CORALS FROM ASPHALT DEPOSITS OF THE ISLAND BUTON (EAST-INDIES)

BY

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(With 2 textfigures and plates XII—XIII).

In 1933 and 1935 K. MARTIN described a new fauna of tertiary Mollusca from asphalt deposits of Buton [1]). The collection, consisting of 35 species, shows very characteristic forms, but not a single species is known from recent, pliocene, miocene or eocene deposits. There are some affinities to miocene and recent types and as the fauna is doubtless younger than Mesozoic, MARTIN had good reasons to consider the fauna younger than the eocene Nanggulan beds of Java but older than the oldest known miocene fauna of the East-Indies (West-Progo beds of Java). He ascribed the Buton fossils to the Upper-Oligocene.

According to HETZEL [2]), however, the localities of the fossils are situated amidst the so called Sampolakosa-beds of upper-miocene or pliocene age. He tried to give an explanation of the remarkable molluscs of Buton by suggesting that the facies of the deposits might be different from any Mollusca bearing strata hitherto known in the East Indies.

I agree with MARTIN that HETZEL's explanation does not seem to be a good one, as there are too many very characteristic Mollusca among the Buton fossils, which are entirely unknown from neogene and recent faunae. MARTIN suggests that the Mollusca might have been thrown up from deeper strata by upper-neogene mud-volcanoes. In this way they might have been imbedded in upper-neogene deposits [3]).

The puzzle is made more intricate still by the results of my examination of the corals described below.

Most corals are from Waisiu. Only one specimen is from Wairiti (*Gon. simplicitexta*). I received them from Professor C. K. VISSER of Delft together with the Mollusca described by MARTIN in his paper of the year 1935. Some molluscs and corals are even from one and the same piece of asphalt. My conclusion about the age of the corals differs, however, widely from MARTIN's conclusion based on the Mollusca from the same rocks.

As a matter of fact I identified only 9 species, but 8 of these belong

[1]) K. MARTIN. Eine neue Tertiaere Molluskenfauna aus dem Indischen Archipel. Leidsche Geologische Mededeelingen VI, 1933, p. 7—32.

K. MARTIN. Oligocaene Gastropoden von Buton. Leidsche Geologische Mededeelingen VII, 1935, p. 111—118.

[2]) W. H. HETZEL. Verslag van het onderzoek naar het voorkomen van asfaltgesteenten op het eiland Boeton. Verslagen en Mededeelingen No. 21, 1936, p. 17—19.

[3]) K. MARTIN. Die Oligocaenen Mollusken von Buton als Auswürflinge eines Schlammsprudels betrachtet. Leidsche Geologische Mededeelingen VIII, 1937, p. 311—314.

to still living species and if the question were not of special importance I should even not have given illustrations of them (two of these 9 species are marked by a "cf", but there is no question that they might belong to a lower-miocene or oligocene species). One species, *Goniastrea simplicitexta*, was found also in the lower-pliocene coral reef of Linggapadang, Java, but the species is close to the recent species *G. retiformis* and *G. hombroni*. In a larger suite gradations might even prove to exist between these "species". The full data on the stratigraphic distribution of the Buton corals are given in the following table:

	Upper Miocene	Plio-cene	Plisto-cene	Recent
1. *Caryophyllia cf. cyathus* ELL. et SOL.				+
2. *Stephanotrochus Weberianus* ALCOCK	+ ?			+
3. *Cyphastrea seraila* (FORSKÅL)		+	+	+
4. *Goniastrea retiformis* (LAM.)		+	+	+
5. „ *simplicitexta spec. nov.*	+	+		
6. *Favia cf. laxa* (KLUNZIGER)	+		+	+
7. *Coeloria daedalea* (FORSKÅL)		+	+	+
8. „ *lamellina* (EHRENBERG)		+	+	+
9. *Platygyra phrygia* (ELLIS et SOL.)		+	+	+
10. *Porites spec. indeterm.*				

All specimens are in the Institute of Mining at Delft.

I studied these corals at the same time with a large suite of recent corals from the bay of Batavia and the Togian reefs and with large collections of tertiary corals from the East-Indies, the results of which will be published elswhere. With the aid of these large collections a safe identification of the Buton corals could be made with the exception of one strongly damaged small fragment of *Porites*.

It is a remarkable fact that three solitary corals, viz. one specimen of *Caryophyllia* and two specimens of *Stephanotrochus* belong to genera which are at present living in deeper water and that these specimens are in an excellent state of preservation. The other species are angular fragments (some of them showing only small patches of the calicular surfaces) of shoal-water corals and it may be that they belong to a different stratigraphic horizon.

Summarizing our knowledge of the fossils from the asphalt of Buton we have the following remarkable list:

(1) 35 Gastropods and Lamellibranchs
age: upper-oligocene, eventually lowermost miocene.

(2) 7 species of shoal-water reef corals consisting of strongly damaged, angular fragments
age: pliocene or younger.

(3) 2 species of solitary corals (from deeper water?) in an excellent state of preservation, nearly unaltered wood, and slightly fossilized raisin
age: upper-miocene??, pliocene or younger.

(4) Globigerinidae and other apparently pelagic Foraminifera.
Sponge spiculae
age: unknown but probably uppermost tertiary or younger (not yet studied in detail)

(5) a mould of *Cocos nucifera* (L.)
age: unknown, but probably subrecent.

I will say a few words about the last mentioned remarkable fossil. The coconut proper is not preserved. The coconut apparently made an impression in the asphalt and after it had decayed entirely the cavity was filled up by normal asphalt material. Hence the asphalt mould has now the shape of the original coconut. The identification of the specimen was not made by the present author (as mentioned by HETZEL) but by

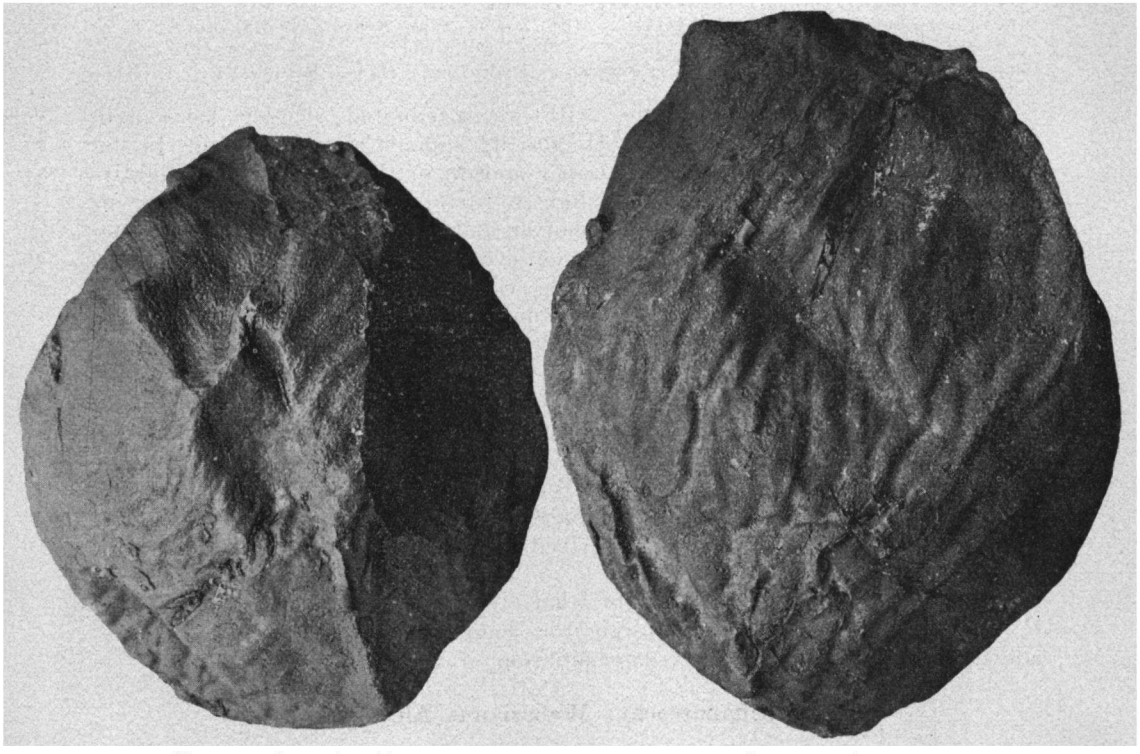

Fig. 1 and 2. Mould of *Cocos nucifera* (L.), upper and lateral view, × $^2/_3$.

Dr. BEUMÉE formerly Director of the Herbarium at Buitenzorg, Java. I am giving illustrations of the interesting fossil (textfig. 1 and 2), which is now in the National Museum of Geology at Leyden.

In fine, it seems to me that the data known at present strongly support MARTIN'S surmise on the occurrence of the deposits. For, all facts are explained if we suppose that eruptions of a mud-volcano broke through fossil bearing layers of different ages and scattered the material hap-hazardly on the surface in the neighbourhood of the vent. Possibly gass and oil giving origin to the present asphalt deposits flowed out from the same vent. How-

ever, these events may have happened at a more recent date than the Upper-Neogene and eventually the reef corals were living *in loco* at that time.

With this hypothesis in mind the opinion of HETZEL's and THOENES'[1]) have to be revised and it is to be hoped that a detailed geological survey of the puzzling fossil localities will show an undisputable solution of the problem.

SYSTEMATIC PART

Caryophyllia cf. cyathus Ellis et Solander.

Pl. XII fig. 10 and 11.

1786 *Madrepora cyathus* J. ELLIS et D. SOLANDER. The Nat. Hist. Zoophytes, p. 150, Tab. 28, fig. 7.
1848 *Caryophyllia cyathus* E. H. Ann. Sci. Nat. IX, p. 287, Pl. 4, fig. 1.
1904 *Caryophyllia cyathus* v. MARENZELLER. Valdivia VII, 3, p. 295, T. XVI, fig. 6.
1918 *Caryophyllia cyathus* L. DÖDERLEIN. Mitt. Zoolog. Stat. Neapel, Bd. 21, p. 117, T. 7, fig. 1.
1933 *Caryophyllia cyathus* J. E. HOFFMEISTER. „Endeavour", Biolog. Results VI, p. 1, p. 14.

Corallum elegantly turbinate, with an attenuated slender basis and slightly rejuvenated at the top. Height 32 mm. Calyx elliptical, 15 to 12 mm. Columella 7 mm below the upper margin of the septa. Septa slightly exsert, 12 primaries reaching only slightly further than the distal ends of the pali, 12 secondary septa slightly shorter and less exsert, 24 tertiary septa reach only halfway the primaries or not even so far. A crown of 12 pali corresponding to the 12 secondary septa. Septa and pali thin with distinct and acute granulae. Columella narrow, elongated according to the longer axis of the corallum and consisting of a few twisted trabeculae. There are costae corresponding to all the septa but they are mere striations. Those of the first two cycles are slightly more prominent.

DÖDERLEIN's description of a specimen from the Gulf of Naples is applicable to the present coral with the exception of the shape of the corallum. In the latter respect the Buton coral corresponds more to the type of ELLIS and SOLANDER. *Caryophyllia cyathus* is a common species in the Mediterranean, but it was described by HOFFMEISTER from the Great Australian Bight.

There seems to me no doubt that the Buton specimen belongs to *C. cyathus*. As no recent material for comparison was available I have added, however, a „cf" to the determination of the fossil.

Stephanotrochus Weberianus Alcock.

Pl. XII, fig. 7—9.

1902 *Stephanotrochus Weberianus* ALCOCK. Monogr. XVIa, p. 25, plate III, fig. 22, 22a.
1923 *Stephanocyathus magnificus* GERTH. Borneo p. 51, Taf. I, fig. 14.

The smaller specimen is undamaged, the septa of the larger one are broken. I compared the fossils with GERTH's type of *Stephanocyathus magnificus* from Borneo in the National Museum of Geology at Leyden and I am convinced that GERTH's type belongs to the recent species *Stephanotrochus Weberianus*. The fossil from Borneo has strongly damaged septa, but it shows a close resemblance especially to the larger coral from Buton. The

[1]) D. THOENES. Het ontstaan van asphalt bitumen. Diss. Delft 1936.

only difference exists in the wall of GERTH's type being not so strongly compressed and the basis being more applanate. The smaller specimen from Buton, too, has a straight lateral wall whereas the larger one shows a concave profil and in that respect agrees with ALCOCK's type.

The description of ALCOCK's is entirely applicable to the fossils studied by me (2 from Buton, 1 from Borneo). It is obvious from the table of characteristics given below that they belong to one and the same species.

GERTH's type is from Tandjong Batu, East Borneo, and derived from deposits of unknown age. GERTH supposes the strata to be upper-miocene. The specimen described by ALCOCK was collected by the Siboga Expedition from a depth of 828 meters.

Cyphastrea seraila (Forskål).

Pl. XII, fig. 2 and fig. 3

1920 *Cyphastrea seraila* (FORSK.), FELIX, Timor, p. 6.
1939 *Cyphastrea seraila* (FORSK.), UMBGROVE, p. 26.
1942 *Cyphastrea seraila* (FORSK.), UMBGROVE.
For synonymy and distribution of recent specimens see UMBGROVE 1939, pag. 26, YABE c. s. 1936, pag. 24 and MATTHAI 1914, pag. 39.

There are two fragments of rather large massive colonies. The structure of the coral is well preserved, but the upper part of the coral is broken off, except for a very small part of one of the fragments, represented in plate XII, fig. 3.

Peritheca dense with thin vesicles and low scattered spines. The calices have a diameter of usually 1.5 to 2 mm and the few that are visible on the surface are 1 mm deep and have obscurely elevated walls. Corallites crowded 1 mm apart or less. Septa thin, slightly exsert with a few very small teeth. Septal loculi comparatively wide. Septa in three cycles, usually twelve septa meeting the columella. Columella finely trabecular. Dissepiments thin nearly horizontal, abundant, about 30 in one centimeter.

This well know recent species was found fossilised in pliocene strata of Java and in plio-pleistocene reef limestones of Timor. Moreover, I collected a specimen in a raised reef limestone near Donggala, Celebes.

Goniastrea retiformis (Lamarck).

Pl. XII, fig. 1; Pl. XIII, fig. 4.

For synonymy see UMBGROVE 1940, p. 281.

Corallites polygonal with solid separating walls; the larger ones drawn-out for fission. Diameter of calices 3 up to 6 mm, average-sized calices 4 to 5 mm. Walls 0.25 mm thick, principal septa of same thickness. In average sized non-dividing calices there are 8 to 10 well developed septa reaching columella. Usually 4 septa slightly thicker than the other ones. Septa thicker near intercalicular walls than near centre of the calice. In larger calices 14 septa reach columella; moreover up to 12 smaller to rudimentary septa may occur in larger calices, some of these fusing with the larger septa. Septal margins preserved. Septal faces smooth. Columella poorly developed, trabecular.

Endothecal dissepiments well developed and occurring at vertical distances of 1 mm or less. Reproduction by subequal fission.

	Septa					Costae		Calyx		Columella
Stephanotrochus Weberianus type of ALCOCK's	Twelve primaries and secondaries conspicuously exsert	1th and 2d cycles with small paliform process near columella	3th cycle less exsert. (3th and 4th cycle equally developed if 5th cycle it present)	3th cycle with large triangular paliform process before they join the columella	Total number of septa 48	on the basis costae of the first two cycles distinct ridges, costae of lower cycle fine striae	on the sidewall all granular and of equal size	Diam. of calice in mm 37	Greatest height in mm 25	granular contorted knobs
smaller specimen from Buton	idem	idem	idem	idem	48	idem	idem	19	14	idem
larger specimen from Buton	idem	idem	idem	idem	56	idem	idem	28	17	idem
GERTH's type from Borneo	idem	idem	idem	idem	57	idem	idem (granulation not distinct)	26	12	idem

The coral is a fragment (60 by 50 mm, height 45 mm) of a large colony. The Buton coral strongly resembles the recent specimen of *G. retiformis* figured by MATTHAI on his plate 31, fig. 5. The species occurs also in the lower-pliocene coral reef of G. Linggapadang.

Goniastrea simplicitexta spec. nov.

Pl. XII, fig. 4 and Pl. XIII, fig. 5

I have studied this new species from six localities; 5 specimens from the lower-pliocene coral reef of Gunung Linggapadang, Java, one specimen from the upper-miocene Tji-Lanang beds, Western Java; one specimen from the upper-neogene of Eastern Java (Geolog. Survey Bl. 93 B 260), one specimen from Idenburg river, New Guinea (coll. G. 108, 1915 Geolog. Institute of Urecht University,) two specimens from Keloko Watu, Central Sumba (coll. H. Witkamp 1911, Geolog. Institute of Utrecht University) and the present specimen from Buton (Wairiti).

I have chosen the specific name *simplicitexta* on account of the very simple structure of the coral being its most characteristic feature.

Corallum forming light convex hemispherical clumps. Corallites polygonal, with solid separating walls. Asexual reproduction by subequal fission. The average-sized calice has a diameter of 4 mm. Walls very thin, between 0.25 and 0.30 mm thick. Septa of same thickness or less. In average sized non-dividing calices there are 6 to 8 well-developed septa, 6 reaching columella. Usually 3 septa thicker than the other ones. If more than six septa occur one or two pairs join before reaching columella. Moreover, exceptionally one or two rudimentary septa occur in some calices. Septal faces smooth. Septal margins not preserved. Columella very poorly developed, consisting of a few trabeculae from the septa. Endothecal dissepiments poorly developed and occurring at vertical distances of 0.5 to 1 mm.

The specimen from Tji-Lanang differs only in the following details. In part of the coral the corallites are of exactly the same dimensions and structure. The larger part of the fragment shows, however, corallites of slightly larger dimensions, diameter up to 8 mm in largest calice, whereas the thickness of walls and larger septa amounts to 0.5 mm (exceptionally even 1 mm). In larger calices up to 14 septa may be counted. The same is true for the specimen from Eastern Java (Bl. 93 B. 260) and from the Idenburg river of New Guinea.

The specimens are without exception fragments of large colonies, the specimen from New Guinea is a boulder measuring 90 by 125 mm.

Goniastrea simplicitexta may be considered a species allied to *G. retiformis* and *G. hombroni*. *Goniastrea retiformis* is different by its greater number of small to rudimentary septa, its well developed endothecal dissepiments and by its usually having a well developed pseudo-columella. *Goniastrea hombroni* is distinguished by its septa being of even thinness and by its many more smaller and rudimentary septa. I compared my specimens also with GERTH's type of *Prionastrea pauciseptata* from Borneo in the Geological Institute of Leyden University. *Goniastrea pauciseptata* (GERTH) differs by its greater number op septa (20, 6 up to 10 reaching columella) and its larger dimensions (diameter of calices 8 to 10 mm). I refer that species to *Goniastrea* on account of its reproduction by subequal fission as shown in GERTH's plate 5 fig. 2.

Favia cf. laxa (Klunzinger).

Pl. XII, fig. 5 and 6

1879 *Orbicella laxa.* KLUNZIGER p. 49, plate 5, fig. 3, pl. 10, fig. 9.
1914 *Favia laxa* (KLUNZIGER). MATTHAI p. 99, plate 24, fig. 5, 6; Pl. 37, fig. 2.
1915 *Orbicella laxa* KLUNZIGER. FELIX, Timor p. 13.
1917 *Heliastraea tabulata* MARTIN. DOLLFUS, Celebes, p. 1014.
1923 *Favia laxa* (KLUNZIGER). GERTH, Borneo, p. 72.

There is a single fragment of a large colony from Waisiu, plate-shaped 130 by 110 mm, and 23 mm thick, which I believe is *Favia laxa.* The surface of the coral is, however, not preserved.

The characters of corallites and peritheca agree with the descriptions of KLUNZIGER and MATTHAI as may be seen from the following description of the Buton specimen.

Corallites circular or elliptical, 4 to 7 usually 6 mm in diameter, 1—2 mm apart. Septa thickening towards walls, 12 to 17 septa reaching columella; between these 6—16 short to rudimentary septa occur, the larger ones curving towards and fusing with sides of principal septa. Septal sides crowded with spinules. Columella trabecular, well developed, about $^1/_3$ width of corallite. Peritheca vesicular. Asexual reproduction by subequal fission.

Distribution: Recent, Pleistocene (Timor, Celebes), Upper-Miocene (Soengei Gelingseh, Borneo).

Coeloria daedalea (Forskål).

Pl. XIII, fig. 1—3.

1939 *Coeloria rustica* (DANA). UMBGROVE p. 33 (with synonyms).
1940 *Coeloria rustica* (DANA). UMBGROVE p. 282, Pl. 24, fig. 4 and 5.
1941 *Coeloria daedalea* (FORSK.). CROSSLAND p. 32.

A small fragment of an apparently rather large colony (Pl. XIII, fig. 3) has slightly gyrose calices, 3.5 up to 5 mm average 3 mm wide; 14 narrow septa in 1 cm, 8 up to 12 meeting columella. Wall thin 0.5 mm or less. Columella feebly developed consisting of septal trabeculae. Surface not preserved. Dissepiments well developed, in places crowded. The coral most resembles *C. sinensis* E. H. which is now a synonym of *C. daedalea* (ELLIS et SOLANDER) as defined by MATTHAI (1928, p. 24).

There is a second fragment of a large colony (Pl. XIII, fig. 1 and 2), 30 cm high, which has rather long maeandring valleys (resembling MATTHAI's Pl. VI, fig. 7 and 8). Walls and septa narrow 10 to 12 septa in 1 cm, 6 or more meeting columella. Valleys 4 to 6 mm wide, average 4.5 mm. Columella feebly developed. Dissepiments well developed. Surface of corallum not preserved. It seems to me that this specimen too belongs to the variable species *C. daedalea* (FORSKÅL). I found the species also in the lower-pliocene coral reef of Gunung Linggapadang.

Coeloria lamellina (Ehrenberg)

Pl. XIII, fig. 6.

For synonymy see UMBGROVE, 1939, p. 33.

The coral has long sinuous valleys 6 to 10 mm wide (usually 7 mm). No single corallites present. Walls solid, thin 0.5 up to 1 mm. Septa very

narrow, placed at regular intervals, 8 to 10, usually 9 septa in 1 cm meeting columella, between these seldom a few small septa. Septa smooth usually alternate, but in places continuous in the septa of the neighbouring valley. Columella of loose texture consisting of twisting trabeculae from the septa, not conspicuous in transverse section, but very distinct in longitudinal sections of corallum. Dissepiments poorly developed, distant.

As the only specimen available is a fragment of a large colony nothing can be said about the depth of the valleys, dentations of the septa etc. The coral most resembles *Coeloria arabica* KLZ. *var. leptochila* EHRB. as described and represented by KLUNZIGER (1879, p. 18, Taf. II, fig. 2) and which belongs to the synonyms of *C. lamellina* (EHRENBERG) according to MATTHAI (1928, p. 37).

Platygyra phrygia(Ellis et Solander)

Pl. XII, fig. 13.

For synonymy see MATTHAI, p. 112 and UMBGROVE 1940, p. 283.

One fragment of a large massive colony from Waisiu. Valleys and collines strongly maeandring, thickness of collines 0.5 to 1 mm, width of valleys 3 to 3.5 mm.

Septa, 16 in one cm of which 12 meeting columella. Sides of septa spinulose. No regularly alternating row of very narrow septa. The coral most resembles the specimen figured by MATTHAI in his plate 65 fig. 4. The species which is widely distributed in the Indo-Pacific was mentioned by GREGORY (1900, p. 210) from the Pleistocene of Christmas Island and occurs in the lower-pliocene of G. Linggapadang, Java.

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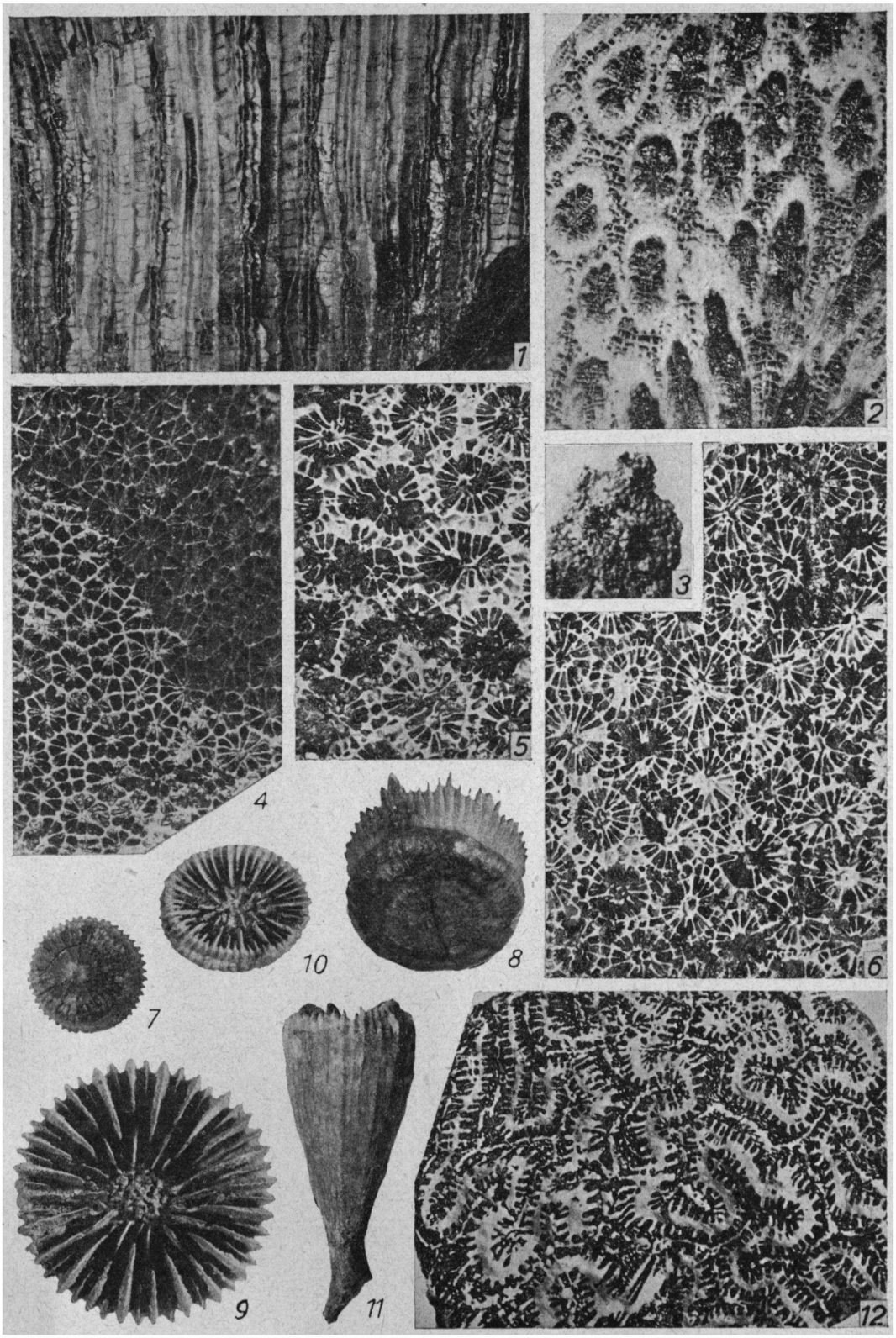
Explanation of Plates.

Plate XII.

Fig. 1. *Goniastrea retiformis* (LAM.) × 2, vertical section showing arrangement of dissepiments.
Fig. 2 and 3. *Cyphastrea seraila* (FORSKÅL). Fig. 2 oblique section, × 3; fig. 3 part of colony showing preserved upper part of a few calices, × 3.
Fig. 4. *Goniastrea simplicitexta spec. nov.* × 2.
Fig. 5 and 6. *Favia* cf. *laxa* (KLUNZIGER) × 2. Fig. 5 showing asexual reproduction by subequal fission.
Fig. 7—9. *Stephanotrochus Weberianus* ALCOCK. Fig. 7 and 9 smaller specimen; fig. 8 larger specimen.
Fig. 7 and 8 × 1; fig. 9 × 2.
Fig. 10 and 11. *Caryophyllia* cf. *cyathus* ELLIS et SOLANDER, nat. size.
Fig. 12. *Platygyra phrygia* (ELLIS et SOLANDER), × 2.

Plate XIII.

Fig. 1—3. *Coeloria daedalea* FORSKÅL. Fig. 1 and 2 larger specimen, × 2. Fig. 3 *sinensis* type, × 2.
Fig. 4. *Goniastrea retiformis* (LAM.), × 2.
Fig. 5. *Goniastrea simplicitexta spec. nov.*, × 2.
Fig. 6. *Coeloria lamellina* (EHRENBERG), × 3/2.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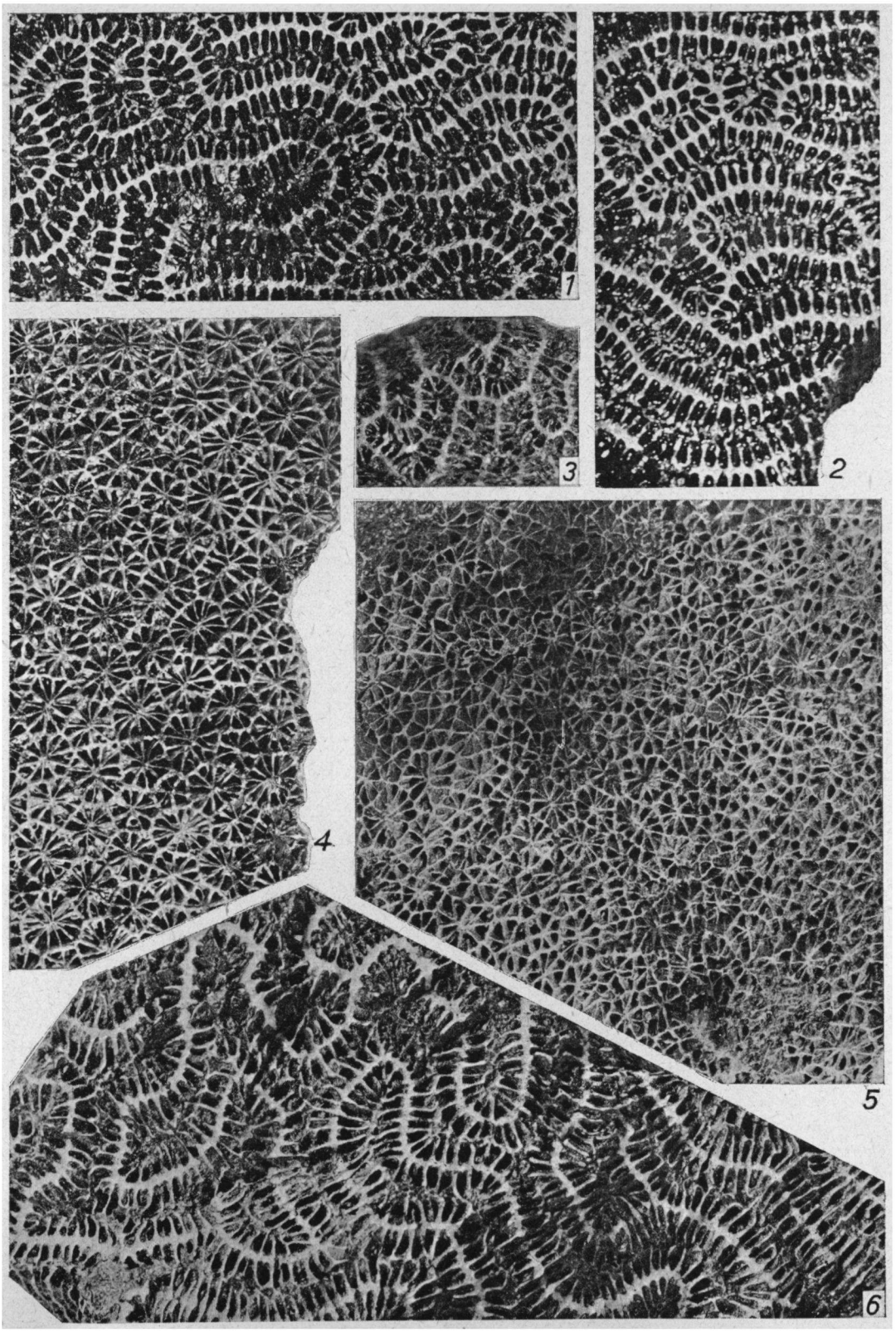
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