figs. 1 & 8. The abundant spinosity in the coenenchyma of the latter may in some measure be dependent on its mode of growth, which is somewhat irregular, a great obliquity discernible. As to the great differences in the coenenchyma there are evident transitions from the solely vesicular structure in fig. 3, to that of figs. 5 & 9 with aculæ, from that to the more developed quasi tubular or cancellate in figs. 2 & 11. This species occurs not rarely at Dudley in England in the Wenlock limestone, more seldom in the strata of Gotland corresponding to the Wenlock shale of England, at the islet Stora Carlsö, and also in the limestone of Simunde, Bara belonging to the stratum *f.* of Gotland. DE KONINCK in »Recherches sur les fossiles paléozoiques de la nouvelle Galles du Sud», p. 24, also cites this species as occurring there, but as I have not seen his specimens I do not feel sure of the identity, the more so as his description is very incomplete.

Plasmopora foroensis n.

Pl. VI, figs. 16—22, Pl. VII, fig. 1, sections I—IV.

Corallum disciform or tuberose or grown in irregular, rounded lumps.

Calicles in diameter 2 millim. at the highest, with thick, exsert edge, a little angularly folded in face of the *septa*. These are of unequal size, long ones reaching near the centre, mixed with much shorter, but without the alternation, so evident in Heliolites porosus. The centre of the calicle is occupied by the superior ends of lower lying septal spines, which in a section project as some irregular dots (fig. 18). They form no laminæ, but are dissolved into large, closely placed, upwards curved spines (see especially fig. 21). The *tabulæ* are extremely fine or thin, horizontal or wavy and slightly concave. The *aureola* is well discernible, though much entangled with excrescences, but attains only half the width of the calicle. As the calicles lie close, there is not much space for other coenenchyma and even the aureolas become mixed up with each other. In a longitudinal section the cancellate structure predominates. The concave laminæ are enclosed between

the zigzagshaped walls of the tubuli and have a peculiar appearance, placed obliquely above each other f. 22.

Coenenchymal gemmation has been observed in this species as represented in pl. VII, figs. 1, I—IV. It begins from the walls of the tubuli between two aureolas, which are dissolved (II) in a number of aculæ, surrounded by an irregular girdle, the first vestige of the future theca. This (in III) gains more regularity and the bases of the septa are visible at several points, while the scattered aculæ in the middle show their tops, which at last (IV) are arranged in regular series, the final shape being nearly attained. This species comes near to the former, but is well distinguished from it through its coarser and thicker vertical elements, through the larger and more dense septal spines and through the entirely cancellate coenenchyma with its peculiar intercrossing lamellæ.

It has been found only in Gotland where it occurs plentifully in the uppermost limestone beds, *f—h*; at the following localities. In the isle of Fårö, from which the name of the species is taken, at Ryssnäs and Dember, at Kylley, Othem, Slite on Lotsbacken, Lännaberget and Enholmen, Tjelders in Boge, Bara backe, Simunde in Bara, Hörsne, Follingbo, Wisby, Myrsjö kanal in Stenkumla, Klinteberg.

Plasmopora calyculata. LINDSTRÖM.

Pl. VI, figs. 23—30.

1883. Plasmopora calyculata LINDSTR. in RICHTHOFEN's China, Bd 4, p. 59, Taf. VII, figs. 8—9.

Corallum grown in semiglobular masses with flat base wrinkled by a thin epitheca.

The *calicles* lie in the midst of the bottom of shallow pits, which are well circumscribed by a polygonal (commonly pentagonal), ridge. (Pl. VI, fig. 23.) Each such well defined cup varies between five and seven millimeters in diameter. The calicle proper in the midst of it attains 2 millims. This interesting feature of clearly divided areas around the small calicles, more evident in this species than in any other, has given the first impulsion to the interpretation of the nature of the coenenchyma which I have tried to express above (at p. 14, 18). According to this view I consider each such polygonal area as the whole of a calicle proper *per se*, consisting of the interior area with the septa, commonly called the calicle, surrounded by the interior theca and outside this the exterior area or border, commonly called coenenchyma, only separated from the adjacent calicles through the dividing ridge, without any exterior theca or epitheca. The same characters have been found in other Heliolitidæ as stated, through not so pronounced as in this species. What of the coenenchyma in the plurality of the species of this group is confluent and not interrupted or marked out by confines and thus forming a common structure for the whole polypary, is in this species portioned of to each individual polyp and thus indicating the signification of its nature. The theca is exsert and raised above the aureola, and in one piece with the septa. The *septa* are well developed, straight and reach nearly to the centre. The theca forms obtuse angles in face of the septa. They consist of a

coherent lamina fringed in the edge by short, fine spines figs. 28—30. Their composition of minute, upwards directed fibrillæ is evident. The *tabulæ* are thin and irregular, as if bent and broken, and much distantiated.

The *aureola* is well developed, the compartments short and broad; the radii richly provided with lateral thorns and barbs. The width of the aureola corresponds to the moiety of the calicle. Outside the aureola there is an abundant *coenenchyma* far more so than in the preceding species where the calicles are more close. Seen on the surface of the coral it is a network af rounded, irregular meshes with funnelshaped bottoms. A little below the surface (fig. 26) almost the same appearance prevails. Deeper down (fig. 27) there is a change and the radii of the aureola are simpler, without lateral barbs, the coenenchyma more regular. In the longitudinal sections the vesicular structure is prevalent, the convex lamellæ are of much unequal size and there are only a few aculæ scattered without order amongst them. Some darker patches may indicate fragments of the vertical elements. A few vestiges point to a cancellate arrangement.

The fig. 25 represents a specimen of coenenchymal gemmation. The incipient theca enclosing eight or nine rudiments of septa is visible. This interesting species has been found only in the lowest shale beds *b* and *c* near Wisby and its neighbourhood, Skälsö, and as far north as Halls huk, in south to Gnisvärd, Eskelhem, Djupvik in Eksta, Stora Carlsö and Sproge. Abroad the only known locality, Dudley in England, has contributed with a few specimens, which probably belong to a higher stratum than in Gotland or to the Wenlock limestone.

Plasmopora calyculata var. *tuberosa* n.

Pl. VII, figs. 2—5.

The corallum forms irregular tubers of variable shape, covered all around with calicles. These are sometimes a little more than 2 millimeters in diameter. The *wall* is exsert and composed by the thick exterior ends of the septa. Instead of the ingoing angle formed at the exterior septal end at the other species, this angle is here completely filled with calcareous matter in the shape of a transverse rhomboid, giving in combination with the annexed often straight septum the aspect of a little nail. The *septa* are simple or also provided with lateral barbs and hooks. They consist of a coherent lamella with edges fringed by small spines and reaching far towards the centre of the calicle. The *tabulæ* are irregular and much scarce.

The *aureola* is present, but much irregular and difficult to decipher. In a transverse section it is more evident, its compartments of unequal size, no doubt depending on their having grown on inclined planes. The *coenenchyma* is abundant and well composed of tubes of variable size and shape. In a longitudinal section these are not so well discernible as the large traverses of convex lamellæ.

Of coenenchymal gemmation there are several instances from beginning alterations of the coenenchyma to different stages of the rudimentary theca and septa.

This pretty coral has chiefly been found in numerous specimens in the limestone stratum *d*. of the Wisby region. There are also specimens from Alnäse and Ryssnäs in Fårö which belong to this species.

The most characteristic feature lies in the formation of the theca and its nailshaped septa, and also in the structure of the exuberant coenenchyma. In a few specimens there are also slight vestiges of shallow pits round the calicles.

Plasmopora scita. MILNE EDWARDS & HAIME.

Pl. VII, figs. 6—18, pl. VIII, figs. 1—3.

1851. Plasmopora scita M. EDW. & H. Pol. pal., p. 222.
1854. » » IID. Brit. Sil. Cor., p. 254, pl. LIX, figs. 2, 2*a*.
1860. » » » H. N. Cor. III, p. 240.
1867. » » LDM. Nom. Foss. Gotl., p. 27.
1879. » » QUENST. Petref. Deutschl. I, p. 145, pl. 148, fig. 32, *o*, *x*, excl. *u* & *y*.
1880. » » NICHOLSON & ETHERIDGE. Girvan, p. 267, figs. *B*, *C*.
1880. Plasmopora exserta IID. Ibid., p. 269, pl. XVII, figs. 4, 4*a*.
1883. Plasmopora scita FERD. ROEM. Lethæa Geogn., p. 511, fig. 121*c*.
1885. » » LINDSTR. List of Foss. Gotl., p. 18.
1888. » » ID. List of Upp. Sil. Foss. Sweden, p. 21.

This, perhaps the most common of all our Plasmoporæ, assumes as may be beforehand inmagined, a great variety of shapes. It is commonly disciform, having the caliciferous, superior surface flat or slightly gibbous, but there are also domeshaped colonies or globular and irregularly spheroidal and tuberose.

The calicles are the smallest in the whole genus and scarcely attain one millim. in diameter. As to their form they vary in the highest degree, especially those from the stratum *d* near Wisby, and there might be justified doubts entertained that such extreme forms as those on pl. VII, fig. 6 and fig. 16 could belong to the same species or even to the same genus, were not numerous transitions found between them, even on the same polypary.

The common form is represented in fig. 6, where the calicles are most regular and the theca entire, its edge a little exsert and tuberculate where the septa continue through it as radii of the aureola. Now it happened that the theca has been, as it were, broken up in twelve disconnected small pieces (pl. VIII, fig. 1) formed by the nodules where the septa cross the theca and continue in the aureola. They become more and more flattened, pl. VIII, f. 2, 3, the boundary line between calicle and aureola vanishes and the broad, flat septa covered with innumerable warts or aculæ are confluent with the coenenchyma, of the tubuli of which only a few indistinctly circumscribed pits remain (fig. 16). That this variety of calicle really belongs to this species is clearly demonstrated by the transverse section (fig. 17) taken a little below the surface, in which the characters of Plasmopora return, to be compared with the other sections (figs. 7, 9, 12, 14, 15), only that in fig. 17 the coenenchyma is a little thicker. As represented in figs. 14 and 15 there is also great difference in the proximity of the calicles.

The *septa* are not lamellar, they consist of a dense row of large, closely packed spines (fig. 18), which reach to the centre and nearly obscure the thin, much distantiated tabulæ. The granulated septa, as seen in the bottom of the superficial calicles, f. 16, represent the bases of the spines, which later grow out from these. In a section from the older portions of a polypary (fig. 11) there are also small aculæ on the superior surface of the tabulæ, no septal spines in the lowest parts and rather scarce in the beginning. But there is no telling whether this is the original structure or rather a condition due to inorganic changes during the fossilization.

The *aureola* is distinct and regular in the typical specimens (as fig. 6). Owing to the proximity of the calicles there is not much space left for other coenenchymal tubes. The *coenenchyma* in a longitudinal section is chiefly vesicular, the convex lamellæ of greatly different size. There are longitudinal rows of aculæ which also combine into rods and constitute irregular tubuli (fig. 18) enclosing traverses.

There are indications of coenenchymal gemmation (fig. 10), as well as of a calicinal one, in small colonies rising out from the surface of older calicles.

This species has been frequently found in the older strata of Gotland. It does not occur deeper than in the marly beds of *b* and not higher than in the Wenlock limestone (*d*) of Gotland. It has been found in the following localities. Ryssnäs in Fårö, Hall, Halls huk, Follingbo, Dalhem, Wisby (*b*, *c* & *d*), Walveref, Blåhäll in Tofta, Nyrefs udde in Tofta, Gnisvärd, Westergarn, on the shore south of Westergarn, Eskelhem, Ekska, Lilla Carlsö, Stora Carlsö, Hoburg.

Out of Gotland it is said also to occur in the Upper Silurian of England, from where I have not seen specimens.

Specimens sent to me from the late Prof. JAMES HALL of Albany, under the denomination Heliolites spinipora from Lockport, N. York seems to belong to this species, not to Propora as M. EDW. & HAIME, H. N. Cor. III, p. 242 have stated.

Plasmopora follis. EDW. & H.

Pl. VII, figs. 19—20.

1850.	Plasmopora follis	EDW. & H.	Pol. palæoz., p. 223, pl. 16, figs. 3, 3*a*.
1860.	» »	FERD. ROEMER.	Tennessee, p. 24, Taf. II, figs. 6, 6*a*.
1860.	» »	EDW. & H.	H. Nat. Cor., III, p. 240.
1876.	» »	ROMINGER.	Michigan, p. 14, pl. III, fig. 2.
1879.	» »	QUENSTEDT.	Petref. Deutschl., p. 147, pl. 149, fig. 1*a*—*c*[1].
1883.	» »	FERD. ROEMER.	Lethæa Geogn., p. 511.
1885.	» »	DAVIS.	Kentucky Fossil Cor., pl. I, fig. 9 (f. 10 too indistinct.).

It grows as a rounded, irregularly spherical corallum.[1]

The calicles are circular not at all exsert, not much more than one millim. in diameter.

[1] The specific name has been derived from the latin *follis*, signifying a pouch or a rounded sack.

The *septa* are of the shortest, scarcely visible in a longitudinal section as small aculæ, which also sit on the very regular tabulæ. The *aureola* is distinct and regular attaining $^3/_4$ of the diameter of the calicles, those of neighbouring calicles being intermingled. The coenenchyma is of the cancellate order, the tubuli with angular or zigzagformed walls, giving in combination with the traverses a polyedric appearance to the compartments of which it is composed, fig. 20. There are also dark patches, probably vestiges of the tubular walls.

This is an exclusively American species. The Swedish State Museum possesses specimens of it from Tennessee, Decatur C^ty^, a gift from Prof. FERD. ROEMER, from Perryville, Cincinnati, and Louisville, Kentucky, a gift from Dr W. R. HEAD in Chicago.

It differs from the other species through its short septal spines and the minute aculæ on the tabulæ, and through its regularly cancellate coenenchyma.

Plasmopora stella n.

Pl. V, figs. 19—26, 29, sections I—VII, pl. XI, figs. 36, 37.

1854. Plasmopora petaliformis M. EDW. & H. p. p. Brit. Foss. Cor., pl. LIX, fig. 1*b*, not the others; this is delineated from a different specimen than the other figures, which represent the true Plasmop. petaliformis.

Corallum discoid, flat on the superior surface, as well as on the inferior one with its thin, finely wrinkled epitheca.

The *calicles* of little more than 1 millim. in diameter, have rather long septa, consisting of large, coherent lamellæ, in the edges serrulate by irregular, upwards directed spines, the lamellæ being striated in the same direction. The *tabulæ* are concave, irregular, intercrossing and being secreted later than the septa at the same height they are intersected by these and reposing between them.

The *aureola* is one of the most regular and typic. (Especially pl. XI, fig. 36.) Its width is equal to $^3/_4$ of the diameter of the calicle. The twelve compartments formed by the prolongations of the septa are equalsized, wedgeshaped, a little widening outwards. In a longitudinal section this zone is distinctly separated from the other narrow coenenchymal tubuli as broader belts, one on each side of the calicular tube, pl. XI, f. 37.

On the outside of the theca, in some specimens (fig. 22) small costæ are to be seen between the radii of the aureola, without any connection with the interior of the calicle.

The *coenenchyma* outside the aureola consists of tubuli nearly like those of a Heliolites (fig. 23 and pl. XI, fig. 37) or also more irregular (figs. 20, 22, 25). They are transversally divided by regular, horizontal tabulæ which, however, sometimes, especially within the aureolar zone, are modified into convex lamellæ.

The coenenchymal gemination has been observed as represented on pl. V, fig. 29, sections I—VII. Out of a highly irregular coenenchyma two new calicles are developed in such manner that the vertical walls of the tubuli by and by concentrated on two points become roughly circular (III) with some incipient septa (IV). In the left hand calicle (V)

there are vestiges of an aureola and 10—11 septa. In section VI the right hand calicle again is more advanced, with twelve septa and eleven rudimentary aureola compartments, also in section VII.

There exists moreover a sort of calicular gemmation, the calicles having grown upwards detached from the ambient coenenchyma, secreting a new coenenchyma around their thecal edge, from which buds grow in accordance with the procedure already described above in Heliolites.

To be remarked is the pitted surface of some specimens, forming small polygones, evidently marking out the boundaries of each single calicle with its interior area, commonly called calicle, in the centre and the coenenchymal border around it as in Pl. calyculata. There are transitions from quite smooth or plane surfaces to such with very shallow pits and at last those with deep ones.

In a few calicles abnormities have been found with only 8 or 10 septa, the only deviation known amongst the Heliolitidæ from the regular number of twelve.

This species has been found in several specimens on the shores near Wisby, evidently derived from the lowest Upper Silurian beds of Gotland, the Arachnophyllum stratum, *a*, and I have also a specimen from a nearly corresponding stratum G^1 at Kattentack in Estland. In Norway it occurs in the islet Malmökalven in the Christiania-fiord.

Plasmopora scala n.

Pl. V, figs. 27—28.

Corallum disciform, thickness at most 10 millims., with calicles only on one side. *Septa* reaching nearly to the centrum, equal, simple and straight, forming a coherent lamella with irregular spines in the edges. The *tabulæ* are concave, distantiated. The *aureola* is regular, in width nearly equal to the diameter of the calicle. Its radii are a little sinuous and provided with short lateral barbs.

The *coenenchyma* seen in a transverse section presents the many, small, irregularly polygone tubuli, the walls of which continue downwards, sinuous, interrupted, enclosing horizontal traverses. There are only few convex lamellæ besides.

The chief differences from Pl. stella lie in the structure of the aureolar radii, these being barbed, not smooth, and also in the irregularity of the coenenchymal tubuli.

It has been found only in the Arachnophyllum bed *a* near Wisby.

Plasmopora rosa n.

Pl. VII, figs. 21—23.

Corallum disciform. *Calicle* scarcely attaining one millim. in diameter, provided with twelve short *septa* reaching halfways to the centre, forming a narrow lamella fringed in the edge and composed in the usual manner by microscopic fibrillæ directed upwards. The *tabulæ* are horizontal or oblique and a little concave, closely set. The *aureola*

resembles that of Pl. stella, has regular, simple radii and in breadth it equals $^3/_4$ of the calicular diameter. The compartments widening outwards. Between the aureolas there is a rich coenenchyma of polyedric tubuli of unequal size, enclosing minute, convex lamellæ, which in each tubulus form two rows, the opposite through their oblique position dovetailing each other (fig. 23) and thus causing the appearance as if there were funnelshaped dissepiments. Besides there are also long zones of the common vesicular appearance.

This species belongs to the same group as Pl. suprema and Pl. rudis in consequence of its peculiar coenenchymal traverses, but differs from them through its well developed septa and the aureola which resembles that of Pl. stella.

It has been found in the uppermost limestone beds (*h*) of Linde klint in Gotland.

Plasmopora suprema n.

Pl. VII, figs. 24—26.

Corallum disciform, *calicles* small, scarcely one millim. in diameter, theca only a little exsert, the *septa* are short or rudimentary, as crenulations in the theca and consequently in a longitudinal section only observable as a narrow, black band with faintly fringed edges. The tabulæ are horizontal and much distantiated, leaving a space of somewhat more than one millimeter between themselves. The aureola is large, but irregular, its width equals the diameter of the calicle. Its radii, all regularly connected with the septa, are unequal in size, bent, with lateral processes, which even cross a compartment and join two radii. The other coenenchyma is abundant, consists of tubuli of different size, polygonal or rounded. They continue downwards, but are interrupted and enclose more convex lamellæ than horizontal traverses. There are also free spaces of vesicular structure.

This beautiful species has been found in the central Gotland hills of Linde and Löjsta in the uppermost limestone.

Plasmopora rudis n.

Pl. VII, figs. 27—31.

The corallum has grown in large rounded, irregular masses, showing, as usual with those from the upper limestone strata, few vestiges of an epitheca. As these strata generally give evidence of being shore or shallow water formations in which waterworn and rolled fossils have been embedded, it cannot be expected to find them so complete as those from the shale beds. The calicles are in the typical variety of the largest in this genus, attaining 2 millims. in diameter. Of *septa* there are only rudiments as broad rounded lists covered with innumerable minute warty protuberances

(fig. 31). In a longitudinal section of the calicular tube (fig. 30) therefore only a thick theca is seen, unless a septal list is sectioned, as in the same figure at left, where it is obliquely streaked with the elementary fibrillæ. The *tabulæ* are rather distantiated, horizontal or concave (fig. 28). The *aureola* is narrow, scarcely attaining a breadth equalling half the diameter of the calicle. Its compartments are short, irregular, intermingled with those of the other, close lying calicles. The *coenenchyma* as seen in a longitudinal section consists of narrow stripes between the calicles, chiefly the aureolar tubes, which enclose the same kind of oblique, dovetailing traverses as in Plasm. rosa.[1]

In the theca of the calicles, represented in fig. 29, there are some lacunæ, as of perforations. They are caused by fissures and attentive examination of other specimens cannot detect any vestiges of perforated walls.

The now described variety is derived from the uppermost limestone beds of the northern part of Gotland, from Rute, Helvi, Klints in Othem, Klinte in Boge, quarries between Slite and Bäl.

In the corresponding strata of south Gotland another variety (fig. 27—28) occurs of the same structure, only deviating in lesser proportions. It has been found in the limestone beds of Sandarfve kulle, Mallgårds klint, Linde klint, Hageby in Etelhem.

Plasmopora heliolitoides n.

Pl. VII, figs. 32—33.

Corallum disciform or tuberose. The calicles of 1,5 millim. in diameter have no elevated margin of the theca and this is very thin. Of *septa* there are only the merest vestiges, some calicles being perfectly smooth inside, others faintly fluted by longitudinal septal lists, the septa protruding in a transverse section as diminutive tubercles. The *tabulæ* are regular, numerous. The *aureola* is the narrowest in the genus, only equalling one fourth of the diameter of the calicle. Irregular as the compartments may be, unequal, more than double broader than long, they are well discernible and twelve, with the radii starting just opposite the septal rudiments. As the calicles are much remote from each other the coenenchyma is most abundant, consisting of unequal tubuli, which in a transverse section are polygonal, exactly resembling those of many true Heliolitæ, but in a longitudinal section (fig. 33) they are by far not so regular, their thecæ are sinuous and crooked, not parallel, and the dissepiment upon the whole horizontal, also oblique. The two calicular tubes in fig. 33 have like others in the same section, not figured, arisen from the coenenchyma through gemmation.

This species has been found in the stratum *d* of Östergarn, Gotland.

In consequence of its regular coenenchyma it could easily be confounded with Heliolites decipiens, if not on a closer inspection its aureola and its more irregular coenenchyma were observed.

[1] The section fig. 30 has beside the calicular tube, at the right hand, only fragments of other calicles, one at left lowest, which is bent in another direction. The feathery lines are fragments of calicular walls.

Plasmopora? reticulata n.

Pl. VII, figs. 34—36.

Corallum disciform. The *calicles* circular, 1,5 millim. without the least vestiges of septa, the narrow theca being only a little indented at the point, where the radii of the aureola meet it. The *tabulæ* are closely set and regularly horizontal. The *aureola* is distinct though very narrow, in width a third of the calicular diameter. Its twelve compartments are unequal, often broader than long, the abundant *coenenchyma* has seemingly regular polyedric tubes of greatest brevity, but these are in fact formed by the transversally sectioned coenenchymal lamellæ. The short aculæ have in great abundance grown upon the convex lamellæ of which the whole vesicular coenenchyma is composed. This species has been frequently found in the Arachnophyllum stratum *a* around Wisby. The longitudinal section fig. 36 also informs us, how an older set of calicles has been overgrown and destroyed by coenenchymal growth and how this has turned sideways above a lacuna, now filled with clay and formed new calicles which have budded up out of it.

In the transverse section fig. 35, on the right hand, the short tubuli lie alongside convex laminæ. It is with some doubt that I place this coral amongst the Plasmoporæ as its coenenchyma rather is more like that of the next genus.

Milne Edwards and Haime have described in Hist. Nat. Cor. III, p. 241 a species of Plasmopora, Pl. micropora, as appertaining to the Devonian formation of Eifel, and they have identified it with Astrea micropora Goldfuss (nomen nudum) in the Museum of Bonn. Professor Clemens Schlüter has been kind enough to inform me that this fossil is no Plasmopora, but a Devonian »Fistulipora», nearly allied to, if not identical with Schlüter's Fistulipora cyclostoma, »Anthozoën des Rheinischen Mitteldevons», p. 161, Tab. XI, f. 7—8. There is thus no Plasmopora found younger than those from the uppermost beds of the Upper Silurian.

Gen. *Propora* M. Edw. & H.

1838. Astræa p. p. Angelin, Museum Paleont. Scand.
1839. Porites p. p. Lonsdale, Murch., Sil. Syst., p. 687.
1844. Sarcinula Dale Owen, Rept. Iowa, Wisconsin etc., p. 76.
1849. Propora Edw. & H., Comptes Rendus, XXIX, p. 262.
1850. Astræopora p. p. d'Orb., Prodr., I, p. 50.
1851. Palæopora p. p. M'Coy, Palæoz. Foss., p. 18.
1851. Lyellia p. p. Edw. & H., Pol. palæoz., p. 150.
1852. Heliolites p. p. Hall, Billings etc.
1878. Pinacopora Etheridge & Nichols., Girvan, p. 52.
1885. Plasmopora Lindstr., Foss. Gotl., p. 18.

Calicles with exsert edges, the septa, entirely wanting in some species, never form coherent laminæ as in Plasmopora and consist of disconnected spines. The tabulæ are generally regular, horizontal, never concave as so common with Plasmopora. The coenenchyma is entirely vesicular with dispersed aculæ and baculi, which do not connect so as to form tubuli. There is consequently no aureola, so distinctive for Plasmopora and only in a few instances the septa continue outside the calicles.

The most prominent characteristics, by which M. EDWARDS and HAIME designated this genus, were that the calicles are exsert, that the septa were more developed in this genus than in Plasmopora and that they are extended outwards so as to form costæ. The first diagnostic is valid for almost all species of this genus, but for the others certainly not. Already in the typical species, Pl. tubulata, calicles occur, even in the same specimen, with external costæ together with others quite devoid of such. Several species are without septa, and in those which have such, they are more rudimentary than in Plasmopora.

The geological distribution of the species in this genus is as follows.

	Lower Silurian.		Upper Silurian.								
	Leptæna limestone.		Basal beds.		Llandovery.	Wenlock shale.	Wenlock limestone.	Ludlow.			
	Lyckholm.	Borkholm.	Borenshult.	Arachnophyllum.							
	F^1	F^2		a	b	c	d	e	f	g	h
Propora tubulata E. H.		*		*		*	*				
euryacantha n.							*		*		
conferta E. H.	?	*		*		?	*	*			
var. minima n.				*							
cancellata n.		*									
speciosa BILL.			*				*		*		
compacta n.							*				
bacillifera n.	*	*									
? ambigua n.				*							

Amongst the Heliolitidæ this genus contains the oldest known species, which reach deepest down in the strata. Upon the whole, four out of the nine forms of the Proporæ are almost exclusively Lower Silurian or from the lowest U. Silurian and of the other only two ascend to the Ludlow strata of Gotland. Now it is interesting to see how the genus Plasmopora, the younger of these two, nearly related genera, which as far as I am aware is not represented in the Lower Silurian strata, is more developed, has perfect septa and a coenenchyma in which the tubulate structure begins to manifest itself and in some even nearly as completely in Heliolites. With the older geological age of Propora its more

rudimentary structure agrees. SARDESON has said[1] that »die Zertheilung der Mauern» (to wit in the coenenchyma) »ist bei Plasmopora-Propora trotz des höheren geologischen Alters bereits weiter fortgeschritten als bei Heliopora». And »bei Propora geht die Reduction der Wände am weitesten». He has thus clearly expressed his opinion that Propora is a genus in the act of regress from a former more complete state. I think the case is quite the opposite and that these oldest forms of all Heliolitidæ are in a state of progress. The aculæ, bacilli and baculi which have grown amongst the ever present vesicular tissue are the fundaments, out of which the tubuli in later times have been developed, as is so well seen in the Plasmoporæ, which are, as it were, intermediate between Propora and Heliolites. They are not remnants of already dissolved tubuli, on the contrary the rudiments out of which the tubuli are built up.

It is also remarkable that the youngest species of Propora, as P. tubulata, in certain respects come near to the Plasmoporæ, especially to Plasmop. scita and show a sort of precursory formation of aureola in its costæ.

The almost absolute defect of the coenenchyma or its scarcity in some of the specimens belonging to Prop. conferta (see pl. VIII, figs. 32, 34, 37 and pl. IX, figs. 31, 32), and also another species (pl. IX, figs. 33, 34), is a feature which leads to the assumption of still older twelve septate corals without any coenenchyma at all, from which the true Heliolitidæ may have descended.

Propora tubulata. LONSDALE.

Pl. VIII, figs. 4—22, 24, 25, 28—31.

1838. Astræa densistellata ANGELIN. Museum Palæontologicum Scandinavicum, N:o 11.
1839. Porites tubulata LONSDALE. Sil. Syst., p. 687, pl. 16, figs. 3, 3*a*—3*f*.
1850. Propora tubulata E. & H. Brit. Foss. Cor. Introd., p. *lix*.
1851. » » IID. Polyp. paléoz., p. 224.
1851. Palæopora tubulata M'COY. Brit. Palæoz. Foss., p. 18.
1851. Lyellia americana E. & H. Polyp. pal., p. 226, pl. 14, f. 3, 3*a*.
1854. Propora tubulata E. & H. Brit. Sil. Cor., p. 255, pl. 59, f. 3, 3*a*, 3*b*. The fig. 3*b* gives no true representation of the interior structure.
1858. » » FR. SCHMIDT p. p. Archiv, p. 226.
1860. » » E. & H. Hist. Nat. Cor. III, p. 241.
1860. Lyellia americana E. & H. Ibid. III, p. 243.
1867. Propora tubulata LINDSTR. Nomina Foss. Gotl., p. 27.
1867. Heliolites (Propora) tubulatus SALTER in MURCH. Siluria, pl. 39, figs. 3—3*f*.
1880. Plasmopora girvanensis NICH. & ETH. Girvan, p. 266, pl. XVII, fig. 2.
1882. Lyellia americana J. HALL. 11th Rept. Indiana, pl. XLVII, f. 5, p. 381.
1883. Propora tubulata F. ROEMER p. p. Lethæa Geogn. I, p. 512, fig. 122 *obs.* The figure and probably also the description are more consonant with Pr. conferta.
1883. Plasmopora tubulata LINDSTR. in RICHTHOFEN's China, Bd IV, p. 60.
1885. » » ID. List. Fossils Gotl., p. 18.
1888. » » ID. List. U. Sil. Faunas Sweden II p., p. 21.

[1] Tabulaten, p. 282.

1892. Propora tubulata LEBEDEFF. Obersil. Fauna des Timan, p. 14, pl. 1, fig. 4*a*—*b*—*c* (not fig. 3). It is not quite sure that this belongs to the said species, which cannot be decided by the imperfect figures and description.

1894. Plasmopora tubulata WEISSERMEL p. p. Korallen der Silurgeschiebe Ostpreussens . . ., p. 668.

1896. Propora tubulata SARDESON. Tabulaten, p. 278, figs. 15—17.

The oldest denomination of this species is that given by ANGELIN in 1838, but as it is only a name without description in a collection of fossils, it is more appropriate to keep that which has been so long in general use.

Besides the above given synonyms there are several which in consequence of too insufficient descriptions and figures must, until nearer notion be gained, remain doubtful. Such are *Propora tubulata* EICHWALD 1860, Leth. rossica, I, 1, p. 455 seems to be a Lower Silurian species. DE KONINCK, Fossiles palæoz. N. Galles du Sud, p. 23, gives only the name of this species. Also in F. ROEMER's Sadewitz, p. 22, Tab. IV, f. 3 where the figure 3 shows a coral much deviating from the typical by MILNE EDWARDS & HAIME. The same species in NICHOLSON, Tabulate Corals, pl. II, f. 3, 3*b* can not be identical, as it does not show any vestiges of septal spines. QUENSTEDT's figure in Petref. Deutschlands, pl. 149, f. 12 does not show the characters. MALAISE 1873 in Silurien du Centre de la Belgique, p. 107 also enumerates Propora tubulatus (!).

This common and as to its surface much variable coral opposes the greatest difficulties to the endeavours to fix the distinctions between it and the closely simulating Plasmopora scita. In both we find a great variability in respect to the shape of the calicles, in the Pl. scita impossibility for the aureola to develop when the calicles are densely crowded and again in the Propora no development of an aureola, even when there is space enough between the calicles for such a development. There are great chances of confounding both species with each other and it may thus happen that the one species is current in scientific papers under the name of the other. And indeed when studying a large number of specimens of both one is at a loss to decide to which species some belong. Moreover the interior structure, as studied in longitudinal sections, is often nearly the same. At last it may perhaps be found that both are linked together through a series of intermediate forms at the opposite ends of which stand what we now call Plasmopora scita and Propora tubulata. It cannot be denied that Plasmopora scita in spite of its aureola has an interior organisation which is more in concordance with that prevalent amongst the Proporæ. It may, however, be borne in mind that the tendency to construe tubuli is stronger in Pl. scita than in Propora. For the present it may be advisable to keep the extreme forms separate and at least temporarily describe both as distinct species.

The characters common to all varieties of this polymorphic species are the following. The margin of the calicular theca is exsert and free above the coenenchyma and the diameter of the calicles larger than in Plasmopora scita. There is no distinct aureola, even in those specimens where the calicles are remote. The coenenchymatous, vesicular tissue is more lax and composed of large bladders as in fig. 10, pl. VIII.

The typical surface, as represented by MILNE EDWARDS and HAIME in Brit. Foss. Corals, pl. 59, fig. 3*a* and of which I through the kindness of Prof. ALPHONSE MILNE EDWARDS have received a plaster cast, is figured anew on plate VIII, fig. 4 from an

English specimen. The characteristic costal radii are on these well expressed, but in the deviating specimen fig. 8 there are no vestiges of them and only shallow grooves radiate irregularly from the calicles. This specimen is also interesting because it shows the bladders of the coenenchyma, which else lie concealed beneath the surface and accessible only in sections. These convex lamellæ are completely covered by diminutive wartlets, the bases of the aculæ, which are so numerous in the interior on the convex lamellæ.

In the variety, fig. 11, there are not the faintest traces of the grooves and there is a nearly even coenenchyma covered with blunt warts. This and similar specimens constitute a variety by themselves, as the interior structure also is deviating (figs. 12, 13) with thick calicular thecæ, longer and larger septal spines, the aculæ also thicker than else. These varieties have grown in ovate, sphæroidal or irregularly globular masses and consequently no epitheca is seen. The calicles are deep and the rim is composed of twelve noduli, exactly corresponding to the exterior end of a septum, fig. 11. In fact, these noduli are the bases of a new or the youngest series of septal spines which through the growth of the corallum become placed more and more deep in the calicular cup, at the same time extending in length and resembling the older ones. The tabulæ are thin, much distantiated, horizontal, sometimes with aculæ on their upper side. Such species as these are derived from the strata *d* of Gotland coëval with the Wenlock limestone of England. From far deeper strata, those of Borkholm, F^2, we have specimens which may be considered as the oldest of this species. They are diskshaped or slightly domeshaped, the calicles are more widely apart than in the younger, the coenenchyma nearly as in the variety fig. 11. (Figs. 18, 21, 22.) The septa are short, and broad, and reach only a little distance from the calicular theca (fig. 18). The coenenchyma is composed by uncommonly small, convex lamellæ and the aculæ are thick and broad (fig. 19).

I have ventured to join with these forms some which have for a long time been considered as belonging to the nearly related genus Lyellia. I have treated more in full further down about this genus and there given my reasons why I consider that it cannot be retained, as the species enclosed within it, partly cannot be distinguished from Propora, and partly must form a new genus. The two species which I consider as belonging to Propora and hardly to be separated from Pr. tubulata, are Lyellia americana (pl. VIII, figs. 24 and 25), and Lyellia parvituba (figs. 29—31). It is to be borne in mind that the specimens which I have seen, especially the former from Point Detour, Michigan, have been much altered through being silicified. Still they retain the characteristic features of their organization. In Lyellia americana the septa are larger, but resemble those in the English specimen of Pr. tubulata (fig. 5). In Lyellia parvituba (fig. 30) the septa again are shorter, but resemble those in figs. 15 and 16. The coenenchyma of both coincides as nearly as possible with that in fig. 10. The aculæ are in Lyellia americana (fig. 25) much enlarged through later additions and in Lyellia parvituba (fig. 31) they are still so in a much higher degree and the calicular tubes are partially filled by an exuberant crystalline growth of later date. There is a third species, Lyellia glabra EDW. & H., of which I have not seen specimens but which, to judge by the figures[1], perhaps also belongs to Propora.

[1] Pol. terr. palæozoiques, pl. 12, figs. 2—2c. Helioliites macrostylus QUENSTEDT, Petref.-Kunde, tab. 149, f. 5, 6 is evidently identic with this species. He has also given a good figure (tab. 149, f. 9) of L. parvituba.

It must, however, be remarked, that the figure of L. americana in the cited work shows peculiar reticulations of the surface, some of them resembling aureolas. In the photographic figures in ROMINGER's work[1] representing Lyellia americana there are no aureolas, rather the same sort of costal radii starting from the calicle as in the typical Propora tubulata. The only difference I at present can find between these American Lyellias and our Propora tubulata is the greater distance between the calicles of the former, though not larger than in the oldest above described varieties of P. tubulata. In my specimens of the American Lyellias I have not been able to detect aureolas and L. parvituba certainly has the calicles on an unaltered surface of a decided resemblance with Pr. tubulata.

The oldest variety of Pr. tubulata has been found in the uppermost Lower Silurian beds F^2 at Borkholm in Estonia and in the lowest Upper Silurian beds of Gotland *a*, the Arachnophyllum bed, near Wisby.

The typical variety occurs chiefly in the stratum *d* (Wenlock limestone) in the Wisby region from Westergarns holme in south to Hall, at Nyrefs udd in Tofta, Gnisvärd, around Wisby in the cliffs, Lummelunds kanal, and also at Eksta, Djupvik and higher in the limestone between Stjernarfve and Lefvede and south of Westergarn.

Abroad it occurs at Wenlock in England, at Undwa in Oesel (Up. Sil.) and at Kozel in Bohemia, this latter a variety with small calicles. The North American, former Lyellia forms, belong to the Niagara and Upp. Helderberg groups.

Propora euryacantha n.

Pl. VIII, figs. 23, 26, 27.

Corallum massive, domeshaped or tuberose. The *calicles*, nearly 2 mill. in diam., are slightly exsert, the elevated rim formed by twelve angular nodules. The septa have no proper lamella but consist entirely of spines, which seen from above are flat, triangular and acuminated and slightly bent upwards. They are densely crowded and rather irregular in their direction. They vary also in their form, being club- or tongue-shaped. They differ much from those in Pr. tubulata, where they are more acuminate and slender. The *tabulæ* are rather numerous, though in the specimen delineated they are rare and much remote. In some instances they are convex in the middle, being evidently disturbed in their regular growth through the septal spines. The *coenenchyma*, as seen on the surface, is of a certain vermiculate appearance with winding grooves. In transverse sections (fig. 26) the free baculi, which intercross the horizontal dissepiments, are prominent between the calicles with starry sections. In a longitudinal section (fig. 27) their structure is readily perceptible, with their featherlike long staffs, with barbs as it were, standing out at both sides, thus indicating a disposition of the fibrillæ around a central axis. The dissepiment or traverses are compressed between these baculi and almost horizontal or faintly convex and again in other places of the common convex shape.

[1] Geol. Survey of Michigan 1873—76, pl. II, f. 1.

This species is restricted to the higher limits of the stratum *d* and also in *f* in the northern part of the isle of Gotland and has been found in the isle of Fårö, at Ryssnäs, Dember, Aluäse and Lansa, and also at Ar and Slite.

Propora conferta. E. & H.

Pl. VIII, figs. 32—39; pl. IX, figs. 1—23, 31, 32, 35.

? 1819. Madreporites mammillaris WAHLENBERG. Petref. Suec., p. 98. Probably the same species, as he gives Ålleberg as locality, where this is the only Propora.
1851. Propora conferta E. & H. Pol. Palæoz., p. 225.
1858. » » p. p. FRIEDR. SCHMIDT. Untersuchung, Archiv, p. 225.
1860. » » E. & H. H. N. Cor. III, p. 242.
1865. Heliolites affinis BILLINGS. Canad. Geol. and Natural., 2 Ser., vol. II, p. 427.
1866. » » ID. Catal. Foss. of Anticosti, p. 5, 30, fig. 12.
1871. Heliolites dubia TÖRNQUIST. Lagerföljden i Dalarne, p. 19.
1873. Plasmopora conferta p. p. LDM. Sv. Undersiluriska koraller. Öfversigt Vet.-Akad. Förhandl. N:r 4, p. 24.
1873. Plasmopora affinis LDM. Ibid., p. 25.
1880. » conferta ID. Fragm. Silurica, p. 33, Tab. I, f. 6—7.
1880. » affinis ID. Ibid., p. 33, Tab. I, f. 8—9.
1882. » » ID. Silur. Korall. aus Russland, p. 13.
1883. Propora conferta F. ROEMER. Leth. Geogn., I, p. 512.
1888. Plasmopora conferta LDM. List. of foss. Fauna Sweden, I, p. 19, 23.
1888. » affinis ID. Ibid., I, p. 23.

The first authors of this species gave no figures of it and a very short description and said themselves that it »n'est encore qu'imparfaitement connue». It was therefore of the greatest importance to know the specimens upon which they had founded their species. With the greatest readiness Professor HENRI DOUVILLÉ, the distinguished keeper of the museum of »Ecole des Mines» in Paris answered my application to see them and placed them in my hands for examination. These two specimens had been collected by M. E. DE VERNEUIL during his Voyage in Russia in 1844 together with Sir ROD. MURCHISON. One is from Borkholm, the other from »Chavli Canal de Windau», but the latter is probably not found in situ as there are no Silurian strata near that place. The accompanying labels in the hand of JULES HAIME, as Prof. DOUVILLÉ assures, are signed »Propora 2», this number meening the second species of their new genus Propora, which in their works is just this. As I was at liberty to make the necessary sections out of them I could with certainty identify a number of specimens from other localities. I then also found that Heliolites affinis BILLINGS, of which I had received typical specimens from the author, almost entirely coincided in its structure with the Propora conferta, only differing a little as to the size of the calicles etc. That it should be regarded as identical with this species, I hope the sections on plates VIII and IX will also sufficiently show.

It has grown in disciform or sphæroidal masses and has generally the *calicles* so closely set, that there is very little place left for any coenenchyma. They attain a diameter of 1,5 millim. or even less in those formerly called »affinis». They are only slightly exsert

and the margin is crenulated by twelve small nodules. As seen in the pl. XI, fig. 11 there are in the same specimen quite regular, smooth, circular calicles along with crenulated ones, the former being probably younger or more recently formed than the crenulated, as is so evident in Dploëpora. There are for the rest no vestiges of broader septal laminæ in the calicle and consequently no spines. The interior walls of the calicinal tube have only the usual fluted appearance. The *tabulæ* are horizontal or a little wavy, more or less remote. In calicles of the oldest variety the tabulæ have formed a number of small grooves near the wall around the septa (pl. IX, f. 4) in a certain way a sort of septal grooves. On their superior surfaces, as also around the interior side of the calicle some specimens (pl. VIII, f. 32—34, pl. IX, f. 1—2) bear numerous small spines, resembling the aculæ. They seem to be of a later inorganic growth, consisting, as in the original specimen from Borkholm of arragonite. In a specimen (pl. VIII, fig. 35) the septal ends are covered with druses of arragonite.

The *coenenchyma*, as seen on the surface, is coarsely granular with shallow dimples between the granules. It consists entirely of convex lamellæ without the least trace of aculæ growing on them, and this feature, as well as the total want of septal spines makes it distinct from other Proporæ.

Amongst varietal forms may be cited that from Ålleberg, Sweden (pl. IX, f. 9—10) with its thick theca and closely set calicles. Probably the specimen from the stratum *a* of Gotland (pl. IX, f. 31, 32, 35) is related to this variety, but the thick-walled calicles are there more closely set, in contact, and the coenenchyma consequently highly reduced.

This species is chiefly a Lower Silurian fossil though also occuring in the Upper Silurian of Estland and rarely in Sweden. The Swedish Lower Silurian localities are Ålleberg in Westergötland, Sandvik in Öland, Boda, Osmundsberg, Östbjörka and Arfvet in Dalecarlia, all belonging to the Leptæna limestone or the Brachiopod-schists. From Estland I have seen specimens found at Borkholm, Pyhalep and Grossenhof in Dagö, Pattakumeggi near Hapsal. From Norway I have specimens found in the islets Malmö and Malmökalven in the Christiania-fiord and from Asker. In the Upper Silurian of Gotland it has been found in the stratum *a* near Wisby, at Walve ref and Gnisvärd, in detached fragments, at Klef in Sundre and Hoburg in the stratum *d*. In Estland it occurs at Selja pank near Taggamois in Oesel, Herkull (G^1), Helterma (G^1), Kallasto in Dagö (G^2), and Ruhde (*H*). The Upper Silurian specimens are entirely of the affinis type, as represented by the Anticosti specimens from Junction Cliff. The Museum of Stockholm also possesses a specimen from the middle Tunguska, 22 verst above the mouth Severnaja.

To this species also in all probality belongs a coral, which in several specimens together with other fossils formed a collection belonging to the Mining Corps of Russia, brought home by the Mining Engineer W. OBRUTSCHEW, geologist to the Expedition of POTANIN, in 1894, and found in the East Kwen-Lun Mountains. It is figured on plate IX, figs. 5 & 6 and is derived from two localities, near the river Tsien-shui below the hamlet Kaien-tze-pu and from the hamlet Tschuan-tou-pa on the same river. I owe to the kindness of the Chief geologist TSCHERNYSCHEV the permission to see this collection.[1]

[1] The other corals in this collection were: Favosites Forbesi E. & H., Fav. asper aff., Fav. maximus QUENST., Syringopora sp., Ptychophyllum sp.

Propora conferta, var. *minima* n.

Pl. IX, figs. 24—26.

It has grown in disciform flats, with calicles of the most diminutive size, only 0,5, in the whole family. They are perfectly circular, smooth without the least vestige of septa or septal flutings or cannelures. In the narrow tubes the tabulæ are regularly horizontal and the coenenchyma is almost vesicular of equal-sized lamellæ without any aculæ.

It has been found in the stratum *a* near Wisby.

Propora cancellata n.

Pl. IX, figs. 27—30.

Coral forming tuberose masses without epitheca. *Calicles* a little more than one millim. in size, with crenulated margin, else without septa and in a section deeper down having the calicles quite circular and smooth. The *tabulæ* are regularly horizontal. The *coenenchyma* is on the surface reticulated with irregular tubuli which, however, do not stretch deeper down, as there is no vestiges of them in a longitudinal section in which the convex laminæ are provided with only a few scattered aculæ. In the transverse section (pl. IX, f. 28) there are still vestiges of the tubuli, but I suppose that here, as well as in a few other Plasmoporinæ, there are only the transversally sectioned convex lamellæ which assume a deceiving appearance of tubuli.

This species occurs in the Lower Silurian beds of Borkholm (F^2)

Propora speciosa. BILLINGS.

Pl. IX, figs. 40—46, pl. X, figs. 1—5.

1865. Heliolites speciosus BILLINGS. Canadian Naturalist and Geologist, Ser. 2, vol. II, p. 426.
1866. » » ID. Catal. Foss. Anticosti, p. 30, fig. 13.
1889. » » MILLER. N. Am. Geol. & Palæontol., p. 192.

Some years ago the State Museum at Stockholm received a typical, well preserved specimen of this species from the late Mr BILLINGS. I will at first describe this specimen, in order to show the identity of specimens from a few other localities.

The polypary is clavate or pyriform elongated, bearing large *calicles* all around, a little more than two millims. in diameter. The *theca* is circular, starformed, crenulated by twelve angular indentations, continuing downwards as septal ridges bearing short, densely packed spines. The outgoing angle of the wall is at its apex provided with a little rounded prominence, similar to the tops of the baculi which project from the coenenchyma. The septa are in several instances visible (pl. IX, figs. 42, 44) as diminutive spines close to the theca. The tabulæ are characteristically remote from

each other, generally a little wavy and on their upper surface in some instances covered with short, blunt spines. The coenenchyma is composed of irregular lamellæ forming a tissue of large bladders. These lamellæ are in a few places traversed by thick longitudinal baculi, which stand out on the surface as small rounded nodules pl. IX, f. 40.

Exactly on the same plan the specimens from the other localities are built, as may be seen by the figures. The only difference lies in the size and proximity of the calicles and the shape of the polypary. In all the size of the calicles is nearly half that of the Anticosti specimens and in the specimens from Borenshult the calicles are nearly contiguous leaving very little space for the coenenchyma. The shape of their polypary is almost sphærical, in some instances pyriform. The English specimens (fig. 43) are a little altered and the septal ridges have acquired an irregular aspect.

More deviating is the specimen from Bara, Gotland, which has been delineated on plate X, figs. 3—5. It is a discoid polypary, with exsert calicular margins, ornated with twelve thick, oviform nodules, and without other vestiges of septa than interior longitudinal ridges without spines. The tabulæ are rather concave. The coenenchyma is of the common vesicular kind with short, thick rods scattered in it and the peculiar nodulose appearance of the surface of the coenenchyma is caused by the protruding of these rods through the coenenchymal lamellæ. As this variety, which perhaps can be seen in the light of a mutation, on the whole comes more near to this species than to any other, I have united it with these forms.

This species has the greatest affinities with a following species, the Lower Silurian Pr. bacillifera, which, however, has large septal spines and a greater number of larger bacilli in the coenenchyma.

Pr. speciosa is an exclusively Upper Silurian species being in Sweden found at Borenshult in Östergötland, and at Bara backe in Gotland. Further at Dudley in England and at the Junction cliff of Anticosti (in BILLING's Middle Silurian).

Propora compacta n.

Pl. X, figs. 6—7.

1883. Hel. interstinctus LINDSTR. Silurische Korallen aus Nord-Russland, p. 19.

Polypary discoid with closely set calicles of a diameter of one mm. enclosed within a thick theca, angularly bent in twelve short in- or outgoing points or angles, the interior ones having the character of short septa not visible in vertical sections. These angles give both sides a fluted appearance. The tabulæ are close, nearly horizontal or bent in convex curves.

The coenenchyma is of a mixed vesiculose-tubular character, consisting of thick and long bacilli, which packed in the narrow intercalicinal spaces coarctate the dissepiments, that have small dimensions, but the common convex form. By their proximity and great number they give the frame of the polypary an appearance of compactness.

This species comes near to Prop. speciosa but differs in a being entirely without any septal spines in the calicles and in having the vertical element of the coenenchyma more fully developed.

It has been found near the river Olenek, Sibiria and also on the shores of Petschora in north Russia.

Propora bacillifera n.

Pl. X, figs. 8—21.

As to the synonymy of this exclusively Lower Silurian species I have no certain data, to which to refer, but it is highly probable that a great number of specimens of it from the Baltic and North Germanic localities have been called Prop. tubulata, by various authors.

This coral has grown in pyriform, elongated or globular masses, also sometimes disciform.

The *calicles* attain in some localities as from Hulterstad in Öland (fig. 12) larger dimensions than is general amongst the Heliolitidæ, viz. 3 mm. in diameter, the other specimens having only 2 or even 1 millim. The calicles are surrounded by a thick theca, having the shape of a twelve-pointed star. The interior angles of this star make the basis of the septa from which long, pointed, upwards directed spines project, placed remote from each other. The septal lamella proper is reduced to a narrow ridge, scarcely perceptible in a longitudinal section. Owing to the long spines the remote tabulæ are not regularly grown, often curved or convex.

The *coenenchyma* is a tissue of large bladders, the convex laminæ forming it being of the largest kind. It is penetrated by numerous long, slightly curved remote rods or bacilli, having the same colour as the theca and the septa (figs. 9 and 20) and finish upwards in a fine point. In transverse sections they ressemble small black dots between the calicles (fig. 16). They grow evidently faster than the convex lamellæ and in advance of them as they on the natural surface of the corallum stand out above these lamellæ.

There can be observed certain local variations; so for instance, the Öland specimens (fig. 15) have shorter bacilli fixed on the lamellæ, as large aculæ. In the specimens from Hohenholm, Dagö, the septal spines do not attain the same length as in the specimens of older geological age.

It has been found at Treberga in the parish of Hulterstad, Öland, at Osmundsberg and Östbjörka in Dalecarlia, at Hohenholm in Dagö, at Piersal (F^1) and Borkholm (F^2) in Estland, very abundant in the last locality, also in Norway at Herö near Porsgrund and is consequently chiefly a Lower Silurian species. In detached fragments it has been found on the shores of Gotland, near Wisby and at Westergarn.

Propora? ambigua n.

Pl. x, figs. 22—24.

Corallum disciform, with concentrically wrinkled epitheca. *Calicles* with low, only faintly indented margin and very short *septa*, which are not visible in a longitudinal section. Seen on the surface the *coenenchyma* resembles almost that of a Heliolites, consisting of a regular reticulation of polyëdric tubuli. These seeming tubuli are, however, as seen in a longitudinal section only convex lamellæ cut transversally and causing this false appearance and there are no tubes. There is instead a vesicular tissue, quite of the same nature as that usual in the genus Propora. The convex lamellæ are larger than else, have some sparse aculæ on their culmen, and at certain distances there has been a sort of fasciæ formed through a concentration of the lamellæ and a richer growth of the aculæ. This is especially remarkable near the surface, where the tabulæ and the coenenchymal elements follow so closely upon each other as to form a nearly compact mass. This concentration seems here to depend entirely upon an abnormal growth and is by no means of such a regular recurrence as in Heliolites fasciatus.

The real systematic place of this species may be contested and I have therefore only hesiatingly united it with the Proporæ. It has been found in several specimens in detached pieces from the Arachnophyllum stratum *a* near Wisby and at Skälsö, north of Wisby.

There are still some specimens of Propora left undescribed and undeterminated until more material can be collected. On plate ix, figs. 33—34 a specimen of Propora has been delineated, the only one found, which has not been placed in any of the described species. It is remarkable for its exceedingly large calicles, measuring nearly 4 millims. in diameter, the largest known in the whole group of the Heliolitidæ. The coenenchyma is scarce consisting of large bladders and in so far resembling Pr. speciosa, but there are vestiges of large septal spines, what on the other hand should approach it to Prop. bacillifera. It is Lower Silurian from Alfaret, weast of Hulterstad, Öland. In the lowest Upper Silurian stratum of Gotland, the Arachnophyllum stratum, which has been so fertile in many different species of Heliolitidæ, some Proporæ have also been found, that cannot be referred to any of the known species. So for instance there is one with short and stout septal spines reminding of those of Pr. tubulata, but the much remote calicles are surrounded by a coenenchyma of the most elementar nature, only of transverse, convex lamellæ, without the least traces of aculæ or other vertical elements.

As appertaining to Propora Milne Edwards and Haime have[1] with some doubt cited:

1. *Propora? acerosa* E. & H. (= Porites acerosus Eichwald, Zool. specialis, t. 1, p. 183). It is no Propora, but according to the figure in Eichwald's Lethæa rossica, pl. 26, fig. 4, it is a Favosites and is there by him renamed as Archæopora acerosa.

2. *Propora? cyclostoma* E. & H. from the Mountain Limestone of England, a doubtful species founded on Hydnophora? cyclostoma Phillips, Geol. of Yorkshire, p. 202, pl. 2,

[1] Pol. terr. pal., p. 225.

figs. 9—10. To judge by the figure it is no Heliolitidean at all, rather more related to Calapoecia. Astræopora antiqua M'Coy, Ann. Mag. N. H., 2[d] Ser., t. 3, p. 133, is by E. & H. considered as identical.

Nicholson has in his »Tabulate Corals» and jointly with Etheridge jr. in the »Fossils of Girvan» described some new forms of Propora of which I have identified a few with ours. Their Pr. Edwardsi, Girvan, p. 270, pl. xvii, fig. 3, seems to be a new and independant species and their Pr. tubulata, which differs from that of Lonsdale, probably identic therewith.

I have on plate ix, figs. 36—39 represented a specimen of Pinacopora Grayi Nich. & Ether. being found by Dr J. G. Hinde at the Junction Cliff of Anticosti and by him presented to the Swedish State Museum. Evidently this specimen, as well as those figured by the said authors, has not preserved its original conformation, but has become oblique and deformed by pressure. If it were permitted to judge by such an incomplete specimen there would be no reason for maintaining the genus Pinacopora as there is so very little to distinguish it from Propora. I would prefer at present to let it stand as a synonym to Propora.

From the morainic accumulations of Öjle myr, Gotland (p. 71 above) Dr Wiman has sent me some small complete specimens of a Propora, which possibly are identical with the Pinacoporæ. They form small, nummuloid disks of a thickness of 3 millimeters, flat on both sides. The circular or sometimes oblong calicles measure nearly 3 millimeters in diameter, have a thin, exsert margin, angularly indented in twelve septalike folds, no spines, flat tabulæ. The calicles are deeper than usual. The coenenchyma seems to be entirely vesicular.

Camptolithus n. gen.

(Καμπτός, curved, arched.)

1851. Lyellia E. & H. p. p. Pol. palæoz., p. 150.

The species on which I have founded this new genus was till now placed in the genus Lyellia, but I will try to demonstrate that it is quite incongruent with the typical species, of which Milne Edwards and Haime construed their genus. If we turn to the synoptical table at page 72 we shall in reality find that there is indeed very little, if anything, to distinguish Lyellia from Propora. If we take the coordinate characters one by one, we see that apparently the only dissimilarity consists in the »murailles épaisses et costulées». But if we take »costulées» and compare with the »cloisons» which in Propora constitute »côtes», both characters coincide. And in a corroded specimen of Propora the calicular tubes appear quite as much »costulées» as those of a Lyellia. The circumstance that in the American specimens of Lyellia the calicles are thus laid bare and only a few shreds of the coenenchyma left, seems to have induced some authors, as Neumayr[1] to

[1] Thierstämme I, p. 312.

consider this purely inorganic phenomenon of corrosion as structural or organic and analogous with the exterior tabulæ of Tubipora. According to the authors of the »Polypiers paléozoïques» this genus embraced only two species: Lyellia americana and glabra. Of these I have had occasion to examine the former and I have above page 92 given the results of this examination. As there stated it shows a remarkable coincidence with sections of Prop. tubulata (which see), so nearly concordant, that I do not hesitate to refer them both to the same genus and even species. There may of course be some slight deviations in the septal spines, else these, the coenenchymal lamellæ, sparingly covered with aculæ, the remote tabulæ in the calicular tube are nearly the same.

The next species, L. glabra, I know only through the excellent figures and description of MILNE EDWARDS and HAIME[1] and they suffice for deciding that this also in all particularities corresponds with a real Propora and that it, in case it is an independant species, should be named Pr. glabra.

Since MILNE EDWARDS and HAIME had published their grand works ROMINGER has described[2] three new species, L. papillata, decipiens and parvituba. Of these I have not seen L. decipiens, but the exact description leaves no doubt that it is a coral of the same type as Pr.? ambigua which has been described above and which perhaps constitutes a new generic or subgeneric type.

ROMINGER himself has sent me specimens of his L. parvituba. On pl. VIII, figs. 29—31 I have represented this species. The corallum is disciform, covered by the densely placed small osculating calicles, scarcely one mm. in width. Seen from above the septa are short, thick, some radii extend outside the theca though not in immediate continuation with the septa. Though consisting entirely of limestone, it is interiorly so much altered, as almost to defy any attempt to find out the original structure. Instead of being provided with ordinary septal spines the calicinal tubes are at irregular intervals filled with large numbers of microscopic crystalline glomerations heaped in masses above each other on the tabulæ and on the interior sides adjoining, and in a transverse section they are seen to cover the whole area of the tabula. The coenenchyma is uncommonly irregular; extraordinary large lamellæ intermingled with smaller. The calicular tubes are also of a highly irregular growth, interrupted by coenenchyma as if overgrown by it and then beginning anew. But after all, detracting from the abnormities, this species is so similar in its fundamental constitution to L. americana and glabra that it must be placed in the genus Propora. If now, as I think, these three species which did properly constitute the genus Lyellia have all characters in common with Propora, as well as the allied Lyellia decipiens, and because the only remaining species, L. papillata, as I will show further down, is widely different from the former it follows 1:o) that the genus Lyellia must be abolished[3] and 2:o) that L. papillata constitutes a new generic type.

DAVIS in his »Kentucky Fossil Corals» has given photographic figures of two other Lyelliæ, viz. L. discoidea and L. puella. The descriptive letterpress of his work seems never to have been published and the figures are too indistinct to give any help in identifying.

[1] Pol. terr. pal., p. 226, pl. 12, fig. 2.

[2] Geol. Survey of Michigan, vol. III, pl. II. Palæontology, p. 16—17.

[3] The genus Protolyellia proposed by TORELL does not show the least affinity with Lyellia or Propora and is in fact no coral at all. See for further particulars »Fragmenta Silurica», p. 31.

The fig. 5, pl. 51, L. puella, represents clearly a Plasmopora, possibly Pl. follis, and Pl. discoidea, pl. 4, f. 3 seems also to belong to that genus.

This genus Camptolithus is to be characterized as follows. The calicles are filled with a coenenchymatoid mass of convex lamellæ instead of tabulæ, and when these have sometimes been developed, they form a much curved, convex arch. The septa are little developed and the coenenchyma consists almost entirely of convex lamellæ with scattered aculæ. At present only one species is known, from the Upper Silurian of the Niagara group in North America.

Camptolithus papillatus. ROMINGER.

Pl. X, figs. 25—30.

1876. Lyellia papillata ROMINGER. Geol. Survey Michigan, vol. III, pt. 2, p. 16, pl. II, fig. 3.
1878. » » QUENSTEDT. Petref. Deutschl., p. 150, pl. 149, figs. 7—8.
1885. » » DAVIS. Kentucky Foss. Corals, pl. 2, f. 2(?), pl. 3, f. 1, pl. 4, f. 4 (bad specimen).

Through decay, being weathered, and through silicification it has been much deformed and shows an exterior similarity with L. americana in having the tubes of the calicles partially standing free and laterally connected by horizontal shreds of coenenchyma, that have withstood destruction. The transverse section shows large *calicles* (2,5 millimeters) provided with twelve short septa, the theca angular or indented in face of them. Through changes during the process of fossilization the septa have assumed quaint shapes, they are cuspidate with hooks or barbs on the sides and in their apex (pl. x, fig. 25) and there are small accessory, septalike spines. The centre of the tabulæ is dotted with a great number of small spines, figs. 25, 27, which possibly may be of organic origin. The calicle, instead of having regular horizontal tabulæ, is filled with convex tabulæ, fig. 30, elevated as an arch in their centre and often so crowded that they interfere with their regular growth and consequently there arises a tissue of smaller convex tabulæ giving the whole an appearance quite similar to the ambient coenenchyma, figs. 28—29. By this the perfect homology of tabulæ and the coenenchymal dissepiments is clearly demonstrated. The *coenenchyma* is composed of nearly equal-sized lamellæ, having sometimes a tendency to be arranged in longitudinal rows (pl. x, f. 30) without being separated through bacilli. Of such there are some (f. 29) in another specimen even in the calicle, but aculæ are dispersed everywhere on the lamellæ. As seen in fig. 26 there are vestiges of costal radii emanating from the theca and the photographic figures of ROMINGER and DAVIS exhibit also such radii. The calicles are much distorted and defaced by later changes.

The Swedish State Museum is in possession of specimens from Point Detour, Lake Huron, Michigan, the only place from which it has been obtained. The specimens were given by Dr ROMINGER.

Diploëpora. QUENSTEDT.

1851. Heliolites p. p. E. & H. Pol. terr. pal., p. 217.
1881. Diploëpora QUENSTEDT. Petrefaktenkunde Deutschl., p. 148.

This genus is most remarkable through having two widely different sorts of coenenchyma (pl. XI, f. 4), an older and interior one entirely of proporidean, vesicular character, and a younger and exterior of a peculiar nature, rather coccoseridean, composed of closely packed, parallel rods or baculi, being of the characteristic featherlike structure. It was in consequence of this double nature of the coenenchyma that QUENSTEDT gave it the apt name, derived from the greek *Διπλόη* = duplication. As to other particulars, they shall be described in detail further down.

Diploëpora Grayi. E. & H.

Pl. X, figs. 31—38, pl. XI, figs. 1—4.

? 1837. Blumenbachium globosum LONSDALE. Sil. Syst., pl. 15, f. 26; according to E. & H., Pal. Foss, p. 217, only a cast of this species.
1851. Heliolites Grayi E. & H. Polyp. terr. pol., p. 217.
1855. » » IID. Brit. Foss. Corals, p. 252, pl. 58, f. 1, 1*a*.
1860. » » IID. H. Nat. Cor. III, p. 238.
1867. » » LINDSTR. Nomina foss. Gotl., p. 27.
1878—80. » » NICHOLSON & ETHERIDGE. Girvan, p. 58, 252, pl. IV, f. 4, 4*a*, pl. V, f. 1. It is uncertain whether all their specimens really belong to this species.
1879. Diploëpora Grayi QUENSTEDT. Petref.-Kunde Deutschlands, Abtheil. I, Bd 6, p. 147, pl. 149, figs. 2, 3, 4.
1883. Heliolites Grayi FERD. ROEMER. Lethæa Geogn., p. 508.
1885. » » LDM. List of Gotl. Foss, p. 18.
1888. » » ID. Foss. Faunas of Sweden II, p. 21.

This species is distinguished from all others in the family through its mode of growth. It is dendroid, branching in terete, fingerlike ramifications or irregular trunks. The English variety is characterised by flat, compressed branches with the dimensions of 45 × 5 millim. taken from one specimen. There are fragments of Gotlandic specimens from Ryssnäs in Fårö, measuring 22 decim. in length and 35 centim. across the branches in thickness, proving that it has been one of the largest corals in the Silurian sea.

It is on all sides covered with tiny, closely set *calicles*, attaining a diameter varying between 0,5—0,8 millims. As may be seen by pl. X, figs. 32—35 they have a different shape according to their state of development, fig. 32 representing the youngest, just beginning stage, fig. 35 the mature or fully developed one. It is interesting to study these as they elucidate the procedure of the formation of the theca and the septa more evidently than in any other Heliolitidean and consequently are of value for interpreting the origin of the said structures also in other species.

It is in the top of the branches that the youngest calicles grow out (f. 32). Their thin edges are regularly circular and smooth (pl. XI, fig. 3) and the first sign of change lies in a curious plication of the thecal edge, only a single one, but visible in several calicles of the same level and in all directed in the same way. Next (f. 33) the edge is incrassated and twelve nodules begin to appear on it, first irregularly, then (f. 34) ordinated regularly around the aperture, like rounded balls covered with small warts. These three calicular forms are from the same specimen. The next, the complete stage, (fig. 35) is taken from another specimen found at Ryssnäs, Fårö. The tubercles are smooth and the septa, which were not visible in the next preceding stage, are at last formed showing their spines in twelve rows. The tubercles should not be taken as belonging to the septal apparatus as they are histologically identical with the baculi which surround them as coenenchyma. The same tale is told through a section as in pl. XI, f. 4. The calicles in the youngest stage, immersed in the central stratum, are of the most elementar character with regular horizontal tabulæ and without any septa. It is quite the same when they are (fig. 2) on the verge to enter into the bacular coenenchyma. There is an indication of a sort of columella in them in the centre of the tabula. In fig. 1, pl. XI, we see the complete change in the arising of scarce, blunt septal spines, as it seems emanating directly from the inner side of the theca without any lamella.

The aspect of the *tabulæ* is also changed, they are thinner, closer and more irregular, wavy or concave, when then calicles are more fully developed. *Pari passu* with the changes in the calicle succeed the alterations of the *coenenchyma*. Of its two transformations we find the simple, vesicular to be the first. It is of the most elementary nature (fig. 4, pl. XI), small convex, equal-sized lamellæ as in some Proporæ, for instance Prop. conferta, and like this without the least vestiges of vertical elements. On the surface it presents the aspect as shown in pl. X, figs. 32 & 33. The second modification of the coenenchyma which arises, so to say, suddenly, is entirely composed of that vertical element for which I have proposed the name of baculi. They are evidently of equal structure with the rods which make up the sceleton in several other corals as for inst. in Heliopora or scattered in the coenenchyma of Prop. speciosa. These baculi of Diploëpora lie closely packed alongside each other with distinct lines of separation and this part of the coenenchyma thence receives a streaked appearance. A single baculus varies in length from 0,8 mm. to 0,5 mm. and its diameter is 0,3. In a transverse section (pl. X, fig. 37), where they lie arranged as a mosaic pavement, they have an irregularly polyëdric outline and a radiated surface, the radii diverging all round from the centre. This stratum forms a tuberculous surface as seen in pl. X, fig. 35. In a longitudinal section they have the formerly described feathery appearance with the fibrillæ on both sides directed upwards from an axial line. The nodules around the calicles are exactly of the same nature, only a little larger (pl. X, f. 37, pl. XI, f. 1) and compose the whole theca. This must far down have changed from its primarily simpler state, when it was environed by the vesicular coenenchyma as in fig. 32, pl. X. In the section pl. X, f. 38 it has acquired the baculi and from some of them prolongations like septa go towards the centre. But it is there environed by a vesicular coenenchyma with traces of some baculi beginning to appear.

As represented in the section fig. 4, pl. XI at right in the bacular coenenchyma there is a recurrence of the vesicular one repeated no less than six times more or less distinctly. The thickness of the different strata amounts to 1,3 cm. for the central vesicular and to 1,1 cm. for the bacular one at the right hand, the small enclosed vesicular bands comprised.

Coenenchymal gemmation occurs and an instance thereof may be seen on the fig. 1*a*, pl. 58 in MILNE EDWARDS' and HAIME's British Corals.

By the gradual development of the different parts we learn, as also has been ascertained by other facts, that in the Heliolitidæ the theca is the first part of the coral formed, that it long persists in its original simplicity, that by and by new deposits are added to it and that at last the septa are formed, so that at least in this group of anthozoa there can be no telling that the theca is constructed through the connection of the before existant septa.

What physiological significance the sudden conversion of the vesicular coenenchyma into the bacular may have, it seems that the coexistense of these two widely different structures in the same specimen may be of phylogenetic value and joint with the knowledge we have gained of the ambiguous nature of Propora? ambigua and its nearest ally Prop.? (Lyellia) discoidea ROM. points to the Proporæ as the parents both of the Plasmoporæ and the Heliolitæ. But Diploëpora has been developed in still another direction. It changed its Proporean nature into one, the counterparts of which we detect amongst the Coccoseridæ, especially in the genus Acantholithus. Thence Diploëpora may in the systematic arrangement fitly be placed last amongst the Plasmoporinæ, but as one of them, next before the Coccoseridæ.

This beautiful and highly interesting species is very common in the Upper Silurian strata, especially in the isle of Gotland. In the lower strata (*bc*) it has only been found at Stora Carlsö. In the higher strata from *d* to *h* it occurs at Ryssnäs, Lansa, Dember (all *d*) in Fårö, along the shores of Fårösund at Wialmsudd, the canal of Stor myr, Rute, Bunge, the quarry at Storugns in Lärbro, Vägume vik, Lergraf, Tjelders and Laxarfve in Boge, Hide vik, the shore north of Länna, and the hill of Länna at Slite, at Klints in Othem, Fole, Bara, Follingbo, at Wisby in the strata *f*—*h*, and the west coast of Lilla Carlsö stratum *f*. I have had specimens to examine from Kirna and Ruhde in Estland both belonging to the higher Upper Silurian and also from Wenlock in England.

I may here remark, that the same conformation of the calicular theca as in Diploëpora also seems to prevail in some Proporæ, as Pr. tubulata (pl. VIII, f. 8, 11, 12) and especially Pr. speciosa (pl. X, f. 3, 4) where the theca of the mature calicle comes very near to that of Diploëpora (pl. IX, f. 34). In Pr. cancellata the younger calicles have completely circular margins (pl. IX, f. 28) while the mature calicle has them of the same type as in Diploëpora. As a rule the indented or starshaped theca belongs to a later stage of growth in a great number of the Heliolitidæ. Compare also Pr. conferta pl. IX, f. 11 with pl. VIII, f. 33.

Tribus III. **Pycnolithinæ** n.

The characters of this tribus are the same as that of the next genus the only one having hitherto been found.

Gen. *Pycnolithus* n.

(Πυκνός, dense.)

The calicle is of the common Heliolitidean type with twelve septa and horizontal tabulæ. The coenenchyma is dense, only on the surface ornamented by shallow grooves and pits of contorted, lengthened outlines, filled up a little below the surface, so that the whole coenenchymal mass is thick and compact without any structure, only traversed by the whitish, longitudinal stripes which denote the thecæ between the superficial grooves.

Pycnolithus bifidus n.

Pl. XI, figs. 5—9.

The polyparium is disciform with an even surface and immersed calicles. The *calicles* are small, scarcely one millim. across. On their interior side there are twelve broad, short, blunt prominences which are homologous with the short septa of several Heliolitidæ. They have besides the peculiarity of being bifid through a small indentation along their margin. In a longitudinal section they are not visible. The interior of the calicular tube is partitioned by regular, somewhat distantiated tabulæ, a little concave and through later deposits much deformed. The *theca* is of unusual thinness and is discernible only as a narrow white lining around the aperture of the calicle. The *coenenchyma* consists near the surface of narrow, verniform grooves, separated through thick partition walls. These cavities are very shallow and extend only to a trifling depth below the surface, giving to this in a longitudinal section (pl. XI, fig. 8) a crenulated appearance. Below, there is all a compact mass of a grayish tint, finely granulated, traversed longitudinally by threadlike, white lines being the narrow thecæ, surrounding the grooves of the surface. In a transverse section they are seen as a net of white lines including the grayish mass (figs. 6—7).

This interesting Heliolitid was found in a detached piece on the shore near Wisby amongst other Gotland fossils and the appearance of the rock to which it is adhering, makes it highly probable that it has been derived from some of the lowest beds, the Stricklandinia bed (*b*) or the next (*c*).

Fam. **Coccoseridæ** n.

As a coordinate family to the Heliolitidæ and related to it, with some of the species of which it has been confounded, that of the Coccoseridæ is to be mentioned. Like the Heliolitidæ its corallum is composed of calicles with twelve radiate septa, but without any distinct theca, with a more or less abundant coenenchyma, which is completely filled with the large erect baculi of which it consists, lying close to each other and only on the surface separated through narrow grooves, which give the false appearance of tubuli. Consequently there are generally no dissepiments in the coenenchyma nor tabulæ in the calicles,[1] the central part of which is filled by long tubular rods emerging on the surface as small papillæ. A common character for all these is that they have grown in exceedingly thin lamellæ, scarcely surpassing a few millimeters in thickness.

The genera which I think may be placed within this family are three:

1. *Coccoseris* EICHWALD.
2. *Protaræa* E. & H.
3. *Acantholithus* n.

They are all exclusively Lower Silurian.

Gen. *Coccoseris.* EICHWALD.

1860. EICHWALD, Lethæa Rossica I, 1, p. 442.

The corallum has grown in thin lamellæ, disciform, with a concentric epitheca; the calicles with broad, triangular septa, surrounding numerous papillæ on the central area. No tabulæ. Coenenchyma with narrow, funnelshaped, shallow tubes enclosed by thick compact walls, often papillose or scrobiculate on the edges. For the rest entirely composed of large baculi of the fibrous structure. The species of this genus are geologically distributed as indicated in the following table.

	Lower Silurian.			Upper Silurian.
	Bala.	Leptæna limestone.		
		Lyckholm.	Borkholm.	
		F^1	F^2	
Coccoseris Ungerni EICHWALD		*		
microporus EICHW.			*	
megastoma M. COY	*			
var. minor		*		
micraster n.			*	

[1] Some specimens of Acantholithus make exceptions.

Coccoseris Ungerni. EICHWALD.

Pl. XII, figs. 3—7.

1855. Lophoseris Ungerni EICHWALD. Bull. Soc. Nat. Moscou, p. 466.
1860. Coccoseris Ungerni ID. Lethæa rossica, vol. I, 1, p. 442, pl. XXV, fig. 4*a*—*c*.
1883. » » FERD. ROEMER. Leth. Geogn., 1[r] Th., p. 456.

It has grown in disciform polyparies of exceeding thinness, commonly one or two millimeters and in tiers of lamellæ above each other. It has not been attached as seen by the free and finely striated epitheca. The *calicles* attain 1,5 or nearly 2 millim. in diameter. They are not separated from the coenenchyma by any distinct theca. There are twelve triangular, broad and somewhat sinuous septa, attaining a length of $^2/_3$ of the distance from the margin of the calicle to its centre. Their surface is coarsely decorated with blunt tubercles and the dividing grooves between them are sinuous. The central area of the calicle is covered by several irregular papillæ some of them in continuation with the septa. There are no tabulæ in the interior and the whole calicular tube is filled with the septa and in the middle with long prismatic baculi of the common fibrous structure, as seen pl. XII, f. 6—7 in longitudinal and transverse sections and it is their tops which project in the calicle as papillæ. In sections the septa are also seen to consist of rods of the same pinnate structure, but they are oblique and directed upwards and inwards, being a little curved, thus upon the whole reminding of the septal spines in the true Heliolitidæ, but cohering and forming a lamella (pl. XII, f. 7).

The *coenenchyma*, which upon the whole is scarce between the closely set calicles, is tubercular with small papillæ or pitted by irregular holes, not very deep and enclosed within thick walls, depending on the state of preservation, as the specimens with pits are weathered. The mass of the coenenchyma consists of baculi (figs. 6—7, pl. XII).

I have examined specimens from Grossenhof, Kerküll, Sutlep in Estland and from Hohenholm in Dagö (F^1) and Oddalem. A fine specimen has been found detached on the shore near Wisby, provenience problematic. No specimens hitherto found *in situ* in Sweden.

Coccoseris microporus. EICHWALD.

Pl. XII, figs. 12—15.

1856. Heliolithes microporus EICHW. Bull. de Moscou I, p. 89.
1860. » » ID. Lethæa rossica, vol. I, 1, p. 454, pl. XXV, fig. 7*a*, *b*, *c*.
1883. » micropora(!) FERD. ROEM. Leth. Geogn., p. 509.

It has grown in an exceedingly thin lamina of 1,5 millim. in thickness, extending its surface in a specimen over a length of more than 3 centim. Diameter of calicles nearly one millim., no theca. The *septa* have a rather indistinct outline, being fringed by large tubercles which without dividing lines are mixed with those of the area, in consequence of what it is often difficult to see where the septum ends and the central area

begins. The papillæ of this area are of greatly unequal size, some coalesced into larger heaps. They may also be placed in a radiate manner, as if continuations of the septa. The calicular tube contains only vertical baculi (fig. 13) and no tabulæ.[1] The *coenenchyma* which also consists of baculi has on the surface numerous starry pits separated through thick walls, finely granulated or scrobiculate. In the longitudinal section there are lacunæ, probably caused by dissolution of the sclerenchyma.

In the fig. 15 EICHWALD's original specimen has been anew delineated in order to show the identity of the other specimens figured. It is preserved in the Geological Museum of the University of Petersburg and through the kindness of Prof. INOSTRANZEFF I have been able to examine it. It is a small thin piece of whitish limestone, much worn already before its being embedded in the limestone stratum during the Silurian period. In comparing this with other specimens from Estland there can be no doubt but that they all belong to the same species.

It is known only from Estland where it has been found at Borkholm, Kurküll and at Maals near Hapsal, the locality of EICHWALD's specimen, this probably not *in situ*.

Coccoseris megastoma. MAC COY.

Pl. XII, figs. 8—11.

1851. Palæopora megastoma M'COY. Brit. Palæoz. Fossils, p. 16, pl. IC, fig. 4; not Porites megastoma M'COY, Syn. Sil. Foss. Ireland, tab. 4, f. 14, to which M'COY refers, but which is quite different.

1854. Heliolites megastoma M. EDW. & H. p. p. Brit. Foss. Cor., pl. 58, figs. 2*c*, 2*d*.

1854. » interstineta M. EDW. & H. ibid., pl. 57, figs. 5*c*, 5*d* probably also belongs to this species.

It has probably, to judge by a variety described below, grown parasitic as a thin lamella. The calicles are closely set with 1,5 millim. in diameter. The *septa* are short, broad, triangular with some irregular tubercles on their surface. The large central area is covered with numerous small papillæ. The *coenenchyma* is coarsely pitted with narrow, funnelshaped perforations and the separating walls project as blunt spines.

The figure given is taken from a cast, obtained through an impression of the coral in a piece of slate, found by Lector S. L. TÖRNQUIST at Applethwaite in Westmoreland, from where M'COY as well as MILNE EDWARDS and HAIME also had their specimens, likewise being negative casts.

Judging by the above cited figures there cannot be any doubt left of the identity of my specimen with theirs. In MAC COY's figure the papillæ of the central area are more clearly indicated than in those of MILNE EDWARDS.

With this species I join a variety of smaller dimensions, found in the Swedish Lower Silurian at Hulterstad in the isle of Öland. It has been figured on plate XII, figs. 9—11. Of the specimens found the best has grown on the calicles of Heliolites hirsutus,

[1] EICHWALD has in his fig. 7*c* drawn the longitudinal section as if composed of regular tabulæ, but no such are found in his original specimen.

where it forms a thin polypary with the dimensions of 15 × 7 millim. The thickness of the whole amounts only to 0,5 mm. The tiny calicles are scarcely 0,5 millims. in diameter, the short septa triangular with small tubercles on their surface and larger ones on the central area. The coenenchyma is bristling with blunt points surrounding irregularly stelliform pits. In the weathered specimen figured (fig. 11) from the same locality the spines are gone and the funnelshaped pits are more visible. If this variety, which belongs to a higher horizon than the English species, must be denominated, I propose to call it Cocc. megastoma, var. minor.

Coccoseris micraster n.

Pl. XII, figs. 16—18.

This little coral has the form of a sphæroid of only 13 millims. in diameter. The stellulate *calicles* have a diameter of only 0,3 millimeter, being the smallest known of all described in this memoir. They are remote from each other and they radiate from the initial centrum towards all points. The septa, as seen on the surface, are triangular, broad and stretch near to the centre of the calicle, where there are two or three columellar tubercles. In a longitudinal section the septa are well conspicuous, being of the same structure as in Cocc. Ungerni with the characteristic curved baculi. The large columella, formed of baculi also exhibits the pinnate structure. The coenenchyma, which is copious, consists of minute stellulate pores, surrounded by the chief mass of thick, closely packed, straight baculi, of the common pinnate structure, which is here well represented. There are no dissepiments at all.

This species is known only from a single specimen found by the late Mr WEGELIN, to judge by the colour of the rock from Östbjörka, Dalecarlia, consequently from the Leptæna limestone.

Gen. *Protaræa*. M. EDW. & H.

1850. Astræopora D'ORB. Prodr. I, p. 25.
1851. Protaræa M. EDW. & H. Pol. terr. pal., p. 146.
? 1856. Diplastræa EICHWALD. Bull. Moscou, p. 111.
1866. Stylaræa VON SEEBACH. Nachrichten von der K. Gesellsch. der Wissenschaften zu Göttingen, p. 238.

Corallum growing in a thin crusta on brachiopoda and shells with close set or contiguous calicles, between which there is no coenenchyma or very little of it, distinguished by shallow pits. Twelve granulated septa surround the papillæ in the centre of the calicle. No tabulæ, nor dissepiment. Entire sceleton made up of closely united, robust baculi, showing the pinnate structure forming a compact mass.

There is nothing in the sclerenchyma of this genus that justifies its being placed in the order of the Perforata of MILNE EDWARDS and HAIME as it is an almost solid mass

of compactly united baculi, not at all showing the spongy texture of the Perforata. Taking in consideration the constant and distinctive character of all the corals of this group to have twelve septa, it is not probable that Protaræa Verneuili (Hist. Nat. Cor. III, p. 185) with its twenty septa belongs to this genus, nor to this family. When the authors just cited write »portant aux angles de la plupart des calices de petites pointes saillantes», they must mean the rounded warts which are so prominent during the first stages of the growth of this coral and in the mature polypary are faintly discernible on the dividing walls between the calicles and not only in the corners.

Nor can I find any reasons with ROMINGER and FERD. ROEMER[1] to see affinities with the protean Thecia. There are no communicating pores between the calicles nor are there any vestiges of tabulæ as they and also SARDESON[2] pretend. The figures 20, 22, pl. XII present the true aspect of the interior structure.

As to SEEBACH's Stylaræa the following remarks may be given. Even if the species named Styl. Roemeri by VON SEEBACH[3] is to be maintained as an independant species, the generic denomination must be entirely abolished on the following grounds.

In 1851 MILNE EDWARDS and HAIME had already established[4] a genus Stylaræa amongst the Poritidæ for a single recent species, Stylaræa Mülleri, quite different, even generically, from the palæozoic fossil. But already in the same year (1851) they abolished[5] this genus and registered it as a true Porites, identifying their Styl. Mülleri with the Linnean Porites punctatus. SEEBACH seems not to have been aware that the name he gave his new genus had been already preoccupied and again cancelled. In consequence it must for ever be kept in disuse.

As to the fossil itself, described by SEEBACH as Stylaræa Roemeri, I have been enabled, through the kindness of Professor VON KOENEN, to examine his original specimen, which belongs to the Roy. geological-palæontological Museum of the University of Göttingen. It is figured anew, partially, on the plate XII, fig. 24. It is a thin lamina, scarcely two millimeters in thickness, with a finely wrinkled epitheca. It is to be borne in mind, that the superior surface with the calicles is much corroded by weathering, so that it is impossible to detect a single fresh or intact calicle. In all particulars it may, for the rest, be compared with Protaræa vetusta (fig. 19) having like this species twelve tuberculate septa, a flat or slightly convex area covered with numerous papillæ; the only appreciable difference being that the walls of the calicles are a little broader. There is not the »schwammige Columella», which SEEBACH thought he saw, but the uppermost pointed tops of the columnar baculi, which fill the centre of the calicle, quite as in Protaræa or in Coccoseris. As to the points (»Zacken») in the corners of the calicles, there are several such almost everywhere on the thecæ. The spongious tissue of the coral, which should unite it with the recent Litharææ is only seeming, owing to the highly corroded surface. In

[1] Lethæa geognostica, 1r Theil, p. 455.

[2] Tabulaten, p. 300.

[3] »Die Zoantharia perforata der Palæozoischen Periode» in »Nachrichten von der Kön. Gesellschaft der Wissenschaften zu Göttingen» 1866, p. 238, and in »Zeitschrift der deutschen Geol. Gesellschaft» 1866, p. 305, Taf. IV, fig. 2.

[4] Polyp. terr. palæoz., p. 143.

[5] Recherches sur les Polypiers. »Monographie des Poritides» in Ann. Sc. Nat., 3me Sér., vol. 16, p. 30.

a broken edge the sclerenchyma plainly consists of a solid, not spongy mass, and the microscopic structure in all probability coincides with that of Protaræa, as do also other specimens from Wesenberg. The columellar portion or the central area is more prominent in SEEBACH's specimen as it has been so much weathered all around. In consequence of what I now have stated, I think that Stylaræa Roemeri cannot be retained as an independant genus nor as a species and that it is rather to be regarded as a form of the highly variable Protaræa vetusta.

NICHOLSON described[1] a new genus of Silurian Corals under the name of Cleistopora (= more correctly Clistopora) and asserts that its affinities are with Protaræa. This cannot, however, be the case as it is composed of a porose, reticulated sclerenchyma without any distinct septa in the calicles.

Protaræa vetusta. J. HALL.

Pl. XII, figs. 19—24.

1847. Porites? vetustus J. HALL. Pal. N. York I, p. 71, pl. 25, figs. 5*a*, 5*b*.
1850. Astræopora vetusta D'ORB. Prodr. I, p. 25.
1851. Protaræa vetusta E. & H. Pol. Terr. Pal., p. 208, pl. 14, figs. 6, 6*a*.
1851. » » ID. Monographie des Poritides, Ann. Sc. Nat. Zool., 3me Sér., vol. 16, p. 47.
? 1856. Diplastræa diffluens EICHWALD. Bull. de Moscou, p. 111.
1860. » » ID. Lethæa rossica I, I, p. 445, pl. 30, fig. 11*a*, *b*, *c*.
1860. Protaræa vetusta E. & H. H. N. Cor. III, p. 185.
1866. » » VON SEEBACH. Zeitschr. d. deutsch. Geol. Gesellschaft, p. 305, Taf. IV, f. 1.
1866. Stylaræa Roemeri v. SEEBACH. Ibid., p. 306, Taf. IV, f. 2.
1873. Protaræa vetusta LINDSTRÖM. Sv. Und. Sil. Corall., p. 21.
1875. » » NICHOLSON. Geol. Survey Ohio, Palæontology 2, p. 221.
1878—81. » » QUENSTEDT. Petref. Deutschl., p. 54, pl. 145, f. 12, 13, p. 907, pl. 178, f. 37.
1878. » » NICHOLS. & ETH. Girvan, pl. 4, fig. 3, 3*a*.
1880. Stylaræa Roemeri LINDSTR. Fragm. Silurica, p. 31.
1881. » » QUENST. Petref. Deutschl., p. 908, pl. 178, fig. 40.
1882. Protaræa vetusta J. HALL. Indiana 11th Rept., p. 378, pl. 49, fig. 4.
1883. » » FERD. ROEM. Lethæa geogn., p. 456.
1883. Stylaræa Roemeri FERD. ROEM. Ib., p. 456.
1888. » » LINDSTR. List of Cambr. Sil. Fossils, p. 23.
1889. Protaræa vetusta LESLEY. Diction. Foss. of Pennsylv., vol. 2, p. 774.
1889. » » MILLER. Catalogue, p. 201, f. 209.
1895. » » WINCHELL and SCHUCHERT. Geol. of Minnesota, vol. III, pt. I, Palæontology, p. 94.
1896. » » SARDESON. Tabulaten, p. 300.
1897. » » var. magna. WHITEAVES. Palæoz. Foss. Canada, vol. III, pt. III, p. 155, pl. 18, figs. 2, 3, 3*a*.

This coral seems to have always grown on other fossils as a thin crust, seldom exceeding 2 millims in thickness. The fig. 21, pl. XII, represents the first foundations of a colony, which is highly deviating in its appearance from the mature form.

[1] Geological Mag. 1888, p. 150.

It consists only of a thin film, covered by a great number of rounded, glossy tubercles, confusedly arranged in squares as if to foreshadow the outlines of calicles and within them heaps of smaller tubercles in lines following the costæ and striæ on the surface of the subjacent shell.

The mature coral has circular calicles of 2 millims. in diameter constantly with twelve, comparatively thick septa, the crest of which is indented with a single row of tubercles. They leave a narrow area free in the centre, covered with a few blunt tubercles. Between the closely packed calicles there is very little space left for a coenenchyma, but a narrow surface covered with tubercles without any pores or tubuli may be indicated as a sort of coenenchyma.

The sclerenchyma is made up of the distinguishing large baculi of pinnate structure and there is not the least vestiges of tabulæ or dissepiment.

There is a sort of coenenchymal gemmation, as new calicles arise out of the surface between the calicles.

This is an exclusively Lower Silurian coral and the oldest known of this family as it is found in the strata of Wesenberg in Estland. But it also ranges higher to the Lyckholm beds of Estland, at Piersal and to the Leptæna Limestone of Dalecarlia. In North America it is very common in the Trenton limestone, in the Cincinnati group, in Ohio and at Richmond, Indiana.

Gen. *Acantholithus* n.

(Ἀκάνθα, spine.)

Corallum grown in thin lamellæ, several close above each other linked together on one side, each of the superior ones being in organic connection with the next inferior or growing from a corner of them. The inferior surface formed by a uncommonly thick epitheca of tubular structure. The superior surface with the calicles, which as a rule have short septa surrounding a central area, covered with numerous short papillæ, which are the heads of the columnar baculi. There are no tabulæ in the calicles, nor are these circumscribed by a well defined theca. The coenenchyma consists of very narrow tubuli, with thick walls of irregularly polygonal or circular shape. These walls show the same pinnate structure as the baculi. In some specimens there are tabulæ, concave, distantiated, but as a rule the walls have increased in thickness as to leave no place for the development of such. This genus which is chiefly Lower Silurian has affinities on the one side with Cosmiolithus through the finely reticulated coenenchyma and on the other hand, with the Coccoseridæ through the well developed baculi and the whole conformation of the calicles. There is a large material still to be found in the Lower Silurian strata of Estland, which, when collected, may clear up some obscure points in the structure of these beautiful corals, as yet difficult to explain.

Acantholithus lateseptatus n.

Pl. XII, figs. 23—30.

This coral has the form of a large, expanded lamella with undulating surface; it is very thin, only 5 millims. in thickness with a surface of the dimensions of 18 × 12 cm.

The basal or epithecal stratum is of uncommon shape and thickness. Instead of the usual, in a section scarcely perceptible film, there is here a well discernible tubular stratum. In the figures 29—30 it is seen below the other sclerenchyma. In the fig. 28 its lower surface is delineated with the apertures of the tiny tubes and in fig. 29 the upper surface, the stellate markings of which possibly may be derived from parasitic, boring organisms.

The calicles are regularly distributed over the superior surface of the coral with a mean distance of 2 millims., having themselves a diameter of a little more than one millimeter. The septa (fig. 23) are short, triangular, broad and covered with small warts. The central area is large, studded with small, rounded papillæ. The interior of the calicular tubes (fig. 29) is in the centre filled with baculi, on the sides of which there are concave tabulæ. In another section (f. 30) of the same specimen the tabulæ are wanting and only baculi are seen.

The coenenchyma is composed of closely set, minute, irregularly polygonal tubes, having in their aperture several short, blunt spines emanating from the interior side and on the crest of the walls also erect, warty prominences project. In a longitudinal section the walls have increased considerably in thickness and the tubes are divided in compartments by some few, distantiated, concave tabulæ. In another section of the same specimen (fig. 30) the baculi, of which the coenenchymal walls are constructed, have grown so as to form a uniform mass in which there is no vestige of any tube nor of tabulæ. It is very difficult to make these intrinsic structural differences to agree with each other. It may be that an excessive growth of the coenenchymal walls in some specimens entirely suppress the formation of tabulæ, leaving no place for these to develop.

A large and fine specimen, belonging to the Geological Survey of Sweden, has been found in a morainic accumulation at Kopparsvik near Wisby, probably like so many others, of Lower Silurian origin. In the Stockholm museum there is also a specimen found on the shore, Norderstrand, near Wisby. As stated on the next page a variety or mutation of this species, now in the University Museum of Breslau has been found at Sadewitz.

Acantholithus asteriscus. FERD. ROEM. p. p.

Pl. XI, figs. 31—35.

1858. Heliolites inordinata FR. SCHMIDT p. p. Archiv, p. 226.
1861. Heliolites interstincta FERD. ROEMER. Sadewitz, p. 24, pl. IV, f. 4.
1880. Heliol. intricatus var. lamellosus, LINDSTR. p. p. apud ANGELIN, Fragmenta Silurica, p. 32, tab. I, fig. 5.
1883. Hel. asteriscus FERD. ROEMER p. p. Lethæa geognostica, Abth. 1, Lief. 2, p. 505.

Corallum forming thin plates of about four millimeters in thicknes. The epitheca is free, unless where growing out from or being in continuation with an older colony as

often is the case. The *calicles* are sunk a little in the coenenchyma, the twelve septa narrow, tapering, reaching halfways to the centre; broadly bifurcated or forming a net at their basis. The theca which links them together is visible only as continuations from their bases and can not be discerned as an independant sceletal element further down in transverse sections. The septa form laminæ which have the same conformation of oblique baculi as in Coccoseris. The central area is covered by pointed papillæ, which in a longitudinal section are seen to be the tops of irregular or sinuous baculi completely filling the centre of the calicle.

The coenenchyma, as seen on the surface, is composed of narrow tubes, the walls of which are provided with small spines on the sides. These walls are relatively thick and increase in thickness lower down in the coenenchyma so as to entirely fill up the tubes (pl. XI, f. 33) and, as seen, are formed like large broad baculi.

It occurs in detached pieces along the shores near Wisby probably mostly derived from the oldest stratum of Gotland *a*. It has also been found *in situ* at Östbjörka in Dalecarlia in the whitish limestone with Leptæna Schmidti, thus from the top of the Lower Silurian. In Estland it seems to bee common in the corresponding strata F^1—F^2 at Worms, Hohenholm in Dagö, at Piersal from which places Academiker Fr. Schmidt kindly has sent me specimens named Heliolites inordinatus.

Through the kindness of Professor Fr. Frech I have been enabled to examine the original specimen of Ferd. Roemer's »Heliolites interstincta», which is preserved in the University Museum at Breslau. I have given a figure of a portion of its surface on pl. XI, fig. 35 and I have found that it in all particulars agrees with other specimens of this Acantholithus.

The Museum of Breslau also possesses six specimens of an Acantholithus from Sadewitz bearing the name Heliolites asteriscus F. Roemer. Of these three belong to the species above described, and are identical with the Gotland specimens as well as with the »Heliol. interstincta» just mentioned and preserved in the same museum and these all are consequently to bear the specific name »asteriscus» by which F. Roemer designated the identic Sadewitz fossils. Two other specimens belong to an Acantholithus which probably is to form a new species, and the sixth specimen is a variety of Acanthol. lateseptatus above described.

On plate XII, figs. 1—2 an underterminated specimen of an Acantholithus has been delineated. It has been found in a single fragment on the shore near Wisby, and is probably derived from the Arachnophyllum stratum *a*. It seems in a certain way to be intermediate between the two other species. It has grown in thin lamellæ, connected with each other, the uppermost with a thickness of 8 millimeters. The calicles nearly of one millimeter across. The *septa* are longer than in the two preceding species and the central area consequently not so wide nor the papillæ so numerous. The calicular tube shows in a longitudinal section on both sides the septa of the structure peculiar to the Coccoseridæ and the centre filled with the narrow contorted baculi. The coenenchymal tubes are distinct, with thick walls and continue downwards provided with distantiated concave tabulæ. The epitheca does not attain the thickness as in Acantholithus lateseptatus and is in a section seen as a finely serrated line.

Explanation of the Plates.

All figures have been drawn by Herr G. LILJEVALL, unless otherwise stated.
The numbers ($^6/_1$) mark the scale of the enlargement.
The plates are executed in Herr C. WESTPHAL's phototypic establishment.

Plate I.

Heliolites interstinctus L. p. 41.

Fig. 1. Surface of a specimen from the Arachnophyllum stratum near Wisby. $^6/_1$.
» 2. Longitudinal section of the same; tabulæ a little irregular, an irregular columella on two of the lowest of them. $^6/_1$.
» 3. Transverse section below the surface of a specimen from the Arachnophyllum beds. $^6/_1$.
» 4. Surface of a specimen with uncommonly small calicles, nat. size.
» 5—6. Transverse sections of the same below the surface, $^6/_1$; fig. 5 situated a little higher up than f. 6.
» 7. Longitudinal section of the same, calicular tube budding out of the coenenchyma.
» 8. Longitudinal section of another specimen, from the same stratum; near the top, in the middle of the calicular tube a streak of sectioned columellas is seen; then it is interrupted and a little higher a continuation appears; on the right side a narrow septal lamina is sectioned. $^6/_1$.
» 9. Surface of typical specimen from the stratum *d* near Wisby. $^8/_1$.
» 10. Surface of a specimen with columellas, stratum *d* near Wisby, nat. size.
» 11. A not fully mature calicle from the same specimen, magnified, showing how the septa, which still are long on the right side, have communicated with the central columella and probably originated it through their union and left it alone, when they have been reduced in size.
Fig. 12. Longitudinal section of a specimen from stratum *a* near Wisby, showing how the calicular tubes and the coenenchyma arise directly from the epitheca; vestiges of columellas a little higher; to observe is the peculiar wavy line formed by the theca. $^6/_1$.
» 13. Part of a specimen from the stratum *a* near Wisby, with a new calicle in the act of developing, the large septa discernible except in the lower right corner; in the centre there is still coenenchyma out of which the columella is formed later; the central line between the walls of the coenenchymal tubes clearly visible, and also in the septa. $^8/_1$.
» 14. Transverse section of a specimen with divided columella, small, partially absorbed septa. $^6/_1$.
» 15. Longitudinal section of a specimen from stratum *d*, near Wisby, showing how two long calicular tubes proceed from the coenenchyma; long columnar streaks in the middle; columella at times evidently divided or branching, origin of coenenchymal tubes through fission evident. $^4/_1$.
» 16. Surface of specimen from *a*, calicles with irregular septa, the left one had just been forming. $^6/_1$.
» 17. Specimen from the highest limestone beds of Bara hill, Gotland, as a type for the

youngest mutation of this species, the calicles of the largest; nat. size.

Fig. 18. Surface of a specimen from the Devonian beds of the »Alpi carniche», Italy, kindly communicated by Dr G. DE ANGELIS D'OSSAT in Rome. $^4/_1$.

» 19. Surface, nat. size, of a large polypary from the stratum *d* near Wisby, with narrow tubular calicles, large columella and convex tabulæ.

» 20. The same, magnified $^6/_1$, columella twisted and branching, the lowest calicle at the right partly overgrown by coenenchyma.

» 21. Two calicles from the same specimen as in figures 19—20, being invaded and overgrown by coenenchyma; the columella is still visible in the left one. $^6/_1$.

» 22. Longitudinal section of the same specimen, showing a peculiar manner of growth; a new polypary having extended sideways and caused the extinction of the older subjacent by covering it. In the large calicinal tube at the left side, in the centre a broad columella has been sectioned, showing a cuspidate crest. At the top of the same tube may be seen a curious accumulation of densely packed tabulæ, a phenomenon also observed in other sections, probably due to an abnormous or pathological secretion, causing the destruction of the polyp. $^6/_1$.

» 23. Another section of the same, showing irregularities in growth through the condensation of the tabulæ. The dark oblique lines below are caused by accidental cracks, causing a partial displacement of the tubes. Columellar streaks and besides small aculæ on the tabulæ. Thecæ of the calicinal tubes sinuous. $^6/_1$.

» 24. Transverse section lower down. The calicles have the »decipiens» facies. The shaded parts of the tubes are due to the horizontal tabulæ of the coenenchyma being sectioned. $^6/_1$.

Fig. 25, 26, 27. Three different, incipient polyparies affixed to brachiopoda. Coenenchyma scanty on the lower side of primary polypierite. All from the stratum *d* of Wisby. $^8/_1$.

» 28. Longitudinal section of another incipient polypary $^8/_1$. Same locality. The coenenchyma has begun on the right side of the first polypierite and the second calicle has budded from it.

» 29. Longitudinal section of a calicle, from the stratum *d*, to show incipient or broken tabulæ forming a sort of septal grooves at their point of contact with the septa. $^8/_1$.

» 30. Transverse section of a primary polypierite, one millimeter above its apex, showing three small septa on the right side, traces of tabulæ; no coenenchyma. $^8/_1$.

» 31. Longitudinal section of a small polypary, showing the irregular manner of overgrowing older polypierites. Initial polypierite to the right. In the larger central calicinal tube there is a series of three longitudinal, interrupted streaks, fragments of septa, as the tube has been cut near the theca, not centrally. $^6/_1$.

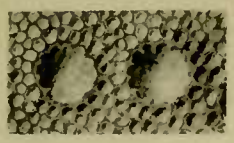
» 32. A series of sections I—IV from the same calicle showing its gradual development out of the coenenchyma beginning at I. Section II contains two stages. $^{10}/_1$.

» 33. Longitudinal section of another calicle, same specimen to show how the coenenchyma is broken up when the gemmation sets in. $^{10}/_1$.

» 34. A series of sections I—IV to show the intracalicinal gemmation, beginning at I. $^8/_1$.

» 35. Two instances of intra-calycinal gemmation; in the left one a new calicle has grown out of the coenenchyma of the older. $^8/_1$.

» 36. Section, longitudinal of a calicinal tube, being overgrown with coenenchyma. There is in the middle a curious funnel on the lower side of which five small globular bodies are fixed, and two below which seem to have fallen down on the uppermost tabula. Parasites? Ova? $^{10}/_1$.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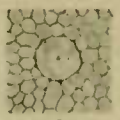
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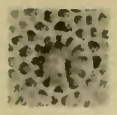
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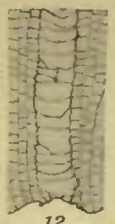
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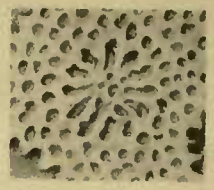
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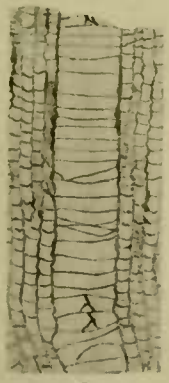
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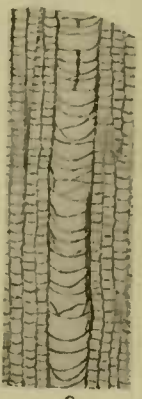
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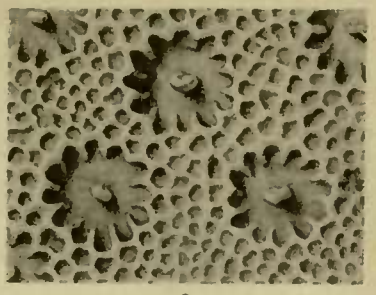
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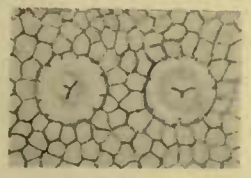
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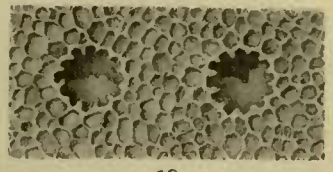
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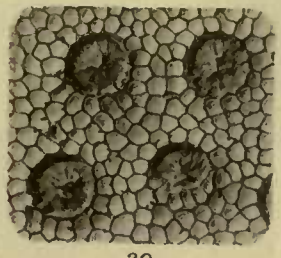
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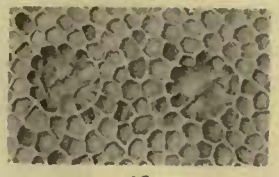
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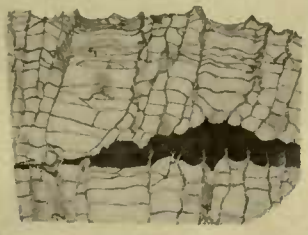
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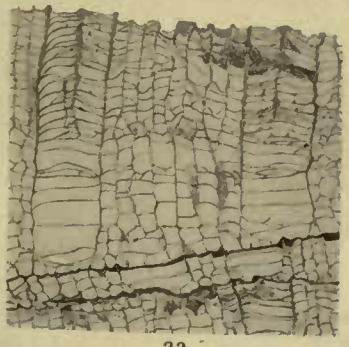
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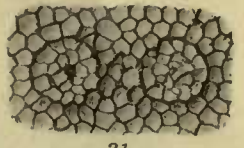
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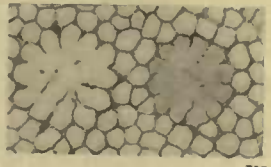
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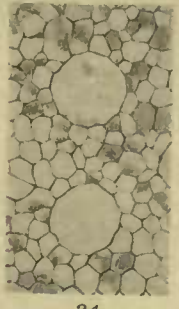
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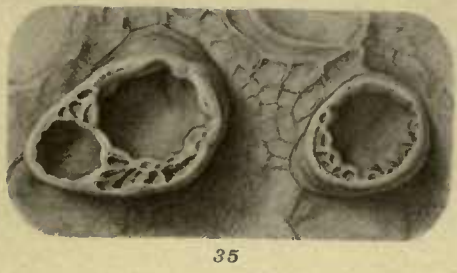
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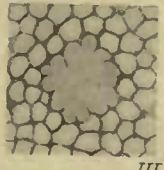
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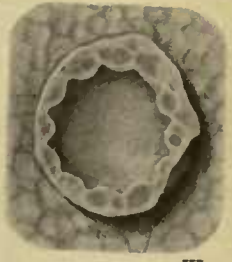
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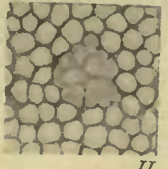
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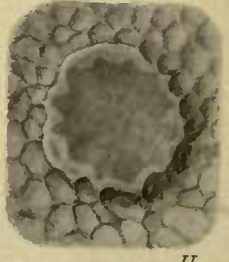
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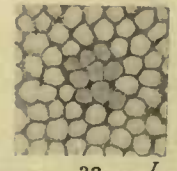
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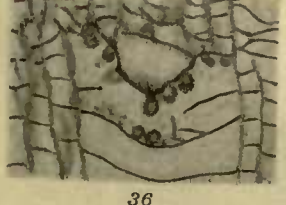
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Plate II.

Heliolites interstinctus L. p. 41.

Fig. 1. Transverse section of a variety from the uppermost limestone of Gotland (Tjelders Boge). The black dots in the centre are sections of the vertical rods. $^{8}/_{1}$.

» 2. Longitudinal section of the same showing a number of vertical rods on the tabulæ, probably residues from the coenenchymal thecæ out of which the calicular tube has through gemmation been developed. The microscopic fibrillæ of the septal and thecal lamellæ are seen at left in the left tube. $^{8}/_{1}$.

Heliolites interstinctus-decipiens p. 48.

Fig. 3, 4, 5, 6. Four calicles, that have grown on the surface of the same polypary. F. 3 youngest with not fully developed septa, f. 4 with twelve long septa nearly as Hel. porosus, f. 5 like the regular Hel. interstinctus, f. 6 the common typical »decipiens» without any septa and like all other calicles of the same polypary, excepting the three first mentioned. $^{6}/_{1}$.

» 7, 8. Transversal and longitudinal sections of a variety from the Arachnophyllum stratum near Wisby. $^{6}/_{1}$. Concave tabulæ.

» 9, 10. Sections of another specimen, same locality, quite circular calicles without the least indication of indentures. $^{6}/_{1}$.

» 11. Surface, nat. size, of a variety from Petesvik, every calicular tube is raised on a little elevation of the coenenchyma so as to be thereby separated from its neighbours.

» 12, 13. Sections of the same. The regularly circular calicles are environed by regular coenenchymal tubes, of which some 13—14 are regularly placed like an aureola around the calicle. In the longitudinal section is seen how the calicular tube arrises directly out of the coenenchyma. $^{6}/_{1}$.

Fig. 14. Surface, nat. size, of specimen from Wisby, stratum *d*, with the large calicles osculating and raised above the coenenchyma.

» 15. The same enlarged. $^{6}/_{1}$.

» 16. Var. bohemicus from Kozel in Bohemia. $^{6}/_{1}$.

» 17. Another specimen of the same, large calicles, nat. size.

» 18, 19. Sections of n:o 17, approaching to interstinctus. $^{6}/_{1}$.

» 20. Specimen from Büchel bei Paffrath Cöln, like a decipiens. $^{8}/_{1}$.

» 21. Cast of MAC COY's type specimen for his figure of Fistulipora decipiens pl. I, *C*, fig. 1, »British Palæozoic Fossils», now preserved in the Woodwardian Museum, University of Cambridge, England, natural size.

» 22. Part of the same enlarged. $^{8}/_{1}$.

Favosites (*Fistulipora*) *canadensis* BILLINGS p. 49.

Fig. 23. Surface of specimen from Widder, Canada, nat. size, presented by Mr. BILLINGS.

» 24. Enlargement of the same. $^{6}/_{1}$.

» 25. Part of the interior showing oscula (pores) and broken tabulæ. $^{10}/_{1}$.

Fig. 26. Another specimen, same locality, being more highly silicified.

» 27. Surface of the same, one large calicle environed by smaller. $^{6}/_{2}$.

Favosites sp.

Fig. 28. Surface, nat. size, to compare with Fav. canadensis. Up. Sil. From Gotland.

Heliolites porosus GOLDFUSS p. 53.

Fig. 29. Typical specimen, with alternating septa, as of two cycles. $^{10}/_{1}$.

» 30, 31. Other specimens with longer septa, f. 31 probably not of final shape, $^{10}/_{1}$; f. 29—31 from Eifel.

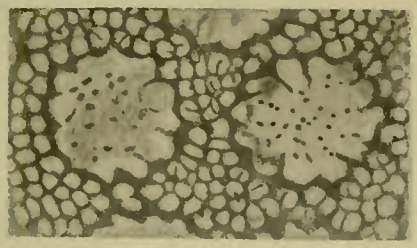
» 32. Specimen from Torquay, Devonshire, England, with very short septa, nearly resembling Hel. interstinctus, from which it however is distinct through the thickened theca. $^{10}/_{1}$.

» 33, 34. Transverse sections of calicular wall and coenenchymal tubes to show the microscopic structure with fibrillæ. $^{36}/_{1}$.

» 35. Showing the same in longitudinal section, to the right a part of a calicular tube, to the left a coenenchymal tube. The septal lamella is seen to stretch farther in the calicle and is fainter shaded. The tabulæ are on both sides incrusted by a growth of minute crystals and the clear interspaces are filled with calcareous spar. $^{36}/_{1}$. Specimens fromEifel.

Fig. 36. Longitudinal section of a calicular tube with five septal lamellæ having serrated edges, probably bases of spines, some fragments of tabulæ visible. Specimen from Kerpen—Nollenbach, Eifel. $^{10}/_{1}$.

» 37 I—VII. Two series of opposite changes in the coenenchyma. To the right coenenchymal gemmation is shown, to the left calicinal degeneration or a calicle slowly changing into coenenchyma. Fig. VII represents the fresh surface of the corallum and the other figures were obtained by cautiously abrading the coenenchyma with a knife. $^{10}/_{1}$. Both close beside each other on the same specimen.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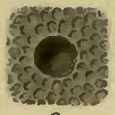
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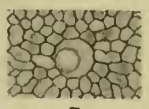
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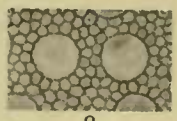
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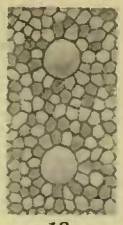
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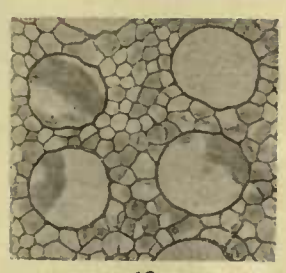
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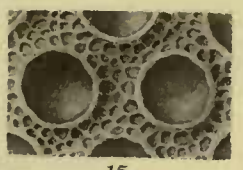
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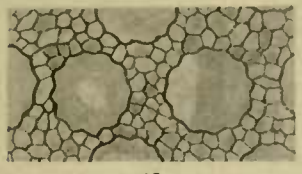
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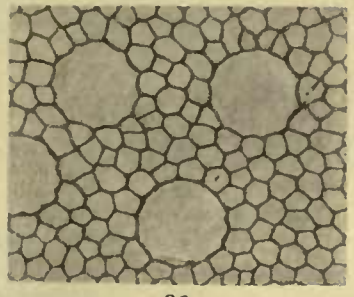
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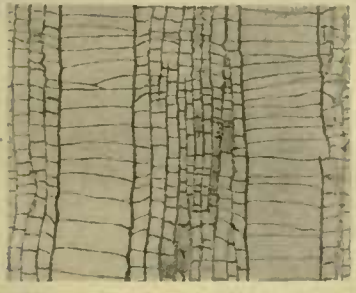
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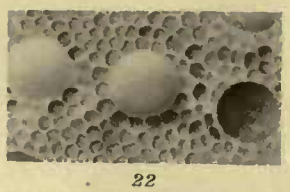
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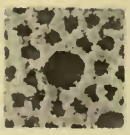
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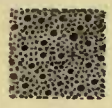
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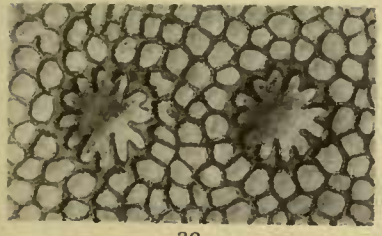
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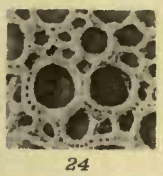
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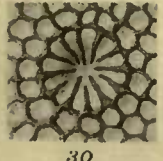
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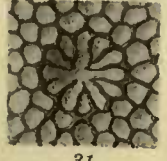
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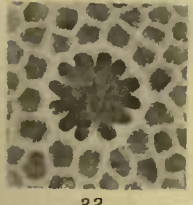
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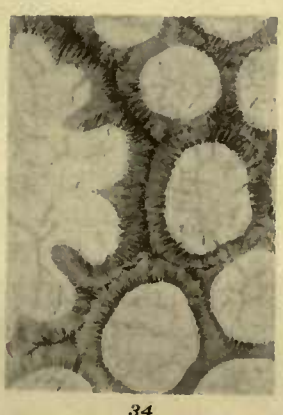
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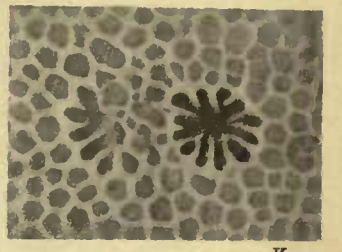
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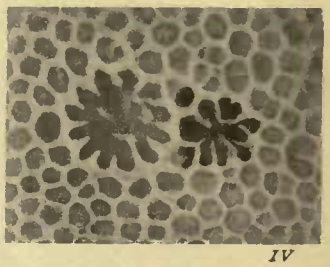
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Plate III.

Heliolites interstinctus L. p. 41.

Fig. 1, 2. Microscopical structure in vertical and horizontal sections of a specimen from Tjelders, Boge, Gotland. $^{36}/_{1}$. In the centre a coenenchymal tube.

Heliolites porosus GOLDF. p. 53.

Fig. 3. A calicle beginning to change to coenenchyma. $^{10}/_{1}$.
» 4. The appearance of the same a little below, with normal structure. $^{10}/_{1}$.
» 5, 6. Three calicles from the same polypary, with different structure. Torquay, England. $^{10}/_{1}$.
Fig. 7. Longitudinal section of a calicular tube from the same polypary as the next previous. $^{10}/_{1}$. To remark the delicate spines of the septal margins and the thick thecæ in the coenenchymal tubes.

Heliolites Barrandei PENECKE p. 58.

Fig. 8. Part of the surface of a specimen from the Arachnophyllum stratum, *a* near Wisby; nat. size.
» 9, 10. Calicles of the same, as seen on the surface. $^{12}/_{1}$. Tops of inferior septal spines protruding in the centre.
Fig. 11. Transverse section of a calicle and coenenchyma. $^{12}/_{1}$.
» 12. Longitudinal section of the same. $^{12}/_{1}$.

var. *spongodes* p. 60.

Fig. 13. A polypary in natural size. Stratum *b—c* Wisby region. Drawn by C. HEDELIN.
» 14. A calicle of the same from the surface. $^{12}/_{1}$.
» 15. Transverse section of the same. $^{12}/_{1}$.
Fig. 16. Longitudinal section; to be observed are the ends of the septal spines in the centre of the calicle. Observe the different coloration in the vertical and the horizontal sclerenchyma. $^{12}/_{1}$.

Heliolites Barrandei PENECKE p. 58.

Fig. 17. Calicle from the surface, from stratum *d* Wisby. $^{12}/_{1}$.
» 18. Longitudinal section of the same. $^{12}/_{1}$.
» 19. Transverse section of larger variety from Lilla Carlsö, stratum *f*. $^{12}/_{1}$.
» 20. Longitudinal section of the same $^{12}/_{1}$. The white patches on both sides of the calicular tube are fragments of coenenchymal thecæ parallel with the sectioned surface.
Fig. 21. Part of the surface of a specimen from Tjelders, Boge, Gotland, nat. size.
» 22. Transverse section of a calicle of the same. $^{12}/_{1}$.

Fig. 23. Part of the coenenchyma to show the intimate structure of the walls of the thecæ. A portion of a calicle is visible on the left side. $^{24}/_{1}$.

» 24. Transverse section of the coenenchyma of a specimen from the Devonian of Graz, Austria, kindly sent from Dr PENECKE. $^{12}/_{1}$.

» 25. Longitudinal section of the same. $^{12}/_{1}$.

Fig. 26. Longitudinal section of coenenchyma from the same specimen as in fig. 18, to show how the tabulæ are on both sides covered with crystalline growth, the tabulæ looking white between.

» 27, I—IV. A series of sections showing the coenenchymal gemmation. $^{10}/_{1}$. Development beginning at section I. Distance between I and IV the fraction af a millimeter.

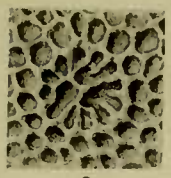
Heliolites parvistella FERD. ROEMER p. 60.

Fig. 28. Part of the surface of the original specimen of ROEMER, belonging to the Geological Museum of the University of Breslau, communicated by Prof. FRECH, found at Sadewitz in Schlesien. $^{12}/_{1}$.

» 29. Longitudinal section of the same. $^{12}/_{1}$. Original in the Museum of Breslau. The brackets in this and several of the following figures are intended to indicate the width of the calicular tube, as it is difficult to distinguish it from the coenenchyma.

Fig. 30. Transverse section of a specimen from Pattakumäggi, Isle of Oesel, Upp. Sil. $^{12}/_{1}$. Part of a specimen in the Museum of Reval.

» 31. Longitudinal section of the same. $^{12}/_{1}$.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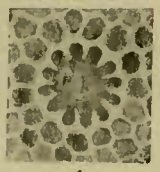
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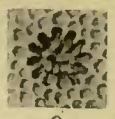
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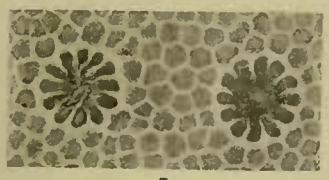
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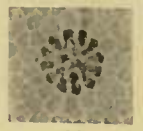
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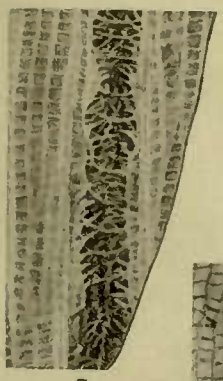
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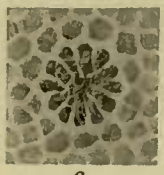
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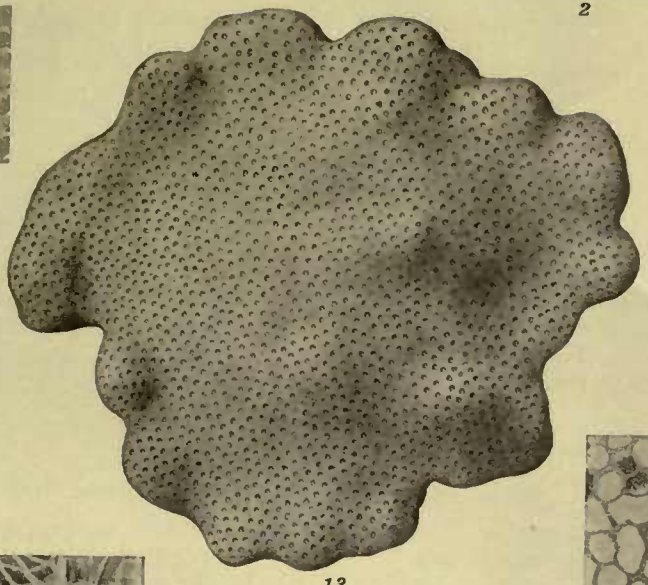
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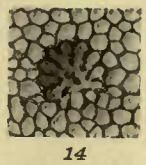
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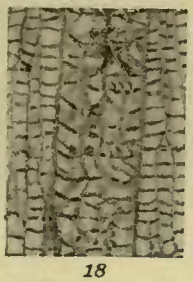
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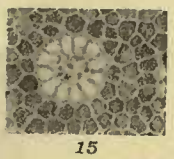
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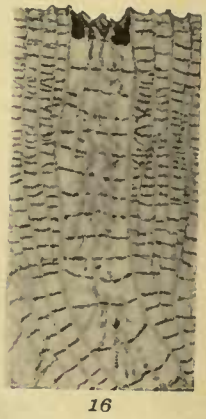
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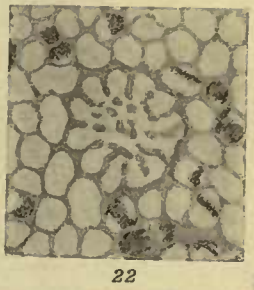
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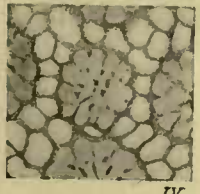
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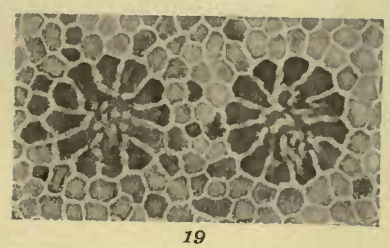
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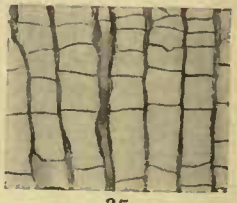
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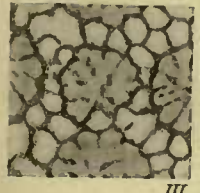
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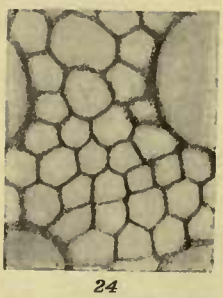
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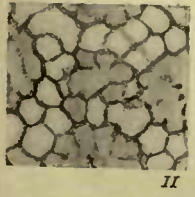
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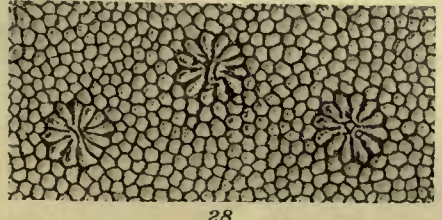
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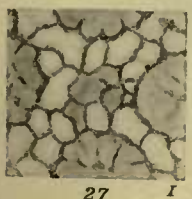
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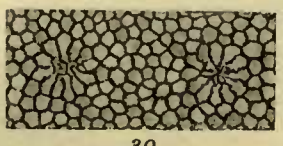
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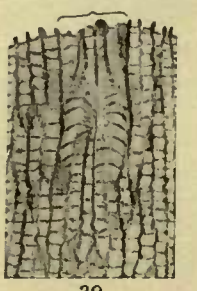
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Plate IV.

Heliolites Barrandei PEN. var. p. 60.

Fig. 1. Arborescent variety from Sandarfve kulle, Gotland, limestone bed *f*, nat. size.

Heliolites parvistella FERD. ROEMER p. 60.

Fig. 2. From the surface of a specimen from Louisville, N. Amer. $^{8}/_{1}$.
» 3. Longitudinal section of the same. $^{8}/_{1}$.
» 4. Part of surface, nat. size of specimen from Kozel, Bohemia, also called Stelliporella lamellata WENTZEL.
Fig. 5. Transversal section of the same a little below the surface. $^{6}/_{1}$.
» 6. Longitudinal section of the same. $^{6}/_{1}$.
» 7. Part of surface of a specimen from the islet Stora Carlsö near Gotland, nat. size.
» 8. The same magnified. $^{10}/_{1}$.
» 9. Longitudinal section of the same. $^{10}/_{1}$.

Heliolites parvistella, var. *intricata* n. p. 63.

Fig. 10. Specimen in natural size from the stratum *c* at Djupvik, Eksta, Gotland. Drawn by C. HEDELIN. $^{8}/_{1}$.
» 11. Portion of the surface with calicles *in statu nascenti*.
» 12. A calicle, fully developed, from the same. $^{8}/_{1}$.
» 13, 14. Transverse sections at different levels from the same specimen, Djupvik, Eksta. $^{8}/_{1}$.
Fig. 15. Portion of the surface as instance of the intracalicular gemmation originating three different polyparia. $^{8}/_{1}$.
» 16. Longitudinal section of a specimen from Djupvik, Eksta. $^{8}/_{1}$.
» 17, 18. Transversal sections of a specimen from the islet Lilla Carlsö, difference in level 1 mm., fig. 17 being the uppermost one. $^{8}/_{1}$.
» 19. From the base of the same specimen showing coenenchymal gemmation. $^{8}/_{1}$.

Heliolites fasciatus n. p. 65.

Fig. 20. Surface in nat. size from the stratum *a* near Wisby.
» 21. A calicle from the same. $^{12}/_{1}$.
» 22. Longitudinal section showing the characteristic banded structure, eight or nine fasciæ seen above each other. Cylindrical tubes of a parasite sectioned. $^{3}/_{1}$.
Fig. 23. A portion of the coenenchyma longitudinally sectioned with a fascia. $^{12}/_{1}$.
» 24. Longitudinal section. $^{12}/_{1}$.
» 25. Transversal section of coenenchyma between the fasciæ. $^{12}/_{1}$.

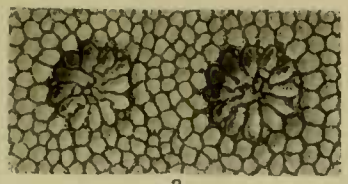
Heliolites repletus n. p. 65.

Fig. 26. The surface in natural size, specimen from the shale beds *b* near Wisby.
Fig. 27. Calicles *in statu nascenti* from the surface. $^{8}/_{1}$.

Fig. 28. A more developed calicle surrounded by irregular thickened coenenchyma of the fasciate nature. $^{8}/_{1}$.
» 29. A fully developed calicle with regular coenenchyma. $^{8}/_{1}$.
Fig. 30. Longitudinal section. $^{8}/_{1}$.
» 31. Transversal section, calicles with absorbed septa. $^{8}/_{1}$.

Heliolites Liljevalli n. p. 66.

Fig. 32. Natural size of calicles and coenenchyma.
» 33. Transverse section. $^{12}/_{1}$.
Fig. 34. Longitudinal section. $^{12}/_{1}$.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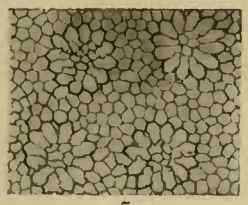
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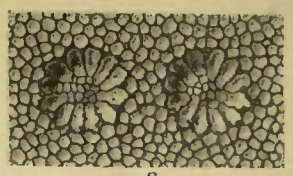
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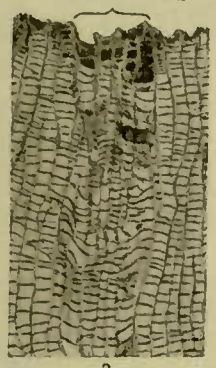
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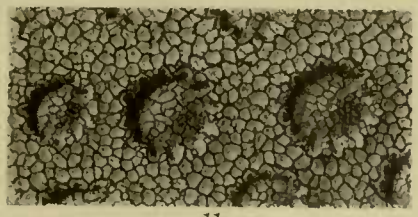
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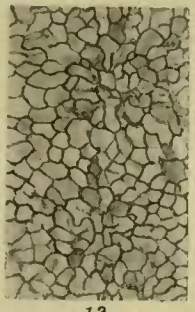
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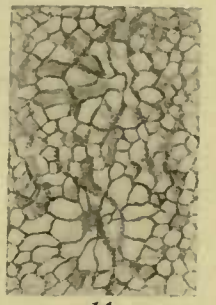
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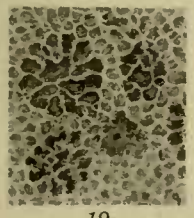
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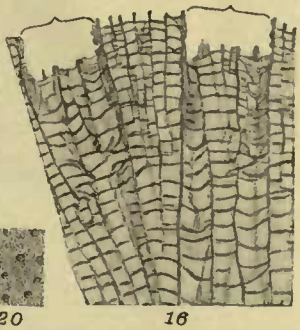
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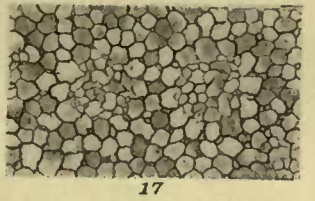
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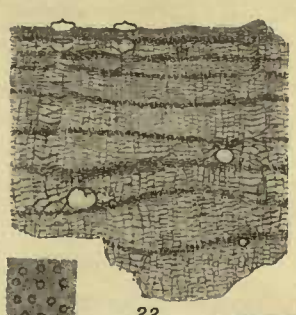
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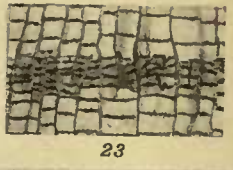
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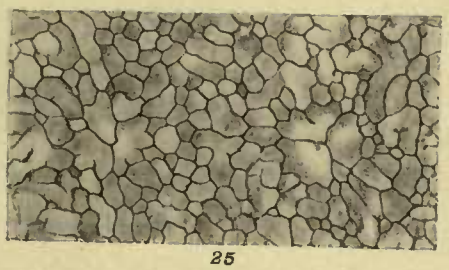
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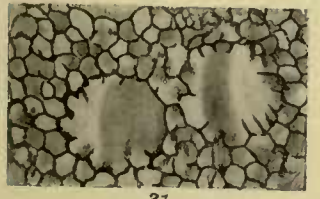
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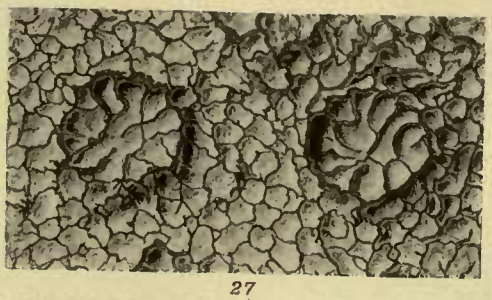
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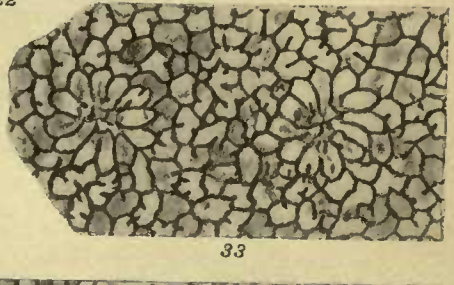
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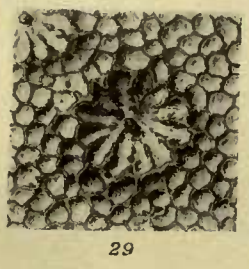
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Plate V.

Heliolites repletus n. p. 65.

Fig. 1, 2. Transverse sections to show the altered coenenchyma when there is a fascia formed. Especially in fig. 2 it is much modified with thick walled tubes having a false appearance as if provided with septa. I do not feel quite sure whether this much deviating structure may not be due to the intrusion of a semi-parasitic Favositoid colony. Both from the lowest strata *b* near Wisby. $^{8}/_{1}$.

Heliolites parvistella var. *intricata* n. p. 63.

Fig. 3. Some incipient calicles to show their development out of the coenenchyma. From Djupvik in Ekstа. $^{8}/_{1}$.

Cosmiolithus ornatus n. p. 68.

Fig. 4. Transverse section of a specimen from the Arachnophyllum shale *a* near Wisby. $^{12}/_{1}$.
» 5. Longitudinal section of the same. $^{12}/_{1}$.
» 6. Part of the surface, natur. size of a specimen, same locality.
» 7. The same magnified. $^{12}/_{1}$.
Fig. 8. Surface of another specimen, nat. size; same locality.
» 9. Transverse section of the same. $^{12}/_{1}$.
» 10. Longitudinal section of the same. $^{12}/_{1}$.
» 11. Longitudinal section of a specimen with more slender walls, from Klinte. $^{12}/_{1}$.

Cosmiolithus halysitoides n. p. 69.

Fig. 12. Part of the surface of specimen from Wisby, stratum *a*.
» 13. The same magnified. $^{12}/_{1}$.
» 14. Longitudinal section of the same. $^{12}/_{1}$.
» 15. Surface of another specimen, magnified. $^{12}/_{1}$.
Fig. 16. Longitudinal section of the same. $^{12}/_{1}$. Irregular lacunæ in the septal laminæ not structural.
» 17. Transverse section deeper down of a third specimen from stratum *a*. $^{12}/_{1}$. Coenenchymal thecæ tightened.
» 18. Longitudinal section of the same. $^{12}/_{1}$.

Plasmopora stella n. p. 83.

Fig. 19. Part of the surface, specimen from the stratum *a* Wisby. $^{4}/_{1}$.
» 20. Transverse section of the same. $^{6}/_{1}$.
» 21. Longitudinal section of the same. $^{6}/_{1}$.
» 22. Transverse section of another specimen, same locality, $^{6}/_{1}$; with small projections like costæ on the outside of the theca.
Fig. 23. Transverse section of a specimen from Kattentack, Estland. $^{6}/_{1}$.
» 24. Longitudinal section of the same. $^{6}/_{1}$.
» 25, 26. Sections of a specimen from the stratum *a* near Wisby.

Plasmopora scala n. p. 84.

Fig. 27, 28. Sections of a specimen from the stratum *a* near Wisby. $^6/_1$.

Plasmopora stella n. p. 83.

Fig. 29, I—VII. A series of transverse sections to demonstrate the coenenchymal gemmation. $^6/_1$.


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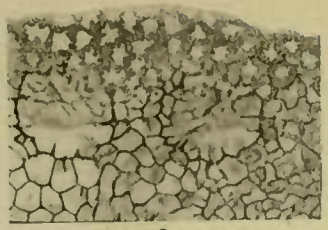
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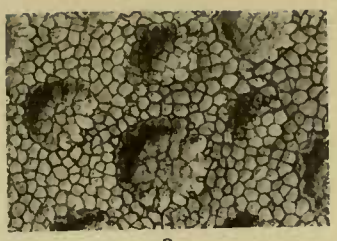
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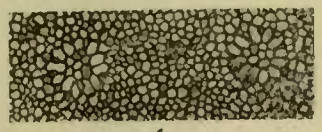
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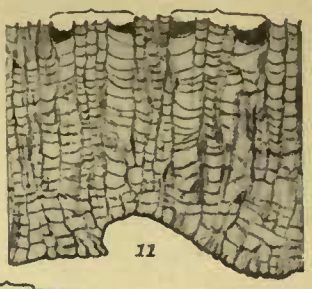
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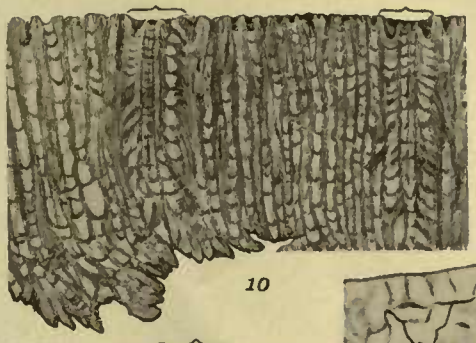
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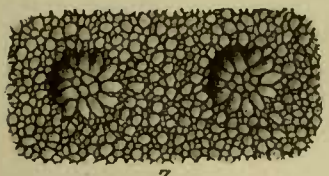
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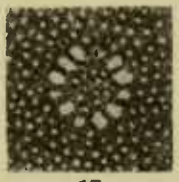
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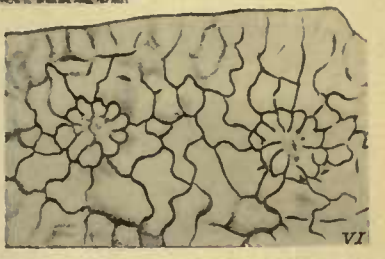
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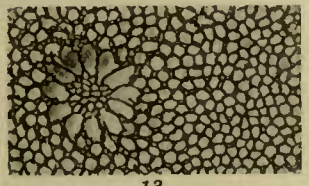
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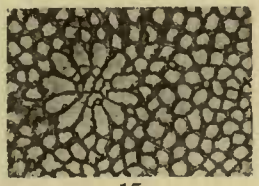
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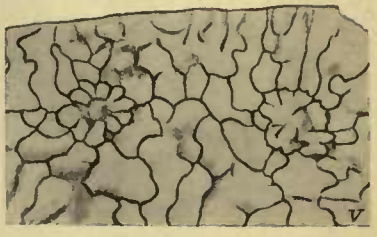
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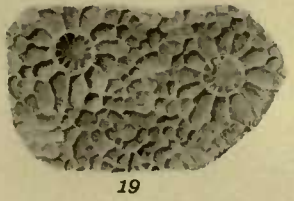
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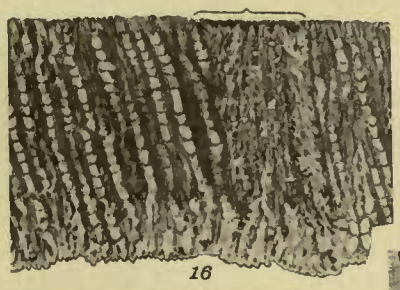
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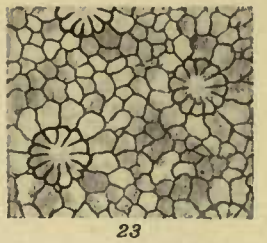
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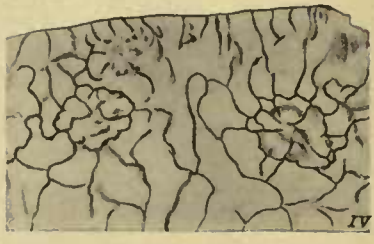
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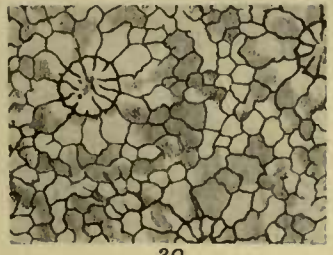
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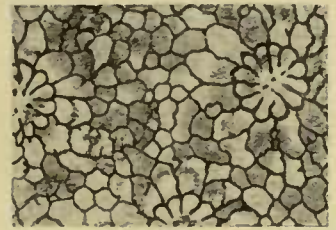
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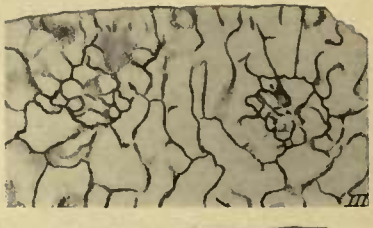
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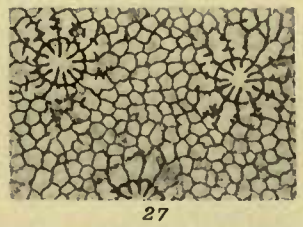
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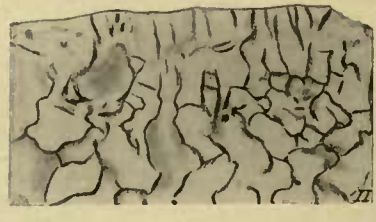
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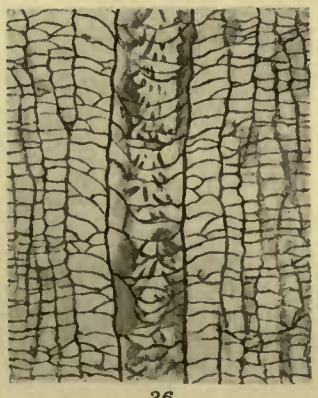
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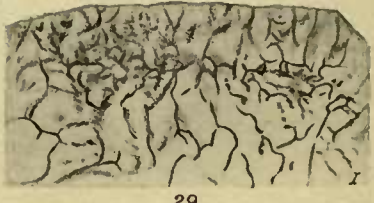
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Plate VI.

Plasmopora petaliformis Lonsdale p. 77.

Fig. 1—5. Transverse and longitudinal sections of two different specimens from Dudley, England. $^6/_1$. Fig. 3 is the basal part of figs. 1 & 2. Fig. 5 shows to the right how the structure prevalent in the coenenchyma of fig. 2 originates from the aculæ. The septa, especially in fig. 4, partially destroyed and absorbed.

» 6. Surface, nat. size, of a specimen from Stora Carlsö.

Fig. 7. Portion of the same magnified. $^6/_1$.

» 8, 9. Sections of the same. $^6/_1$. Observe in fig. 9, central coenenchyma, aculæ placed in longitudinal rows and at last forming bacilli.

» 10—12. Sections of a specimen also from Stora Carlsö. $^6/_1$. The shaded, vertically streaked patches in figs. 11 & 12 probably walls or thecæ of coenenchymal tubuli, the section going alongside these.

Plasmopora, variety of *P. petaliformis* p. 78.

Fig. 13. The surface magnified. $^6/_1$. From Tjelders in Boge, Gotland.

Fig. 14, 15. Sections of the same. The dotted lines in the right calicular tube are rows of septal spines seen *en face*. $^6/_1$.

Plasmopora foroensis n. p. 78.

Fig. 16. Surface, magnified, $^6/_1$, of a specimen from Tjelders in Boge, Gotland, irregularly grown.

» 17. Surface, magnified $^6/_1$, of a typical specimen from Ryssnäs, Fårö.

» 18—20. Sections of a specimen from the same locality. $^6/_1$.

Fig. 21. Longitudinal section of a specimen from Slite. $^6/_1$.

» 22. A similar of a specimen from Slite, Lännaberget. $^6/_1$.

Plasmopora calyculata Ldm. p. 79.

Fig. 23. Typical specimen from Norderstrand, Wisby, nat. size.

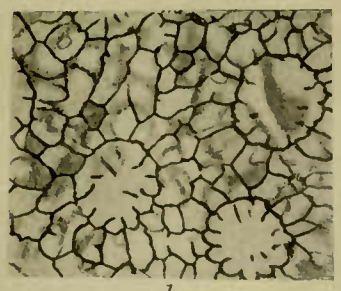
» 24. Portion of the same, magnified. $^6/_1$.

» 25. A bud from the surface of the same, rudimentary theca and septa. $^6/_1$.

Fig. 26. Section a little below the surface, showing the dissimilarity with section (f. 27) taken lower down.

» 27—29. Sections of specimen from Wisby, stratum *b*. $^6/_1$.

» 30. Longitudinal section of a specimen from Dudley, England. $^6/_1$.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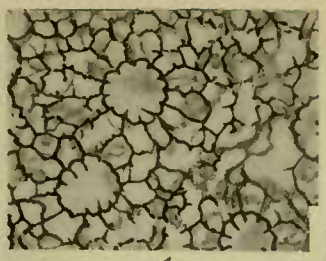
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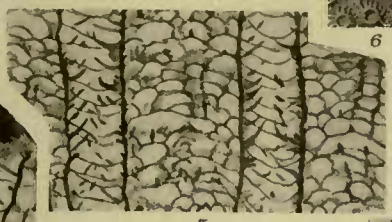
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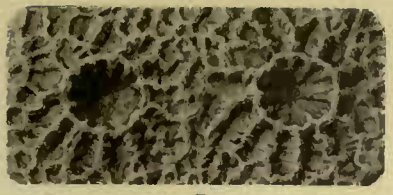
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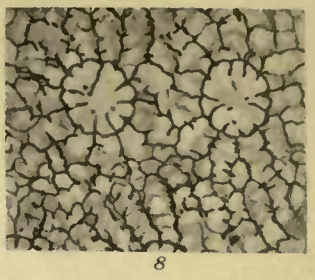
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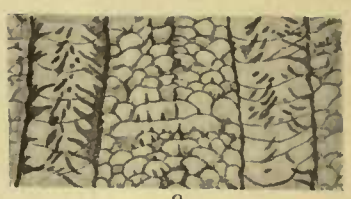
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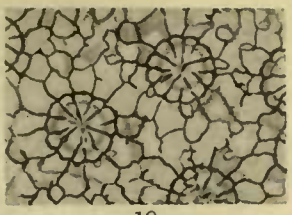
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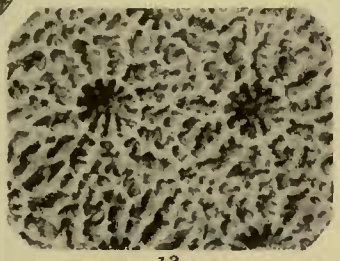
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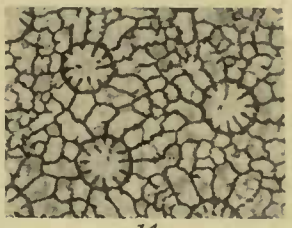
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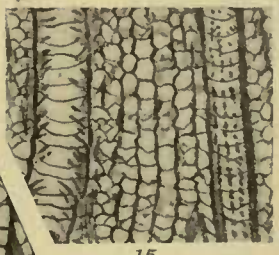
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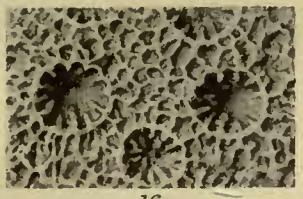
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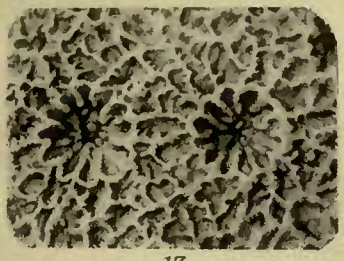
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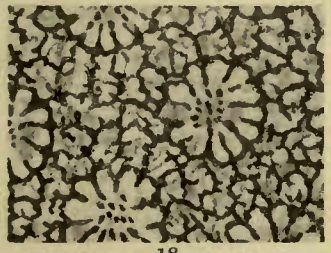
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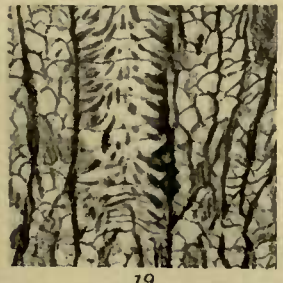
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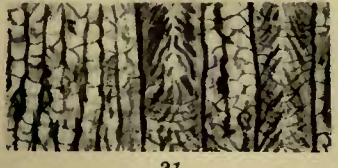
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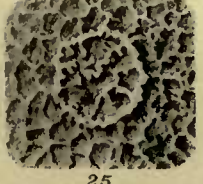
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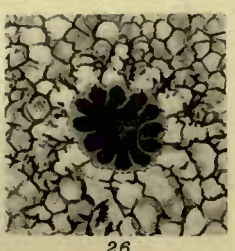
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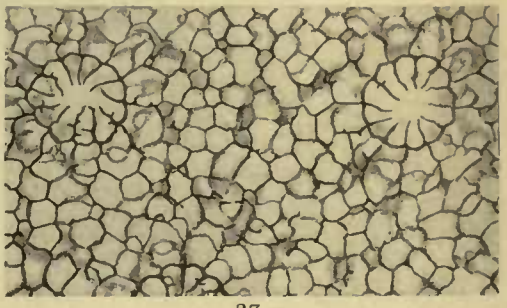
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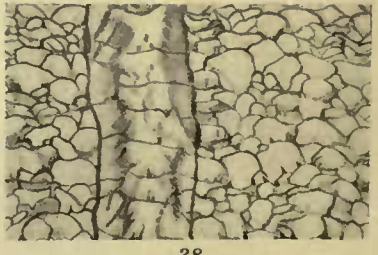
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Plate VII.

Plasmopora forvensis n. p. 78.

Fig. 1 (I—IV). Series of coenenchymal gemmation.

Plasmopora calyculata var. *tuberosa* p. 80.

Fig. 2. A polypary, natural size, from the stratum *d* near Wisby. Drawn by C. HEDELIN.
» 3. A calicle magnified. $^6/_1$.
Fig. 4, 5. Sections of the corall. In the middle of the longitudinal section of the calicular tube the margins of three septa are seen.

Plasmopora scita EDW. & H. p. 81.

Fig. 6. Surface of a polypary from Stora Carlsö. $^6/_1$.
» 7, 8. Sections of specimen from Lilla Carlsö. $^6/_1$.
» 9, 10. Sections of specimens from Djupvik, Ekstа. $^6/_1$. To remark the transitions from aculæ to bacilli.
» 11. Sections of lower portion of specimen from Stora Carlsö, showing a different coenenchyma, which higher up in the same specimen resembles the previous. $^6/_1$.
Fig. 12, 13. Sections of specimen from Wisby, stratum *d*. $^6/_1$. The central calicular tube in fig. 13 cut near the theca. $^6/_1$.
» 14, 15. Another specimen from Wisby, stratum *d*.
» 16. Surface of specimen from Wisby showing a variety of calicles which occurs with normal ones on the same specimen. $^6/_1$.
» 17, 18. Sections of the same, showing normal structure. $^6/_1$.

Plasmopora follis EDW. & H. p. 82.

Fig. 19, 20. Sections of a specimen from Perryville, Cincinnati. $^6/_1$.

Plasmopora rosa n. p. 84.

Fig. 21. Transverse section of specimen from Linde klint. $^6/_1$.
Fig. 22, 23. Longitudinal sections of the same. $^6/_1$.

Plasmopora suprema n. p. 85.

Fig. 24. Surface of specimen from Linde klint. $^6/_1$.
Fig. 25, 26. Sections of the same. $^6/_1$.

Plasmopora rudis n. p. 85.

Fig. 27, 28. Sections of specimen from Sandarfve kulle. $^{8}/_{1}$.

» 29, 30. Sections of specimen, typical, from Helvi. $^{6}/_{1}$.

Fig. 31. Portion of interior calicular wall, showing the rounded septal lists covered with minute granules and crossed by fragments of the tabulæ. $^{6}/_{1}$.

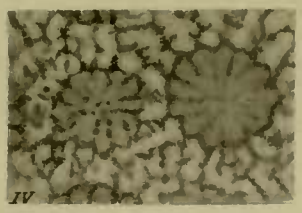
Plasmopora heliolitoides n. p. 86.

Fig. 32, 33. Sections of specimens from Östergarn. $^{6}/_{1}$.

Plasmopora? reticulata n. p. 87.

Fig. 34. Part of the surface, nat. size, specimen from the Arachnophyllum stratum of Wisby.

Fig. 35, 36. Sections of the same. $^{6}/_{1}$.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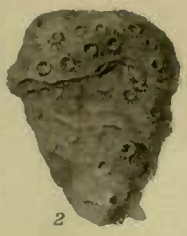
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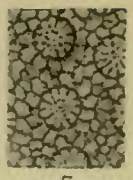
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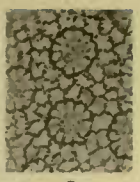
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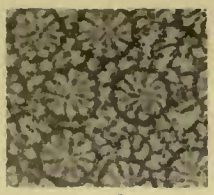
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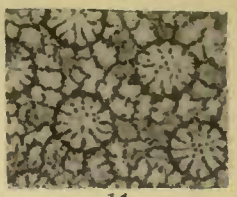
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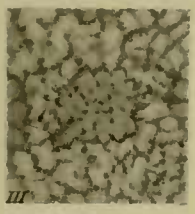
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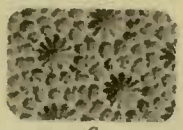
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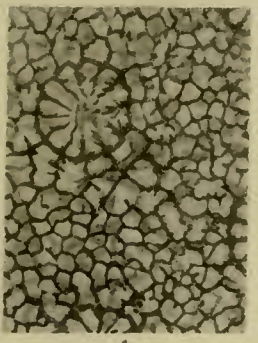
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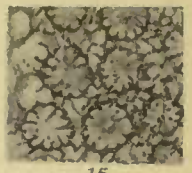
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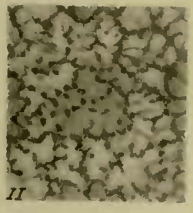
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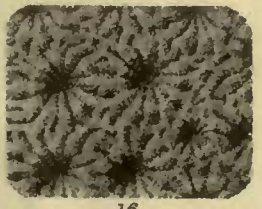
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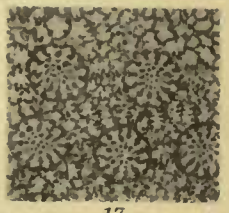
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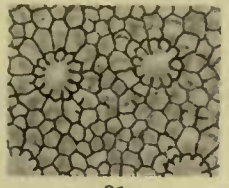
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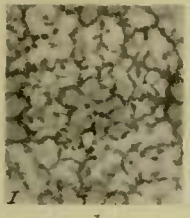
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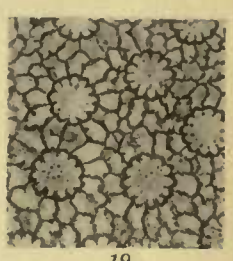
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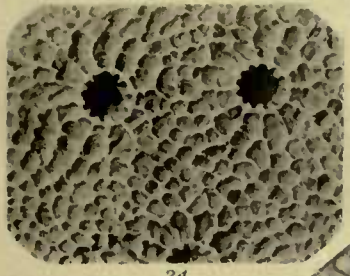
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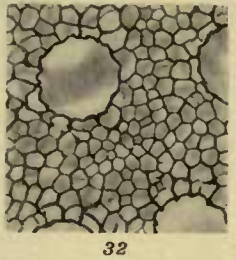
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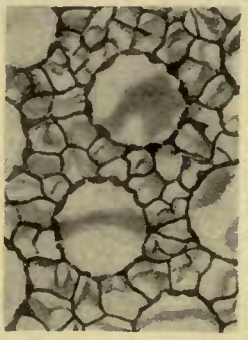
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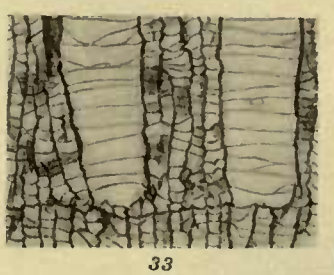
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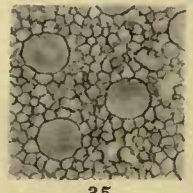
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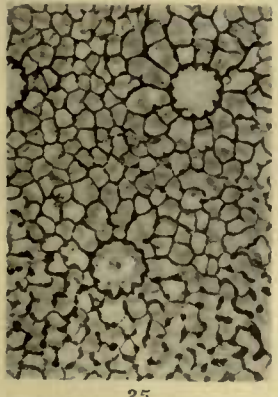
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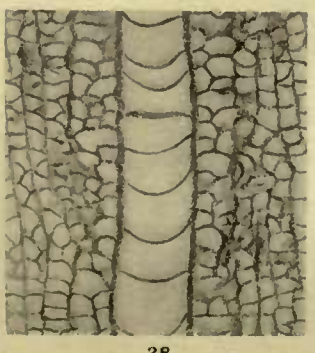
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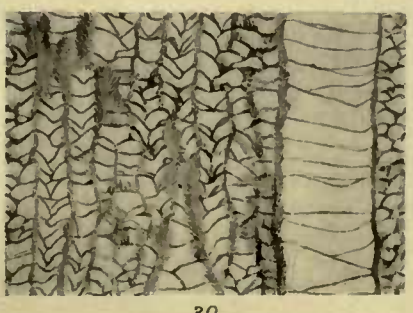
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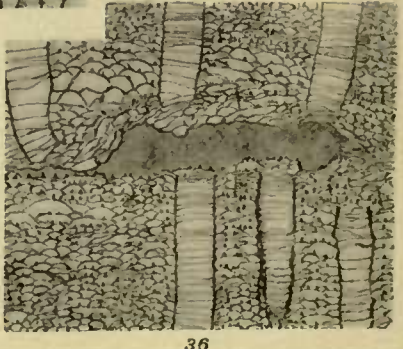
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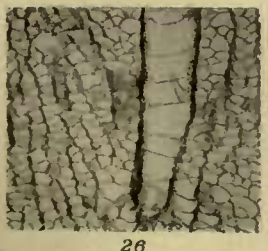
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Plate VIII.

Plasmopora scita Edw. & H. p. 81.

Fig. 1, 2. Aspects of different calicles to be compared with figs. 6 & 16 on plate VII showing the gradual transition of calicle fig. 6 through 1 and 2 to fig. 16, pl. VII, magnified. $^6/_1$.

Fig. 3. Calicle of a variety of Pl. scita. $^6/_1$.

It is to be observed that the communications with the coenenchyma in the margin of the calicle exist only on the surface of the coral.

Propora tubulata Lonsdale p. 89.

Fig. 4—7. Surface and sections of a specimen from Dudley, England. Fig. 4 typical form with calicles resembling those in Milne Edward's figures, $^5/_1$. Figs. 5—7 magnified, $^6/_1$. Fig. 7 basal part of fig. 6 showing epithecal gemmation.

» 8. Surface of a specimen from Gotland, Wisby; stratum *d*, the costal radii replaced by convex laminæ of the same kind which constitute the vesicular tissue of the interior; they are covered with minute warts, or aculæ probably of the same sort seen in the interior on the top of the convex laminæ. $^5/_1$.

» 9, 10. Sections of the same specimen. In f. 9 between the calicles the convex laminæ sectioned.

» 11. Surface showing a variety approaching to that in fig. 8 the concave laminæ nearly all effaced and the surface of the coenenchyma granulated. From Wisby *d*. $^5/_1$.

Fig. 12, 13. Sections of the same, the longitudinal one showing great similarity with that of Plasm. scita. $^5/_1$.

» 14, 15. Sections of another specimen from Wisby. $^5/_1$.

» 16, 17. Sections of a specimen from Oesel, Undwa, belonging to the Geological Survey of Sweden. $^4/_1$.

» 18, 19. Sections of a specimen from Borkholm, Estland, Lower Silurian, stratum F^1. Older variety with distantiated calicles and more compact vecicular tissue. $^4/_1$.

» 20. Surface, nat. size, of same specimen as in figs. 16, 17.

» 21. Surface, nat. size, of specimen 18, 19.

» 22. Ditto of specimen from the Arachnophyllum stratum *a* of Wisby same variety as in figs. 18, 19.

Propora euryacantha n. p. 92.

Fig. 23. Calicle showing the flat triangular septal spines, specimen from Fårö, Gotland. $^6/_1$.

Propora tubulata, var. p. 91.

Fig. 24, 25. Sections of specimen, called Lyellia americana Edw. & H., from Point Detour, Michigan, to be compared with fig. 10 & 15.

Propora euryacantha n.

Fig. 26, 27. Sections of specimen from Fårö, of another specimen than in fig. 23. Fig. 26 near the surface.

Propora tubulata Lonsd. p. 89.

Fig. 28. Showing calicinal gemmation, a young colony on an old polypary. $^{6}/_{1}$. Eksta, Gotland.

» 29—31. Sections of specimen called »Lyellia parvituba» Rominger from Louisville, Kentucky, Niagara group. It is a variety of Pr. tubulata, compare figs. 9 & 10 or 14 & 15. In fig. 29 the calicles are completely filled with adventitious crystals of later growth, of which so great masses are seen in the calicular tubes and also around on the convex laminæ of the coenenchyma. $^{6}/_{1}$. In the section, fig. 31, the frequent breaks in the continuity of the calicular tubes are also to be observed, caused by the exuberant growth of the coenenchyma.

Propora conferta Edw. & H. p. 93.

Fig. 32. Transverse section of the original specimen, preserved in the Collection Verneuil in the »Musée de l'École des Mines» in Paris. From Borkholm in Estland, stratum F^1. $^{4}/_{1}$.

» 33. Calicles a little more enlarged, same specimen, to show the curious aspect of the septa, crystals having grown in tufts on their extremities.

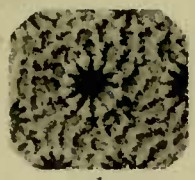
» 34. Longitudinal section of the same specimen. $^{4}/_{1}$.

» 35. Part of a calicle of specimen from Borkholm in Estland, highly magnified, $^{12}/_{1}$; to show the deformation of the septal ends, being covered by cristals of arragonite.

Fig. 36. Surface of specimen, nat. size, from Walve ref, Gotland found detached, and of the same structure as the specimen of Milne Edward's. The aculæ on the tabulæ in this and other specimens are not indisputably organic, but rather cristals of minerals.

» 37. Surface of the second of Milne Edward's original specimens, in École des Mines, from »Chavli» in Estland, nat. size.

» 38, 39. Sections of the same. $^{4}/_{1}$.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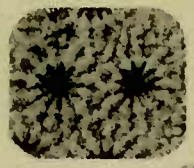
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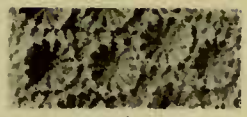
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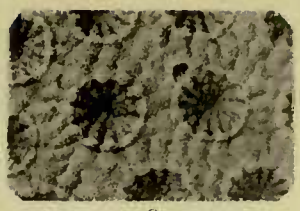
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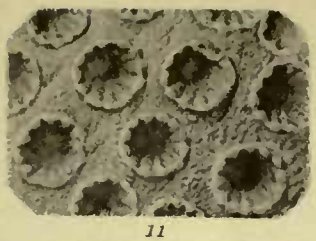
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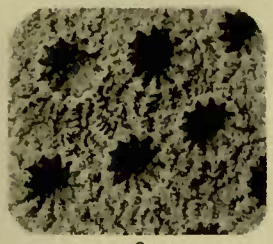
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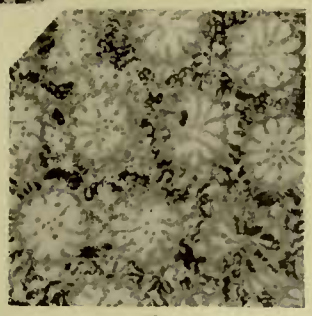
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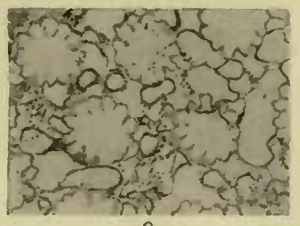
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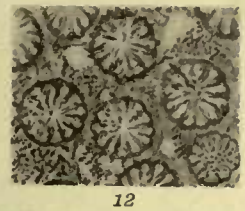
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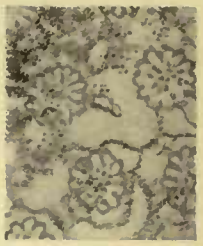
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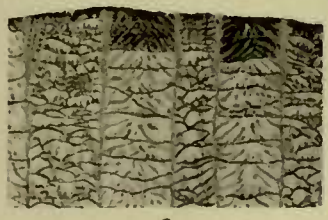
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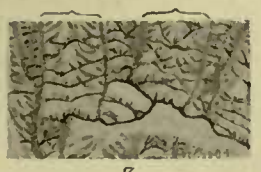
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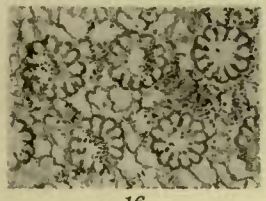
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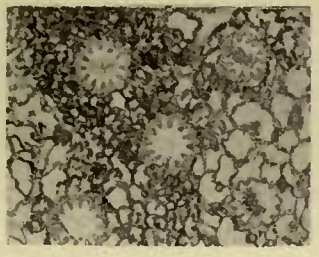
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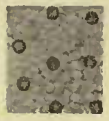
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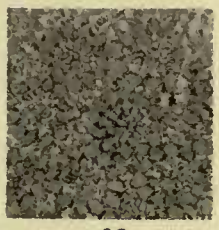
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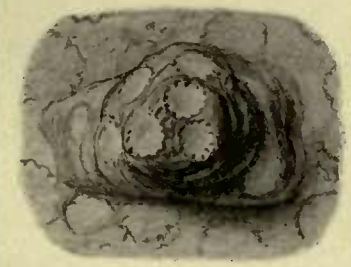
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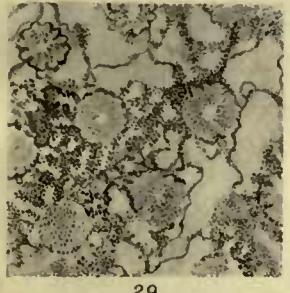
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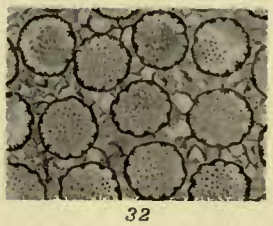
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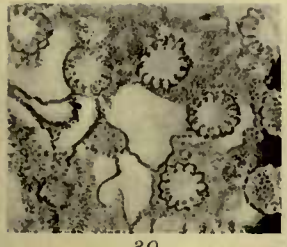
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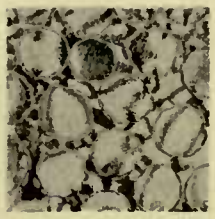
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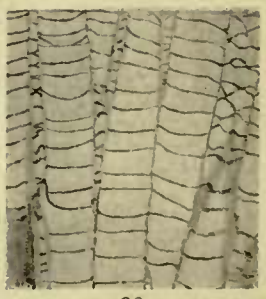
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Plate IX.

Propora conferta Edw. & H. p. 93.

Fig. 1, 2. Sections of specimen from Borkholm, Estland. $^4/_1$. The fine needles visible on the interior walls of the calicles and on the tabulæ are inorganic or crystals.
» 3. Microscopic structure of calicinal thecas. Specimen from Piersal (F^1) Estland. $^{12}/_1$. The composition of the thecæ and septa of fibrillæ is plainly visible. The Favositoid structures in the centres of some calicles possibly of parasitic nature.
» 4. Fragment of a calicle in longitudinal section, same specimen. $^4/_1$. A pair of septal ridges between which the tabulæ form a sort of septal groove, as indicated by the concave lines.
» 5, 6. Sections of a variety from Tsiën-shui in China. $^6/_1$. In fig. 6 partial destruction of calicinal theca through coenenchyma. No apertures in the theca to be assumed.
Fig. 7, 8. Ditto of a specimen from the middle Tunguska, Siberia. $^6/_1$.
» 9, 10. Ditto of a variety with uncommonly thick walls from Ålleberg, Westrogothia. $^4/_1$.
» 11, 12. Sections of a specimen from Anticosti, Canada, from type specimen of Billing's Heliolites affinis. $^4/_1$.
» 13. Surface of the same in nat. size.
» 14, 15. A variety from Klef in Sundre, Gotland, 14 nat. size, 15 a calicle magnified. $^6/_1$.
» 16. Part of the surface of a specimen from Dalecarlia, Sweden, nat. size.
» 17, 18. Sections of a specimen from Arfvet in Dalecarlia, Sweden. $^4/_1$,
» 19. Part of the surface of the same nat. size.
» 20. Ditto, specimen from Östbjörka, Dalecarlia.
» 21, 22. Sections of the same. $^4/_1$.
» 23. Longitudinal section, $^4/_1$, of a specimen found detached in a canal at Wall, Gotland.

Propora conferta var. *minima* p. 95.

Fig. 24, 25. Sections of a specimen from the Arachnophyllum-beds near Wisby. $^4/_1$.
Fig. 26. Part of the surface in nat. size.

Propora cancellata n. p. 95.

Fig. 27. Part of the surface, nat. size, from Borkholm, Estland.
» 28. Transverse section. $^4/_1$.
Fig. 29. Part of the surface magnified. $^4/_1$.
» 30. Longitudinal section of the same. $^4/_1$.

Propora conferta var. p. 94.

Fig. 31. The corall in nat. size, from the Arachnophyllum stratum near Wisby.
Fig. 32. Natural longitudinal section of the same. $^4/_1$.
» 35. Transverse section. $^8/_1$.

Propora sp. indet. p. 98.

Fig. 33. Part of the surface, natur. size, Alfvaret, west of Hulterstad, Öland.
Fig. 34. A longitudinal section, effected through weathering. $^2/_1$.

Propora (Pinacopora) girvanensis NICHOLS. & ETHERIDGE p. 99.

Fig. 36. Surface of a specimen from the Junction Cliff, Anticosti, Canada. $^5/_1$.

Fig. 37—39. Various sections of the same. $^5/_1$.

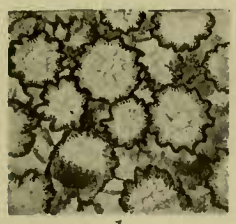
Propora speciosa BILLINGS p. 95.

Fig. 40. Part of the surface of a specimen from Anticosti, Canada. $^4/_1$.

» 41, 42. Sections of the same. $^4/_1$.

Fig. 43, 44. Sections of a specimen from Dudley, England. $^4/_1$. Septa much transformed.

» 45, 46. Sections of a specimen from Borenshult, Ostrogothia, Sweden. $^4/_1$.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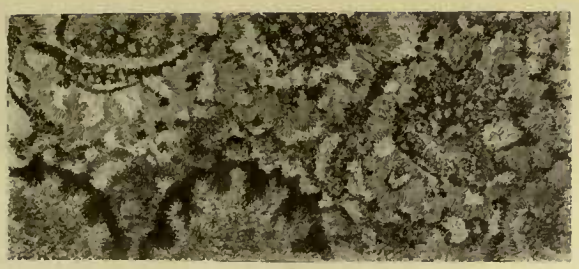
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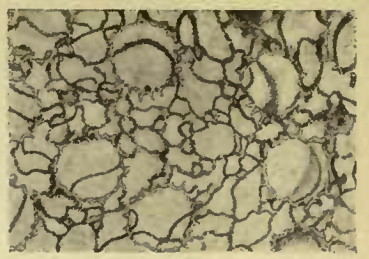
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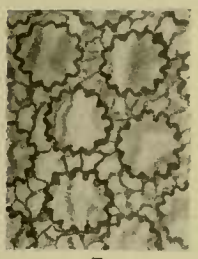
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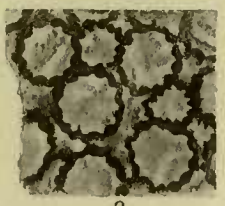
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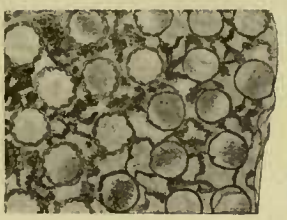
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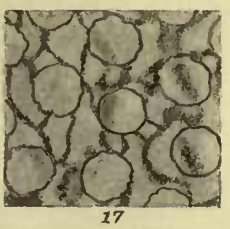
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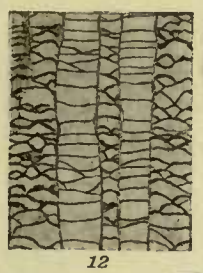
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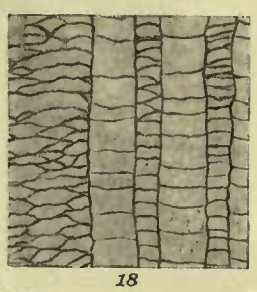
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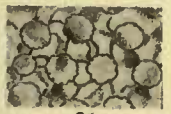
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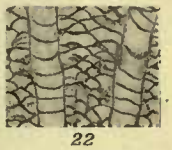
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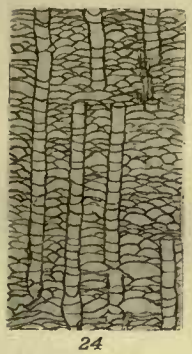
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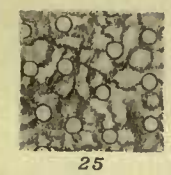
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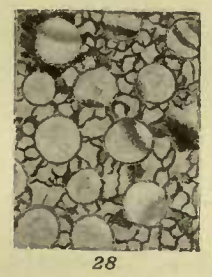
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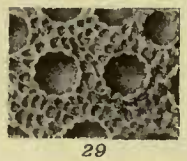
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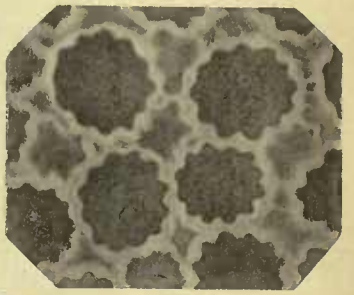
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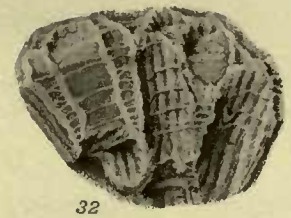
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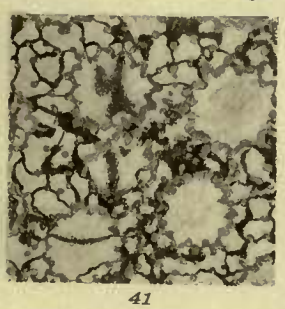
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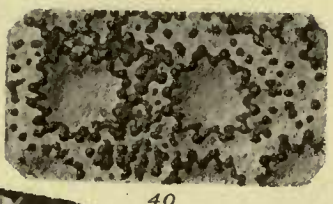
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Plate X.

Propora speciosa Bill. p. 95.

Fig. 1, 2. Transverse sections of specimens from Borenshult. $^4/_1$.

Fig. 3. Surface of a variety or mutation from Bara backe, Gotland. $^6/_1$.

» 4, 5. Sections of the same.

Propora compacta n. p. 96.

Fig. 6, 7. Sections of a specimen from Olenek, Sibiria. $^6/_1$.

Propora bacillifera n. p. 97.

Fig. 8—10. Sections of a specimen from Dalecarlia. $^4/_1$.

» 11. Surface of the same, nat. size.

» 12. Surface of another specimen, same locality, nat. size.

» 13. Surface of a specimen, nat. size, from Öland.

» 14, 15. Sections of the same. $^3/_1$. In fig. 15 in a lacuna at the left side of the section a little oval fossil is seen, possibly a Saccammina.

Fig. 16—18. Sections of specimen from Borkholm, Estland. $^4/_1$.

» 19, 20. Sections of specimen, from Piersal, Estland. $^4/_1$.

» 21. Surface of the same, nat. size.

Propora? ambigua n. p. 98.

Fig. 22, 23. Sections of specimen from the stratum *a* Wisby. $^4/_1$.

Fig. 24. Surface of the same, nat. size.

To observe the irregular growth of the coenenchymal lamellæ and how they have disturbed the development of the calicles. At the base no calicles visible, possibly directed the other way.

Camptolithus papillatus Rominger p. 101.

Fig. 25—27. Transverse sections of various specimens from Point Detour, Michigan, Am. $^6/_1$.

Fig. 28—30. Longitudinal sections of specimens, same locality. $^6/_1$.

Diploëpora Grayi Edw. & H. p. 102.

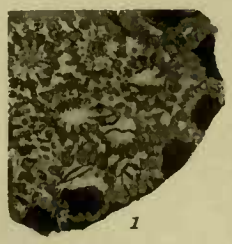
Fig. 31. A branchlet, nat. size, from Wisby.

» 32—35. Views of the surface to show the changes by growth fig. 32 being the oldest or first stage from the tip of a branch, fig. 35 the youngest, from Ryssnäs, isle of Färö, Gotland, f. 32—34 from the uppermost strata *f—h* near Wisby. $^{10}/_1$.

Fig. 36. Part of the surface of fig. 35, nat. size.

» 37, 38. Transverse sections of a mature specimen (as fig. 35) f. 38 deeper down than f. 37 which shows the densely packed baculi around the twelve baculi of the calicle, all with their fibrillæ. $^{10}/_1$.

As to the growth of the theca in the genus Propora I may here remark that in several species changes occur in a manner somewhat similar to what happens in Diploëpora. The initial sharpedged circular margins assume the shape of a ring of small beads, which form the bases of trabeculæ (baculi), out of which, twelve in number, by and by, the theca is made up in the later stage of growth. These trabeculæ of the common fibrillous structure lie close against each other and as may be seen from weathered specimens where the calicular tubes stand free, they form a compact theca, although it is very thin between the baculi. Sometimes there is seen as long, narrow slits in the theca, but this may be due to disintegration through pression or later changes. In plate XI, fig. 2 there is perhaps a side view of a wall with its trabeculæ. It is remarkable that in the oldest Proporæ as P. conferta and bacillifera this structure of the theca is not so prominent as in the Upper Silurian ones.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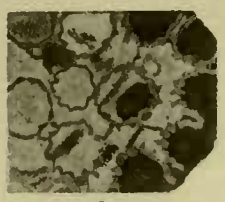
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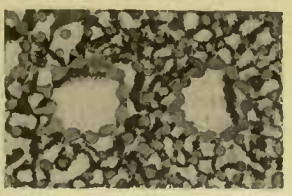
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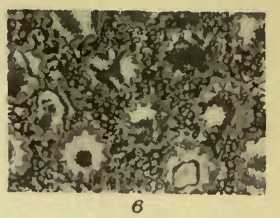
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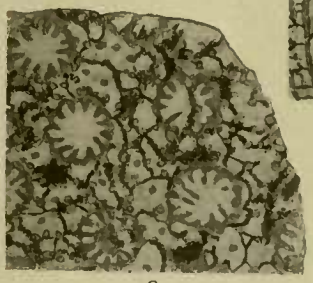
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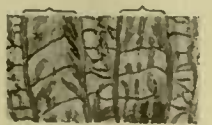
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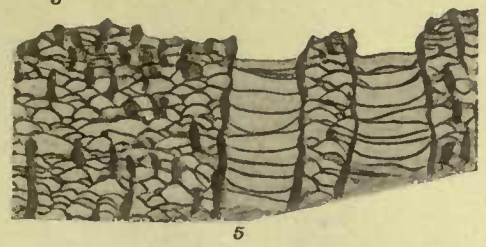
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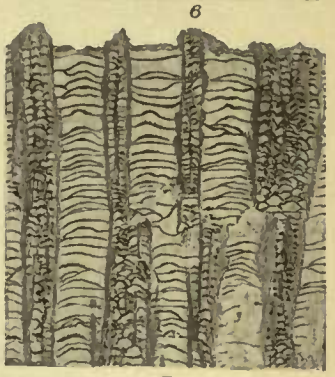
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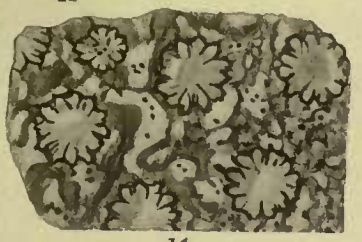
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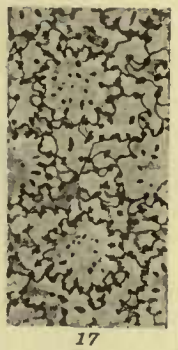
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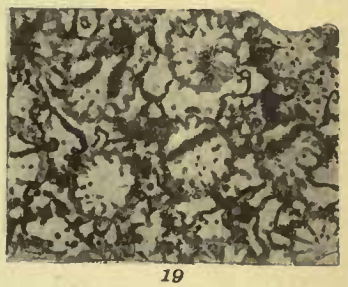
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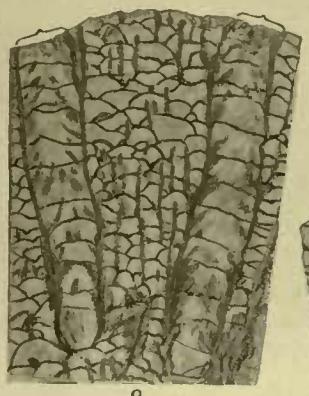
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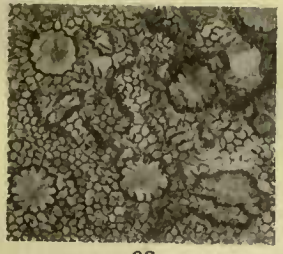
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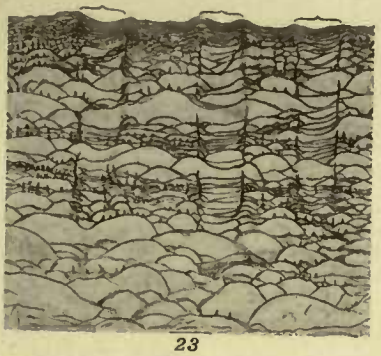
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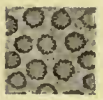
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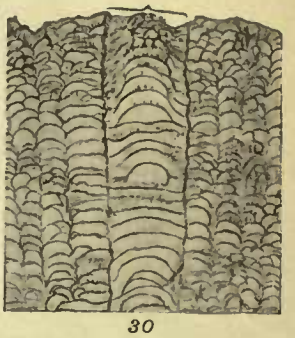
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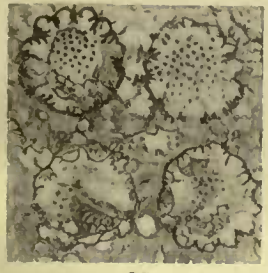
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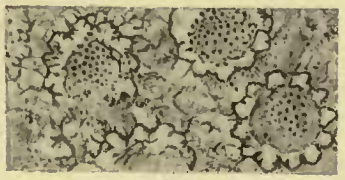
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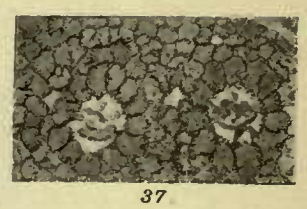
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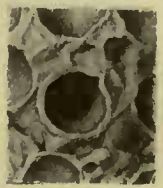
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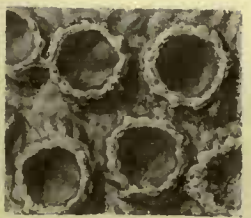
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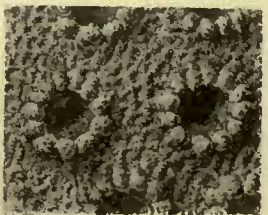
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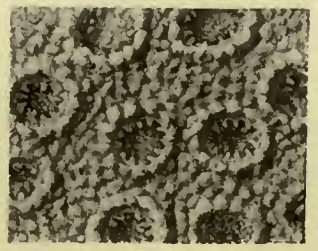
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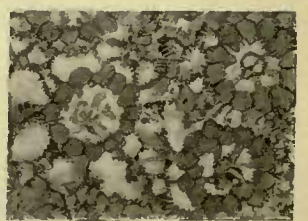
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Plate XI.

Diploëpora Grayi Edw. & H. p. 102.

Fig. 1. Longitudinal section of the bacular stratum, the vesicular stratum seen in the bottom. $^{10}/_{1}$.
» 2. Section of calicular tubes on the transition from vesicular coenenchyma to the bacular. $^{10}/_{1}$. In the lowest tube to the left as if columellas on the tabulæ.
» 3. Transverse section of the vesicular coenenchyma. $^{3}/_{1}$.
Fig. 4. Section of an entire branch of the coral from side to side showing the central vesicular coenenchyma surrounded by the bacular coenenchyma on both sides. Section placed in the direction of the growth. In the bacular coenenchyma at the right hand there is recurrence of the vesicular coenenchyma repeated four or five times. $^{3}/_{1}$.

Pycnolithus bifidus n. p. 105.

Fig. 5. Part of the surface magnified. $^{8}/_{1}$ Specimen probable from the stratum *a* near Wisby.
» 6. Transverse section a little below the surface. $^{8}/_{1}$.
» 7. Transverse section still deeper. $^{8}/_{1}$.
Fig. 8. Longitudinal section near the surface, showing grooves in the coenenchyma. $^{8}/_{1}$.
» 9. Longitudinal section. $^{8}/_{1}$. The tabulæ below the two upper ones have been made thicker through later accumulations. Longitudinal white lines thecæ of coenenchymal tubes.

Proheliolites dubius Fr. Schmidt p. 70.

Fig. 10. Surface in nat. size.
» 11. The same magnified. $^{8}/_{1}$.
» 12. The same magnified, favositoid and irregular. $^{8}/_{1}$.
» 13. Transverse section, lower down, $^{8}/_{1}$, septal spines incrassated through crystalline deposits. Specimen from Worms, Estland.
» 14. Longitudinal section showing parts of three calicles with septal spines directed downwards and covered with crystals of iron-oxidehydrate. Also from Worms. $^{20}/_{1}$.
Fig. 15. Transverse section of the same. $^{20}/_{1}$. Crystal accumulations also in the small incipient calicles.
» 16. Section of a specimen from a morainic deposit at Öjle myr, Gotland, collected by Dr C. Wiman. $^{8}/_{1}$. The calicular centre of several tubes is filled with a whitish siliceous mass and the septal spines are deformed, so as to look as if bifid.
» 17. Longitudinal section of the same, $^{8}/_{1}$, showing the downwards directed septal spines.

Heliolites hirsutus n. p. 64.

Fig. 18. Part of the surface, a little weathered. $^{6}/_{1}$. Specimen from Pattakumäggi, Estland, near Hapsal.
» 19. Transverse section a little below the surface, $^{6}/_{1}$, from the Alfvar near Hulterstad, Öland.
» 20. Part of a calicular tube, longitudinally sectioned, $^{12}/_{1}$, same locality.
Fig. 21. Side of a weathered polypary with three calicles visible. The septal spines deformed through weathering and posterior depositions, $^{12}/_{1}$; same locality.
» 22. Longitudinal section, same locality. $^{6}/_{1}$.

Acantholithus lateseptatus n. p. 113.

Fig. 23. A calicle magnified, $^{12}/_{1}$, with the surrounding coenenchyma. Specimen belonging to the Geological Survey of Sweden, found in a morainic mass near Kopparsvik, Wisby, Gotland.
» 24. Section of the same, a little below the surface. $^{12}/_{1}$.
» 25. Section lower down. $^{12}/_{1}$.
» 26. Surface in natural size.
» 27. Bottom stratum of the polypary just above the epithecal stratum. $^{12}/_{1}$. The black, branching figures probably caused by parasites.
Fig. 28. Microscopic structure of the epithecal stratum $^{12}/_{1}$.
» 29. Longitudinal section showing the scarce, concave tabulæ in the coenenchyma and in the calicle, and also the epithecal stratum in bottom, like a crusta. $^{12}/_{1}$.
» 30. Another longitudinal section with denser coenenchyma and the same epithecal stratum. Lacunæ through parasites or inorganic. $^{12}/_{1}$.

Acantholithus asteriscus p. p. FERD. ROEMER p. 113.

Fig. 31. Calicle and coenenchyma of a specimen from Wormsö, Estland. $^{12}/_{1}$.
» 32. A transverse, somewhat oblique section of the same. $^{12}/_{1}$. The left part deepest.
» 33. Longitudinal section of the same. $^{12}/_{1}$.
» 34. Magnified part of a surface, from Wormsö, Estland. $^{12}/_{1}$.
Fig. 35. Surface with two calicles, magnified. $^{12}/_{1}$. From the original specimen of FERD. ROEMER's Heliolites interstinctus in Silur. Diluv. Geschiebe von Sadewitz, Taf. IV, fig. 4, belonging to the Palæontological Museum at Breslau.

Plasmopora stella n. p. 83.

Fig. 36. Transverse section of a specimen from the stratum *a* near Wisby. To observe the most regular aureolas. $^{6}/_{1}$.
Fig. 37. Longitudinal section of the same. The larger aureolar space on both sides of the calicular tube clearly discernible from the other coenenchyma. $^{6}/_{1}$.


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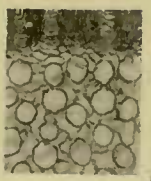
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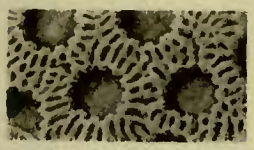
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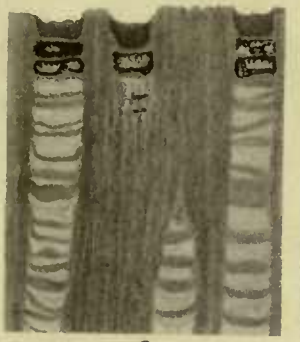
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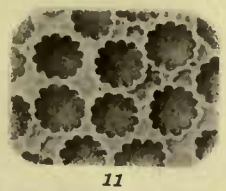
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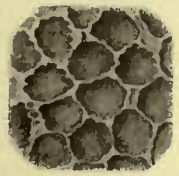
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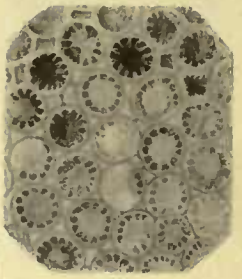
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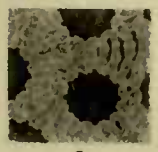
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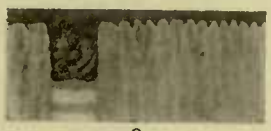
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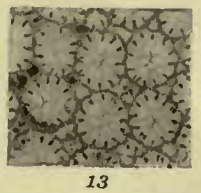
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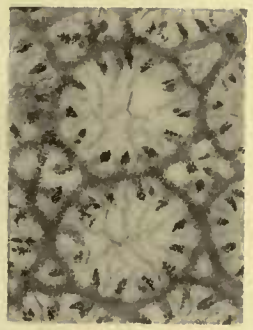
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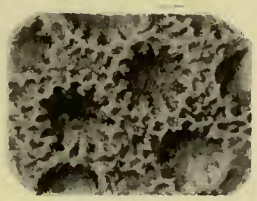
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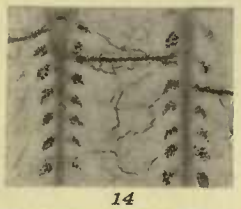
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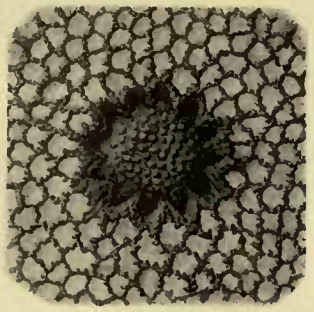
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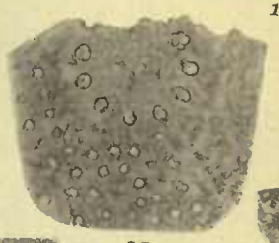
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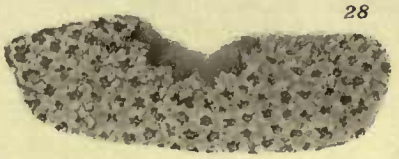
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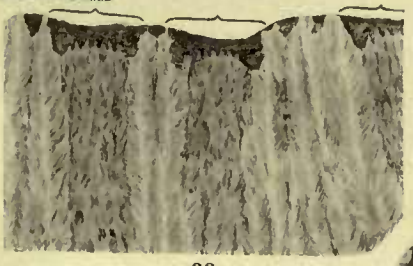
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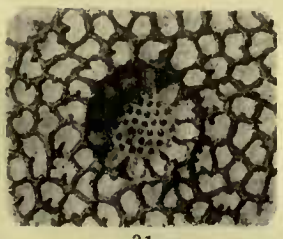
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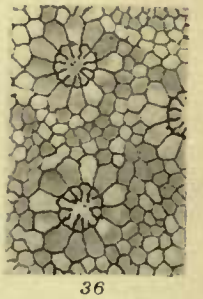
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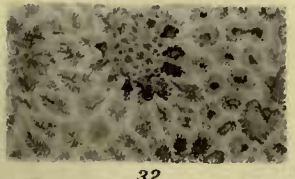
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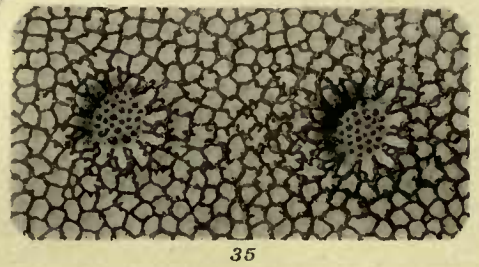
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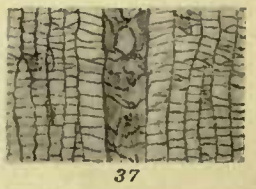
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Plate XII.

Acantholithus sp. *indet.* p. 114.

Fig. 1. Portion of the surface, from the stratum *a* of Wisby. $^{12}/_{1}$.

Fig. 2. Longitudinal section of the same. $^{12}/_{1}$.

Coccoseris Ungerni EICHWALD p. 107.

Fig. 3. Portion of surface of specimen from Grossenhof, Estland. $^{12}/_{1}$.

» 4. The same natural size.

» 5. Surface, nat. size, probably a variety of the former, from Sutlep, Estland.

Fig. 6. Transverse section of this, across a calicle, with its central (columellar) and septal baculi. $^{20}/_{1}$.

» 7. Longitudinal section passing through two calicles. $^{20}/_{1}$. A narrow stripe of coenenchyma between them.

Coccoseris megastoma MAC COY p. 108.

Fig. 8. Surface of specimen from Applethwaite, Westmoreland delineated from a positive cast in plaster taken on the negative original. $^{10}/_{1}$. Presented by Lector S. L. TÖRNQUIST.

» 9. Variety *minor* from Hulterstad, Öland. $^{12}/_{1}$.

Fig. 10. The same from the same locality, weathered specimen. $^{12}/_{1}$.

» 11. Surface in natural size of another specimen, same locality.

Coccoseris microporus EICHWALD p. 107.

Fig. 12. Surface in nat. size, of a specimen from Borkholm, Estland.

» 13. Longitudinal section of the same. $^{20}/_{1}$.

» 14. Portion of the surface magnified. $^{12}/_{1}$.

Fig. 15. Portion of the original specimen of EICHWALD's Heliolites microporus from Maals near Hapsal, now in the Museum of the University of St. Petersburg, kindly communicated by Professor INOSTRANZEFF.

Coccoseris micraster n. p. 109.

Fig. 16. Surface in natural size, specimen from Östbjörka, Dalecarlia.

» 17. The same magnified. $^{10}/_{1}$.

Fig. 18. Longitudinal section showing two calicles and the bacular coenenchyma. $^{10}/_{1}$.

Protarea vetusta J. HALL p. 111.

Fig. 19. A somewhat weathered specimen from Richmond, Indiana. $^{12}/_{1}$.

Fig. 20. Transverse section of specimen from same locality, $^{20}/_{1}$, four calicles sectioned. Observe the great similarity with fig. 6.

Fig. 21. An initial colony from Richmond, Indiana, grown on a brachiopodous shell. $^{12}/_{1}$.

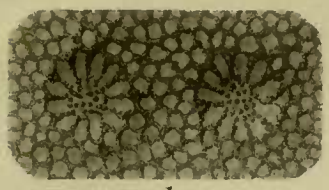
» 22. Longitudinal section of an older specimen, same locality. $^{20}/_{1}$.

» 23. Part of the surface of specimen from Wesenberg, Estland. $^{12}/_{1}$.

» 24. Portion of the surface of the original specimen of v. SEEBACH's Stylaræa Roemeri, kindly communicated by Prof. VON KOENEN. To be compared with fig. 19.

Fig. 25. Calicle of a recent *Thecopsammia*, magnified. This and the next figure are drawn by M. WESTERGREN, p. 14, 17.

» 26. Young colony of a *Turbinaria* grown on the surface of an older. Showing coenenchymal gemmation, p. 14.



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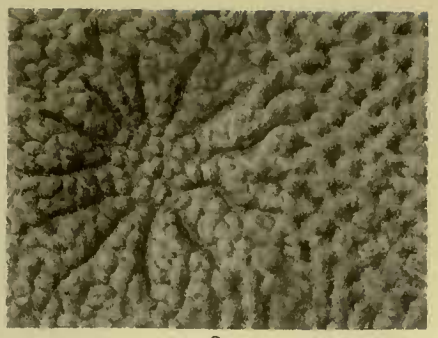

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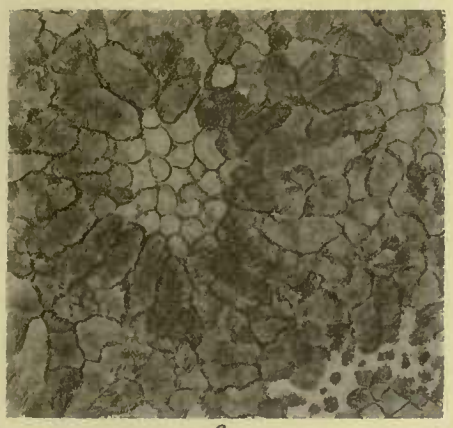

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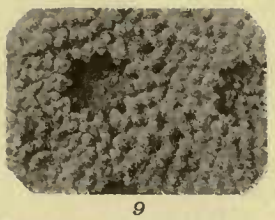

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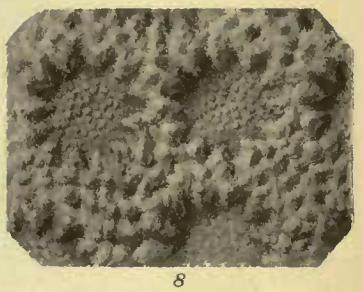

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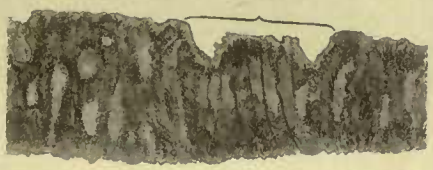

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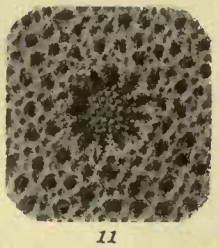

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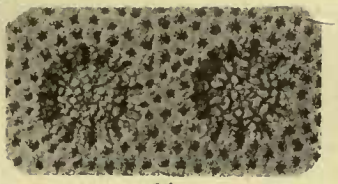

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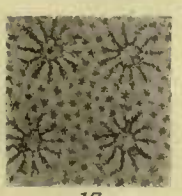

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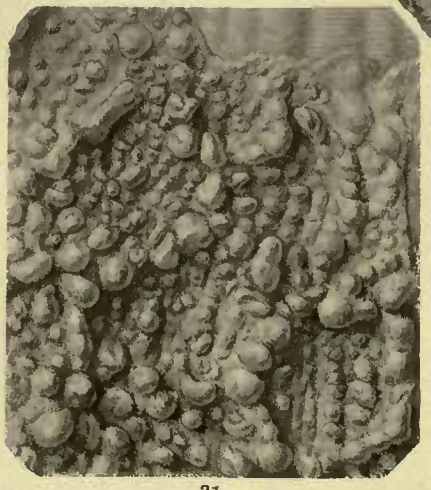

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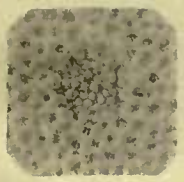

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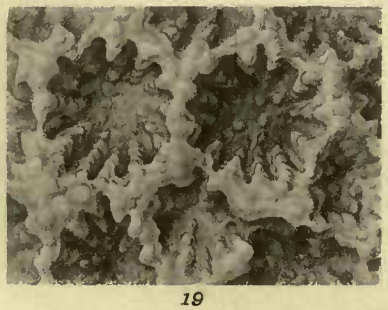

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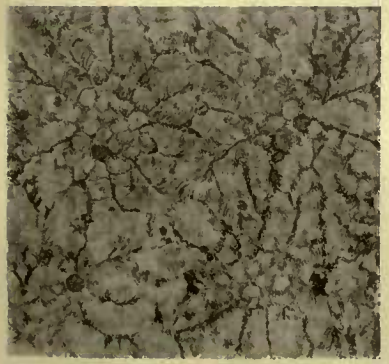

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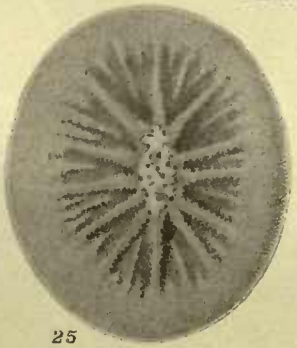

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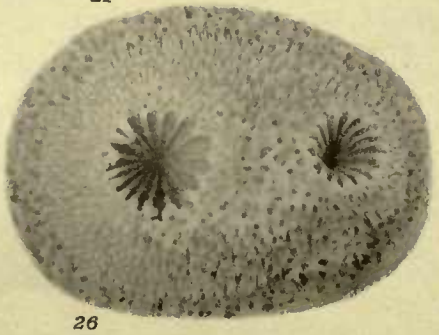

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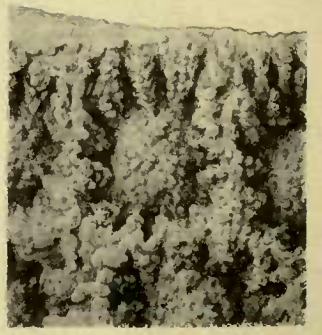

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Index.

A page-number in solid type denotes that the genus or species is specially described on that page. Synonymes are in *italics*. Species else mentioned without description are in spaced type.

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