Zoology. — "*On the Food of Madreporaria.*" By Dr. H. BOSCHMA. (Communicated by Prof. C. PH. SLUITER.)

(Communicated at the meeting of November 24, 1923).

The data available in the literature regarding the nature of the food of Madreporaria are still very scanty. We are told, indeed, in many publications on the biology of reef-corals, that the food of these animals consists of planctonorganisms. Most often, however, these statements are not based upon researches with the animals themselves on the digestive phenomena or on the nature of the food. This renders the statements entirely valueless. [1])

So far as I have been able to ascertain, this dictum is not applicable to five researchers (GARDINER, DUERDEN, CARPENTER, VAUGHAN and WALTHER): their data regarding the nature of the food of Madreporaria, or regarding the mode of ingestion are derived from a previous investigation of these phenomena in the polyps themselves.

A number of GARDINER's publications [2]) contain data on the nutrition of reef-corals. According to GARDINER the food of these animals consists chiefly of commensal algae (zooxanthellae), which occur in large quantities also in the endoderm. Many species obtain their food only by means of these algae. In about 1 or 2 percent of the preserved polyps of *Pocillopora* and *Astraea* organic remains of foreign origin were found (GARDINER 1903), which proves that these corals sometimes ingest foreign organisms, although in normal circumstances they feed only on zooxanthellae. [3])

---

[1]) Instances of it may be found in: W. SAVILLE KENT, The Great Barrier Reef of Australia, London 1893.

E. WOLF, Korallenriffe. Handwörterb. d. Naturw. 1914.

[2]) J. STANLEY GARDINER, The Building of Atolls. Proc. 4. Int. Congr. of Zoology, 1899.

—— On the Rate of Growth of some Corals from Fiji. Proc. Cambr. Phil. Soc. Vol. XI, 1902.

—— The Maldive and Laccadive Groups, with Notes on other Coral Formations in the Indian Ocean. The Fauna and Geogr. of the Mald. and Lacc. Arch. Vol. I Part. III 1902, p. 320 and Part. IV 1903, p. 421.

—— The Formation of Coral Reefs. Nature, Vol. LXIX, 1904.

[3]) HICKSON's suggestion (Coelenterata & Ctenophora in: The Cambridge Natural History, 1906) that reef-corals derive perhaps in some cases a considerable part

DUERDEN[1]) found zooxanthellae (yellow cells) in the endoderm-cells of the polyps of all the species of West-Indian Madreporaria examined by him, with the exception of *Phyllangia americana* and *Astrangia solitaria*. These yellow cells also occur in the interior canals of *Madrepora* and *Porites*, but DUERDEN maintains emphatically, that they never occur free in the gastric cavity of the polyps, except in the larval stages (1902, p. 417). According to DUERDEN the food of the reef-corals consists of small planctonorganisms. The occurrence of zooxanthellae in the endoderm of the reef-corals is not a matter of necessity, seeing that colonies of *Oculina*, *Cladocora* and *Agaricia*, living in shady places may lose their zooxanthellae, which generally occur in large masses in colonies of the same species, and yet live a healthy life outwardly.

In a subsequent publication[2]) DUERDEN demonstrated that the mucus secreted on the surface of coral polyps plays a prominent part in the nutrition of these animals. Small objects falling down upon this layer of mucus, are imbedded in this substance, and later on the mucus is ingested through the mouth, after which the particles of food contained among the objects, are digested. These researches were carried out with species of *Fungia* and *Favia*. Meat of crabs and other animal food, also extracts of animal matter, were ingested by these corals, when brought within reach of the oral surface of the polyps. Data concerning the nature of the food in normal conditions are not found in this publication.

The way, in which *Isophyllia* ingest food, has been studied by CARPENTER[3]) who fed the polyps with an extract of meat. According to this author the normal food of these corals consists of small planctonorganisms, captured by the tentacles and afterwards digested in the gastric cavity by the mesenterial filaments.

VAUGHAN[4]) has examined in elaborate experiments the mode of ingestion of various reef-corals. On the reefs he observed that specimens of *Dendrogyra cylindrus*, *Maeandra clivosa* and *Siderastrea siderea*

---

of their food from their symbiotic zooxanthellae, is probably founded upon GARDINER'S data. But HICKSON denies the possibility of reef-corals that feed exclusively on zooxanthellae.

[1]) J. E. DUERDEN, West Indian Madreporarian Polyps. Mem. Nat. Ac. Sci. Vol. VIII, Washington 1902.

[2]) J. E. DUERDEN, The Rôle of Mucus in Corals. Quart. Jour. Micr. Sci. Vol. XLIX, 1906.

[3]) F. W. CARPENTER, Feeding Reactions of the Rose Coral (Isophyllia) Proc. Amer. Ac. Arts Sci. Vol. XLVI, 1910.

[4]) T. WAYLAND VAUGHAN, Studies of the Geology and of the Madreporaria of the Bahamas and Southern Florida. Carnegie Inst. Washington. Yearbook no. 11, 1912.

had caught small medusae, belonging to the genus *Linuche* and that a specimen of *Maeandra areolata* had consumed all the soft parts of a small crab. In his extensive experiments VAUGHAN used meat of crabs and other animals and also extracts to stimulate the polyps Animal substances, solid as well as liquid, were relished, diatoms were not. Diatoms soaked in an extract of meat were taken up by the polyps, but afterwards the diatoms were discharged undigested. VAUGHAN concluded from this that the food of corals consists solely of animal matter (p. 161). Excepting the cases above-quoted, in which medusae and crabs are named as the food of corals, no mention is made in this publication of the food that occurs in normal cases in the gastric cavities of the polyps.

In a later publication VAUGHAN [1]) again maintains that the food of corals consists of animal organisms, notably of small swimming and floating plancton animals. In this connection he raises the supposition that the limit of the vertical distribution of the coral-fauna of the shallow water (46 m.) is determined by the quantitative decrease of these planctonorganisms at that depth.

Concerning zooxanthellae MAYER [2]) observes: "Certainly they do not directly supply nourishment, for corals refuse all plants as food" (p. 28). MAYER maintains that the food of corals is exclusively animal food and bases his pronouncement on the above researches by VAUGHAN and on DUERDEN's [3]) data who kept his colonies of *Siderastrea radians* during a long space of time in perfect health in an aquarium, by feeding them with the meat of crabs and other animals.

WALTHER [4]) reports that in fresh-conserved corals chlorophyll can be established spectroscopically. In addition he points out that he could not find any tentacles in many forms of corals from the islands in the Bay of Batavia and that no planctonic food occurs inside the polyps of these corals. WALTHER concludes from this that the nutrition of many reef-corals occurs through chlorophyll-assimilation. These statements have, however, not been worked out, neither did the author name the reef-corals upon which he had worked.

---

[1]) T. WAYLAND VAUGHAN, Corals and the Formation of Coral Reefs. Smithsonian Institution. Annual Report for 1917. Washington 1919.

[2]) A. G. MAYER, Ecology of the Murray Island Coral Reef. Carnegie Inst. Washington. Dep. of Marine Biology, Vol. IX, 1918.

[3]) J. E. DUERDEN, The Coral Siderastrea radians and its Postlarval Development. Carnegie Inst. Washington. Pub. no. 20, 1904.

[4]) J. WALTHER, Allgemeine Palaeontologie. Geologische Fragen in biologischer Betrachtung. I. Teil, Berlin 1919.

From November 1920 to September 1922 I have been examining a large number of living coral-polyps in order to establish the nature of the food of these animals in normal circumstances. I made my researches especially in the island of Edam, but I have studied corals also in other islands in the Java Sea and Sunda Strait (Pulu Kelapa and the surrounding islands, Noordwachter, Huisman's Eil. near Sebesi). During the Danish Expedition to the Kei Islands, I have been able to gather further data concerning the nutrition of corals, in shallow water as well as in deeper water (± 250 m.).

Now as far as the reef-corals are concerned my results square fairly well with GARDINER's: the food of these animals consists mainly of zooxanthellae. GARDINER's observations on the nutrition of reef-corals have been published as brief notices in memoirs chiefly devoted to other subjects; this is perhaps why they are little known. Moreover in a later publication [1]) he is less decided in his opinion that zooxanthellae generally constitute the most important part of the food of reef-corals. Although he states that most probably a large number of zooxanthellae are ingested by coral-polyps when they require food, he also mentions that it is supposed that coral-polyps catch and digest the small organisms occurring in superficial water of the sea. It may be of interest, therefore, to communicate my results, also because they are different from the results of most of the researchers quoted above.

The endoderm of nearly all Madreporaria from shallow water contains large quantities of zooxanthellae. I found these algae in all species of the following genera: *Madracis*, *Seriatopora*, *Pocillopora*, *Stylophora*, *Euphyllia*, *Cyphastrea*, *Echinopora*, *Galaxea*, *Favia*, *Favites*, *Goniastrea*, *Leptoria*, *Maeandra*, *Hydnophora*, *Mussa*, *Symphyllia*, *Merulina*, *Fungia*, *Herpolitha*, *Polyphyllia*, *Halomitra*, *Pavona*, *Psammocora*, *Turbinaria*, *Montipora*, *Acropora* (= *Madrepora*), *Goniopora*, and *Porites*. In Madreporaria the zooxanthellae seem to be restricted to certain genera: when they occur with one species they are also found in other species of the same genus and conversely there are other genera of which none of the species possesses zooxanthellae. Zooxanthellae also occur in Madreporaria from somewhat deeper water (± 50 m.), but these species always belong to a genus that is also represented by species on the reefs in shallow water. Contrary to HICKSON's [2]) statement that these algae do not

---

[1]) J. STANLEY GARDINER, The Shore, in: Science of the Sea, edited by G. HERBERT FOWLER, London 1912.

[2]) loc. cit. p. 374.

or hardly ever occur in *Pocilloporidae*, I found zooxanthellae in large quantities in all the species of the genera *Pocillopora* and *Seriatopora* that I examined.

The zooxanthellae (yellow cells) of the reef-corals are spherical, dark-yellow, unicellular algae from 7—10 μ in diameter. It is difficult to decide whether the colour is confined to definite chromatophores. In the living zooxanthellae the whole cell is of an evenly yellow colour and in fixed material I have not observed any single chromatophores. The living yellow cells contain a highly refractive granule (sometimes two), apart from that they present nothing particular. This granule stains a brownish-violet with iodin, which reaction will take place more readily when the cells have first been treated with an acid. This staining method implies that the refracting granule contains an amyloid assimilation-product. The reaction proves that this substance is different from the starch of higher plants, which is of a much darker blue after treatment with iodin. The nucleus of the zooxanthellae, which is not recognizable in the living cells, becomes distinctly visible, after the addition of acetic acid, as a granular body usually of slightly smaller dimensions than the assimilation-product. Addition of fuchsin also reveals the nucleus of zooxanthellae as a corpuscle of light red coloration.

In fixed material some further particulars are to be noted after treatment of the yellow cells with nuclear stains. Among the various staining methods I got the best results with HEIDENHAIN's iron-haematoxylin method; safranin and light-green also yielded good results. The nucleus contains a number of highly stainable granules (Fig. 2). Of the intensely refractive corpuscle in the living yellow cells only the central portion is stained. The outer layers of this corpuscle, the assimilation-product proper, now remain unstained, so that the central portion, the pyrenoid, becomes distinctly visible. Furthermore the protoplasm reveals a considerable number of vacuoles in many preparations [1]).

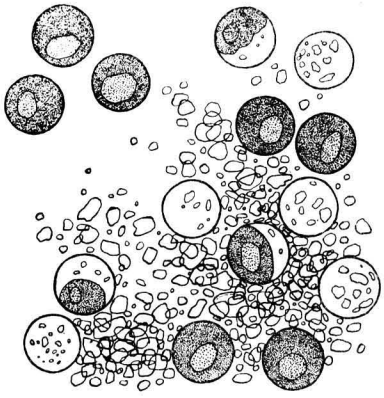

Fig. 1.

[1]) A short description of the zooxanthellae is also given by DUERDEN (1902) and MATTHAI (A Revision of the Recent Colonial Astraeidae possessing distinct Corallites. Trans. Linn. Soc. London (2) Zool. Vol. XVII, 1914). In the figures of these publications the nucleus and the pyrenoid with the assimilation-product are distinctly visible. In DUERDEN's figures a few smaller granules have moreover

When investigating the nutrition of coral-polyps in normal conditions, I have closely examined the contents of the gastric cavity in a great number of polyps of all the species of Madreporaria that I found on the reefs. In the cavity there are generally partially digested food-rests consisting of a mucous mass, that can easily be removed with a fine pipette. When reef-corals are being fixed they often discharge the food-rests through the mouth which accounts for the fact that, as a rule, little information can be got on the nutrition of corals from preserved material. In all the true reef-corals examined (i.e. the species containing zooxanthellae in their endoderm) the mucous substance from the gastric cavity contained a large number of undigested yellow cells, quite similar to those in the endoderm-cells. Besides those there were generally a few cells which were partially decoloured (partially digested zooxanthellae) and always a large number of colourless spherules of the size of zooxanthellae, but all varying as to their contents. (Fig. 1). I could observe all stages intermediate between intact yellow cells and these colourless spherules, so that the latter are undoubtedly zooxanthellae in an advanced stage of digestion. That they retain their spherical shape so long points to the fact that the wall of the zooxanthellae is highly resistent. Besides the above-named corpuscles distinctly recognizable as yellow cells and their products of decomposition, the contents of the gastric cavity of reef-corals contains always a good many smaller colourless granules of irregular shape, probably composed for the greater part of further products of decomposition of the zooxanthellae. Furthermore the mucus of the coelenteron contains almost always nematocysts and portions of them.

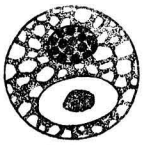

Fig. 2.

In most reef-corals the food remnants contain only exceptionally other organisms or fragments of them besides zooxanthellae and nematocysts. Sometimes a few diatoms are found in the coelenteron of the forms with small polyps such as species of *Porites*, *Acropora*, *Pocillopora* and *Cyphastrea*, but generally no other organisms than zooxanthellae. The rule is that the quantity of foreign organisms of which there is a certain percentage in the content of the gastric cavity, increases with the size of the polyps. Only in the species of some genera with large polyps (*Fungia*, *Favia*, *Favites*, *Symphyllia*, *Mussa*) do we nearly always find other organisms in the mucus of the gastric cavity, namely Copepods, nauplius larvae, remains of An-

---

been marked in the protoplasm, which, however do not occur in the zooxanthellae of my material.

nelids, foraminifera, diatoms, *Lingbya* and other algae. Together with these organisms the polyps have generally taken in also detritus such as sponge-spicules and skeletal corpuscles of Holothurians. But still zooxanthellae remain the chief constituent of the food in normal conditions, also in those species in which usually foreign organisms are found in the coelenteron.[1])

I examined two species of the genus *Fungia* (*F. fungites* (L) and *F. actiniformis* Q. & G.) for their capacity to ingest plancton. When placed in a glass and allowed to stand for some time, corals of this species will secrete a layer of mucus at their oral surface. Now plancton-organisms (especially Copepods) were added to the water and presently a large number of them stuck to the layer of mucus. Ultimately the polyp took in the mucus with the organisms piecemeal by the mouth, in the way described by DUERDEN (1906) for another species of *Fungia*.

In living coral polyps it is generally not easy to ascertain where the food is digested. Only with *Favites abdita* (Ell. & Sol.) could I observe that the contents of the coelenteron (an accumulation of mucus with many half-digested zooxanthellae and plancton-organisms a.o. a number of Copepods) could be observed only on the mesenterial filaments. These plugs of mucus, which had no connection with each other, were clearly visible, especially in colonies of this species, which had been standing longer than a day, and of which the mouths of the polyps had opened during the night. Most likely it is, therefore, that the mesenterial filaments in *Favites* play a prominent part in the digestion of food, just as CARPENTER (1910) has demonstrated for *Isophyllia*.

The zooxanthellae in the coelenteron of the reef-corals have as a rule probably been ingested by the mouth of the polyp. This opinion is supported by the following observations: 1. In the mucous layer secreted in *Fungia* on the oral surface many zooxanthellae are always to be found, that afterwards are taken in by the mouth together with the mucous layer and the organisms of foreign origin. Even when this layer has just originated, zooxanthellae are already present; 2. In *Seriatopora* it can always be observed microscopically that some free zooxanthellae move along the branches of the colony across the ectoderm and that finally they are taken in by the polyp's mouth. In the gastric cavity there is a small plug of

[1]) It is striking that most often I found in the living coral polyps remnants of food in the gastric cavity and in those remnants zooxanthellae, whereas DUERDEN reports that he never observed zooxanthellae in the coelenteron of the West-Indian Madreporaria.

mucus often in circular motion, in which zooxanthellae are clearly distinguishable.

Theoretically two more possibilities must of course be considered: either the zooxanthellae in the coelenteron are derived from the endoderm-cells of the polyp itself, or they have been introduced from the seawater. Now it is a fact, that in the coelenteron of *Dendrophyllia coccinea*, a species that lodges no zooxanthellae in the endoderm, only very rarely a single zooxanthella can be found, also in those polyps living in the proximity of a number of colonies of reef-corals. Now if the latter had taken up the zooxanthellae, which constitute a prominent part of their food, from the seawater, these organisms should necessarily also always be found in the food-rests of *Dendrophyllia*. Seeing that this is not the case, it is probable that the zooxanthellae present in the gastric cavity of the reef-corals were living previously in tissues of the corals themselves.

The infection of the young larvae with zooxanthellae takes place in the mother-animal. DUERDEN (1902) showed already that the young planulae lodge many yellow cells. I found the same in the newly hatched planulae of *Fungia actiniformis*, which will sometimes contain as many as 180 zooxanthellae. So long as the eggs are still attached to the mesenteries, zooxanthellae are found, indeed, in their proximity, but they themselves have not yet been infected. Developmental stages previous to the planulae I have not been able to find. Therefore I cannot say in which stage infection takes place. This infection of the young stages implies that the association with the yellow cells is greatly to the benefit of the coral-polyps. The phenomenon is an instance of symbiosis[1]). It is difficult to decide whether this is of a mutualistic nature, or whether the association of the two organisms is to be considered as a case of parasitism, as PRATT[2]) thinks, in which the coral-polyps live upon the zooxanthellae. The large quantities of symbionts, present in a living state in the endoderm are rather indicative of a mutualistic association.

Because they require light for their photosynthesis of carbohydrates, zooxanthellae cannot live at a lower depth than 50 to 70 m. This factor chiefly determines the vertical distribution of reef-corals, as GARDINER also supposed (1899).

---

1) P. BUCHNER, Tier und Pflanze in intrazellularer Symbiose. Berlin 1921.

2) E. M. PRATT, The Digestive Organs of the Alcyonaria and their Relation to the Mesogloeal Cell Plexus. Quart. Jour. Micr. Sci. Vol. XLIX 1906. In this publication and in others by the same writer the yellow cells are invariably termed „zoochlorellae". However, judging from their description and from the figures hey are zooxanthellae.

Zooxanthellae of the same shape, structure and colour as in reef-corals also occur in the Hydrocorallid *Millepora* and in the Alcyonarian corals *Tubipora* and *Heliopora*. The polyps of the species of these genera also feed chiefly on their zooxanthellae. For other genera of Alcyonaria PRATT [1]) has described zooxanthellae not differing in any way from those of the Madreporarian corals. They are also found in the tissues of many Actiniae and Scyphomedusae.

The zooxanthellae occurring in large numbers in *Tridacna* in the light coloured parts of the mantle [2]), also closely resemble those of the corals. Here also a considerable portion of the food is furnished by the zooxanthellae: in the stomach and the adjoining part of the intestine of *Tridacna* I detected large quantities of zooxanthellae in all stages of digestion.

The zooxanthellae of a species of *Collozoum* in the island of Amboina I compared with those of corals. They are larger than the latter (12—15 μ), of a lighter yellow, and are chiefly distinguished by more than one product of assimilation in each cell. They are completely like the yellow cells of various Radiolaria examined minutely by BRANDT [3]). According to BRANDT the amyloid substance appears as bodies with a large vacuole; these bodies, however, are massive and possess a central highly stainable grain, a fact, afterwards pointed out by STIASNY [4]). So in this respect the product of assimilation corresponds with that of the zooxanthellae of the corals, in which there is also a central body (pyrenoid) that may be coloured with nuclear stains.

No zooxanthellae are to be found in some species of Madreporaria living in shallow water, sometimes close to the surface, such as *Dendrophyllia micranthus* (Ehrb.) (= *nigrescens* Dana) and *Dendrophyllia coccinea* (Ehrb.) [5]), two species of general occurrence in Amboina and the Kei Islands. Now it is striking that in *D. coccinea* large quantities of yellowish-green corpuscles of irregular shape occur in the endoderm, not to be found in the tissues of reef-corals. In teased preparations of the tissues of the living animal, these

---

[1]) E. M. PRATT, The Alcyonaria of the Maldives. Pt. II. Fauna Geogr. Mald. and Lacc. Arch. Vol. II Pt. I 1903. Compare also the above cited publication.

[2]) cf. NUSSBAUM-KARSTEN-WEBER, Lehrbuch der Biologie, 2 Aufl. 1914, p. 550.

[3]) K. BRANDT, Die Koloniebildenden Radiolarien (Sphaerozoëen) des Golfes von Neapel. Fauna und Flora des Golfes von Neapel. 1885.

[4]) G. STIASNY, Zur Kenntnis der gelben Zellen der Sphaerozoen. Biol. Centralblatt. Bd. XXX, 1910.

[5]) The new nomenclature of these species is adopted from C. J. VAN DER HORST, Eupsammidae. Siboga Expedition Monogr. XVI*c*, 1922.

corpuscles are isolated and assume a globular shape. They are of a granular structure, in some of them one portion stains more deeply, but a nucleus cannot be made out with certainty. Besides these greenish yellow corpuscles the above-named species still contains a finely distributed red pigment in the outer layers. *Dendrophyllia micranthus* has the same greenish yellow corpuscles in the endoderm and, besides, a black pigment instead of the red one of *D. coccinea*. In the gastric cavity of these animals rests are found of small Crustacea, diatoms, foraminifera, Oscillatoria and detritus, such as sponge spicules, but besides these also a number of the greenish yellow corpuscles like those of the endoderm of a fairly rounded shape. Sometimes also a few zooxanthellae can be made out, but only with animals living near other corals that contain zooxanthellae in their tissues.

Now this invites us to conclude that the greenish yellow corpuscles in *Dendrophyllia* play the same rôle as the zooxanthellae in reef-corals. MAC MUNN's[1]) researches lend support to this hypothesis. This author demonstrated spectroscopically that in two species of *Dendrophyllia* (*D. nigrescens* and *D. Willeyi*) a chlorophylloid pigment occurs. The greenish yellow colour of the said corpuscles renders it probable that the chlorophylloid pigment is localised here. The fact also that these greenish yellow corpuscles are regularly present in the food, suggests an analogy to the zooxanthellae of reef-corals.

Regarding the nature of the greenish yellow corpuscles there are two possibilities: they are either elements of the tissues of the polyps themselves, or they are symbiotic individual organisms. In the latter case, however, the organisms (algae) are supposed to be highly reduced[2]). That the yellowish green corpuscles should be formed by the coral-polyps themselves seems to be an untenable hypothesis, if we consider that in all the cases, where formerly animal chlorophyll was recorded, it has been demonstrated afterwards that this chlorophyll was derived from a foreign source. For the present the available data do not enable me to solve this question.

In the tissues of a small *Balanophyllia*, generally met with at the lower surface of large colonies of reef-corals in the Java Sea,

---

[1]) C. A. MAC MUNN, On the Pigments of Certain Corals. Fauna and Geogr. of the Mald. and Lacc. Arch. Vol. I, Part. II, 1902.

[2]) Cases are known in which symbiotic algae lose entirely their individual character and cannot any longer live without the animal (cf. F. KEEBLE and F. W. GAMBLE, The Origin and Nature of the Green Cells of Convoluta roscoffensis. Quart. Journ. Micr. Sci. Vol. LI, 1907).

the same greenish yellow corpuscles occur in large numbers. I have not been able to find any remnants of food in these corals.

In the genera of the Madreporaria, of which the species are found only in deeper water, the tissues contain no zooxanthellae[1]) Little is known as yet concerning the food of these corals. GRAVIER[2]) found in the gastric cavity of *Stephanotrochus diadema* rests of a crustacean, fragments of arms of Ophiurids and sand with many foraminifera. Now conclusions on the nature of the food of deep-sea-corals should not be drawn without due consideration. If one finds in the coral-polyps from deeper water only sand with foraminifera, this does not prove that they have ingested this as food, since in the majority of cases the sand has entered into the gastric cavity while the polyps were being dredged up. In some of them I found, besides sand, remains of animals or plants in a mucous substance. These are presumably remnants of the food of the polyps. In the gastric cavity of a *Dendrophyllia* dredged up in the Bay of Amboina between 45 and 90 m. I found the remains of small Crustacea and many diatoms. The food-rests of *Cyathohelia axillaris* (Ell. & Sol.) of Amboina (about 130 m.) contained Copepods, diatoms, and sponge spicules. In *Odontocyathus* sp. from Station 2 of the Danish Expedition to the Kei Islands (± 200 m.) I found in the coelenteron remains of extremities of Crustacea, foraminifera and sponge spicules. Also *Stephanophyllia formosissima* Mos. (same Exp., Stat. 41, 245 m.) contained remains of small Crustacea in the gastric cavity of some specimens. In the gastric cavity of many other specimens of various species many foraminifera occurred, but these had probably entered there during the dredging.

Leiden, November 1923.

From the Zoology Laboratory of the University.

EXPLANATION OF THE FIGURES.

Fig. 1. *Acropora variabilis* (Klunz.) Remnants of food from the gastric cavity of a polyp, with normal and partially digested zooxanthellae. The dotted parts were coloured yellow. × 825.

Fig. 2. Zooxanthella from the endoderm of *Goniopora stokesi* M.—E. & H. Preserved material (alcohol) stained with safranin and light-green. × 1950.

[1]) The "zooxanthellae", occurring according to BOURNE (Report on the Solitary Corals collected by Prof. HERDMAN in Ceylon. Rep. Pearl Oyster Fisheries, 1905) in *Heterocyathus* and *Heteropsammia* are cells of a quite different nature belonging to the tissues of the polyps themselves.

[2]) CH. GRAVIER, Madréporaires provenant des Campagnes des Yachts Princesse-Alice et Hirondelle II. Résult. Camp. Scient. Fasc. LV, Monaco 1920.