III. *On the Structure and Affinities of* Guynia annulata, *Dunc., with Remarks upon the Persistence of Palæozoic Types of Madreporaria.* *By* P. Martin Duncan, *M.B. Lond., F.R.S., Professor of Geology in King's College, London.*

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Contents.

I. During their comprehensive study of the Fossil Corals of the Palæozoic rocks, MM. Milne-Edwards and Jules Haime were impressed with the necessity of founding the great section of the Madreporaria called the Rugosa; they established the section in 1850*, and confirmed its differentiation in 1860†. The characters of the Rugosa were then decided to be as follows:—"In this division, which comprehends simple as well as compound corals, the septal structures never form six distinct systems... and appear to be referable to four primitive elements. Sometimes this arrangement is evidenced by the great development of four principal septa, or by the existence of a corresponding number of depressions which are seen at the bottom of the calicular fossa and which give a crucial appearance to it. In other instances one depression or one large septum exists so as to interrupt the perfection of the septal star. Occasionally no groupings or systems can be distinguished; and the septa are represented by striations which rise up on the upper surface of the tabulæ, or by endothecal vesicles which may be observed on the inner side of the wall. The corallites are always distinct and separate from each other, for they are never united by an independent cœnenchyma. The wall is usually feebly developed. The visceral chamber is usually occupied by a series of tabulæ, or by vesicular endotheca, which often constitutes the bulk of the corallum. The septa, although often incomplete, are never porous or spongy, and they are rarely granular, and never have synapticulæ attached to their laminæ. The individual corallites multiply by gemmation, and do not undergo fissiparous division. The reproductive buds usually

* Monograph of the British Fossil Corals. London, 1850, Palæontographical Society.

† Histoire Naturelle des Coralliaires. Paris, 1860.

grow upon the calice of the parent, whose growth they arrest, and thus a superposition of generations is induced. In some genera the gemmation is lateral."

This section of the Madreporaria necessarily included a great number of genera; and as they all could be readily distinguished from those of the other great sections, the new arrangement was adopted by palæontologists.

It was all the more acceptable because the predominant idea of the geologists of those days was favoured by the assertion of the existence of any definite groups of organisms which were characteristic of and peculiar to certain geological formations. The Palæozoic series of rocks was supposed to contain the fossil remains of a fauna and flora which became extinct before the deposition of the Triassic sediments took place, and a great break in the continuity of life on the earth was believed to have happened. Every generalization which appeared to favour such hypotheses was usually accepted as correct without being subjected to searching criticism; and consequently the foundation of the section Rugosa, in contradistinction to those of the Aporosa and Perforata, was supposed to necessitate the inference that the Palæozoic Madreporaria differed most essentially from the Neozoic.

Thus the distinguished author of 'Siluria' writes:—" One of the most important of these discoveries, resulting from the labours of Professor MILNE-EDWARDS, and his coadjutor, M. JULES HAIME, appears to be, that the majority, if not all, of the corals of the Silurian system, and indeed of the whole Palæozoic era, belong to divisions of the coral tribe unknown in modern seas: with rare exceptions, these groups became extinct at the close of the Palæozoic epoch. If this be established, and the large cup- and star-corals (Zoantharia rugosa) and the massive Millepores (Z. tabulata) be, as a whole, distinct in structure from the star-corals and Madrepores of the Secondary and Tertiary rocks and of existing coral-reefs, we gain a new fact in the history of animal life upon the globe, which is in harmony with results obtained by the study of the Crustacea, Mollusca, and Fish of the older epochs" ('Siluria,' 4th edition, 1867, p. 217). Moreover, in a note to page 220 of the same work, the restriction of the non-rugose corals to the Mesozoic and Cainozoic periods is inferred.

Although the Zoantharia tabulata are as numerous in the existing coral-faunas as they were in the Palæozoic (and some of the genera are closely allied), the presumed fact of the restriction of the Rugosa to the Palæozoic formations tempted many to come to the erroneous conclusion respecting the break in the continuity of coral life at the end of the Permian age.

The characteristic nature of the Palæozoic coral-fauna was, moreover, strengthened in the minds of some by the able manner in which MM. MILNE-EDWARDS and JULES HAIME overthrew the old classification of the corals of the Muschelkalk and St. Cassian strata of the Trias, and proved that they were not of Palæozoic genera. Strengthened by the opinions of many geologists respecting the limitation of life, a number of able palæontologists have persisted in refusing credence to any facts which should prove, if they were no longer called anomalies, that the Rugosa were not restricted to the Palæozoic

age, and that there has not been a break in the succession of coral species by descent since the first of them appeared in the seas of old. If the supporters of the hypothesis which restricts the Rugosa to the Palæozoic rocks had studied the great work of the distinguished French zoophytologists so often mentioned by me, they would have found that the following words occur therein:—"Le groupe des Zoanthaires rugeux... se compose presqu'entièrement d'espèces fossiles appartenant aux terrains anciens"*. The exception alluded to was a most remarkable and striking one, which was well known to every geologist of note. LONSDALE† had described a common fossil which was discovered by FITTON in the Lower Greensand of Atherfield: it was a coral with rugose characteristics, and MM. MILNE-EDWARDS and JULES HAIME placed it amongst the Rugosa and named it *Holocystis elegans*, Lonsdale, sp. The specimens are abundant, and they evidently grew and lived in the Neocomian seas. The existence of the species was considered to have been anomalous; but it excited much attention amongst those palæontologists who were disposed to consider such anomalies as broken links in a great chain of evidence. Any forms which might connect the Neocomian species with the Palæozoic were eagerly sought for, but without success; and the distinctness of the Palæozoic and Neozoic coral-faunas (excepting the Zoantharia tabulata, about which much may be said) might still be generally admitted, had not the results of the explorations of the sea-floor by the Americans and by the naturalists of the 'Porcupine' expeditions reopened the question.

Count POURTALES‡ found a coral with rugose characteristics amongst the dredgings which were obtained from off the floor of the sea, five miles distant from the Florida reef, in 1868; he founded a new genus to receive the interesting form, and described it specifically as *Haplophyllia paradoxa*, Pourtales. Fortunately the living tissues were examined and described.

Within the present year (1871) I have examined numerous specimens of a coral which is new to science, and which presents most marked rugose peculiarities. The specimens were dredged up in the last expedition of the 'Porcupine' from off the Adventure Bank in the Mediterranean§, and their description forms the most important part of this communication.

The presence of two genera of Rugosa in the existing coral-fauna has led me to examine the rugose peculiarities of several species of the genus *Conosmilia* which were described by me in an essay on the Fossil Corals of the Australian Tertiary Deposits‖, and also to reconsider the evidence offered respecting the descent of many Lower Liassic corals from Palæozoic Rugosa, and which was published in 1867¶.

With a view to connect this evidence with the results of the reconsideration of the Australian species just alluded to and the discovery of the recent Rugosa, I have intro-

* Hist. Nat. des Corall. vol. iii. p. 324. † Quart. Journ. Geol. Soc. vol. v. 1849.

‡ Contributions to the Fauna of the Gulf-stream at great depths, 2nd series, 1868 (L. F. POURTALES).

§ CARPENTER and JEFFREYS "On Deep-sea Researches," Proc. Royal Soc. vol. xix. pp. 175, 176.

‖ Ann. & Mag. Nat. Hist. September 1865, and Quart. Journ. Geol. Soc. February 9, 1870.

¶ Brit. Foss. Corals, Supplement issued for 1867. Palæontographical Society, London.

duced in this paper a notice of the species of the Secondary rocks which were known to depart from the usual hexameral type, and which were described by MM. MILNE-EDWARDS and JULES HAIME* and by M. DE FROMENTEL†. This course of proceeding is necessary in order to show how the rugose type has persisted during the Neozoic ages.

II. Genus GUYNIA.

The corallum is simple and long. The wall is thick and solid. The septa are well developed, lamellar, unequal, and are continuous from the base to the calice. There are four systems of septa, and one primary septum is longer and larger than the others. The columella is essential, and is attached to the larger septa. There is no endotheca. The costæ are visible on the growth-rings of the outside of the wall. There is an epitheca.

Species *Guynia annulata*, sp. nov. Plate I. figs. 1–8.

The corallum is long, cylindrical, and narrow; it is sometimes curved. The accretion-ridges are well developed and regular, and are marked with prominent short spinules, laminæ, or granules which correspond with the costæ. The epitheca ornaments the ridges, and is delicate. The costæ extend over the whole length of the corallum, and usually exist as flat bands between the close and rather wavy accretion-ridges.

There are four principal septa, one of which is larger than the others at the calice. The four secondary septa are often as large as the primary, but the eight tertiary septa are almost rudimentary. There are four systems of septa, and three cycles in each; none are exsert. The columella is stout, cylindrical, deeply seated in the calice, and adherent to the larger septa. The interseptal loculi are large, and the transverse outline of the corallum is sometimes rather angular. The length of the perfect corallum probably $\frac{3}{4}$ inch, the breadth $\frac{1}{20}$ inch.

Locality. Adventure Bank in 92 fathoms.

The numerous specimens of this coral are in excellent preservation, and their condition is that of living forms whose soft parts have been crushed or washed out during the operation of removal from their usual locality. Many of the corals adhered by their sides to mollusca, and resembled annelid-tubes marked with a regular series of ring-like accretion-ridges.

III. The numerous growth-rings or accretion-ridges give the species a very palæozoic facies, especially when there is a very decided constriction between two annular prominences: this facies is made more decided when the tetrameral arrangement or type of the septa is noticed and the solid columella is distinguished. The stout wall and the absence of endotheca are exceptional peculiarities; but although they are not mentioned in the diagnosis of the Rugosa by MM. MILNE-EDWARDS and JULES HAIME, they are admitted as characterizing a most important family of them—the *Cyathaxonidæ*.

* Hist. Nat. des Coralliaires, 1860.

† E. DE FROMENTEL, 'Polypiers fossiles,' 1858–61.

The following is the diagnosis of the *Cyathaxonidæ*, the second family of the section Rugosa*:—

"Corallum having a well-developed septal apparatus, the laminæ extending uninterruptedly from the base to the summit of the visceral chamber, and leaving open fossulæ between them without dissepiments, tabulæ, or synapticulæ. The primary septa are not decidedly more developed than the others, and do not form a cross as in most of the Stauridæ."

Up to the present time but one genus has been associated with this family, viz. *Cyathaxonia*, Michelin†; it is thus described by MM. Milne-Edwards and Jules Haime‡:—

"The corallum is simple, free, finely pedicellate, and has the shape of an elongate and curved cone. There is a complete epitheca. There is a well-developed septal fossula situated on the side of the great curvature. The columella is styliform and very projecting. The septa are smooth and numerous, and most of them unite with the columella."

The accretion-ridges and wall are particularly well marked in *Cyathaxonia tortuosa*, Michelin, and the size of the septal fossula varies with the species. The genus was represented in the Upper-Silurian strata of Gothland, and perhaps in the Ludlow rocks of England, but its species have not been found in Devonian strata: nevertheless it is not a rare fossil genus in the American and Belgian Carboniferous strata. *Cyathaxonia cornu*, Michelin, is said to be found in English and Belgian Carboniferous deposits.

The great distinction between *Guynia* and *Cyathaxonia* is the absence of the septal fossula in the first genus; but its species has a large septum, which is a very marked rugose peculiarity, and the replacement of such septa by depressions or fossulæ is common.

There is therefore no reason why *Guynia annulata* should not be placed in the family of the *Cyathaxonidæ*, and that its genus should not be closely associated with *Cyathaxonia*§.

IV. Count Pourtales describes the genus *Haplophyllia* (Plate I. figs. 13–15) as follows‖:—

"Corallum simple, fixed by a broad base, covered with a thick epitheca; columella styliform, strong, very thick at the base. Interseptal chambers deep, uninterrupted by tabulæ or dissepiments, but filling up solid at the bottom."

An introductory paragraph¶ supplies the defective information respecting the septal apparatus. He therein states:—"The singular coral next to be described strikes one at first sight by its resemblance to some of the members of the group of the Rugosa of Milne-Edwards and Haime. A closer examination tends to confirm that view, much as it seems improbable to find a living representative of a group so long extinct. In no other division of the corals is the septal apparatus subdivided into systems that are multiples of four; but such is the case in our specimen, though a little obscured by acci-

* Hist. Nat. des Corall. vol. iii. p. 329.

† Icon. Zooph. 1846.

‡ *Op. cit.* p. 329.

§ I have named the genus after Mr. Gwyn Jeffreys, F.R.S.

‖ *Op. cit.* p. 140.

¶ Pages 139 and 140.

dental causes. Another, though perhaps less important, character is the smoothness of the septa, which present neither perforations, nor synapticula, nor granulations. Tabulæ, however, there are none, the interseptal characters being open from top to bottom. Among the Rugosa this character is only found in the family of the *Cyathaxonidæ*, to or near which, therefore, our coral must find its place. From the genus *Cyathaxonia* it differs in being attached by a broad base, and also by the absence of a septal fossula."

Haplophyllia paradoxa, Pourtales.

"Corallum subcylindrical, short, fixed by a broad base; epitheca thick, wrinkled, reaching higher than the calice, and forming around it several concentric circles as if representing the separated borders of several superposed layers. Calice circular, fossa deep. Septa smooth, without granulations or perforations, not reaching the border of the calice; like all the internal parts of the calice, their surface is like enamel. Columella composed of two smooth conical processes, very thick at the base and tending to fill up the chambers. Eight septa, larger and connected with the columella, alternating with smaller ones which touch the columella at a much lower level. A further cycle is indicated by small ridges of the wall-surface in some of the chambers. No distinction can be made between primary and secondary septa among the eight larger ones, as they all appear equal.

"Height about $\frac{1}{2}$ inch; diameter of the calice $\frac{1}{2}$ inch.

"The coral was living when obtained; the polyp was of a greenish colour, but was not otherwise examined when fresh. After having been in alcohol it could be lifted out entire from the calice, presenting an exact cast of the chambers. The mouth is surrounded by a circle of about sixteen rather long tentacles, bluntly tuberculated at the tip. Outside the circle of tentacles extends a membranous disk with radiating and concentric folds."

This unique specimen was dredged up in 324 fathoms off the Florida reef.

It is evident that this interesting form and that which was dredged off the Adventure Bank have much in common. Both must be classified amongst the *Cyathaxonidæ*; and it is quite possible that future dredgings may discover intermediate forms which will necessitate the absorption either of the genus *Haplophyllia* or of *Guynia*. At present the shape of the closely allied forms, their septal number, the nature of the columellæ, and the characters of the epithecal structures must be considered to separate them generically. The large septum, so visible in some of the specimens of *Guynia annulata*, constitutes in itself a differentiation.

Admitting the generic alliance to be of the closest, *Guynia* and *Haplophyllia* will form with *Cyathaxonia* the three genera of the family *Cyathaxonidæ* of the section Rugosa.

V. In describing some fossil corals from the Miocene deposits of Australia in 1865, I noticed some species of a new genus in the following manner*:—"The new genus *Conos-*

* Ann. Mag. Nat. Hist. 1865, xvi. p. 185.

milia possesses the twisted ribbon-shaped columella of the subfamily *Caryophyllaceæ*, the endotheca and septal margin of the *Trochosmiliaceæ*, and the irregular septal arrangement which was so common in the corals of the Oolitic age, and which, from its octomeral type, reflected the Rugosa of Palæozoic times."

The Geological Survey of Victoria sent me a great number of Miocene corals for examination and description, and the species were figured and described in an essay on the Fossil Corals of the Australian Tertiary Deposits, read before the Geological Society, February 9, 1870. The four well-marked species of the genus *Conosmilia* were examined and reconsidered; but I could not separate them naturally into two groups, although three out of the four had the octomeral septal arrangement; the fourth had the usual Neozoic hexameral type of septal apparatus. I wrote as follows*:—"The most interesting of the corals from the Cainozoic deposits of South Australia are the *Conosmiliæ*. It is a genus perfectly Australian in its abnormalities. A simple coral with a pellicular epitheca, having a beautiful herring-bone ornamentation, with an essential, twisted, "sérialaire" columella with endothecal dissepiments, and with plain septa, which have the hexameral arrangement in some and the octomeral in others, is a form containing the elements of several classificatory series. The irregular septal arrangement amongst the closely allied species may be considered to depend upon atavism. Such octomeral cyclical arrangements occurred in some genera in the Lower-Greensand period and during the Oolites, &c."

When the rugose peculiarities of three out of the four species of this genus are considered in relation with the discoveries of existing corals belonging to the section Rugosa the opinion that they were due to recurrence to ancestral types may well be modified. Like *Haplophyllia* and *Guynia* the *Conosmiliæ* did not belong to a reef-fauna, but to those deep-sea faunas which contain so many persistent types. If the theory that the *Conosmiliæ* were originally of an hexameral septal type is correct, then the three out of the four known species have departed from it and reflect the peculiarities of the ancient Rugosa; but if it be admitted that the genus belonged originally to the tetrameral or octomeral type (for they are identical), then these three Miocene forms were direct descendants of the Palæozoic Rugosa, and the one hexameral species was a modification. Whichever theory is accepted, the descent from a Palæozoic type is inferred. There is an interesting relation between so many recent Australian animals and plants and those of the late Palæozoic and early Neozoic ages, that, believing in the possibility of the persistence of coral types belonging to those remote times, I have investigated the structures of the *Conosmiliæ* with a view of associating three of the species with the Rugosa. The result is somewhat remarkable; for it indicates that if the *Conosmiliæ* can be regarded as *Rugosa*, they must be placed amongst the *Stauridæ*, in the neighbourhood of the genus *Polycœlia*, whose species are of Permian age in Europe.

Conosmilia elegans, Dunc., *Conosmilia lituolus*, Dunc., and *Conosmilia anomala*, Dunc., have, in addition to the rugose septal arrangement, an endotheca which closes off the

* Quart. Journ. Geol. Soc. vol. xxvi. p. 309.

lower portions of the interseptal loculi; but it is curved and arched, and is dissepimental rather than horizontal and tabulate. Their fasciculate columellæ and faint pellicular epithecas are remarkable structures; and their costal arrangement, by which the septum corresponds with the intercostal space, is eminently characteristic of some Rugosa.

They differ from the *Cyathaxonidæ* in having an endotheca; but their completely lamellar septa and their distinct costæ associate them with the next, or rather the first family of the Rugosa—the *Stauridæ*.

The *Stauridæ* were formed into a family by MM. MILNE-EDWARDS and JULES HAIME in 1850*, and it was differentiated as follows:—

The septa are well developed, and are formed of perfect laminæ, which extend uninterruptedly through the length of the visceral chamber; they are united laterally by lamellary cross dissepiments, and they are arranged in four systems, usually characterized by the presence of four large septa arranged in the shape of a cross. The wall is well developed and imperforate.

The family contained in 1850 two genera of compound and two of simple corals.

The first are, of course, out of the line of the present communication, except that one of them, the *Holocystis* of the Lower Greensand, offers a remarkable proof of the persistence of the rugose type.

The second or simple coral genera are *Polycœlia* and *Metriophyllum*.

Polycœlia has no columella, and the dissepimental tissue is in the form of horizontal tabulæ, and in *Metriophyllum* the septa are grouped in four fasciculi. Had a species of *Polycœlia* a fasciculate columella and a few arched dissepiments, it would represent one of the *Conosmiliæ* with the tetrameral type—the *Conosmilia lituolus* for instance.

The manner in which curved or arched dissepiments are associated with and follow tabulæ in the same rugose corals may be seen in many specimens of Carboniferous species, so that the distinction between the two conditions is not so great as was thought formerly. The absence of a columella is a generic distinction.

Conosmilia, according to the theory of its being a persistent type, should be admitted into the *Stauridæ*, in the neighbourhood of the genus *Polycœlia*.

MM. MILNE-EDWARDS and JULES HAIME classify the *Stauridæ* as the first family of the Rugosa, and the *Cyathaxonidæ* as the second; and the distinction is the want of endothecal structures in the last-named natural division.

VI. If the occurrence of a tetrameral septal arrangement in a Miocene genus in which there is a species with the normal Neozoic hexameral type has any significance with reference to older forms, corresponding phenomena should be more common in more ancient faunas,—that is to say, the secondary strata should contain a greater number of tetrameral and octomeral types combined with the hexameral than the tertiary deposits; and the fossil corals of the oldest secondary rocks should retain greater evidences of their descent from Palæozoic Rugosa than those of a later date.

The following data may be advanced in proof of the occurrence of these requirements.

* *Op. cit.* vol. iii. page 324.

The discovery of the rugose *Holocystis elegans*, Lonsd. sp., in the Necomian has already been noticed; it is a species which belongs to the same family as *Stauria* and *Conosmilia*.

M. DE FROMENTEL has arranged many genera of Secondary and Tertiary corals according to their septal types; and he notices that a doubtful generic title is given to *Dimorphocœnia corallina* by ETALLON, and that the form which belongs to the Middle Oolite coral-fauna is one of the Rugosa. The other species of the genus, and which is the type of it, has the hexameral septal arrangement, and is a Neocomian fossil.

The same author notices and describes *Pleurostylina corallina* from the Middle Oolite, and proves that, with the normal Neozoic hexameral septal type, it has a relic of the rugose structure in a large septum which passes into the axial space.

Stephanocœnia is a genus with existing Lower Cretaceous and Middle Oolite species having the hexameral septal type; but there are other species found in the Eocene and in the Lower Chalk which have the octomeral arrangement.

Stylocœnia has species with a pentameral type in the Eocene and Lower Cretaceous deposits, and some with the octomeral septal arrangement in Eocene and Miocene strata*.

Stylina has species with the hexameral arrangement in the Upper, Middle, and Inferior Oolites, and others with the octomeral in the Middle Oolite and Lower Chalk; moreover it has species in the Trias and Middle and Inferior Oolites which have the decameral septal type.

Cryptocœnia has hexameral types in the Neocomian and in the Middle and Inferior Oolites; but the Middle and Inferior Oolitic strata contain species of it with the octomeral septal arrangement.

Goniocora affords examples of hexameral species in the Upper and Middle Oolites and in the Lias, whilst there is an octomeral type in the Middle Oolitic rocks.

Astrocœnia has hexameral species in the Eocene and Neocomian deposits, octomeral in the Lower Cretaceous and Middle and Upper Oolitic strata, and in the Tertiaries of Castel Gomberto†; but all the species described by me from the lowest Liassic strata possess the decameral type. The lowest coralliferous secondary deposits of Great Britain contain badly preserved fossils, and yet the Thecosmilian from the White Lias of Watchet and the cast of a congeneric form from that of Sparkfield have very rugose characters‡. The *Thecosmiliæ* from the "Guinea bed" at Binton (zone of *Ammonites planorbis*) have the great septum and thin wall of many Rugosa§; and the species of *Oppelismilia* from the next and higher zone of *Ammonites angulatus* has no distinct septal arrangement, but a thick epitheca and calicular gemmation. The great Astrocœnian fauna of the zone is composed of twelve species, all of which have the decameral septal arrangement, and none of them the hexameral. Many of the *Montlivaltiæ* of the zone are so irregular in their development that they cannot be classified under any

* Reuss, Castel Gomberto, Foss. Anthoz. Kaiser. Akad. der Wissen. Wien, 1868.

† Reuss, *op. cit.* ‡ P. M. DUNCAN, Pal. Soc. Lond. vol. xxi. p. 67. § Id. p. 66.

type; others have the hexameral arrangement, and *Montlivaltia Murchisoniæ*, Dunc., has its septa collected together in four systems. All the species have epithecate walls.

In the zone of *Ammonites Bucklandi* the genus *Lepidophyllia* has a very rugose facies; and *Montlivaltia radiata*, Dunc., of the zone of *Ammonites raricostatus*, is evidently furnished with a septal arrangement on the tetrameral type, the four principal septa being very large. Even in the Middle Lias, *Lepidophyllia hebridensis*, Dunc., has a rugose aspect; and the greatest of all *Montlivaltiæ*, the *Montlivaltia Victoriæ*, of the zone of *Ammonites Henleyi*, has an epithecate wall, although there are six systems of septa.

Thus from the Rhætic beds to the Middle Liassic strata the examples of more or less modified rugose types are frequent; for the species with the decameral septal arrangement very probably originated from forms of Rugosa with indefinite septal numbers. After the age of the Lias to the Tertiary period the septal arrangements of many species and subgenera appear to be very confused; but still many rugose types persisted, having the tetrameral disposition or the decameral; so that if it is admitted (and it may be so consistently with exact truth) that some of the Triassic corals, especially the *Montlivaltiæ*, have certain but rather faint rugose characters, there is evidence that there has not been a marked break in the continuity of coral life.

Doubtless many species have varied and have recurred to their ancestral forms; and this may account for the appearance of tetrameral or octomeral types late in the world's history in genera whose older secondary species were of the hexameral type; but the persistence of the rugose type, more or less modified, up to the present day can no longer be denied.

Probably many genera with hexameral septal arrangements originated in Palæozoic times; and I have noticed in a former communication* the interesting relation of the Carboniferous *Heterophylliæ* and the Devonian *Battersbyiæ* to the corals of the normal Neozoic type.

VII. It is very remarkable that the two recent species of Rugosa, *Haplophyllia paradoxa*, Pourtales, and *Guynia annulata*, Duncan, should belong to the same family of the section, and that the tertiary *Conosmiliæ* with Palæozoic affinities should of necessity be included in a closely allied family of the Rugosa.

That the American and Mediterranean species should be closely allied is in keeping with the results of the study of the distribution of deep-sea as well as of shallow-water forms in those distant localities. The Hippurite limestones of Jamaica contain the same species of Madreporaria as the Cretaceous rocks of Gosau in Austria; the dark Eocene shales of the same island have yielded the same species of Madreporaria as the early Tertiary deposits of North-western Europe; the Miocene fauna of the Caribbean islands contains the characteristic species of the corresponding Falunian deposits of France, Italy, and Malta; and even the recent Algæ of part of the West-Indian area resemble those

* Philosophical Transactions, 1867, p. 643.

of the Mediterranean. As regards the Radiata and the Foraminifera, there has been a very prolonged correspondence of identical and representative species between the distant areas, and now the occurrence of closely allied species belonging to the persistent rugose type attests still further the interesting biological relations between the two margins of the great Atlantic.

It has been noticed that the *Conosmiliæ* of the old Australian seas, now found included in Midtertiary deposits along the northern shores of Victoria and South Australia, belong to the Stauridæ, and that their close ally in that rugose family is the genus *Polycœlia*. This genus is extinct, and formed the characteristic coral-fauna of the very uncoralliferous Permian deposits. Considering the well-known Triassic, Jurassic, and, indeed, the Palæozoic facies of portions of the recent and tertiary Australian faunas, the establishment of the *Conosmiliæ* with their Permian affinities as part of a family of the Rugosa is highly suggestive.

In conclusion, I think that there can be no doubt about the persistence of the rugose type of Palæozoic Madreporaria through the Neozoic formations to the present time, and that the species with hexameral and decameral septal arrangements descended from rugose types, and the latter especially from those with an indefinite septal number.

VIII. Explanation of the Plate.

PLATE I.

Fig. 1. Portion of the corallum of *Guynia annulata* fixed to a shell. Magnified.

Fig. 2. A specimen showing the calicular end and the costæ. There are eight large primary septa, and one is united to the columella. Magnified.

Fig. 3. A specimen showing the transverse epithecal markings. Magnified.

Fig. 4. Cross section, magnified. There are eight primary septa and several secondary. Magnified.

Fig. 5. View of a nearly perfect corallum, showing constrictions, costæ, and epitheca. Magnified.

Figs. 6, 7, 8. Portions of a corallum in which at one end there is an hexameral arrangement of the septa (fig. 7), and midway there is the usual octomeral arrangement.

Fig. 9. Corallum of *Conosmilia anomala*, Dunc.

Fig. 10. The calice, magnified, showing eight primary septa.

Fig. 11. Corallum of *Conosmilia lituolus*, Dunc. Magnified.

Fig. 12. The calice, magnified.

Figs. 13, 14, 15. The corallum of *Haplophyllia paradoxa*, Pourtales (from Pourtales's 'Deep Sea Corals').

NOTE.—March 25, 1871.

Some days after this communication was sent to the Royal Society, Mr. J. GWYN JEFFREYS, F.R.S., forwarded me several specimens of *Guynia annulata* which he had found adherent by their sides to mollusca obtained from the Adventure Bank. These specimens are well preserved, and one of them shows the small commencement of the long cylinder of the coral. Others exhibit the columella and the large septa and the normal septal arrangement (octomeral). But one rather deformed coral exhibited on a fractured surface which was at right angles to the long axis six large septa instead of the usual eight: this of course required careful examination and explanation. The septa in the lower and therefore older part of the coral were clearly irregular in their growth; but a section midway between this portion and the fractured part established the interesting fact that the lower part of the corallum possessed the normal octomeral septal arrangement, and that the upper, in consequence of the abortion of two septa, had the Neozoic hexameral type. This is very suggestive in the matter of the evolution of hexameral from octomeral types, or rather from the tetrameral.

March 24, 1871.