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Taxonomic study of scleractinian corals (Coelenterata-Anthozoa), with notes on structure and condition of reefs in the Adang-Rawi Island group, Tarutao National Park, southern Thailand

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ABBREVIATION

In each species description, studied materials were given in abbreviation.

For instance;

245 / Ad.XII, Rf, 3.5 / br,d.gr,br.pur-stom

means specimen no. 245 was collected from site XII of Adang Island, on reef flat, at 3.5 m deep (depth was simply reported at actual collecting time, while tidal range is about 3 m). Colour of specimen is partly brown and dark green. Stomodaeum of polyp is brownish purple.

Abbreviation used in text is as following:

abbreviation	meaning
Rf	reef flat
Ed	reef edge
Sl	reef slope
Bt	bottom of reef (slightly out off reef slope periphery)
Ad	Adang Is.
Rw	Rawi Is.
Gt	Gata Is.
Hn	Hin-Ngam Is.
Jb	Jabang Is.
Tr	Tarang Is.
Bs	Bis-See Is.

abbreviation	meaning
Ba	Batuang Is.
Lp	Lee-pe Is.
Br	Butrat Island
Lk	Lokoai Is.
Sk	Sakai Is.
Bl	Bulo Is.
Sm	Samuang Is.
Tk	Takiang Is.
Sr	Sarang Is.
br	brown
cr	cream
yel	yellow
gr	green
bl	blue
g	grey
r	red
or	orange
wh	white
pur	purple
d	dark
tip	tip of coral branch
top	top of colony
edge	edge of colony
tentacle	polyp tentacle
stom	polyp stomodaeum

abbreviation	meaning
a	arborescent form
ct	caespitose form
cb	corymbose form
t	table form
f	foliaceous form

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บทคัดย่อ

จากการศึกษาทางอนุกรมวิธานของปะการังแข็ง บริเวณหมู่เกาะอาดัง ราวี ณ อุทยานแห่งชาติตะรุเตา ได้จำแนกชนิดปะการังที่เก็บได้ออกเป็น 140 ชนิด จาก 47 สกุล 14 วงศ์ ในแต่ละชนิดได้มีการวิจารณ์ถึงการผันแปรของโครงสร้างหินปูน การผันแปรนี้อาจจะเป็นผลมาจากการเปลี่ยนแปลงระดับพันธุกรรมหรือไม่ได้มีการเปลี่ยนแปลงในระดับนี้ พบว่าความเข้มข้นของแสง ตะกอน และความขุ่นของน้ำเป็นปัจจัยสำคัญที่เกี่ยวข้องกับการผันแปร

แนวปะการังบริเวณที่ศึกษาสามารถแบ่งออกเป็น 2 รูปแบบ คือแบบที่มีการสร้างตัวอย่างสมบูรณ์และแบบที่เจริญเติบโตเป็นกลุ่มเล็ก ๆ บนแนวหินแกรนิตตามชายฝั่งที่เป็นหน้าผา พบว่าลมมรสุมมีอิทธิพลต่อการสร้างตัวของแนวปะการังแต่ละรูปแบบ ในวิทยานิพนธ์ได้รายงานถึงสภาพของแนวปะการังในแง่พื้นที่ครอบคลุมของปะการังแข็งที่ยังมีชีวิต ปะการังตาย ปะการังอ่อน และพื้นทรายหรือหิน รวมทั้งชนิดปะการังที่ขึ้นครอบคลุมพื้นที่อย่างหนาแน่น และความลึกของแนวปะการัง

ABSTRACT

One hundred and forty species from 47 genera and 14 families of scleractinian corals of the Adang-Rawi Island group in the Tarutao National Park were described. Genotypic and /or phenotypic variations in skeletal structures within species are discussed. They were found to relate to the influence of light intensity, wave action and sometimes of turbidity.

Reefs in this region were categorized into two main types; the typical reef and the community of corals associated with coastal granite rock. The influence of monsoon winds on the formation of these reefs was discussed. The conditions of reefs in terms of cover of live coral, dead coral, soft coral and substrate, the dominant species of coral and the depth of reefs are reported.

CHAPTER 1

INTRODUCTION

The Scleractinian corals are grouped into the division Zoantharia , phylum Coelenterata. Hermatypic corals, the reef building corals, are dominant organisms on tropical coral reefs which develop wherever the ecological conditions necessary for the growth of such coral exist (Wells, 1975).

Snedaker & Getter (1985) have stated that coral reefs have a large variety of direct and indirect uses that benefit man and society.Among the dominant and most valued uses are the large yield obtained from marine fisheries supported by the reef system. This yield includes a large variety and quantity of organisms'caught elsewhere but whose existence is dependent upon the reef. As a source for lime production , mining of the living coral reef and back-reef areas is still common in many part of the world. As coral reefs tend to be positioned perpendicularly to the mean direction of wind generated swell currents flowing over the reefs, they can serve to weaken incoming waves, thereby minimizing erosion and coastal harzards behind the reef. Moreover, coral reefs are important in the promotion and development of income-earning tourist industries.

In the Andaman Sea, fringing coral reefs are found on most islands. At present, most of these island groups in Thailand have been declared National Parks. The Tarutao National Park is located in the Andaman Sea next to Malaysian border. It is the oldest Marine Park of Thailand, covers an area of about 1,500 km^2,and consists of 51 islands. Tarutao

is the largest island and the Adang-Rawi group of islands, lying about 50 km further west, have fringing reefs along the coastlines. The islands are subject to a monsoonal climate: the southwest monsoon (from May to October), which brings rain from the Indian Ocean, and the northeast monsoon (from November to April) which is equivalent to the dry season.

This study is divided into two sections; taxonomy of scleractinian corals,and structure and condition of reef resources. The first section is the major part of the thesis. Series of coral specimens were mostly collected during December 1982 to May 1983. This part was conducted by the author as part of an investigation team from the Prince of Songkla University under the support of the International Union for Conservation of Nature and Natural Resources. The survey of the structure and condition of coral reefs of the islands was conducted in January 1986 as part of a survey of *Acanthaster planci* in the Andaman Sea, conducted by the research team of the Phuket Marine Biological Center (PMBC).

The history of coral taxonomic works and the problems arising from variation of corals, have been reviewed by Veron & Pichon (1976). Coral taxonomy has been studied for over 200 years. Veron & Pichon (1976) when discussing the ecomorph concept stated that "the intraspecific skeleton variations are phenotypically and/or genotypically determined in response to ecological condition". Coral taxonomists are aware of this problem when working with corals which display polymorphism in different geographical locations.

In recent years, a variety of applications, including numerical taxonomy, immunological techniques, multivariate analysis, and study of the histological structure and ultrastructure of skeletal elements,have been responsible the great advances in our understanding of coral tax-

onomy.

In Thailand, the taxonomy was only intensively studied by Ditlev (1980). In that work, all of the coral specimens were generally collected from islands along the west coast of Thailand. Coral specimens were stored in the reference collection at the PMBC. Ditlev had published the text," A Field Guide to the Reef-building Corals of the Indo-Pacific", with identification keys and brief characters of the coral species. The study reported in this thesis aims to compile a listing and fully describe the structures of scleractinian coral species in a specific region, the Adang-Rawi Island group. Since the structure and condition of the reefs has not been completely surveyed before, this work also aims to obtain a measure of these aspects.

Coral taxonomy was also studied by Jirawat (1985). Ninety species of coral from the Gulf of Thailand were described.

In this thesis, identification is based mainly on the literature by Veron et al. (1976, 1977, 1979, 1982, 1984). The terminology used in coral classification has been described by Wells (1957), Ditlev (1980), and Betterton (1981). The author hopes that this thesis will provide information on the coral species of the Tarutao National Park and that this will be useful in furthering our understanding of coral taxonomy in a specific region and provide a basis for comparative studies between different geographical locations. Finally, it is hoped that baseline information provided by this research will assist the long term plans of the park management and help in conservation.

CHAPTER 2

CORAL TAXONOMY

MATERIALS AND METHODS

Prior to the collection of specimens, a preliminary survey around the island group was made in order to gain some information for site selection. Initial collection and species familiarization were made by thorough examination of the reef of site III of Adang Island (see Fig. 223). This collection was then used as a " mental reference " by which the decision to collect or not collect specimens at other reef sites was made. The field guide to corals, " Reef-Building Corals of the Indo-Pacific " (Ditlev, 1980), was used as a reference for preliminary collecting. For each species, a series of specimens from different habitats was collected as far as this was possible. For large colonies, several parts of the colonies were collected. Hammer and chisel were used in collecting. All collection were made by snorkel or SCUBA diving.

Before separating the specimens from the substrate, the following data were recorded on a writing pad; behaviour of polyps (eg.,extended or not), colour, approximate size and growth form of colony, conditions of habitat (eg., exposed or sheltered, light or dark situation, clarity or turbidity of water and depth of collecting site) and time.General views of many of the reefs have been photographed.

Collected specimens were soaked in fresh water for about a weak, then dead tissue was removed by flushing with water. Dried coral skeletons were identified under a stereo-microscope (Nikon Microscope with magnification at 15x10, 15x24, or 15x60).

SPECIES DESCRIPTION

Over 700 specimens (including small coral fragments) were observed under the microscope. They were identified as 140 species from 47 genera and 14 families. A detailed description of the species follows, together with a discussion of each species mostly in relation to the Scleractinia of eastern Australia, as described in the Australian Institute of Marine Science Monographic Series (Veron et al., 1976, 1977, 1979, 1982, 1984). About 500 specimens were labeled and deposited in the reference collection building of the PMBC.

FAMILY THAMNASTERIIDAE VAUGHAN & WELLS, 1943

There is only a single genus, *Psammocora* , that was placed in this family. However, the taxonomic status of this family is unclear at present. Veron & Pichon (1976) have pointed out that the *Psammocora* wall structure (which is synapticulothecal), the high degree of septal fusion, and typically thamnasteroid structures such as the uniting of septo-costae or biseptal laminae , are characters also found in the families Agariciidae and Siderastreidae.

GENUS PSAMMOCORA DANA,1846

Colonies are massive, columanar, laminar, foliaceous, or encrusting. Corallite walls are absent or weak. The petal-like primary septo-costae are emmbeded in secondary septo-costae, forming distinctive species-specific patterns. Columellae consist of groups of pinnules.

Psammocora contigua Esper, 1798

MATERIAL STUDIED

1/Ad.XI, Rf, 3 / wh.cr

2/ Ad.III, Rf, 2.5 / d.br

3/ Ad.III, Rf, 2.5 / d.br (Fig. 2)

4 & 5 / Jb, sl, 4 / br

491 & 492 / Tr.I, sl,4 / g.br

CHARACTERS

Coralla may be totally thin, encrusting or partly encrusting at the bases and form irregular,twisted,anastomosing plate-like branches.Thick

masses may be formed according to branch anastomosing. Corallum surfaces on encrusting bases are rather smooth, while those on branches form irregular ridges or nodules. In the latter case, corallites tend to be arranged in series. The petalloid corallites are about 1 mm across, with calicular fossae of 0.15 mm diameter and more or less 1 mm apart. Number of septa per corallite is extremely variable. Septa have structures identical to those coenenchymal lobes, giving a confusing appearance to these structures. They are covered by hirsute granulations. Columella is usually of single trabecula with hirsute granulations which are very variable in degree of development.

DISCUSSION

Series of specimens here have characters corresponding well with the species description given by Veron & Pichon (1976). In addition, three specimens from shallow reef flats have a high tendency to be encrusting, a character which these authors had not mentioned. Specimens nos. 4 & 5 were found sitting close together, however they differ significantly , in that the former has twisted plate-like branches while those of the latter are stunted and more irregular. Two specimens nos. 491 & 492 were found sitting close together, but the plate-like branches are very different in size. This situation may be a distinct example of genotypic variants.

Psammocora digitata Edwards & Haime, 1851

MATERIAL STUDIED

6/ Ad.III, S1, 8 / d.br.gr, wh.cr-tip (Fig.3)

7/ Ad.XII, Rf, 3 / yel.gr.br

CHARACTERS

Coralla are thick masses of explanate or encrusting bases and irregular columns, circular or elliptical in cross section, usually about 2.5 cm thick. Individual corallites or short series of them are irregularly enclosed by low coenosteal ridges, giving corallum surfaces slightly rough in appearance. The petalloid septa form psammocoroid corallites of 2,5 mm diameter, with axial fossae 0.4 mm in diameter and usually 2-3 mm apart. The columella consists of few granulated trabeculae or occasionally a single trabecula.

DISCUSSION

This easily recognised species (as already noted by Veron & Pichon, 1976) has very distinct axial fossae of corallites and septa which are evenly radiated around the fossae. This makes corallites well separated from the coenosteal matrix. This character is differnt from that of *P. contigua* (see p. 6).

Psammocora profundacella Gardiner, 1898

MATERIAL STUDIED

8/ Ad. (Fig. 4)

CHARACTERS

Corallum is submassive and partly encrusting. Its surface is rough in outline, resulting from irregular ridge formation (however, some

parts of the corallum surface are rather smooth). Ridges may be sharp or rounded on upper edges. They are about 1 mm high (if measured between two corallite fossae either side of the ridge). Corallites may be single or in short series enclosed by ridges. Septa are usually not in petalloid pattern but being rather thin, bifurcate or trifurcate, and 2-3 rows of synapticular rings associated with them contribute to the synapticulothecate walls. Septal margins are ornamented with flattened, twisted, high denticles. Pointed spines cover septal denticles through septal sides. Axial fossae are about 0.4 mm diameter, each with a few columellar trabeculae.

DISCUSSION

This single specimen has characters falling within the range of variation of species discussed by Veron & Pichon (1976).

With the same condition as noted by these authors, this single specimen is also inhabited by parasites; gastropods and polychaetes.Perhaps this situation is typical for this species throughout the wide geographic areas.

FAMILY POCILLOPORIDAE GRAY,1842

Colonial and mostly hermatypic. Colonies are generally ramose,with plocoid to cerioid calices (1-2 mm across) which arise from extratentacular budding.Septa are in two cycles or less. Columella is styliform when present. Coenosteum is covered with spinules.

GENUS POCILLOPORA LAMARCK, 1816

Colonies are mostly ramose. Corallites are plocoid or tending to-

wards cerioid on tips of branches. Calices are commonly situated on short protuberances (verrucae). Septa usually reduce to rows of spines. Columellae, if present, is usually styliform. Coenosteum is covered with spinules.

Pocillopora damicornis Linnaeus, 1758

MATERIAL STUDIED

17/ Ad,III, Sl, 3 / yel,cr,wh (Fig. 5)

CHARACTERS

Corallum consists of numerous small branchlets formed through branch tips, giving the bushy appearance to corallum. True verrucae are absent. Corallites are cerioid, with circular, oval or polygonal calices, the latter case is common at branch tips. Calices are about 0.9 mm diameter. In each calice, septa are usually in 12 rows of spines and columella appears as a slightly domed floor covered with a group of smaller spines (with the exception that those calices on branch tips usually lack internal structures). Coenosteum is smooth and covered with spines.

DISCUSSION

This single specimen collected from the upper slope corresponds well with characters that Veron & Pichon (1976) described for the ecomorph of *P. damicornis* from semi-protected biotopes.

Pocillopora verrucosa Ellis & Solander,1786

MATERIAL STUDIED

18/ Ad.III, Sl, 4,5 / br

19/ Ad.VIII, Sl, 10 / br

20/ Tr.I, Sl, 2 / br

21/ Ad.III, Rf, 2.5 / br (Fig.6)

CHARACTERS

Coralla have branches of about 1-2 cm thick,with true verrucae,about 2 mm diameter.Branches are usually flattened and wider than their bases. Septa may be in 2 cycles (12 septa) as in *P. damicornis* Linnaeus or 3 cycles (24 septa). Their dentations may be hirsute. Columellae are covered with spines. Calices near branch tips usually lack internal structures. Coenosteum is covered with fine granules and spines which may be hirsute as septal dentations.

DISCUSSION

Two specimens of this collection, nos. 20 and 21 correspond well with characters that Veron & Pichon (1976) described for ecomorph of *P. verrucosa* from semi-protected biotopes. They differ from the other two which were from the bottom of the reef, due to their higher development of verrucae and the internal structure of calices.

In addition, all specimens of this series have red brown algae at the bases of coralla. This feature characterises the species (Ditlev, 1980).

Pocillopora eydouxi Edwards & Haime, 1860

MATERIAL STUDIED

16 / Tr.I, S1, 2 / cr (Fig. 7)

CHARACTERS

Corallum has branches usually thicker than 2 cm and branch ends are flattened and wide (such as 6 cm). Verrucae are 2-4 mm diameter (but the average size is greater than that of *P. verrucosa*). Septa are in 2 regular, subequal cycles. One or two directive septa may be recognised in the direction facing to the edge sides of large flattened triangular-shaped columellae. Septa are irregularly dentate. Fine granules cover through septa and columellae. Calices near branch tips may lack internal structures as other species. Flattened spines are ornamented around calices and scattered on coenosteum.

DISCUSSION

It is easy to recognise this species from other *Pocillopora* by its larger branches and especially the internal structure of calices as described above.

FAMILY ACROPORIDAE VERRILL, 1902

Colonial, hermatypic and mostly extent. Colonies are formed by extratentacular budding and have all growth forms known for hermatypic corals.

Corallites are plocoid to immersed. Septa are in 2 cycles or less. Columellae are trabecular, weak or absent.

GENUS MONTIPORA DE BLAINVILLE, 1830

Colonies are submassive, laminar, foliaceous, encrusting or ramose. Corallites are very small (less than 1 mm diameter). Columellae are poorly developed or absent. Corallite walls and the coenosteum are porous and may be highly elaborated.

Montipora cf./ allied *crassituberculata* Bernard, 1897

MATERIAL STUDIED

22 / Ad.III, Ed, 3 / br

23 / Ad.VI, Sl, 8 / br, wh-tip (Fig. 12)

24 / Ad.XI, Rf, 3 / br, pur-edge

25 / Ad.III, Sl, 3 / br.pur (Fig. 12, 13)

26 / Ad.III, Ed, 3 / br

27 / Ad.III, Sl, 3 / cr, wh-edge

28 & 29 / Rw.VI, Sl, 3 / ?

30 / Ad.III, Sl, 3/ br.gr

31 / Ad.XII, Ed, 4 / yel.br (Fig. 14)

CHARACTERS

Coralla are explanate or encrusting plates. In outline appearances corallum surfaces are ragged, because of irregular development of large tuberculae (about 3 mm diameter). Each tuberculum is a component of many hirsute, spike-like papillae, each of which is 0.35 mm diameter. On the periphery, papillae tend to be arranged into a series of fine ridges. Corallites are situated on or between tuberculae.Calices are 0.5-0.9 mm diameter. Septa appear as vertical rows of non-tapered spines

arranged into 2 cycles. Primaries are 3/4 R and secondaries are about half of this, but usually in complete. Directives may be recognised and may be fused at inner centres. Thecae are the components of surrounding papillae which extend to cover all coenosteal surfaces. On undersurfaces, calices are of uniform small size (0.5 mm diameter). They may be immersed on even surfaces comprising of small reticular papillae, or exsert with thecal papillae.

DISCUSSION

Author could not certainly place this series of specimens into *M. crassituberculata* by the description given by Veron & Wallace (1984). By an large, specimens closely resembles the PMBC specimen labeled for the latter species by Veron. This specimen, however, has large tubercular ridges (about 1.5 mm diameter), the structures of which are poorly developed in specimens of this series, except specimens nos. 22 and 23 . Nevertheless, size of ridges is probably not of taxonomic significance, since fine ridges are present in specimen figured 312 shown in the literature of the mentioned authors.

Othor variations among specimens are rather obvious. Growth forms show cup or funnel-shaped, whorl-shaped, horizontally explanate or evenly encrusting explanate. In the latter two growth forms, irregular branches (or nodules), up to 2.5 cm high are usually developed on plates. This case also occurs in PMBC specimen. Thickness of corallum peripheries ranges from 1.5-4.5 mm. Primary septa in cup or whorl-shaped specimens tend to extend out of calices (in which case Betterton,1981 had described for *M. informis* of the Malaysian reef). On the undersurfaces of the two specimens, nos. 24 and 28, large irregular tubercu-

lae are developed with a tendency of further growth to be small laminae. (up to 1 x 2,5 cm).

Although specimen no, 27 has the general appearance or the others, calices are rather smaller (all uniformly 0,5 mm diameter) and its plate is extremely thin (1.3 mm on edge). These two characters are noted by Veron & Wallace to characterise *M. aequituberculata* Bernard , the most allied species.

Specimen no. 31 seems to be at the extreme end of the variation among specimens of this series. It has a neat appearance and closely resembles specimen no. 30, but spines of papillae are much more hirsute.

Since all specimens were collected from a similar biotope,it is difficult to discuss the differences among specimens in relation to environmental condition.

Montipora cf. *efflorescens* Bernard, 1897

MATERIAL STUDIED

33 / Ad.I, Rf, 0.5 / yel.br, d,br (Fig.15, 16)

34 / Ad.XII, Rf, 1 / br

35 / Ad.III, Rf, 2.5 / br, yel.br

36 / Ad.XII, Rf, 3 / yel.br

37, 39 & 40 /Ad.III, Rf, 2.5 / yel.br, pur-edge

38 / Ad.III, Rf, 2.5 / yel.br, pur-edge (Fig.15, 17)

41 / Ad.I, Rf, 3 / d.br, yel-tip

CHARACTERS

Coralla are massive, encrusting (submassive) or horizontally ex-

planate (approximately 3 mm thick on peripheries). In the latter case, small corallites are occasionally differentiated on undersurfaces.Coral-lum surfaces are irregularly mounded with globular protuberances of about 2-10 mm diameter. Corallites are scattered regularly on surfaces. Calicu-lar diameter is uniform or becoming slightly smaller near plate peripher-ies. It ranges from 0.5-0.8 mm . Septa consist of vertical rows of spines arranged into 2 cycles ; primaries are 1/2-3/4 R, secondaries are 1/3 R . Directives are usually distinguished and joined (either with primaries) at centres. Calicular synapticulothecal walls are partly separated from coenosteal matrix. Reticulum and thecal papillae may be equal or unequal (see discussion) and in general thecal papillae incompletely encircle calices. Thecal papillae are sometimes fused into narrow laminae.

DISCUSSION

This series of specimens have very close affinities to *M. efflores-cens* described by Veron & Wallace (1984), however some characters show variation from that species description and can be confused with *M. hispida* Dana . According to Veron & Wallace, *M. efflorescens* is dis-tinguished from *M. hispida* by having thecal and reticulum papillae of almost uniform size, ie., they are seldom clearly differentiated,whereas *M. hispida* has thecal papillae of clearly larger size than reticulum papillae . Among specimens here, those thecal papillae on globular pro-tuberances are usually more prominent than reticulum papillae ,but this difference is usually indistinct or has disappeared on smooth surfaces of coralla (with the exception of specimen no.36 which already shows papillae of uniform size).

Although all explanate plates here have generally less developed pro-

tuberances, but thecal papillae, especially of specimen no.37 are obviously prominent than reticulum papillae as shown in Fig.219 in literature of Veron & Wallace. However,this character does not show this specimen to be *M. hispida* , since it is in contrast to what the latter authors have noted, " papillae may be completely absent on plate-like coralla " .

The young specimen, no.41 which is encrusting and partly explanate has thecal papillae fused often as cylinders around calices. This specimen is thought to be *M. grisea* Bernard. However, this appearance of papillae may occur on the tops of protuberances in other specimens of this series.

Four coralla, nos.37, 38,39 and 40 form large explanate plates,about 1 m in diameter. With exception to the growth form, their skeletal structures are similar to those of the other specimens of this series.However, they are thought to be *M. peltiformis* Bernard, because of their foliaceous growth form.

These deviated characters may concern about ecomorphs of the species, however,a number of series of specimens are needed more to prove such hypothesis.

Montipora hispida Dana, 1846

MATERIAL STUDIED

42 / Ad.I, Rf, 2 / yel.gr, br

43 / Ad.III, Rf, 2.5 / ? (Fig. 22, 23)

44 / Ad.VI, Sl, 10 / br, wh

493 / Ad.III, Ed, 3 / br

CHARACTERS

Coralla are encrusting (may be with explanate peripheries), or explanate, sometimes with digitate structures at central areas. Corallites exsert slightly by means of raising of ring-like thecal walls (as collars) and thecal papillae which are fused or growing on thecal walls. Those corallites on concave surfaces are usually immersed. Calices are 0.6-0.8 mm diameter (but may be 0.45 mm near plate peripheries). Septa are of vertical rows of spines arranged into 2 cycles; primaries are up to 3/4R, secondaries are slightly shorter but may be absent. Directives are slightly thicker than others. All septa tend to curve out of calices. Thecal papillae are almost always prominent than reticulum papillae, except in the case where corallites are immersed, papillae are equal.

DISCUSSION

Other than growth form, the appearances of papillae vary markedly among different specimens. Specimen nos. 43 and 44 which fit the description of *M. hispida* have papillae with open-elaborated tips (thecal papillae are of ridged, twisted blades with thin long spines flaring out), where as the doubtful specimen no. 42 has papillae much more densely elaborated, giving the thick appearance. The latter specimen tends to develop small tubercles to support corallites situated at central area other than collar-like thecal papillae which usually occur on explante parts. These structures of papillae may not deeply concern with taxonomic significance of the species, since those figures shown in monograph by Veron & Wallace (1984) are also of wide range of papillae development. The confused point appeared here is a dense

arrangement of corallites (usually less than 1 mm apart) on undersurface of specimen no. 42. This case contrasts to what Veron & Wallace noted, ie., corallites are widely spaced on undersurface.

Specimen no. 493 is more similar to specimen no. 42 in having slightly larger corallites than those of other two. Its papillae are of the same manner as specimen no. 43 and also corallites on undersurface are rare and tend to aggregate into small groups. The unique character of this specimen of which sometimes occurs in others (except specimen no. 42) is the appearance of joined directive septa which give rise to the development of poorly-developed irregular columellae tangles.

Montipora cf. *spongodes* Bernard, 1897

MATERIAL STUDIED

45 / Ad.III (Fig. 27)

CHARACTERS

Coralla is thin, explanate (2 mm thick at periphery). Surface is slightly rough with small irregular tubercles (such as 1 mm diameter) which either partly support corallites or scatter between corallites. All corallites are immersed, with calices of 0.7 mm diameter. To the naked eye, calices are not circular but star-shaped as a consequent of well developed septa. Septa are in 2 cycles:primaries are wedge-shaped blades, with dentate margins, or may be vertical rows of spines, about 1/4 R. Coenosteum and tubercles are covered with simple spines or flattened spines with forked tips. Undersurface calices are 0.5-0.7 mm diameter. Septa of both orders are a mixture of dentate blades and rows

of spines (more irregular than those on upper surface). The marked appearance is the slightly raised walls which are seen even by the naked eye to be separated from coenosteum matrix by surrounded grooves. Walls and coenosteum are covered mostly with pointed spines.

DISCUSSION

This single specimen is probably the true *M. spongodes* if calice diameter is not less than range 0.7-0.8 mm, given by Veron & Wallace (1984).

In other manner, it is somewhat similar to *M. hispida* which Veron & Wallace (1984) had noted for the explanate specimen of this species, ie., papillae may be completely absent on plate-like coralla. However, as described above, structures of septa are different, and the dense arrangement of undersurface corallites of *M. spongodes* is also distinguished character.

Montipora cf. *tuberculosa* (Lamarck, 1816)

MATERIAL STUDIED

46 / Ad.XII, Rf, 0 / yel.gr

47 / Ad.VI, Sl, 5 / yel.gr.br

48 / Ad.I, Rf, 2.5 / pur.br,yel.br

49 / Ad.III, Sl, 3 / cr (Fig. 18)

CHARACTERS

Coralla are encrusting to massive, with irregular mounded surface. Calices are 0.6-0.7 mm diameter (or may be smaller on peripheries),

Those on mounds are usually partly exsert by papillae while those on concave areas between mounds are immersed on smooth surfaces. Septa are of vetical rows of spines or blades (specially for directive ones) with dentate margins, being arranged into 2 cycles; primaries are 2/3-3/4R, secondaries are 1/3R or absent. Directive septa may fuse deep within calices. The ring-like thecal walls are partly-separated from coenosteal matrix. Elaborate-tipped spines covering coenosteum are of the same structures as those papillae.

DISCUSSION

The description above is specially designed for specimen no. 49, since the series of specimens listed above, although having most of characters in common, shows some variate appearances. With regard to papillae, specimen no. 46 is by and large similar to fig. 13 (presented for *M. tuberculosa)* or even to fig. 67 (present for *M. turtlensis)* in the literature of Veron & Wallace (1984). However, the latter figure has papillae more cone-shaped, while other specimens have papillae usually fused to encircle corallites as shown in fig. 15 (*M. tuberculosa)* of that text. These different appearances are probably variations of *M. tuberculosa* (although some confusion with *M. turtlensis* still exists)

Specimen no. 47 also, has a unique appearance of the calices, ie. calices are usually larger (0.9 diameter) and conical shaped (instead of cylindrical as in others). This may be a different species.

Montipora cf. *undata* Bernard, 1897

MATERIAL STUDIED

50 / Ad.III, Rf, 2.5 / yel.gr (Fig. 20, 21)

51 / Ad.

CHARACTERS

Coralla are thick contorted plates, with irregular columns or knobs. Calices are immerse within wooly tubercles which are fused into ridges. On the top of corallums, tubercular ridges form a pattern of flame-shaped projections. Calices are usually 0.6-0.7 mm diameter. Septa are of vertical rows of spines arranged into two cycles; primaries are up to 1/2R, secondaries are up to 1/4 R or absent. Coenosteal reticulum and tubercles are covered with slender pointed spines or with thin blades with tips forking into slender spines.

DISCUSSION

These two specimens have characters very similar to *M. undata* which was described by Veron & Wallace (1984). However, some features are found to be not excactly the same, ie., tubercles on corallum plates are simply fused irregularly to enclose calices (although unfused individual tubercles also occurred).According to Veron & Wallace (1984),these tubercles on plates are usually parallel and perpendicular to the corallum margins. In this case ridges are very long as shown in their Fig.120 and 121 . In the specimens here, ridges which are perpendicular to margins are obsolete, ie., they appear only up to 0.5 cm from margins. Another different character is the size of calices. The range of sizes mentioned above is slightly larger than that mentioned by Veron & Wallace.

The only distinct difference between these two specimens is the development of septa . Septa (of both orders) in specimen no. 51 are much more irregular than those of specimen no. 50 .

All these differences assumed to reflect variations within *M. undata*; however, more specimens are needed to support this assumptiom.

Montipora verrucosa (Lamarck, 1816)

MATERIAL STUDIED

52 / Ad.XII, Rf, 3 / br, yel.cr, pur

53 / Ad.I, Rf, 5 / yel.gr

54 / Ad.XI, Rf, 3 / cr, yel.gr-edge (Fig. 26)

CHARACTERS

Coralla are explanate, usually partly ramose. Surfaces are covered with verrucae which are approximately 2 mm across and show a tendency to fuse into smooth ridges running between verrucae. Calices are usually 0.9 mm or sometimes up to 1.2 mm diameter (young calices on peripheries are smaller than this range). Septa are of vertical rows of irregular tapered spines (usually twisted) arranged into 2 cycles; both are subequal, up to 2/3 R, or secondaries are much smaller to absent . Septa of the first cycle are often irregularly fused deep within calices, sometimes giving the appearance of the rudimentary columellae. The open spongiose reticular coenosteum and verrucae are similarly covered with simple pointed- or forked flattened- or elaborate-tipped spines.

DISCUSSION

Characters described above correspond very well to those described

by Veron & Wallace (1984). Variation among the few specimens here is not distinct.

Montipora digitata (Dana, 1846)

MATERIAL STUDIED

55 & 57 / Ad.XII, Rf, 0 / br (Fig. 28, 31, 32, 33)

58 / Ad,XII, Rf, 0 / br (Fig. 29)

56 / Ad.

59 / Ad.XII, Rf, 1 / br, wh-tip

60 / Ad.XI (Fig. 28, 30)

CHARACTERS AND DISCUSSION

Coralla are digitate, sometimes with encrusting bases. Variation among different coralla is distinct even though most of specimens are from the same locality and same habitat.

According to Veron & Wallace' s (1984) conclusions about the appearances of ecomorphs of *M. digitata*, specimens of this series may be separated into 3 groups with respect to size of branches and calices as follows:

Group 1: Specimens nos.55 & 56 have branches of 0.5-0.9 cm thick and calices of 0.3-0.5 mm diameter. Branches of no.55 are oval in cross section while those of no.56 are flattened and highly anastomosed in the vertical plane. Corallum surfaces are glabrous. Septa of both cycles are irregularly dentate blades and are subequal (about 1/2 R).

Specimen no.59 has reticulum ridges and well excavated corallites. These characters were noted by Veron & Wallace for coralla from a sub-

tidal biotope. However, no.59 is not excactly of the same type since calicular diameter is smaller than that (0,8 mm) given by Veron & Wallace.

Specimen no.58 is slightly ridged. Branch tips are highly proliferate, giving a very compact corallum.

Septation of specimens nos.58 & 59 is the same; primaries are of irregularly dentate blades, up to 2/3 R, secondaries are spines, less than 1/4 R, or absent. Directives are usually distinguished.

Group 2: Specimen no.57 has primary branches of 1 cm thick, but they become highly anastomosed, giving a stout appearance. Some side branches are small and identical to those of specimen no.58 . Calicular diameter is 0.5-0.8 mm . Surface is glabrous or slightly ridged. Primaries are blade-like, with nearly smooth margins, up to 2/3 R (more exsert towards inner calicular centres, giving cone shape to calices). Secondaries appear as small ridges or rows of spines, less than 1/4 R.

Group 3: Specimen no.60 has main branches of 1.5 cm thick (becoming tapered towards the tips). Calices are 0.8 mm diameter and are excavated with reticulum ridges; however, lower parts of branches and branch sides, where light intensity is limited, are rather glabrous. Both primary and secondary septa are spines of irregular length (even in the same row). Directive septa are blades and usually join deep within calices. The specimen is from a subtidal reef flat and it appears to correspond with those coralla from a reef slope noted by Veron & Wallace (1984).

In all specimens, coenosteal reticula are covered with a combination of flattened spines (with either smooth or slightly elaborated margins) and simple pointed spines, although the former are dominant.

Montipora angulata Lamarck, 1816)

MATERIAL STUDIED

61 / Ad.XI, Rf, 2 / br, yel.edge (Fig. 24, 25)

62 / Ad.

CHARACTERS

Coralla are digitate, with encrusting to explanate bases. Branches are flattened, more or less 1 cm thick, and usually fused into plates. Corallum surfaces are strongly ridged. The reticulum ridges may enclose the short series of corallites or individual corallites, giving the appearance of foveolate corallites. Corallites are immerse, with calices of 0.6-0.8 mm diameter. Septa are of vertical rows of tapered spines arranged into two cycles; both are subequal, up to 1/2 R (but secondaries are usually incomplete). They are usually irregularly fused deep within calices, forming rudimentary columellae. Directive septa are never distinguished. The flattened thecal rings are partly separated from coenosteal reticulum. The foveolate tuberculae are covered with simple pointed- or forked spines with tips slightly elaborated.

DISCUSSION

The two specimens here only differ from those in the literature of Veron & Wallace (1984) in having more potential to develop ridges. In contrast, on undersides of branches of specimen no. 62, corallites are completely glabrous.

Montipora sp. 1

MATERIAL STUDIED

63 / Ad.XI, Rf, 3 / br,pur.br-edge (Fig. 34, 35)

CHARACTERS

The corallum is a young thin plate. Each calice (about 0.7 mm diameter) is immersed in a tubular tubercle, 1.3 mm diameter and up to 2 mm long. Septa are of vertical rows of irregular spines or broken blades arranged into two cycles:primaries are 2/3 and secondaries are 1/4R.Directives are rarely recognised. Tubercles and coenostea are densely covered with extremely hirsute spinules.. Tubercles on periphery are formed into fine ridges as are those in specimens conferred to *M. crassituberculata*. On the under surface also, structures are similar to those described for *M. crassituberculata* but are much finer.

DISCUSSION

The outline appearance of this specimen is very similar to *M. incrassata* Dana, the species which has distinct tubular tubercles. However, structures of spines covering tubercles and coenosteum are much different. In other respect, it is also somewhat similar to some specimens conferred to *M. crassituberculata*, but structures of the spinules are greately different in size.

GENUS ACROPORA OKEN, 1815

Colonies are usually ramose to arborescent, bushy or plate-like or rarely encrusting and submassive. Corallites are of two types, axial

and radial. Colomellae are absent. Corallite walls and the coenosteum are porous.

Acropora (Isopora) palifera (Lamarck, 1816)

MATERIAL STUDIED

64 & 66 / Ad.III, Sl, 2.5 / br (Fig. 36, 37)

67 / Ad.III, Rf, 1 / br

CHARACTERS

Coralla have wedge-shaped branches and show a tendency to form encrusting bases. Branches are generally 2 cm thick and their width varies accordingly to the degree of their anastomosis. Axial corallites, which are irregularly scattered on tops of branches, may be easily distinguished from the intermixed radial corallites by their complete circular, large and thicker calicular walls. Radial corallites have variable size, about 1-1.5 mm diameter. The smaller ones, with calices 0.5 mm diameter, are dominant on lower parts of branches while the larger ones, with calices 1 mm diameter (or up to 1.2 mm, the size of axial calices) are dominant on upper parts. They tend to be nariform or sometimes cochleariform. Two cycles of septa are usually complete and subequal, 1/3-1/2R, with slightly larger directives (this pattern is same with that of axial corallites). Septa are strongly irregularly dentate. Coenosteum is densely covered with flattened spines with elaborate tips.

DISCUSSION

The series of specimens placed for this species corresponds fairly well with those described by Veron & Wallace (1984). Since they are from the same habitat, upper slope (except specimen no. 67 which is from shallow reef flat), variation among them is not obvious. As an exception to the above description, some specimens have radial corallites which develop unequal septa; primaries are up to 3/4R and secondaries are 1/3R or absent and septal margins are subentire. These characters are not obviously related to environmental influence.

Acropora (Acropora) nobilis (Dana, 1846)

MATERIAL STUDIED

68 / Ad.I, Rf, 3 / br

69 / Ad.XII, Rf, 3 / br.yel.gr,wh-tip (Fig. 44, 45)

70 / Ad.I, Rf, 3 / br,pur-tip

467 / Tr.IV, Sl, 3 / br

CHARACTERS

Coralla are openly arborescent, with branches of about 1.3-2.5 cm diameter. Axial corallites are about 2 mm exsert,2.7-5.0 mm diameter, with calices of 0.9-1.8 mm diameter. Primary septa are 1/2-3/4R and secondary septa are up to 1/4R. Radial corallites are of mixed sizes and shapes. The long ones are tubular, up to 4 mm long and with strongly dimidiate openings. They exsert from 45^{o}-90^{o} to branches. The small ones are subimmersed, with nariform or dimidiate openings. Primary

septa are 1/4-1/3R and secondary septa are up to 1/4R or absent. All corallites are strongly costate with coenosteum between corallites openly reticulate with simple spinules.

DISCUSSION

Two of the specimens in this collection, nos. 68 and 69 have the typical characters of the species as described above. In contrast, specimen no. 70 shows markedly different character, ie. radial corallite openings are almost always oblique or circular. If these characters are variations of *A. nobilis*, then specimen nos. 68 and 70 are probably a couple of genotypic variants, since they were from the same habitat. On the other hand, the oblique or circular openings of radial corallites are relatively large, of a size within the limits given by Wallace (1978) for *A. grandis*. However, the *A. grandis* specimen of PMBC has radial corallites of a larger size (up to 1.9 mm diameter) and these carallites always protrude at right angles on the sides of branches. This difficulty causes some uncertainty in placing specimen no. 70 in either *A. nobilis* or *A. grandis* at present. As mentioned by Wallace, these two species may have a close relationship and they require further study in a field.

Specimen no. 467 is an exceptional case as regards the dimension of its colony , ie., its branches grew up to 0.9 m high and 5.5 cm in diameter.

Acropora (Acropora) formosa (Dana,1846)

MATERIAL STUDIED

71 / Ad.I, Rf, 1 / br, wh-tip (Fig. 40, 41)

72-76 / Ad.XII,Rf, 3 / br, pur-tip & wh-tip

CHARACTERS

Coralla are openly arborescent with branches up to 2 cm diameter. Axial corallites are about 1.5 mm exsert and 2.3-3.0 mm diameter, with calices of 0.9-1.2 mm diameter. Primary septa are about 3/4R and secondary ones are up to 1/4R. Radial corallites near branch tips are usually tubular, of equal size (about 3 mm long) while those on the lower part range from subimmersed to tubular. Their openings are round or oblique. Primary septa are well developed (about 3/4R) but secondary ones are poorly beveloped or absent. Directive septa are slightly larger than the primary ones. Corallites are broken costate and tend to have an arrangement of elaborate spines on their upper walls. Between radial corallites, coenosteum is reticulate with simple spines.

DISCUSSION

This is the dominant species of *Acropora* in the study area. the marked variation among specimens involves the development of radial corallites. Radial corallites may be neatly arranged in rows along branches or have a tendency to be irregularly scattered. In the latter case, eg., specimen nos. 71 and 72, the prominent corallites, which have similar structures as those of axial corallites, usually develop along branches, giving coralla ragged in appearance. this may be used as a clue for field diagnosis of this spenies.

Acropora (Acropora) sp.1

MATERIAL STUDIED

77 / Ad.II, Rf, 1 / cr

78 / Ad.II, Rf, 2 / br (Fig.43, 46)

CHARACTERS

Coralla are openly arborescent, with slender, solid branches tending to grow vertically. They are rarely branching, so that branches are up to 30 cm long. Branches are 1.5 cm thick. Axial corallites are 2.5 mm exsert, 2.8-3.5 mm diameter, and with calices of 0.8 mm diameter. Primary septa are 2/3 R and the secondary ones are 1/3 R. Radial corallites are of mixed sizes, those of the small ones may face downwards or in other directions. All radial corallites are subimmersed or tubular appressed with circular or nariform openings. Primary septa are 1/3 R and secondary ones are 1/4R. Costae and coenosteum develop in the same maner as *A. formosa* (see p.30).

DISCUSSION

The above description applies excactly to specimen no.78 . Specimen no.77 is similar but some structures are larger, eg., branches are thicker (up to 3 cm), and axial corallites and calices are larger (4 mm and 1.4 mm diameter respectively). Furthermore, in specimen no.77, radial corallites have more well developed septa, ie., septa of both cycles may reach 1/2-3/4 R . These two specimens are mostly similar to *A. formosa* but their branching pattern and development of corallites are rather unique . More specimens of this type from this area are needed for identification at species level.

Acropora (Acropora) valenciennesi (Edwards & Haime,1860)

MATERIAL STUDIED

79 / Ad.II, Rf, 2.5 / br, pale pur-tip

80 / Ad,I

CHARACTERS

Coralla are openly arborescent, with fragile branches of 0.8-15 mm thick. Axial corallites exsert up to 3.3 mm . They are 2.8 mm diameter, with calices of 1.2 mm . Primary septa are 1/2-1 R and secondary septa are usually absent. Radial corallites are of mixed sizes ranging from immersed to appressed tubular. Their openings are rounded, becoming oblique or dimidiate accordingly to the longer corallites (up to 4 mm) near branch tips. Both primary and secondary septa are poorly developed, sometimes only directive septa appear. Radial corallites are neatly costate and the coenosteum between them is openly reticulate with simple or laterally flattened spines.

DISCUSSION

These two specimens fit the description for *A. valenciennesi* given by Wallace (1978). Variation between them is rather obvious, ie. , radial corallites of specimen no.80 are neatly arranged through the whole branches, in contrast to specimen no. 79, which has corallites rather ragged in appearance, since they are more prominent and widely spaced. This latter condition was also noted in specimens from turbid water by Wallace (1978). However, the both two specimens of the present collection were obtained from the same habitat, where the water was turbid.

Acropora (Acropora) horrida (Dana, 1846)

MATERIAL STUDIED

81 / Ad.I, Rf, 3 / pale gr, yel-tentacle (Fig. 47,49)

CHARACTERS

Corallum is arborescent, tending to form more branches on upper part, giving a bushy appearance on top. Branches range from 0.7-2.0 cm thick. Axial corallites are usually oval, 2.7-5.5 mm across,with calices of 0.9-3.0 mm across. Primary septa are 3/4 R and secondary septa are 1/3R. Radial corallites, although having subequal circular openings (about 0.85 mm diameter), are irregularly developed, ie.,they vary from immersed to appressed tubular and also are irregularly oriented. Those on main branches are usually immersed to subimmersed. They are widely spaced through whole branches. Primary septa are 1/4 R while secondary septa are usually absent. Protuberant radial corallites near branch tips are costate, while those on lower parts are openly reticulate,with forked spinules similar to those on the coenosteum.

DISCUSSION

Although this single specimen appears to be more closely similar to Fig. 616 of *A. tortuosa* Dana in the monograph by Veron & Wallace (1984) than it does to Fig. A plate 56 of *A. horrida* dana in Mem Qd Mus., by Wallace (1978). However its radial corallites have smaller calices than those of *A. tortuosa*, which range from 1.0-1.3 mm diameter (Veron & Wallace, 1984), but correspond well with the range of 0.6-0.9 mm for *A. horrida* (Veron & Wallace, 1984).If the extending of polyps during

the day is a rule for *A. horrida*, then this specimen should be *A. horrida* since its polyps also extended in the day-time. However, its axial corallite diameter is much larger than that mentioned by Wallace (1978). Further collections of this type of specimen should be made in order to gain more understanding of the variation of this species.

Acropora (Acropora) vaughani Wells, 1954

MATERIAL STUDIED

82 / Ad.XII, S1, 3.5 / cr, wh-tip (Fig.48, 50)

CHARACTERS

Corallum is arborescent with branches of about 1 cm thick. Axial corallites are 2.0-2.4 mm diameter, and with calices of about 0.9 mm diameter. Primary septa are 3/4 R and secondary septa are 1/4 R or absent. Radial corallites are subimmersed at branch bases, becoming tubular appressed near the tips. Their openings are circular to slightly oblique with diameter of 0.5-0.9 mm . They usually face at approximately 90^{o} from branch side and tend to face upwards near tips. Two cycles of septa are usually complete. Primaries are 2/3 R and secondaries are 1/4 R.The coenosteum is composed of fine, closely compacted spinules with elaborated tips, except near branch tips where the coenosteum is still costate on new corallites.

DISCUSSION

This single specimen has characters which fit well with the description given by Veron & Wallace (1984). In addition, the small rounded

Acropora (Acropora) aspera (Dana, 1846)

MATERIAL STUDIED

85, 86 & 89 / Ad.III, Rf, 1 / br.gr.yel., wh-tip

87 / Ad.XII, Rf, 0 / yel.gr.br, wh-tip (Fig. 51, 54)

88 / Ad.XII, Rf, 0 / gr.pur.br, pur-tip

90 / Ad.I, Rf, 3 / br, wh-tip

91 / Ad.XII, Rf, 3 / br, bl-tip

92 / Ad.XII, Rf, 0 / gr.yel, d.br, wh-tip

CHARACTERS

Coralla are corymbose or sometimes arborescent, with relatively short branches of about 1-2 cm thick. Axial corallites range from 2.5-4.5 mm diameter, with calices of 1-2 mm diameter. Septa of 2 cycles are subequal, 1/3-3/4 R . Radial corallites are usally of subequal size,with circular calices of about 0.8 mm diameter, having only lower walls developed as lips, which may be thick or pointed. Both cycles of septa are poorly developed, sometimes only directive septa appear up to 1/4 R . Coenosteum is costate on radial corallites and openly reticulate with flattened spines in between.

DISCUSSION

According to Veron & Wallace (1984), *A. aspera* is a very polymorphic species. In this collection, specimens show distinct variations both in growth form and calicular structures corresponding well with descriptions in the literature. Another variation noted here is shown by two specimens, nos. 85 and 86, which were collected from an exposed

radial corallites with tiny circular openings seem to be a typical character of this species.

Acropora (Acropora) pulchra (Brook, 1891)

MATERIAL STUDIED

83 / Ad.XII, Rf, 1.5 /yel.br, d.br, wh-tip

84 / Ad.XII, Rf, 1.5 / yel.br, d.br, wh-tip (Fig. 55, 57)

CHARACTERS

Coralla are usually small, caespitose, with branches of up to 1 cm thick. Axial corallites are about 2.8 mm diameter, with calices of 0.8-1.1 mm diameter. Primary septa are 1/2-3/4 R and secondary septa are 1/4 R or absent. Radial corallites are of mixed sizes (more than two sizes), with circular calices ranging from 0.5-1.0 mm diameter. Their lower walls are well developed and usually swollen, while the upper walls are poorly developed, giving the character of tubular appressed, with nariform to dimidiate openings. Primary septa are up to 2/3 R and secondary septa are 1/4 R or absent. Coenosteum is costate on radial corallites and openly reticulate with very unevenly arranged flattened spinules.

DISCUSSION

According to Veron & Wallace (1984), *A. pulchra* has the closest affinity to *A. aspera* . Moreover, a hybrid appearance sometimes occurs (Wallace, 1978). However, in this study, the two specimens are already distinguished from *A. aspera* by the distinct appearance of radial corallites of mixed sizes and the tendency of corallites to develop nariform or half tubular as was the case noted by Crossland (1952).

reef front and have a costate coenosteum, with fine dentations on margins of the laminae. This appearance has not been found in other specimens inhabiting the same type of environment.

Acropora (Acropora) florida (Dana, 1846)

MATERIAL STUDIED

93 & 94 / Ad.XII, Rf, 3 / d.br,or.br-tip

95 / Ad.XII, Rf, 3 / wh,or.br-tip

96 / Ad.XII, Rf, 3 / gr.cr,or.br-tip

97 / Ad.XII, Rf, 2 / pur.br,pur-tip

98 / Ad.XII, Rf, 3 / or.br

99 / Ad.XI, Ed, 3 / br (Fig. 52)

100 / Ad.XII, Rf, 3 / cr

CHARACTERS

Coralla are sturdy openly arborescent, with many short secondary branchlets forming hispidose structures. Main branches range from 1 cm to nearly 4 cm thick, secondary branchlets are up to 2 cm long and 8 mm thick. Axial corallites are 2.9-3.7 mm diameter, with calices of 1.1-1.7 mm diameter. Axial septation is very variable among different coralla; primary septa are 1/4-3/4R, with their lower parts more exsert than those on upper calicular walls or may be equally developed, secondary septa may be slightly smaller than first ones or appear as small dentations or be absent. Radial corallites range from immersed to tubular appressed with circular, dimidiate or nariform openings of 1.1 mm diameter. Septation is also very variable; primary septa may be laminar

with dentate margins or series of spines of 1/4-3/4R, secondary septa usually appear as series of smaller spines or absent. Coenosteum is broken costate on radial corallites and reticulate with flattened spines in between.

DISCUSSION

As noted by Wallace (1978), this species is highly variable in 2 aspects, namely, shape of colony and density and prominence of secondary branchlets. As specimens of this collection were generally collected from similar types of environment, non-exposed reef flat to edge zone, variation among specimens is not obvious except in the thickness of the main branches. Nevertheless, this thickness is more related to age of the colony. It should be noted that colour of living colonies is highly variable even in a single biotope.

Acropora (Acropora) hyacinthus (Dana, 1846)

MATERIAL STUDIED

101 / Ad.III, Rf, 1 / br,gr,bl-tentacle

102 & 103 / Ad.III, Rf, 1 / br.gr,gr-tentacle

104 / Ad.III, Rf, 1 / br,yel

105 / Ad.XII, Rf, 1 / br (Fig. 53, 56)

106 / Ad.II, Rf, 1 / br,wh-tip

CHARACTERS

Coralla are flattened corymbose plates, with branchlets, usually 1.5 cm long and 4 mm thick. Axial corallites are 1 mm exsert, 1.9-2.2 mm

diameter, with calices about 1.1 mm diameter. Septation is very variable among different coralla; septa of two cycles are usually subequal (or secondary septa may be absent), ranging from 1/3R to nearly 1R. Radial corallites on branchlets have only lower walls developed as rounded thin lips. Those on main branches are immersed, with rounded opening about 0.9 mm diameter. Septation is very poor; usually only directive septa and few spines are developed. Coenosteum is strongly costate on radial corallites and very spongiose, sometimes with flattened spines in between.

DISCUSSION

All specimens identified as *A. hyacinthus* here are from shallow water and their characters correspond well with those described by Veron & Wallace (1984). Specimen no. 106, however, has some different characters from above. It is a young colony in vasiform stage of development, the case that Wallace (1978) has referred to as Dana's type. In addition, this specimen has relatively thick radial (and axial) corallites, which are flaring on thin margins of the outer walls, and their subequal septa of 2 cycles are almost always well developed, almost fusing in inner calicular centres. This strong development of septa is probably the same aspect that Wallace noted.

Acropora (Acropora) clathrata (Brook, 1891)

MATERIAL STUDIED

107 / Ad.I, Rf, 2.5 / br,pur-tip (Fig. 58, 59)

108 / Hn.I, Sl,6 / gr.br,br,pur

CHARACTERS

Coralla are generally formed by anastomosing of branches in a horizontal plane, with some branchlets grow obliquely. Degree of branch anastomosis is variable; coralla may be open networks to solid plates. Branches are usually 7-10 mm or up to 3 cm diameter. Axial corallites usually appear at corallum periphery since corallum extends horizontally. They are 2.3 mm in diameter, with calices 1 mm in diameter. Primaries are less than 1/4R or 1/2R (directives are slightly more extended at inner calicular centres) and are dentate; secondaries are usually absent. Radial corallites are tubular appressed becoming tubular, up to 3 mm long, towards corallum periphery. The tubular appressed corallites have nariform openings while tubular ones have circular, oblique or dimidiate openings of the same diameter, about 0.6 mm. They usually project upwards except those inclined ones on corallum periphery. Primary septa develop as incomplete series of spines, 1/4R (directive septa are usually more developed as broken laminae), secondary septa are absent. Coenosteum is costate on radial corallites and reticulate with some flattened spines in between.

DISCUSSION

The couple of specimens above do not raise any problems for identification of this easily recognised species. A minor character which deviates from those description by Veron & Wallace (1984) is the development of septa, especially those of prominent corallites; all septa are almost absent except those directive septa which appear as small series of spines. In contrast with their description of well

developed septa (perhaps 3/4R for primaries). This is probably reflects variation in a different geographic range. Variation between the two specimens here is also obvious, ie. specimen no. 108 has radial corallites almost always strongly dimidiated (except those on undersurface of branches and of cyst-like, abnormal surface), while the other specimen has the pattern of radial corallites as described above.

Acropora (Acropora) humulis (Dana, 1846)

MATERIAL STUDIED

109 / Ad.XII, Rf, 2 / br,wh-tentacle (Fig. 60, 63)

110 / Ad.XII, Rf, 2 / gr,br,gr-tentacle

CHARACTERS

Coralla are caespitose, with broad encrusting bases and branches of 1-1.7 cm thick. Branch tips are rather obtuse, with axial corallites slightly exsert up to 1 mm and 4 mm diameter and calices of up to 1.5 mm diameter. Septa of 2 cycles are subequal, 1/4-1/3R. Radial corallite are intermixed of 2 sizes. The large ones are tubular, 2.8 mm diameter, with oblique to nariform openings 1 mm diameter and protrude more, up to 3.5 mm, towards the middle of branches. The small corallites are tubular appressed, with less developed outer walls, giving them a smaller appearance although their nariform openings are subequal to the previous ones. All corallites on lower parts of branches are subimmersed to immersed, of equal openings. Primary septa are < 1/4R and secondary septa are absent or weakly developed. Coenosteum is costate or reticulate with simple or flattened spines on radial corallites and

reticulate with spongy appearance in between.

DISCUSSION

The two specimens of this collection fit well with those described by Wallace (1978), Grigg et al. (1981) and Veron & Wallace (1984).

Acropora (Acropora) samoensis (Brook, 1891)

MATERIAL STUDIED.

111 & 113 / Tr.II, S1, 3 / br, cr, d.gr

112 / Tr.II, S1, 3 / br, cr, d.gr (Fig. 61, 64)

CHARACTERS

Coralla are caespitose, with broad, encrusting bases. Branches are about 1 cm thick, with axial corallites slightly exsert, 3.3-3.7 mm diameter, and calices of 1.4-1.6 mm diameter. Septa of two cycles are subequal, up to 1/4 R. Radial corallites are intermixed of two sizes and shape as those of *A. humilis* (see p. 41), but they are relatively smaller (large corallites are about 2.1 mm diameter). Primary septa are well developed, up to 3/4 R and secondary septa are up to 1/3 R or occasionally absent. They may be broken laminae (especially directive septa) or series of spines. Coenosteum on radial corallites is arranged with irregular flattened or simple spines (or that on new corallites are broken costae) and being openly reticulate in between.

DISCUSSION

These three specimens are from a habitat exposed to strong current. They are very similar to *A. humilis* Dana both in growth form and

corallite structures, with slightly smaller, more tapering radial corallites. However, the last character is rather different from that described by Veron and Wallace (1984), ie. radial corallites of this species have poorly developed septation. Nevertheless, radial corallites of these three specimens are identical to *A. samoensis* specimen deposited at PMBC but this specimen, which inhabited a different biotope, is caespito-corymbose. The PMBC specimen was already confirmed to be *A. samoensis* by Wallace.

Acropora (Acropora) sp. 2

MATERIAL STUDIED

114 / Ad.XII, Rf, 3 / br (Fig. 62, 65)

CHARACTERS

Corallum is caespito-corymbose, with branches about 1 cm thick. Axial corallites slightly exsert, 3-3.5 mm diameter and with calices of 1.2 mm diameter. Septation is very variable; primary septa are 1/4-3/4R and secondary septa are less than 1/4-1/3R. Radial corallites are of 2 sizes and almost identical to those of *A. samoensis* (see discussion). Coenosteum of radial corallites is irregularly broken costate. These costae have very smooth margins. Coenosteum between corallites is reticulate.

DISCUSSION

This single specimen is similar to those specimens placed for *A. samoensis* (see p.43). Although its radial corallites are equal in

size to those of the latter species, their inner walls are completely diffused on branch sides while those of *A. samoensis* are slightly developed out off branch sides, giving slightly more tubular structures. The great difference between these two species is that radial corallites of this specimen have septa of 2 cycles (and even the directive septa) equally developed. All septa are thicker towards circular walls and pointed towards centres. This character is very distinct from that of *A. samoensis* and other *Acropora* species. At present author cannot place this specimen in any variants of *Acropora*.

Acropora (Acropora) cf. *lovelli* Veron & Wallace, 1984

MATERIAL STUDIED

115 / Ad.II, Rf, 3 / ? (Fig. 66, 69)

CHARACTERS

This small corallum tends to be caespitose on single dead branch. Axial corallites exsert up to 1.5 mm, 3.5-4 mm diameter and with calices 1-1.5 mm diameter. Primary septa are nearly reaching 1R, secondary septa are 1/3R. Radial corallites are of mixed sizes; the large ones are tubular, up to 4 mm long, usually with circular or slightly oblique openings of 1 mm diameter, the small ones range from subimmersed to immersed with circular openings subequal to the previous ones. Primary septa are usually well developed, up to 3/4R, secondary ones are 1/4R or sometimes absent. Coenosteum is roughly costate on radial corallites or may be arranged with flattened spines on the old radial corallites. Coenosteum between corallites is reticulate.

DISCUSSION

This small corallum was found growing on single dead branch in a non-exposed turbid area. It remains doubtfully to be identified as *A. lovelli* since its growth form was not fully developed, although corallite structures are almost identical to a specimen, *A. lovelli*, which is deposited at PMBC, with the exception that the corallites of the latter specimen have poorly developed septation. More variants of this species are needed for study.

Acropora (Acropora) nasuta (Dana, 1846)

MATERIAL STUDIED

116 / Ad.I, Rf, 3 / br

117 / Ad.XII, Rf, 3 / d.gr.br,wh.cr-tip (Fig. 67,70)

118 / Ad.XII, Rf, 3 / br,wh.cr-tip

CHARACTERS

Coralla are corymbose or thick table form, about 8 cm high from bases. Branches are about 0.6-1 cm thick. Axial corallites are 1.5 mm exsert, 2.1-2.4 mm diameter, with calices 0.8 mm diameter. Primary septa are very variable, from 1/4-3/4R; secondary septa are absent or just visible. Radial corallites are tubular appressed, 2-4 mm long and 1.4-1.7 mm diameter, with elongate nariform openings. They become subimmersed to immersed, with calicular openings of about 0.5-0.8 mm diameter, towards main branches. Septation is very variable in different specimens (see discussion). Coenosteum on radial corallites is arranged

with simple or elaborated spinules or sometimes spinulose costae. That between radial corallites is reticulate, with spinules which are usually arranged in rows.

DISCUSSION

Although these three specimens were collected from the same habitat which has high assemblage of *Acropora* species, they show variations that raise confusion with *A. cerealis* Dana, the species that Veron & Wallace (1984) report is closest in affinity to *A.nasuta*. Especially in specimen no. 118, radial corallites have lower walls developing into long, hook-like processes, the structures that were noted to characterise *A. cerealis*. However its growth form thicker and less anastomosing branches separates its from *A. cerealis* (Veron & Wallace, 1984). In contrast, those radial corallites of specimen no. 116 are completely nariform and those of specimen no. 117 fall in between the other two. In another aspect, septation of the first specimen is well developed into 2 cycles, 1/2R and 1/3R, while in the second specimen usually only primary septa occur up to 1/3R, which in the last specimen both cycles occur but the secondary septa are usually incomplete in cycle. These 3 specimens are probably represent a continuous variation of the species. However, the single environment of these specimens precludes the use of environment as an explanation of this variation.

Acropora (Acropora) latistella (Brook, 1892)

MATERIAL STUDIED

119 / Ad.II, Rf, 0.5 / br,cr-tip

120 / Ad.XII (Fig. 68, 71)

CHARACTERS

Coralla are corymbose plates or caespitose, with main branches of about 1.5 cm thick and branchlets of 4-8 mm thick. Axial corallites are 2-2.5 mm exsert, 2.1-2.4 mm diameter, and with calices of 0.6-0.9 mm diameter. Septation is very variable; primary septa may slightly exsert on upper walls then steeply slope and almost adjoin together deep within centres, or may exsert horizontally nearly up to 1R on upper walls then vertically descend. Secondary septa may be absent or visible as spines up to 1/3R. Radial corallites on branchlets are tubular appressed, ranging from 1-3 mm exsert, with openly rounded to slightly dimidiate openings. Septa of both cycles are usually developed up to 1/3 and 1/4R (or subequal) and irregularly dentate (except directive septa which usually have smooth margins). Coenosteum on radial corallites are costate, with lines of simple to elaborated spinules or densely arranged with such spinules. Those between radial corallites are reticulate, with spinules more openly arranged.

DISCUSSION

These two specimens are very similar to an *A. selago* Studer specimen deposited at PMBC, but they are already distinguished from this species by their structures which are more solid. In addition, PMBC specimen has slightly prominent radial corallites. Variation between these two specimens is not distinct, except that radial corallites of specimen no. 119 which was collected from turbid water are generally shorter, giving

a scale-like appearance since calices are also widely open.

Acropora (Acropora) subulata (Dana, 1846)

MATERIAL STUDIED

121 / Ad.XII, Rf, 3 / br.gr (Fig. 72, 79)

122 / Ad.XII, Rf, 3 / cr

123 / Ad.I, Rf, 1 / cr,pur-tip

124 / Ad.III

CHARACTERS

Young coralla are caespito-corymbose, becoming corymbose plates when fully developed. Main branches are 0.7-1.5 cm thick and branchlets are about 0.45 mm thick and usually 3 cm long. Axial corallites are 1.5-3.5 mm exsert, 1.6-2.5 mm diameter, with calices about 0.7 mm diameter. Primary septa are 1/3-2/3R; secondary septa are usually just visible as spines or absent. Radial corallites on branchlets are uniform in appearance, ie. they have little or no upper walls, lower walls expand as elongated or rounded lips as those of *A. hyacinthus*. Radial corallites on main branches are immeresd, with calices of 0.6-1.3 mm diameter. Primary septa and directive septa are usually developed as broken laminae or series of flattened spines, up to 1/3R or just visible, secondary septa are absent or just visible as few spines. Coenosteum is costate with an arrangement of simple or flattened spinules on radial corallites and reticulate with spinules in between.

DISCUSSION

Besides the distinct variation of growth form, vase-shape in young coralla and corymbose plates in mature coralla, the degree of branchlet development is also variable, such as in specimen no. 121 and 122, which both are corymbose, and although they are under the influence of same environment, branchlets of the former are much more crowded and more solid. Consequently this couple of colonies are certainly exhibit genotypic variation. The young specimen, no. 123, which was collected from turbid water is rather solid. This contrasts to Veron & Wallace's (1984) remark that the thin structures are found in those colonies inhabiting a turbid environment.

Acropora cf. *dendrum* (Bassett-Smith, 1890)

MATERIAL STUDIED

125 / Ad.I, Rf, 2.5 / cr (Fig. 73, 76)

126 / Ad.XI

CHARACTERS

Coralla are corymbose plates, with branchlets about 2-5 cm long and 7 mm thick. The main branches may be partly arranged into 2 horizontal planes. Axial corallites are about 2.2 mm diameter, with calices about 0.9 mm diameter. Primary septa are 3/4R or adjoined at calicular centre, and secondary septa are subequal to the former or absent and may irregularly fuse to the former. Radial corallites are usually subimmersed (or tubular appressed near branch tips) with circular

or nariform openings, 0.7-0.9 mm diameter. Septation is in the same manner as that of axial corallites except septa are more irregular (they are irregularly thickened or may appear as spines). Directive septa are very well developed. Coenosteum is densely arranged with elaborate spinules on radial corallites (except for that of costate appearance on new radial corallites on branch tips). Such spinules also extend all over thick, partly grooved masses of coenosteum between radial corallites.

DISCUSSION

The specimen no. 125 has a general growth form very close to specimen no. 122, which is placed for *A. subulata* (see p.49) but its skeleton structures in detail correspond with the description of *A. dendrum* given by Veron & Wallace (1984). Specimens placed for this species are heavily infested with banacles; giving branchlets a distorted, nodular appearance. This situation was also noted in their description.

Comparing the two specimens, no. 126 is much more spongy in appearance. This specimen was found in deeper water.

Acropora (Acropora) divaricata (Dana, 1846)

MATERIAL STUDIED

127, 128 & 129 / Ad.XII, Rf, 2.5 / d.yel.br,pur-tip & wh-tip

130 / Ad.XII, Rf, 2 / d.br (Fig. 74, 77)

131 / Ad.XII, Rf, 1.5 / br,wh-tip

132, 133, 134 / Tr.I, Sl, 2 / br

CHARACTERS

Coralla are caespito-corymbose or thick table (usually 8-12 cm thick). Main branches lie horizontally and give off secondary branches growing vertically at inner areas or obliquely at corallum peripheries where branches have proliferous tips. Main branches are about 1.3-1.7 cm thick and secondary branches are slightly smaller. Axial corallites are 2.1-3 mm diameter, with calices of 0.5-1.1 mm diameter. Primary septa are 1/3-3/4R and secondary septa are 1/4-1/3R or absent. Radial corallites may be regular or irregular in different coralla (see discussion). They are tubo-nariform or tubo-dimidiate towards tips and becoming more appressed to immersed proximally. Circular calices are 1 mm diameter. Coenosteum is broken costate or arranged with rows of flattened, forked or pointed spinules on radial corallites and more openly reticulate in between.

DISCUSSION

This series of five specimens although being collected from a single biotope, a shallow patch reef at site XII of Adang Island, shows great variability both in growth form and corallite structures. Specimen no. 131 tends to be corymbose with a colony up to 12 cm thick, while other specimens are completely caespito-corymbose (or thick table) of about 8 cm thick. The previous specimen and no. 128 have rather regular tubo-nariform corallites graded to subimmersed proximally, whereas the radial corallites of other specimens are very irregular, ie. those corallites near tips are very prominent (5 mm or occasionally

up to 1 cm long) as a result of rostrate development (which makes corallites thick and strongly dimidiate) and slightly graded proximally. These irregular corallites usually have compressed angular walls, giving a coralla ragged in appearance to the coralla. In addition, many of them face to irregular directions or even downwards.

These downwardly directed corallites and rostrate development have already been described by Wallace (1978).

The other three specimens were from site II of Tarang Island which is exposed to strong current and is consequently being dominated by soft corals. Although branches are not thicker than those of the previous groups, their skeletal structures, eg. coenosteum, are more densely arranged with spinules. In general nos. 133 and 134 have growth form very similar to fig. 701, *A. donei* of Veron & Wallace (1984). However their calicular structures are different from *A. donei*. Specimen no. 132 is very similar to *A. loripes* Brook.

Acropora (Acropora) longicyathus (Edwards & Haime, 1960)

MATERIAL STUDIED

135 / Ad.III, S1, 6 / d.br,wh.cr-tip (Fig. 79, 80)

CHARACTERS

Corallum is bushy, resembling a bottle brush, and consists of a primary branch (1 cm thick) that gives another 3 orders of branches of which the last order are about 5 mm thick, and up to 1 cm long. However, the last order of branchelets is not easy to define since these branches may appear as axial corallites with or without radial corallites or even

as prominent tubular radial corallites. Generally, these suspected corallites are up to 3.4 mm diameter with relatively small circular calices of up to 1 mm diameter. Septation is in 2 patterns, ie. near branch tips, septa of 2 cycles may be equal, 1/4R, or primaries are 3/4R and secondaries are 1/3R at older parts of branches. In both cases, secondaries may be incomplete in cycle or completely absent. Radial corallites range from immersed (the usual case on main branches), appressed tubular to prominent tubular (which usually causes confusion with the axial corallite). Their openings are circular or oval with size and septation generally identical to those axial corallites. Coenosteum are in 3 patterns, ie. near branch tips, coenosteum both on corallites and between is strongly costate, with finely dentate margins. This pattern gradually changes into a progressively broken costate pattern until it has a dense arrangement all over of spines with elaborated tips. The last case gives a skeletal texture of a more solid appearance and corresponds to that part of corallum exposed to lower light intensity.

DISCUSSION

This single specimen has characters corresponding fairly well with those of *A. longicyathus*, described by Wallace (1978) and Veron & Wallace (1984), with the exception that the axial corallite diameter above (up to 3.4 mm) is larger than the range, 2.1-2.8 mm, given by these authors. This is probably an example of species variation other than growth form in a species having a wide range (Veron & Wallace, 1984). In addition, it differs from *A. rosaria* Dana (described by Wallace, 1978), which these authors placed for a synonym of *A. longicyathus;* ie., *A. rosaria*

has shorter axial corallites (1.0-2.0 mm long).

Acropora (Acropora) austera (Dana, 1846)

MATERIAL STUDIED

136 / Ad.III, Rf. 3 / cr,pur-tentacle

137 / Ad.

138 / Ad.I (Fig. 81)

CHARACTERS

Coralla are arborescent to caespitose, with branches about 1 cm thick. In caespitose form, branchlets are well developed, giving the appearance of a bottle brush. Axial corallites vary from about 2.8-3.9 mm diameter, with calices of about 1 mm diameter. Primary septa are 1/2-3/4R and secondary septa are 1/4- 1/2R. Radial corallites vary from immersed to appressed tubular, with circular or oblique openings. Primary septa are up to 3/4R and secondary septa are 1/4R or absent. Septal margins may be smooth or dentate. Coenosteum both on radial corallites and in between is reticulate with forked spinules all over.

DISCUSSION

Three specimens of this collection show the great variability of this polymorphic species. Specimen no. 136 is caespitose while the other two are rather arborescent. Apart from the fact that many branchlets developed in this specimen, a ragged appearance resulted from the obvious contrast between prominent and immersed radial corallites a feature which characterises this specimen. The prominent radial corallites

are similar or identical to axial corallites, ie., they are thick and have septa descending vertically into calices. By contrast, the other two specimens, nos. 137 and 138 have radial corallites of rather uniform size, appressed tubular, with septa steeply sloping into calices. However, openings of radial corallites of specimen no. 137 are circular while those of specimen no. 138 are oblique. Since the radial corallites of specimen no. 136 are circular, specimen no. 137 seems to be an intermediate variant among the specimens.

According to Veron & Wallace (1984), the arborescent form of this species is abundant in biotopes exposed to some wave action while the caespitose form is found in protected areas. However, the habitats of the three specimens of this collection do not correspond well with this distinction.

GENUS ASTREOPORA DE BLAINVILLE, 1830

Colonies are massive, laminar, encrusting or foliaceous. Corallites are immersed or conical with short, numerous, neatly spaced short septa. Columella are deep-seated and compact. Walls are porous to solid. Coenosteum are trabecular and reticular.

Astreopora myriophthalma (Lamarck, 1816)

MATERIAL STUDIED

9 / Ad.I, Rf, 1 / br,yel-edge

10 / Ad.XII, Rf, 2.5 / br (Fig. 8)

11 / Ad.XII, Rf, 2.5 / br

12 / Ad.VI, Rf, 3 / br

13 / Ad.XI, Sl, 4 / cr,pur-edge

CHARACTERS

Coralla are massive, with partly explanate or encrusting peripheries. Mature corallites are conical in shape, usually 4-4.5 mm diameter at bases. Calices are 2 mm diameter. The young corallites, interspersed between the large ones, are subimmersed and may be only 0.9 mm diameter. All corallites are generally at right angles to corallum surfaces. Primary septa are narrow above and flare deep within the calicular centre where they may join. Their margins may be smooth or dentate. Secondary septa only appear as ridges. Septa of third cycle are absent or poorly developed. Coenosteum are reticulate, covered with spinules which have strongly flaked tips. These spinules are also aligned on thecal trabeculae, giving pseudocostate appearnce.

DISCUSSION

Description above specifically relates to specimens nos. 10 and 11. By and large the characters of these two specimens are well matched with those described for *A. myriophthalma* by Veron & Wallace (1984), except that the authors mentioned the absence of tertiary septa in their specimens. However this may due to geographical variation. Several problems are faced in considering the other specimens in this collection. It is found that corallites, especially those on corallum sides are very prominent (up to 7 mm long) and face in an irregular direction. This appearance is noted to characterise *A. gracilis* Bernard (Veron & Wallace). However corallites on top of coralla face at right angles. These appearances support Veron & Wallace (1984) that *A. gracilis* is in a heterogenous

group which integrades with *A. myriophthalma*. Perhaps the latter species also integrades closely with *A. ocellata* Bernard since it was found that specimen no. 13 has an average calice diameter reaching 2.5 mm, the same as *A. ocellata* (Lambert, 1982). However, Veron & Wallace gave the range of calice diameter of *A. myriophthalma* about 1.8-2.8 mm.

Astreopora cf. *expansa* Brugemmann, 1877

MATERIAL STUDIED

14 / Hn.I, Bt. 10 / wh,gr,br (Fig. 10)

CHARACTERS

Corallum is explanate of about 2.5 cm and 0.5-1 cm thick at centre and periphery of corallum respectively. Upper surface is almost flat, growing horizontally. Corallites are slightly raised or immersed, with circular calices of 1.8 mm diameter. Calice rims compose of spinules with flaked tips which are the end of corallite trabeculae raising higher than the coenosteum spinules. Primary septa are narrow above and flare deep within calicular centre. Septa are usually adjoined at centre by synapticular ring or irregular blade-liked structures and adjacent septa sometimes fuse themselves. Secondary septa appear as ridges, with slightly dentate margins, and sometimes their inner parts are developed into irregular blades which may fuse with primary septa. Coenosteum appears as thin, smooth laminar structures (which are usually overlapping, according to their upwards growth) covered with flaked spinules.

DISCUSSION

This single explanate specimen is very similar to *A. expansa* described by Lambert (1982). However, by contrast with what he mentioned, calices of this specimen is slightly raised as found in specimen labeled for *A. listeri* (see below). Veron (1985) suggested that, *A. expansa* cannot be claimed as a valid species. Hence, specimen no. 14 may be *A. explanata* Veron.

More specimens are needed to prove these close relationships.

Astreopora listeri Bernard, 1896

MATERIAL STUDIED

15 / Hn.I, Sl, 6 / cr,wh,pur-edge (Fig. 11)

CHARACTERS

Corallum is massive, hemispherical, with generally smooth surface. Corallites are immersed, but their rims are slightly raised with thin walls and surrounded by flaked spinules. The circular calices are 1.3-2.0 mm diameter. Primary septa occur as those in *A. expansa* Brugemmann, except synapticular rings are poorly developed and inner parts of adjacent septa are irregularly fused. Secondary septa appear as small ridges or are absent. Coenosteum consists of horizontally (or obliquely) twisted blades intermixed with prominent, thin, flaked spinules, giving the hirsute appearance to corallum surface.

DISCUSSION

This single specimen has skeletal characters, within variations described by Veron & Wallace (1984) and Lambert (1982).

FAMILY FAVIIDAE GREGORY, 1900

Colonial and hermatypic. Colonies are formed by intra- and/or extra-tentacular budding. Corallites are plocoid, cerioid, meandroid or phaceloid. Septa and paliform lobes (which are commonly developed) are structurally similar. Columellae are mostly trabecular. Wall are composed of thickend septa and synapticulae.

GENUS FAVIA OKEN, 1815

Colonies are usually massive, either flat or dome-shaped. Corallites are plocoid and mostly monocentric. Daughter corallites are formed by intra-tentacular budding. Colomella trabeculae are long and twisted, forming a spongiose mass.

Favia cf. *favus* (Forskal, 1775)

MATERIAL STUDIED

203 / Ad.XII, Sl, 5 / br,cr,wh,gr (Fig. 114)

204 / Ad.XII, Rf, 2.7 / wh,gr,br-calice

CHARACTERS

Coralla are encrusting or submassive. They are plocoid, with corallites about 9-14 mm diameter. They may be exsert up to 6 mm, with slightly broad bases. Corallites may be circular or irregular in shape. Septa tend to be arranged into 3 orders. They exsert about 1 mm over thecae. The size of septa in each order are variable. First order septa descend steeply inside the deep conical calice towards the centre.

These septa usually form a paliform crown. Second order septa are slightly smaller than the first and do not reach the centre. Third order septa, if present, are smallest and sometimes only appear as thin ridges. All septa have granulated sides and irregular dentations. These dentations are themselves finely serrated, especially at their tips which frequently form minute, horizontal fans. Paliform lobe margins are also serrated. Columellae are small and trabecular. Costae are equal and dentate. Those of adjacent corallites are usually not aligned. Intercostal ridges are rare. Coenosteum is blistered.

DISCUSSION

The characters of these specimens are similar to those of *F. favus* described by Veron et al. (1977) although there are some different characters. Corallites with broad bases are only found at the corallum edge or very often on the contorted corallites. In addition, costae of the adjacent corallites are usually not aligned as they are in the description given by Veron et al. However since this species is one of the most variable of the genus *Favia*, it is rather difficult to separate the specimens from *F. favus* by these differences.

Favia amicorum complex

MATERIAL STUDIED

205 / Ad.XII (Fig. 115)

206 / Ad.XII, Rf, 0 / yel.br

207 / Ad.III, Rf, 2.5 / yel.br,br-calice

208 / Ad.

209 / Ad.XII, Rf, 2.7 / wh.yel.gr,br,pur.br-stom

CHARACTERS

Coralla are submassive or encrusting, with exsert corallites. Septa are in two indistinct orders. Sometimes second order septa appear as rows of spines or ridges. First order septa have strongly dentate inner margins. Dentations are finely serrated and frequently formed into minute horizontal fans. Costae are always prominent, equal and strongly dentate or beaded. Those of adjacent corallites are not joined and are usually separated by a small ridge. Paliform lobes are usually indistinct. The trabecular columellae may be strongly or loosely compact. Coenosteum is blistered.

DISCUSSION

The specimens show the common characters of this heterogenous group, *F. amicorum* complex. The growth forms do not tend to be subramose as described by Veron et al. (1977). This may be due to a small amount of sediment in the area.

Favia cf. *speciosa* (Dana, 1846)

MATERIAL STUDIED

210 / Jb., S1, 4 / wh.br,gr-stom (Fig. 116)

CHARACTERS

Corallum is massive, with partly encrusting periphery. The ploco-cerioid corallites are about 6-13 mm diameter, with calices about 6 mm

deep. Corallites are circular or irregularly squashed together. Thecae are thin (less than 0.5 mm thick). Septa are in 3 cycles. They are almost uniformly thin (slightly thicker over thecae). Third cycle septa, if present, appear as ridges or small broken laminae along endothecae. Septa of first two cycles descend gently inside cone-shaped calices. Paliform lobes formed by first cycle septa are indistinct. Septa are dentate and granulated on sides. Costae are finely dentate. Columellae are spongiose, trabecular and usually compact. The coenosteum, which occupies a small space, is blistered.

DISCUSSION

This specimen is similar to the holotype of *F. speciosa* illustrated in fig. 45 in the monograph by Veron et al (1977), except that corallites of this specimen are much more crowded. Another character which also contrasts is that paliform lobes of this specimen are not as well developed as they should be. However more specimens are needed to prove a variation of the species.

Favia pallida (Dana, 1846)

MATERIAL STUDIED

211 / Ad.III, Rf, 2.5 / br,g-stom

212 / Rw.VI, Sl, 3 / cr,br.gr-stom

213 / Ad.III, Sl, 3 / br,gr-stom (Fig. 117)

CHARACTERS

Coralla are massive and usually hemispherical. Corallites are ploco-cerioid, about 8 mm diameter. They are circular or irregularly squashed together. Thecae are thin (less than 0.5 mm thick). Septation is variable among different colonies (see discussion). All septa descend abruptly down vertical thecal walls and half way they form obvious paliform crowns reaching columellae. Septa are regularly dentate and granulated. Costae and septocostae, when present, are equal, and finely dentate. Columellae are spongiose and trabecular. Coenosteum may be solid or blishtered.

DISCUSSION

Three specimens of this collection correspond well to characters of the species described by Veron et al. (1977). They may be distinguished from *F. speciosa* by their calices being of cylindrical shape instead of cone shaped. This is due to the angle at which septa slope in *F. speciosa*.

The obvious variation among specimens is the development of septa. Specimen no. 212 tends to have only one cycle of septa while the other two have 2-3 cycles. In addition, no. 212 has a more compact columellae and more dense skeletal structures. These variations fit well with the ecomorph concept, as specimen no. 212 was collected from clearer water.

Favia sp. 1

MATERIAL STUDIED

214 / Ad.XII, Rf, 3 / yel.gr.cr,br-septa,pur-paliform lobe,gr-

stom (Fig. 118)

215 / Ad.XI

CHARACTERS

Coralla are massive. Corallites are circular, about 8.5 mm diameter. They incline and face downwards on the surface of corallum. Septa are arranged in three orders. First order septa are thicker above the corallite wall and descend steeply inside theca, then curve upward to form a spine-like paliform crown with vertically descending margins. Second order septa are smaller and less exsert than the first. They usually develop only as rows of granules. First and second order septa are dentate and granulated. Columellae are rather large, spongiose and very compact. Costae are present and dentate. Those of first and second orders are equal while those of third are much smaller. Costae of adjacent corallites are usually not joined.

DISCUSSION

The characters of these two specimens are very close to *Montastrea curta* but the predominance of intratentacular budding shows them to be *Favia* spp. The inclined corallites may be a character of species level.

Favia stelligera (Dana, 1846)

MATERIAL STUDIED

242 / Ad.

482 / Jb., Sl, 4 / wh,br,gr

483 / Rw,VI, Sl, 3 / br,d.gr,bright cr-top

484 / Ad.VI, Rf, 3 / br,cr-top

485 / Bs.I, Rf, 2 / br,or.br,d.gr-stom

486 / Ad.XII, Ed, 3 / br,cr-top(Fig. 135)

CHARACTERS

Coralla are densely massive (usually forming columns) or rarely explanate. Corallites are cerio-plocoid, about 3-4 mm in diameter. Calices range from 2.4-3.3 mm diameter. Septa are in 3 irregular orders. First order septa, with an average of 9 in number per corallite, usually reach the columella and form paliform lobes. Some of them exsert to the centre about 1/3R as second order septa. The latter do not form paliform lobes. Both first and second order septa exsert upwards (relatively high) and equally over the corallite wall. Third order septa only appear as fine ridges. Columellae are superficial and trabecular. Costae of first two orders are equal and those of third order appear as ridges corresponding to septa. All septal and costal margins are dentate. The septa, costae and paliform lobes are covered with small pointed spines.

DISCUSSION

All specimens of this species show characteristics that fit well with those described by Veron et al. (1977).

Variation among different coralla is not obvious except for the growth form, which does not cleary relate to the environment, from

these observation.

GENUS FAVITES LINK, 1807

Like *Favia* but cerioid or subplocoid. Adjacent corallites mostly share common walls.

Favites pentagona (Esper, 1794)

MATERIAL STUDIED

216 / Ad.I, Rf, 2 / yel.br,br-stom (Fig. 119)

217 / Ad.I, Rf, 2 / br,d.br-stom,gr.br-tentacle

218 / Ad.I

CHARACTERS

Coralla are encrusting and tend to be massive. Corallites are cerioid, angular in appearance, with diameter about 7 mm. Corallite walls are relatively thick. Septa are usually in 2 orders, with a third order of septa rarely appearing as small ridges or rows of irregular spines. All septa are regularly dentate and granulated. Dentations develop as the serrated horizontal fans become longer towards the deep centre. Then the lowest, longest dentation of each first order septum develops as a vertical, rod-like paliform lobe which nearly always connects to a few dentations above. Columellae are spongiose and trabecular. Budding is entirely extratentacular.

DISCUSSION

This *Favites* species is well defined and readily distinguishable from other species. Since the three specimens were collected in the same biotope, the variation among them is not significant. For individual variation of corallum, specimen no. 217 shows the common appearance of ridges between the second order septa in the corallites which are less exposed to light.

Favites ruselli (Wells, 1954)

MATERIAL STUDIED

219 / Ad. (Fig. 120)

220 / Ad.XII, Rf, 2.7 / yel.br,br-calice (Fig. 121)

221 / Ad.I Rf, 3 / yel.br,d.br-calice,d.gr-calice (Fig. 122)

222 / Ad.XII, Rf, 2.5 / yel br,d.gr-calice

CHARACTERS

Coralla are encrusting and tend to be submassive. They are cerioid or subplocoid, with corallites circular or irregular in outline. Three irregular orders of septa can sometimes be distinguished. In each corallite a few of the highly exserted primary septa can be distinguished from the other of the first order. All septa are thick above the thecae and become thinner towards the centre. They descend abruptly or steeply into the deep calice. Those of the first and sometimes the second order terminate at the prominent paliform lobes which are separated from septa by deep notches. All septa and paliform lobes are dentate and granulated.

Dentations are finely developed on the upper margins of septa and become strongly exsert inwards on the lower parts. Septa of higher orders are frequently joined to lower ones of adjacent corallites. Columellae are rather small. They are trabecular and compact.

DISCUSSION

These three specimens have characters very similar to *F. bennettae* (Veron, Pichon & Wijsman-Best) but the appearance of some third order septa is used to place them in *F. ruselli*. Some variations are seen between them. Specimen nos. 220 and 221 are subplocoid while nos. 219 and 222 are almost completely cerioid. However the notched appearance at joining points of septa of the adjacent corallites make the living colonies look plocoid which characterises *Favia*.

All specimens are strongly calcified except specimen no. 222 which has delicate, long dentations that make corallites more ragged in appearance. These differences should be caused from genotypic variation since they were collected from similar biotopes. However the explanation is not clear because of the limited amount of specimens.

Favites flexuosa (Dana, 1846)

MATERIAL STUDIED

223 / Ad.I, Rf, 2 / yel.gr,br-stom (Fig. 123)

CHARACTERS

Corallum is encrusting, and tends to be massive. Corallites are always completely cerioid, angular in outline, about 8-25 mm across

and with sharp walls. Calices are about 6-10 mm deep. Septa are in two regularly alternating orders. First order septa have dentations which tend to point upwards. These dentations become longer towards the deep centre where those few dentations of each septum usually pile up vertically form a lobe. Second order septa are small, less exsert and finely dentate. All septa are granulated, especially on the first order. Granules are arranged in rows running towards dentation tips. Septa of adjacent corallites are regularly joined above the thecae. Columellae are well developed. They are spongiose and trabecular.

DISCUSSION

There is only one specimen of *F. flexuosa* in this collection. The characters described above are typical of those in the literature.

Favites cf. *rotundata* Veron, Pichon & Wijsman-Best, 1977

MATERIAL STUDIED

224 / Ad.III, S1, 3 / br,gr,wh,gr-stom (Fig. 124)

CHARACTERS

Corallum is encrusting and tends to be submassive. It is subplocoid, with circular or contorted circular corallites at the edge of the corallum. Corallites are about 12-20 mm across, with calices about 5-8 mm deep. Septa are in three orders. They are thick over the theca and become thinner towards the centre. First order septa descend at about 45^{o} and end in a vertical drop, about 2.5 mm high as paliform lobes around the columellae. Second order septa vary in

development, ie. in each corallite about 5-8 second order septa reach half of the calice then may form paliform lobes. The rest develop in the same manner as first order septa. Third order septa are much reduced. All septa are regularly dentate. Septal margin dentations become larger towards the centre and on paliform lobe margins, especially on the first order. Septal sides are sparsely granulated. Columellae may be loosely or densely compact and spongiose. Septo-costae develop in size, proportionately to and exsert correspondingly with septa. They are finely dentate. Those of adjacent corallites are usually regularly joined.

DISCUSSION

In this collection there is only single specimen having the characters as described for *F. rotundata* by Veron et al. (1977). There is one confusing character, ie., the development of second order septa. This is not clear cut since they might be the first order septa which are not fully developed. However as Veron et al. (1977) mentioned, the first two orders of septa are not always clearly differentiated, thus in this case it is probably correct to identify this speciemen as *F. rotundata.*

Favites abdita (Ellis & Solander, 1786)

MATERIAL STUDIED

225 / Ad.XII, Rf, 1 / yel.br,br-stom (Fig. 125)

226 / Rw.VI, Rf, 2 / yel.br

CHARACTERS

Coralla are encrusting, and tend to be massive, with hillocky appearance. Mature corallites are about 6-14 mm across, with walls angular in outline. Septa are in 3 regular orders, those of the first order are most exsert and reach the columellae. Third order septa usually occur as ridges. All septa have regular dentation. Dentations may become more prominent toward the centre, especially on first order septal marings. They are usually developed as spinulose rods (or granulated rods) or fringed-horizontal fans. Paliform lobes are either absent or weakly developed. Columellae are spongiose, trabecular and compact.

DISCUSSION

Wijsman-Best 1976 mentioned that this is a well known and highly varied species throughout the Indo-pacific with typical distinct characters. In this collection, the 2 specimens fit very well those from protected, shallow biotopes in Australian waters, observed by Veron et al. (1977).

GENUS GONIASTREA EDWARDS & HAIME, 1848

Colonies are massive, usually spherical or elongate. Corallites are monocentric and cerioid to polycentric and meandroid. Paliform lobes are well developed. Meandroid colonies have well-defined columella centres.

Goniastrea retiformis (Lamarck, 1816)

MATERIAL STUDIED

32 / Ad.X, Rf, 3 / br,cr (Fig.128)

234 / Ad.X, Ed, 5 / br,cr-tip (Fig. 129)

235 / Ad.III, Sl, 3 / br,cr

253 / Bs.I, 0.5 / cr,yel.gr-polyp

478-480 / Ad.X, Rf, 3 / cr

CHARACTERS

Coralla are massive, sometimes with explanate peripheries or partly encrusting. Corallites are polygonal, about 2.5-5 mm diameter. Septa are in 3 orders. First order septa are often distinguished from the second ones, by being more exsert (always reaching centres), and consisting of paliform lobes, while second order septa have no paliform lobes or sometimes just tend to form them. First order septa join with synapticular rings. Third order septa appear as small ridges. All septal margins (especially of the first two orders) are ornamented with horizontal fan-shaped dentations covered with small spines. The spines are also irregularly scattered on septal sides and plaiform lobe structures columellae are small, trabecular and enclosed by synapticular rings. Septa of adjacent corallites are often joined but they are usually from two different orders.

DISCUSSION

The characters given above correspond to *G. retiformis* described

by Veron et al. (1977). The most distinct variation appearing among specimens is that specimen nos.32 and 253 have very shallow corallites, with thin walls and prominent paliform lobes. This is probably a character of colonies inhabiting the intertidal zone. However, the appearance in this case seems to contrast with the description given by Veron et al. (1977).

Goniastrea sp. 1

MATERIAL STUDIED

236 / Ad. (Fig. 130)

CHARACTERS

Corallum is massive and hemispherical. Corallites are polygonal, 3-5 mm diameter. Septa are thin and equally developed. On their upper part they exsert horizontally then abruptly descend and form small thin paliform lobes deep within centres.Septal margins have trabecular dentations fringed with spinules.Septal sides are granulated.Thecae are as thin as septal structure. Trabecular columellae are small and enclosed by a crown of septa and paliform lobes.

DISCUSSION

This single specimen does not match any species described in the literature. The corallite size is close to that of *G. edwardsi* Chevalier, however detailed structures are obviously different.

Goniastrea cf. *pectinata* (Ehrenberg, 1834)

MATERIAL STUDIED

237 / Ad.I, Rf, I / yel.gr,cr,br-stom,d.br-stom

238 / Ad.XI, Rf, 3 / cr,yel.br (Fig. 131)

239, 240 / Ad.III, Rf, 2.5 / br (paler on edge)

241 / Ad.III, Rf, 2.5 / br (Fig. 132)

471 / Jb., S1, 4 / br (Fig. 133)

472 & 474 / Ad.XI, Rf, 3 / br

473 / Ad.XI, Rf, 3 / br (Fig. 134)

475, 476 & 477 / Ad.X, Rf, 3 / br

CHARACTERS

Coralla are massive or centrally encrusting, with explanate peripheries. Corallites are monocentric or forming valleys of up to 5 centres, giving an elongate shape (such as 4 mm wide and 23 mm long). Septa are in 3 irregular orders, ie. they may not alternate orderly. First order septa always reach columellae and form a distinct paliform crown. Second order septa are about half the length of the first ones and sometimes form paliform lobes. Third order septa are usually absent or sometimes appear as fine ridges. Septal dentations and granulations develop in the same manner as those described for *G. reniformis*. Septa of adjacent corallites may join or just alternate. In the first case, a notch is developed between the fused septa. Columellae appear as trabeculae projecting vertically from solid floors.

DISCUSSION

The characters described above tends to correspond with *G. pectinata* described by Veron et al. (1977), however third order septa are not mentioned by the authors.

The obvious variation seen among specimens is the thickness of thecae. This variation was also mentioned by Crossland (1952). Some specimens seem to have thin sharp thecae since their septa slope straight towards centres. On the other hand, septa of some specimens slightly exsert horizontally on upper part before descending vertically to centres. In the latter case the appearance of the thecae looks thicker to the naked eye. However, some specimens (eg.,475, 476 and 477) have mixed types, ie., corallites on central part of the coralla have thick walls while those on perpheries have thin walls. The range of variation in the description above does not clearly relate to the biotopes.

GENUS PLATYGYRA EHRENBERG, 1834

Colonies are massive, either flat or dome-shaped. Corallites are rarely cerioid, commonly meandroid. Paliform lobes are not developed. Columella centres are seldom distingusihable.

Platygyra daedalea (Ellis & Solander, 1786)

MATERIAL STUDIED

243 / Ad.X, Sl, 3.5 / yel.br,pur.br-stom

244 / Ad.X, Sl, 3.5 / d.br,d.gr

245 / Ad.XII, Rf, 3.5 / br,d.gr,br.pur-stom (Fig. 136)

246 / Ad.VI, Bt, 14.5 / br,g-stom

247 / Ad.III, Sl, 6 / br

248 / Ad.XI, Rf, 3 / br,d.gr stom

249 / Ad.XI, Rf, 3 / br,yel.gr

250 / Ad.XI, Sl, 4/ yel.br,d.gr-stom

CHARACTERS

Colonies are massive or encrusting and usually rounded or occasionally flattened. Valleys are about 5 mm wide and very long. Some colonies have short valleys or mixtures of both short and long valleys. The walls are usually narrow although some parts are up to 4.5 mm wide. They are often perforated. Septa highly exsert and usually have pointed or ragged tips and are frequently joined by fine trabecular linkages above walls. Two orders of septa are recognised but sometimes they are equal or the second order septa may be extremely reduced or absent. They have large dentations, especially on their lower edges, where they are shaped as horizontal, long, flattened spines with wider edges. As with other species of *Platygyra*, fine granulations are present on septal sides. Paliform lobes may be found in short, broad valleys but they are poorly developed. The spongy, trabecular columellae are usually conspicuous, except for the specimen taken from deep water, columellae tend to be vesicular structures. Centres are not usually formed only when valleys join.

DISCUSSION

Specimens of this collection are from different biotopes, eg., reef flat, reef slope and the bottom (lower edge) of the slope. Variation among specimens from reef flat and reef slope is not obvious. Specimen no. 246 which is from the deepest water is quite different from others, ie., it has rounded walls like *P. lamellina*. However detailed skeleton structures are close to *P. daedalea*.

Platygyra pini Chevalier, 1975

MATERIAL STUDIED

251 / Ad.I, Rf, 1.7 / br,d.gr,d.br-stom (Fig. 137)

252 / Ad.I, Rf, 2.7 / br,d.gr,wh.gr-stom

254 / Ad.XII, Rf, 2.7 / cr,d.gr,br-stom (Fig. 138)

255 / Ad.XII, Ed, 4 / wh.gr.yel,d.br-stom (Fig. 139)

256 / Ad.III, Sl, 6 / wh.pur.br,wh.br-stom

CHARACTERS

Coralla are encrusting and tend to be massive. They are cerioid, with corallites about 7 mm diameter. Corallites often develop into short valleys composed of up to three centres each. The walls are relatively thick. Sometimes three orders of septa are distinguishable. However the third order septa do not commonly appear. In comparison with other *Platygyra* spp., septa are dentate and have fine granules on their sides. Dentations, especially on the first order septal margins usually form paliform lobes which are variable in size. The spongy,

trabecular columellae are usually well developed and sometimes integrated with septal dentations.

DISCUSSION

From this collection, specimens can be distinguished into 3 principal ecomorphs associated with the biotopes they occupy

Platygyra pini from wave exposed biotope: (specimen no.254)

The specimen has relatively larger corallites than the others. The skeleton structures are very thick. Septal dentations are granulated, irregularly exsert and some are rounded and very long. Paliform lobe development is variable although in individual corallites often form as vertical dentations.

Platygyra pini from turbid water: (specimens nos.251, 252)

The two specimens develop short valleys. Septal dentations develop as regular serrated horizontal fans. They tend to be longer towards the centre and piled up to form a crown around the centre. These piled-up dentations may bend upwards to form a paliform crown around the columella.

Platygyra pini from reef slope biotope: (specimens nos.255, 256)

In specimen no. 255, septa are very thin. Although corallite walls are thick, similar to those of the previous two biotopes, they are very vesicular. Columellae are poorly developed. Specimen no. 256 has characters different from the latter case, the skeletal structures being very similar to those collected from turbid water. Thus this case may be a genotypic variation.

Platygyra verweyi Wijsman-Best, 1976

MATERIAL STUDIED

257 / Ad.XI, Rf, 2 / yel.br,d.br-stom (Fig. 140)

CHARACTERS

Corallum is massive, rounded and regular in appearance. The polygonal corallites are mostly monocentric. Short meanders of up to 3 centres do not occur frequently. The corallites or short meanders are about 4-8 mm across. Calices are relatively deep. Thecae are thin, sometimes perforated at their tops. Septa are in 2 irregular orders, with third order septa are occasionally occuring as thin ridges. First order septa descend more or less half way into the calices then vertically descend and reach the columellae. Second order septa are less exsert and do not reach the columellae. All septal margins are finely serrated, sometimes with irregular dentations. As with other *Platygyra* species, each of the first order septa usually has a few twisted, horizontal plates on its lower edge and also the septal side is granulated. There are no paliform lobes. Columellae are small, with twisted trabeculae.

DISCUSSION

In this collection there is only one specimen which shows the typical characters of *P. verweyi*, described as a new species by Wijsman-Best (1976). She mentioned that this species is known only in the region of the Indonesian archipelago.

GENUS LEPTORIA EDWARDS & HAIME, 1848

Colonies are hump-shaped. Corallite valleys are highly meandroid and very uniform (3-4 mm across). Columellae are Wall-like and do not form centres. Paliform lobes are absent.

Leptoria phrygia (Ellis & Solander, 1786)

MATERIAL STUDIED

261 / Bs.I, Rf, 0.5 / br,wh.gr-stom

262 / Ad.XI, Rf, 3 / br,yel.gr-stom

263 / Ad.X, Sl, 3.5 / br,wh.gr-stom (Fig. 142)

CHARACTERS

Coralla are hemispherical or irregular in shape, usually with undulating surfaces. The skeleton is very hard and dense. Valleys are of indefinite length, of very regular apperance and constant width (about 2.7 mm), and are comparatively deep. Septa are not distinguished by order but are of regular size and appearance, with constant interseptal distances. They are regularly exsert, with those of adjacent valleys usually joined. The septal margins may have smooth surfaces, triangular dentations or granular-fringed horizontal fans. At the columella level the vertical series of septal processes develop as synapticular bars fused with the columellae. Septal sides have fine granules which may be arranged into synapticular rows or formed into ridges. Centres are not distinct. Columella may be compose of a single vertical plate or a few contorted-plates linked with adjacent centres by a series of vertical,

lobed-plates. Thin epitheca are present at the corallum periphery.

DISCUSSION

This is an easily recognised species of the Faviidae family. The characters of the three specimens are as described by Veron et al. (1977). Variation between specimens is not obvious. Specimen no. 261 has valley walls slightly higher and thinner than those of the other two. In addition, septal margins of the former develop into horizontal fans while those of the latter two develop into triangular dentations or have rather smooth surfaces.

GENUS OULOPHYLLIA EDWARDS & HAIME, 1848

Colonies are massive and meandroid. Valleys are short, broad (up to 20 mm) and have walls with acute upper margins. Columellae usually form well-defined centres. Paliform lobes may be present.

Oulophyllia crispa (Lamarck, 1816)

MATERIAL STUDIED

258 / Ad.XII, Sl, 5 / yel,pur.br-stom

259 / Ad.VI, Rf, 3 / br,d.gr,br-stom

260 / Ad. (Fig. 141)

CHARACTERS

Coralla are massive and tend to be hemispherical. They are meandroid, with comparatively short valleys. The average width of these is 13 mm and the average depth is 12 mm. The walls are thin

and perforate on upper parts. Vesicular endothecae are well developed. Septa are usually thin and continuous between valleys. They can be placed in two orders of irregular length. The first order septa are slightly more exsert over thecae and into calices than the second. Over the thecae, the upper margins, of all septa are dentate as trabecular fans or ridges which are irregularly, densely fringed with granules or spinules. The upper half of septal margins ranged from finely dentate to smooth while the lower parts are strongly but irregularly dentate, and form paliform lobes, especially in the first order. Paliform lobes usually curve at an angle to columellae. Adjacent centres in the same valley are usually separated from each other by the two most exsert primary septa which are on the opposite sides of the valleys. At each joining point of these, there are trabecular laminae with spongiose margins or a trabecular network running to join with centres. Columellae are well developed. They are spongiose, trabecular and granulated as are the septal sides.

DISCUSSION

The three specimens in this collection have the same characters described by Veron et al. (1977). Although there are no papillae at the top of the columellae, the specimens can be placed in *O. crispa* since this species in one of the most variable. However the variation between colonies of this collection is not obvious. A typical variation in an individual colony is seen in specimen no. 260. Where the skeletal structure exposed to less light intensity is thin and very vesicular.

GENUS MONTASTREA DE BLAINVILLE, 1830

Colonies are similar to *Favia*, *Favites* and *Goniastrea* but being readily separated with the predominance of extratentacular budding.

Montastrea valenciennesi (Edwards & Haime, 1848)

MATERIAL STUDIED

227 / Tr.II, Sl, 2 / yel.br,d.br (Fig. 126)

228 / Tr.II, Sl, 2 / yel.br,d.br

229 / Ad.I

CHARACTERS

Coralla are massive or encrusting. They are subplocoid, with polygonal mature corallites, about 6 mm diameter. The young corallites are usually rounded. Three orders of septa are distinct. The first and second order septa are equally exsert and thicker over the thecae. They are equal or subequal in thickness. The former reach the columella and form a paliform crown. Sometimes the adjacent first order septa fuse to each other before reaching the columella. The second order septa usually do not reach the columella and sometimes fuse with the first order. The third order appear as thin ridges. All septal margins may be dentate in irregular forms or serrated horizontal fans, or only finely serrated. These structures are granulated. The degree of columella development varies. Costae are well developed and correspond to the septa. Their margins are also dentate in a similar manner to the septa.

This species is distinctly characterised by the presence of a groove or tubercle structures between corallites. These structures consist of a thin skeleton layer shaped like a long pipe, almost always with the top cut away. They lie between and along the corallite sides and at different distances they become deeply inserted into the exothecal dessipiment. These structures have a diameter about 0.5 mm.

DISCUSSION

The specimens in this collection show skeletal variations corresponding to biotopes as follows.

Ecomorph from surf zone:

Specimens nos. 227 and 228 were found encrusting on rock boulders close to each other. Although these two specimens are encrusting type, the important character of *M. multipunctata* (Hodgson), they are clearly differentiated on the basis of corallite morphology.

The couple of specimens may be a genotypic variation. While specimen no. 227 has the distinct regular three orders of septa, the first and the second order septa of specimen no. 228 are usually equal, and hardly distinguishable. The fourth order septa are usually developed in the protruding corallites. Paliform lobes are generally well developed in both specimens. Sometimes individual first order septum of the specimen no. 227 has two paliform lobes and an incomplete synapticular ring connecting the major paliform lobes. In addition, the second order septa may form paliform lobes which do not reach the columella. Columellae of both specimens are small, loosely trabecular.

Ecomorph from tubid water:

This specimen is massive. It shows the typical characteristics of the species. Septal development and arrangement are similar to those of specimen no. 228. Paliform crowns are delicate in structure and less distinct. Septal and costal dentations are shaped in thin serrated horizontal fans.

All specimens from this collection had neither extratentacular budding nor intratentacular budding discernably dominant.

Montastrea cf. *curta* (Dana, 1846)

MATERIAL STUDIED

230 / Ad.XII, Rf, 1 / br.yel,pur,gr-stom

231 / Ad.III, Rf, 2.5 / br,bl.g-calice,gr-stom (Fig. 127)

232 / Ad.III, Sl, 2.8 / d.br,yel,d.gr-stom

233 / Gt.I, Sl, 3 / d.br,g-stom

CHARACTERS

Coralla are submassive or encrusting. Corallites are slightly exsert except at the corners where corallites are more exsert. They are nearly circular or are squeezed into an irregular shape. Calices are about 6 mm diameter. Septa are regularly arranged in three orders. Inner margins of first order septa descend vertically inside theca, then curve upward to form a sharp paliform crown. The inner margins of paliform lobes descend vertically, close to columellae. Second order septa are smaller and less exsert than the first and they usually do not form paliform lobes. Third order septa are smallest and sometimes

present only as ridges. All septal margins are dentate and granulated. Columellae are small, spongy and compact. Costae are present. They are dentate and may be equal or unequal. Costae of adjacent corallites are usually not joined. Intercostal ridges do not develop.

DISCUSSION

These four specimens are very similar to those of *Favia pallida* but the latter has slightly larger corallites and has a predominance of intratentacular budding.

Specimen no. 230 has equal costae while the others have unequal costae. This is due to the presence of well developed third order septa.

The corallite morphology are not exactly same as those figures of the species in the monograph by Veron et al. (1977) and Wijsman-Best (1977). These specimens may be of the ecomorph "Lamarckiana" which Wijsman-Best refered to the work of Chevalier (1972), since colices are rather shallow.

GENUS DIPLOASTREA MATTHAI, 1914

Colonies are large dome-shaped, with very even surfaces. Plocoid corallites are formed by extratentacular budding. Walls are mostly septothecate, but partially synapticulothecate and porous. Septa are thick peripherally and thin internally. Columellae are large.

Diploastrea heliopora (Lamarck, 1816)

MATERIAL STUDIED

264 / Ad.I, Rf, 2.5 / ye.br,g-stom

265 / Ad.III, Sl, 2.8 / gr,or.br,wh-stom

266 / Ad.VI, Sl, 14.5 / d.br,g-stom (Fig. 143)

CHARACTERS

Coralla are massive, sometimes with encrusting peripheries. Corallites are ploco-cerioid, polygonal, about 10 mm across. Walls are mostly vesicular and septothecate but partially synapticulothecate and porous on upper parts. Septa are in 2 orders. First order septa are much larger and more exsert into calices than second. The former are thick peripherally and thin internally. All septa are dentate and granulated. Columellae are well developed, with compact spongiose trabeculae.

DISCUSSION

Since these three specimens were collected from different biotopes, the skeleton variations among them as described above are very obvious.

Diploastrea heliopora from shallow turbid water, specimen no. 264 was found encrusting on an *Acropora* branch. It is very ragged in appearance since the dentations on septal margins are very irregular and prominent. Synapticulothecate structure is very well developed. However, on the part of corallum which is exposed to low light intensity, septal dentations are shorter and very regular. The walls become more

synapticulothecate and corallites appear to be completely cerioid.

In general, the biotope of deep water and shallow turbid water affect the coral skeleton development in the same manner, ie., skeleton structures are delicate. However in this case specimen nos. 265 and 266 which were collected from the deep water have structures different from those of specimen no. 264, ie., the latter two are massive and have thicker septothecate walls especially specimen no. 266. The primary septa of the latter are swollen over the walls and very thin at the centres. Dentations on septal margins are small, regular and triangular in shape. As regards specimen no. 265, septa are a lot less swollen and septal dentations are rather prominent but more neatly arranged than those of specimen 264.

GENUS LEPTASTREA EDWARDS & HAIME, 1848

Colonies are massive, usually flat or dome-shaped. Corallites are subcerioid to plocoid. It is distinguished from *Montastrea* by the absence or weak development of costae, by the presence of papillose columellae and by minute dentatations of the septa.

Leptastrea transversa Klunzinger, 1879

MATERIAL STUDIED

268 / Ad.XI, Sl, 5 / yel.br,yel.gr,gr.g-stom

269 / Ad.XI, Rf, 3 / yel.br,g-stom

270 / Ad.XI, Sl, 5 / cr,d.br,gr-stom

271 / Ad.III, Sl, 6 / yel.br,pur.g-stom

272 / Ad.XII, Rf, 3 / yel.cr,pur.g.br-stom (Fig. 144)

273 / Ad.XII, Sl, 3 / yel.br,br-stom

274 / Ad.XII, Sl, 3 / wh,br-stom

275 / Ad.XI, Rf, 3 / cr,gr-stom

276 / Ad.XI, Sl, 5 / g.d.br,g.br-stom

CHARACTERS

Coralla are massive or encrusting. They are ploco-cerioid, with polygonal corallites about 3-7 mm across. The large corallites usually occur at the top or convex parts of corallum. Septa are in 4 orders, although fourth order septa may not be complete in each corallite. In each corallite, six large first order septa gently slope or curve inwards to about two-thirds of the calice radius before descending vertically to columella. Septa of other orders range to smaller size in order. They descend steeply in the calice with only second order septa usually reaching the columella. Third order septa sometimes fuse with the second deep within the calices. First order septal margins usually have only a few dentations near columella while the upper margins are finely serrated as a result from granules forming neat pseudosynapticular rows or ridges. The other order septa have dentations almost on entire margins and dentations become larger towards centre. The indistinct paliform lobes are formed from the innermost dentations of the first and second order septa. These paliform lobes intermix with the pinacles at the centre to form the columella. Both septa and columellae are granulated. All septa exsert above walls in propotion to their size. Septa of adjacent corallites are either aligned or alternate with each other, but they are almost never joined, thus leaving an intercalicular

groove.

DISCUSSION

The description above is the typical of characters for specimens in this collection, however septal structures of specimen nos. 270, 271 and 275 show variation from those described above. Of the latter three specimens, the second order septa are often well developed and extend into calices as much as the first. All septal margins have uneven surfaces. In specimen no. 268 the second order septa are well separated from the first as described above but all septal margins have uneven surfaces. The second order septa have their own typical formation, ie., when descending just below the wall level they usually curve inwards as horizontal trabecular lobes before sloping steeply to centre. These variations are not clearly correlated with biotopes since specimens collected from the same biotope show different characters. These differences may be genotypic variation.

Leptastrea cf. *pruinosa* Crossland, 1952

MATERIAL STUDIED

277 / Ad.III, S1, 6 / br,gr-stom

278 / Ad.XI, Ed, 5 / br,wh.gr-stom (Fig. 145)

CHARACTERS

Coralla are encrusting or submassive. They are ploco-cerioid, with polygonal corallites, about 2-5 mm across. The large corallites usually occur at the top or convex parts of coralla. Septa are in 3 regular

orders. They may descend into calices with steep or gentle slope (see discussion). The first two order septa always reach the columellae and the first are most exsert. Third order septa often fuse with the first. All septa have dentations with relatively dense, spinulose tips. The innermost dentations of the first two order septa are formed into indistinct paliform lobes surrounding or intermixing with columella which are composed of one or a few pinacles. All septa are irregularly granulated. They are thick and exsert over the walls but those of the adjacent corallites are always separate leaving the presence of an intercalicular groove.

DISCUSSION

The two specimens mentioned above have characters very similar to *L. pruinosa* and *L. transversa* Klunzinger but the latter species can be distinguished from the former by the appearance of the six prominent primary septa. The presence of four septal orders may be a character of both species but fourth order septa are not completely developed. Septa may be quite impossible to place into orders in some corallites of both species. Corallites of the two specimens above are dominant with a size of 3 mm across while those of *L. transversa* are 4 mm across. From a general rule described by Veron et al. (1977), the author places these two specimens into *L.* cf. *pruinosa* since they have *L. pruinosa* typical colour; chocolate brown, with green oral disc. Also their polyps extended during the day as in *L. pruinosa*. However, there are some variations in the corallum. Of specimen no. 278, the part of corallum which is exposed to more light intensity has deep calices and

septa with irregular dentations of less dense granulated structures. The whole corallum of specimen no. 277 has corallites developed in the same manner.

GENUS CYPHASTREA EDWARDS & HAIME, 1848

Colonies may be massive, encrusting, sub-foliaceous or ramose. Corallites are plocoid, with calices up to 3 mm diameter. Costae are generally restricted to the corallite wall. Coenosteum is granulated.

Cyphastrea microphthalma (Lamarck, 1816)

MATERIAL STUDIED

289 / Ad.VI, Sl. 10 / gr,br

290 / Ad.III, Sl, 3 / yel.br,d.br (Fig. 146)

291 / Ad.III, Sl, 2.3 / br.or

292 / Ad.XII, Rf, 2.7 /yel.br,gr-stom,br-stom

293 / Ad.III, Sl, 2.8 / br.yel

294 / Ad.VI, Sl, 7 / g,br

295 / Ad.XI, Sl, 5 / yel.br

296 / Ad.XI, Ed, 5 / gr,yel.gr,br-stom

297 / Ad.XI, Rf, 3 / pur.g.br

CHARACTERS

Coralla are encrusting or submassive. They are subplocoid to plocoid, with calices circular about 1.2-2.0 mm diameter. Septa are in 2 regular orders of 10 each in the majority of mature calices. First order septa reach the columella while second order exsert in the

calice, about one-fourth of the calice radii. All septa have relatively prominent, irregular dentations. The latter are usually developed as long spined-trabeculae. The prominent paliform lobes develop on first order septa. The columella consists of a few twisted trabeculae. All calicular structures are covered with granules or spinules which appear as flattened trabeculae. Costae are usually equal and support elongated, spinulated trabeculae which extend across the coenosteum.

DISCUSSION

In this collection the specimens show a range of corallite exsertion, ie., specimen no. 292 has corallites tending to be cerioid while those of specimen nos. 293 and 294 are extremely exsert. In the latter, the corallites are swollen and proturde as in *Astreopora*. However, on some parts of the last two specimens, corallites also tend to be cerioid.

Cyphastrea chalcidicum (Forskal, 1775)

MATERIAL STUDIED

281 / Ad.III, Sl, 6 / br,gr

282 / Ad.XII, Rf, 1 / yel.cr,pur-calice

283 / Ad.VI, Bt, 15 / g.br

284 / Ad.XII, Rf, 2 / wh.yel.cr,br-calice

285 / Ad.XII, Rf, 3 / yel.br,cr

286 / Ad.XI, Rf, 3 / or.br,gr-stom

287 / Ad.XII, Rf, 3 / cr,yel.br,d.gr-stom (Fig. 147)

288 / Ad.XII, Rf, 1 / yel.br,br-stom

CHARACTERS

Coralla are massive or encrusting. They are subplocoid to plocoid, with circular calices, about 1.5-2.0 mm diameter. Septa are in 2 orders of 12 each in mature calices. First order septa are usually divided into two hexameral cycles. The primary septa are thicker and more exsert than second. They all reach the columellae and are usually connected to each other by synapticulae. Second order septa are much reduced. All septa have relatively prominent dentations that become longer towards centres as in *C. microphthalma*, but paliform lobes are not developed. The columella consists of a few twisted trabeculae. All calicular structures are granulated as in *C. microphthalma*. First order costae are usually well developed while those of the second order are reduced. The coenosteum is frequently blistered and always ornamented with granulated exothecal spines.

DISCUSSION

Some specimens in this collection have characters that make it difficult to separate them from *C. serailia*. These are nos. 282, 285, 288. In these specimens, corallites that are exposed to higher light intensity are more exsert and the costae of the third order are very reduced, while those exposed to less light intensity are less exsert and the costae of all orders are subequal as in the appearance of *C. serailia*. The cone-shaped corallites are found all over specimen no. 283.

Cyphastrea cf. *serailia* (Forskal, 1775)

MATERIAL STUDIED

279 / Ad.XI

280 / Ad.XI, Sl, 5 / yel.br,or.br,r.pur (Fig. 148)

CHARACTERS

Coralla are massive, usually with encrusting peripheries. The corallites are conical in shape. The characteristic structures are almost the same as those described for *C. chalcidicum* (see p. 93) except the specimens of this series have costae of 2 orders developed subequally, or almost absent.

DISCUSSION

As Crossland (1952) and Veron et al. (1977) gave the specific rules for separating *C. serailia* from *C. chalcidicum*, ie., the former has costae of the first two cycles not nearly so prominent as in *C. chalcidicum*. Those of the third nearly equal them, or all costae are poorly developed, consequently the two specimens above are more likely to be *C. serailia* than *C. chalcidicum*. However, paliform lobe development is not obvious as mentioned for *C. serailia* in the literature. Since the variation of paliform lobe development is not reported in any literature, the author confers these specimens to *C. serailia*. These specimens also do not match with those intermediate form which Wijsman-Best (1977) mentioned for a large collection form Phuket, since corallites are not widely separated as described in literature.

GENUS ECHINOPORA LAMARCK, 1816

Colonies are massive, ramose or foliaceous or mixtures of these forms. Corallites are plocoid with calices up to 5 mm diameter. Septa are exsert and irregular. Costae are usually restricted to the corallite wall. Columellae are usually prominent. Coenosteum is usually granulated.

Echinopora lamellosa (Esper, 1795)

MATERIAL STUDIED

298 / Ad.III, Rf, 2.5 / d.br

299 / Ad.III, Sl, 2.5 / d.br.gr

300 / Jb., S. 4 / br (Fig. 149)

301 / Ad.III, Ed, 2 / br,bright br-edge

CHARACTERS

Coralla are thin, contorted, unifacial laminae tending to grow horizontally. Corallites are circular, with walls slightly raised or completely flat. They are about 2.5 mm in diameter. Septa are in 3 irregular orders. The first two orders of septa are equally thick (in some coralla those of first order are slightly thicker) and reach the columellae. Third order septa are rudimentary if present. Upper margins, especially those of the first two orders are covered with relatively long, slender echinulations (or pillar trabeculae) which range from 1-3 in number per septum. Septal sides and echinulations are ornamented with sharp pointed spinules. The lower parts of septal margins have dentations which have identical structures

as columellae. These dentations exsert horizontally and usually connect with projecting spiniform processes which function as paliform lobes. Paliform lobes may be identical with septal echinulations or smaller, or sometimes absent. The columellae consist of inclined trabeculae forming spongiose structures. Generally thecal costae are not obvious since thecal walls are only slightly raised from exothecal floors. Exothecal costae appear as low parallel ridges or sometimes completely diffuse on the smooth surfaces of the exothecae. They are regularly ornamented with echinulations which are identical but smaller than septal echinulations. Exothecal costae become more lamellar on growing peripheries of coralla.

DISCUSSION

The variation of skeletal structures among different specimens in this collection is rather distinct. The most obvious ones is the diameter of corallites and septal development specimen no. 301 has corallites slightly larger than those of other specimens and also its septal echinulations are more prominent. Although septal and costal echinulations of this specimen are rather hirsute, similar to those of *E. hirsutissima* Edwards & Haime, most of the skeleton structures do not fall within the limit of variation of the this species as described by Veron & Pichon (1979). Specimen no. 300 has its septa very irregularly developed and its third order septa are mostly absent. This specimen was found in the slope zone, at a sheltered habitat, and perhaps should be considered typical for this species. In this specimen, rows of small shallow depressions running along the rims of exothecal costae are probably unusual since they are rare or completely lost in other specimens.

This character is not mentioned in the literature.

Echinopora gemmacea (Lamarck, 1816)

MATERIAL STUDIED

267 / Ad.III, S1, 6 / gr.br,yel.br-edge

468 / Ad.III, Ed, 2.7 / gr.r.br,yel.br-edge (Fig. 150, 151)

CHARACTERS

Coralla are lamellar, sometimes with small irregular ramose structures. Corallites are up to 4.5 mm diameter. They are superficial or slightly protruding especially on the convex surfaces. Septa are in 3 cycles, those of the first two reach the columellae. Primary septa are thick (the hollow structures usually appear when they are broken) on theca and thin towards centres. Each consists of 2 irregular dentate lobes which are highly exsert. The tips of dentate lobes consist of elaborate spines (or flattened denticles). Secondary septa are thinner and usually consistof one dentate lobe. They descend deep within calices and connect to the columellae by series of long horizontal trabeculae (septal dentations). Third cycle septa appear as ridges along endothecae. All septal sides are granulated. Paliform lobes are not distinct. Columellae are of flattened trabeculae with granulated tips. Costae are composed of rows of spines with thick bases and echinulations at tips. Exothecal costae are lamellar on corallum periphery.

DISCUSSION

Generally, two specimens of this collection have characters which correspond to those described for *E. gemmacea* By Veron et al. (1977). However, conical corallites are quite never distinct here , and also corallites are not set close together, the character that Betterton (1981) described for *E. gemmacea*.

Echinipora horrida Dana, 1846

MATERIAL STUDIED

469 / Ad.VI, Sl, 4 / yel.br,d.gr (Fig. 153)

470 / Ad.III, Sl, 6 / yel.br,d.gr (Fig. 152)

CHARACTERS & DISCUSSION

The two specimens above have well developed irregular branches with lamellar bases. In general, their calicular structures are similar to those of *E. gemmacea*, despite the perfect development of branches which is the major part of the colony of specimen no. 469. In addition, the other detailed character is the hirsute appearance of costal spines. In contrast, specimen no. 470 has very poorly-developed costal spines and exocostae are lamellar all over the corallum surface. Furthurmore secondary septa of specimen no. 470 hardly reach the columellae as they do in the other specimen. In conclusion, specimen no. 469 is certainly *E. horrida* while no. 470 was thought to be this species.

FAMILY PORITIDAE GRAY, 1842

Colonial and hermatypic. Colonies are massive, laminar or ramose, with small, compact cerioid corallites formed by extratentacular budding. Walls and septa are porous. Coenosteum is usually poorly developed or absent.

SUBGENUS PORITES

Colonies are massive (generally hemispherical or helmet-shaped), branching, columnar or flat (foliaceous or encrusting).

Corallites are small (less than 2 mm diameter), immersed and filled with septa.

Porites (Porites) annae Crossland, 1952

MATERIAL STUDIED

181 / Ad.III, Sl, 6 / d.br,g

182 / Ad.XI, Rf, 3 / d.br,yel.br-top

183 / Ad.XI, Rf, 3 / d.br,yel.br-top (Fig. 111, 112)

CHARACTERS

Coralla consist of irregular branches, usually anastomose. Calices are 1.4-1.8 mm diameter. They have a variable septal configuration although they are adjacent corallites. Where it is concave, or where corallites are exposed to less light intensity, skeleton spinulation develops densely. At this area triplets usually fuse at their extremities and develop one palus. Each corallite has 6 pali. Palus on dorsal

directive is the smallest. Septum usually has 2 denticles shaped as pali, When exposed to higher light intensity, corallite structures are less developed. Thin ridged-walls with denticles occur in this area. Triplet may have lateral septa connecting the ventral directive by a synapticular bar or triplet may have free margins. In this case, triplet has three small pali. Thus, there are four large pali on four pairs of lateral septa, one small palus on dorsal septum and three small pali on ventral triplet. Septum usually have one denticle. There are two synapticular rings; one is below pali and another at septal bifurcatio level. The last one is usually not complete. Columellae are usually present with a structure similar to small pali.

DISCUSSION

Specimens of this collection have characters that correspond with those described by Veron & Pichon (1982).

Porites (Porites) lutea Edwards & Haime, 1860

MATERIAL STUDIED

184 / Ad.III, Sl, 8 / d.br,cr-top

185 / Ad.XII, Rf, 0 / yel.gr

186 & 187 / Ad.XII, Rf, 0 / pur.br,gr.yel

188 / Ad.XII, Rf, 0 / br,gr.yel

189 / Ad.XI, Rf, 3 / d.br,yel.br (Fig. 110, 113)

190 / Ad.

CHARACTERS

Coralla are massive. They have smooth even surface, often developing irregular humps of variable size. Calices are 1-1.2 mm diameter. Corallites have thin walls and usually appear as ridges formed by a series of laterally compressed denticles. Septation is distinctive. The ventral triplet is fused. The fusion is usually affected by a transverse rod connecting the margins of the lateral septa to the side of the ventral directive to form a trident, or a few have the margins of all three septa fuse at their extremities. Those on the lateral septa of the trident and on dorsal directive are smallest. Two synapticular rings are present; one is at pali level, another is adjacent to the wall. Outside the outer ring (which is often incomplete) septa of the lateral pair become bifurcate. Columellae are mostly well developed. There are usually five radii joining septal margins to the columellae.

DISCUSSION

In this collection there are no problems with this well defined species.

Porites (Porites) cf. *australiensis* Vaughan, 1918

MATERIAL STUDIED

191 / Ad.XII, Rf, 0 / yel.br.gr (Fig. 104, 107)

192 / Ad.

CHARACTERS

Coralla are massive. Surfaces are smooth or nodular. Calices are 1.1-1.4 mm diameter. Corallite walls are thick and ridge-like. Corallites may be shallow with gently sloping septal margins or deep with correspondingly steep sloping septa. Septa of the ventral triplet usually have free margins; the two lateral septa are usually longer than the ventral directive. In this case each septa of the triplet has a small palus the same as that of the dorsal directive. Occasionally a trident is formed or septal margins are fused at their extremities. Connection of the three rods at the extreme ends of the triplet occurs deep within the calice, thus the fusion is not distinct. There are two denticles on each septum of the lateral pairs, one or two on the lateral septum of the triplet and one on the ventral and dorsal directive. Each calice usually consists of 8 pali, those on the dorsal directive and triplet are the smallest (usually as small as the denticles). Pali on lateral pairs are larger and taller than denticles. Two synapticular rings at the level of the pali and outer septal denticles are usually present, but also usually incomplete. Septa may bifurcate between the outer synapticular ring and the corallite wall. Columellae are usually well developed and laterally compressed in the plane of directives. Columellae are connected to septa by radii in variable numbers.

DISCUSSION

Characters of these two specimens are almost perfectly matched with those Veron & Pichon(1982) have described for *P. australiensis*.

They mentioned the development of two denticles on the dorsal directive and one on the lateral pair of the triplet and ventral directive which is longer than the lateral ones. Taking this into account, the author confers his specimens to this species at present.

Porites (Porites) stephensoni Crossland, 1952

MATERIAL STUDIED

180 / Ad.XI, Ed, 5 / cr,yel.br-tip

193 / Ad.III, Rf, 2.5 / br,yel.gr-tip

194 / Ad.XII, Rf, 0 / br,gr.yel

481 / Bs.I, Rf, 0.5 / ? (Fig. 103)

CHARACTERS

Coralla are massive, globular or columnar or with irregular short branches or knobs. Calices are 1.2-1.3 mm diameter. Corallites have thin walls reducing to ridges composed of laterally flattened denticles. Septa are short, approximately 1/2R. Septa of the triplet usually have free margins (see discussion). The triplet and dorsal directive septa are shorter than the lateral pairs. Each corallite consists of 8 pali. Those of the triplet and dorsal directives are always smaller than those of lateral pairs. All septa have vertical inner margins plunging into the central deep fossae. Each of the upper margins of all septa bears one denticle which is sometimes embedded in the wall structure or sometimes absent. Pali of lateral pairs are usually more prominent than denticles. Two synapticular rings are present. The outer one,

below the septal denticles, develops as a horizontal, broad, bar which is thin and fused to the wall, giving the wall a thicker appearance to the naked eye. The inner one, below pali, develops as a circular rod which sometimes forms a cylindrical tube. Columella occurs as a deep-seated single granule connected by a variable number of radii to the septa.

DISCUSSION

The appearance of thin calicular walls tends to show characters of *P. stephensoni*. However confusion still remains. It is somewhat difficult to say that the fusion of triplets occurs here because palar synapticular rings interfere, so it is hard to confirm the occurence of trident formation, a character that does not develop in *P. stephensoni*.

Specimen no. 180 has very close affinity to *P. lichen* since the walls are thick to the naked eye. When observed under the microscope, the thick part is shown to be the broad fused septa close to the wall as in *P. lichen*, Fig. 73 of monograph by Veron & Pichon (1982).

Porites (Porites) nigrescens Dana, 1848

MATERIAL STUDIED

197 / Ad.III, Sl, 3 / pur (Fig. 106, 109)

198 / Ad.III, Sl, 3 / br.g,wh-polyp

199 / Ad.III, Sl, 1.7 / pur

200 / Ad.III, Sl, 6 / br,wh.cr-tip

201 / Ad.XI, Rf, 3 / d.br

202 / Ad.XI, Rf, 3 / d.br,g-tip

CHARACTERS

Coralla are branching with explanate or encrusting bases. In outline appearance branches are about 0.5-1 cm thick, 1-5 cm long. They may be cylindrical or slightly compressed laterally. Short branches are usually compact and anastomosed. Corallites are rounded or they become polygonal and slightly excavate near branch tips. Calices are about 0.9-1.2 mm diameter. Septa are relatively thick and sometimes flattened. The ventral triplets are usually fused but frequently incomplete (ie. only two septa are fused). Five to eight pali may develop (those on triplet are usually incomplete, ie. there may be up to three but only one palus is the normal case). The palar synapticular rings develop well although often incomplete. Septum has only one denticle close to the wall. The central fossae are deep. Columellae are absent or present as granular processes.

DISCUSSION

The variation among specimens in this collection is obvious both in growth form and calicular structures. Those specimens from shallow water (ie., specimen nos. 201 and 202) have very compact branches and their corallum surfaces (even at branch tips) are very smooth as *P. cylindrica*. Their septa and coenosteal elements are flattened. However the appearance of one denticle on the septum can be used to identify these two specimens as *P. nigrescens* (Veron & Pichon, 1982).

SUBGENUS NAPOPORA QUELCH, 1884

Like subgenus *Porites*, but corallites are widely separated by well-developed, ridged coenosteum.

Porites (Napopora) vaughani Crossland, 1952

MATERIAL STUDIED

195 / Ad.VI, S1, 10 / br,wh-polyp (Fig. 105, 108)

196 / Ad.III, S1, 6 / br,g,wh-polyp

CHARACTERS

Coralla are columnariform, with plate-like or encrusting peripheries. Columns are irregular in shape and irregularly fused. The surfaces of most coralla are rough, with corallites separated by coenosteal ridges. Corallites are about 1 mm diameter and 0.4-1 mm diameter apart. Septa are relatively thick and have a well-defined pattern. The triplets are always fused at extremities. Each triplet has one palus. There are 6 pali in each corallite. The palus on the dorsal directive is the smallest one. Each septum usually has 2 denticles but sometimes a couple of denticles are fused into a large one. Columella is usually poorly developed as a small denticle with radii in irregular numbers connected to pali. Synapticular ring is present below pali. In some colonies, it fuses with radii and develops as a thick plate.

DISCUSSION

The most striking character found in specimens of this collection

is that of the septa of the triplet always being fused, a case which sometimes or frequently occurs in *P. vaughani* of Australia (Veron & Pichon, 1982). This is certainly a variation of the species from a different area.

SUBGENUS SYNARAEA VERRILL, 1864

Like subgenus *Porites*, but corallites are smaller, superficial and widely separated by finely reticulated coenosteum.

Porites (Synaraea) rus (Forskal, 1775)

MATERIAL STUDIED

175 / Rw,VI, Sl, 3 / pur

176 / Ad.III, Sl, 6 / r.br,yel.br-tip

177 / Ad.VI, Bt, 14 / d.br

178 / Ad (Fig. 99)

179 / Ad

CHARACTERS

Coralla are submassive to massive, columnar, irregularly branching, encrusting or irregularly explanate. Corallum surfaces may be smooth (usually where concave) or rough, with short irregular coenosteal ridges (especially in columnar corallum). Calices are very small, up to 0.7 mm diameter. They become crowded(or clumped) and are smaller where corallum is concave, or between coenosteal ridges. Septa of the triplet are always fused at their extremities. Six pali are well developed and the one on the dorsal directive is the smallest (or occasionally absent).

Pali usually reach the level of surface of coenosteum. A palar synapticular ring is usually developed below pali. Columellae are very variable in development between different coralla or even in individual corallum. If present, it appears as a single rod with echinulated tip, similar to but smaller than the palus. If absent, the calicular centre appears as a deep fossa surrounded by a cylindrical tube formed by the fusion of inner margins of septa and the palar synapticular ring. Coenosteum are reticular, covered with denticles. However on the tops of coralla, coenosteum are openly reticular, with poorly developed denticles.

DISCUSSION

In general characters of specimens above correspond with *P. (Synaraea) rus* described by Veron & Pichon (1982).However the septal denticles are clearly seen only in specimen no. 179 while in the other specimens denticles usually appear on corallite walls.

GENUS GONIOPORA DE BLAINVILLE, 1830

Colonies are massive, columnar, ramose or rarely encrusting. Corallites have thick but porous walls and calices are filled with compacted septa and columellae.

It is recognized in nature by the long-stemmed retractable polyps with an apical crown of tentacles.

Goniopora cf. *lobata* Edwards & Haime, 1860

MATERIAL STUDIED

323 / Ad.I, Rf, 3 / yel.gr,wh.cr

324 / Ad. (Fig. 164)

CHARACTERS

Coralla are massive and round in appearance. Corallites are round or polygonal. Calices are uniform in size of about 3.5 mm diameter and the depths vary from very shallow to 2 mm. Septa are usually in 2 orders of 12 each, although the second ones are often absent or appear as rows of dentations. First order septa appear as large porous blades, highly exsert with irregular dentations. The gonioporoid pattern may appear but is incomplete. All septa are granulated. Paliform lobes do not develop. Columellae are usually small, consisting of a few twisted dentations but may be up to 1/2 calice diameter in width. The walls are composed primarily of septa linked by synapticulae, which leave porous structures when viewed from both the side and top.

DISCUSSION

The description above is taken from specimen no. 324. In general it could be applied to specimen no. 323 with some variation of skeletal structures. This specimen (no. 323) has deeper calices, up to 4 mm and the first order septa are less exsert but have very long dentations. This specimen does not fit the description of *G. stokesi*

Edwards & Haime as there is no evidence of clear gonioporoid pattern as found in *G. stokesi*. I consider these specimens as *G. lobata* since they show the typical characters of the species, ie., round and massive colonies, poorly developed columellae and the correct size of corallites. Specimen no. 324 shows the clear gonioporoid pattern (a character found in this species) in the shallow, solid corallites which are at the side of coralla exposed to less light intensity.

Goniopora djiboutiensis Vaughan, 1907

MATERIAL STUDIED

325 / Gt.I, Sl, 2.5 / br,pur

326 / Ad.XII, Sl, 3 / pur.g.br (Fig. 162, 163)

327 / Ad.VI, Sl, 5 / br,bl-tentacle tip

328 / Ad.

CHARACTERS

Coralla are massive. They may be hemispherical or columnar. Corallites are round or polygonal, with calices 4.2 mm on average in diameter. Septa are all short, of uniform size and are regularly spaced. The group of each 3 or 4 septa usually fuse at inner margins where prominent paliform lobe develop. Thus each calice consists of 6 paliform lobes. The gonioporoid pattern is not distinct since this fusion occurs at the extremities of septa of equal size. All septa are granulated and regularly dentate. Columellae are usually well developed in a dome shape. They are segmented and correspond

with the paliform lobes. Corallite walls are about 1 mm thick and becoming thicker near the bases of coralla. Usually there are grooves on walls.

DISCUSSION

Among the four specimens of this collection, only specimen 328 has the hemispherical massive form. The other have columnar form. In the latter case, size (length and diameter) of branches vary between different coralla and in each corallum. However all specimens clearly show the typical characters of the species, ie., their paliform lobes and columellae are joined together as dome-shaped structures.

Goniopora columna Dana, 1846

MATERIAL STUDIED

329 / Ad.VI, Sl, 5 / br,bl-tentacle tip

330 / Ad.XII, Rf, 1 / yel.br,wh.bl

331 / Ad.XII, Rf, 1 / yel.br,yel.gr (Fig. 156, 157)

CHARACTERS

Coralla are massive, usually with encrusting peripheries. Corallites are polygonal or nearly circular. Calices are about 2-3.5 mm diameter. Septa are fine, highly perforate and irregular. The gonioporoid pattern of fusion sometimes appears. The incomplete cycle of 6 primary septa may be seen, especially in deep calices. The development of paliform lobes varies greatly, although they are usually

inconspicuous or absent. Columellae are diffuse and occupy 1/2-3/4 of the calice diameter. Corallite walls are highly perforate.

DISCUSSION

The *G. columna* in this collection are all represented by specimens having massive, or thick encrusting forms, instead of columnar form which are usually described in the literature. The author considered the above 3 specimens to be *G. columna* since they show the very fine, irregular septa, highly perforate walls and diffuse columellae that characterise the species. Although they are close to *G. stokesi* and *G. lobata*, in general appearance in this collection, *G. columna* has slightly smaller corallites.

Goniopora sp. 1

MATERIAL STUDIED

332 / Hn.I, Rf, 3 / pale gr (Fig. 165, 169)

CHARACTERS

Corallum is massive, with an even surface. Corallites are polygonal or nearly round, with calices 3.0 mm of average diameter. Giant corallites of up to 5.5 mm diameter occasionally occur. Septa are very thin and arranged in distinct gonioporoid pattern. All septa are regularly dentate. Columellae are developed 1/2-3/4 of calice diameter.

DISCUSSION

This single specimen was found to be free living on sand, sheltered by large coral colonies. Polyps are transparent, pale yellow green which was probably caused by expulsion of zooxanthellae.

The outline skeleton structures are similar to *G. columna* Dana, especially when considering corallite size. But in contrast, septa are arranged as in *G. djiboutiensis* Vaughan, but columelle and paliform lobes are not as prominent. In addition, walls of this specimen have sharp edges which contrast with the walls of *G. djiboutiensis* which have grooves and flattened edges. Thus it is not classified as a variant of *G. columna* or *G. djiboutiensis*. Since there is only one specimen represented with these characters. From an environmental point of view its habitat could be defined as extreme, it is not possible to place it in any species.

Goniopora minor Crossland, 1952

MATERIAL STUDIED

333 / Ad.III, Rf, 2.5 / gr.br,gr-polyp (Fig. 158, 159)

CHARACTERS

Corallum is submassive with rounded, nodular surface. Coralli-tes are polygonal or almost round with calices of about 1.5-2.0 mm diameter. Walls are about 0.8 mm thick, and thinner on concave sur-faces. Septa are in 3 cycles, the first two are subequal, the third vary from small to absent. They are arranged in gonioporoid pattern

which may be irregular even in an individual corallum. Each calice consists of 6 well developed, granulated paliform lobes which are fused together by a synapticular ring. The latter usually raise slightly above columella. Columellae range from small to 1/2 calice diameter. In the latter case, columellae structure is a loose tangle of fused synapticulae. This usually occurs in corallites consisting of septa of irregular gonioporoid pattern. Walls are primarily composed of septa which are evenly exsert with pointed granulated tips.

DISCUSSION

Although there are few variations of calicular structures in this single specimen, they correspond well with the range of variations described for *G. minor* of the Great Barrier Reefs, Crossland (1952) and Veron & Pichon (1982) and for that of Malaysian reefs, Betterton (1981).

The characters of specimen are close to those of *G. fruticosa* but its corallite walls are slightly thicker and not flattened as those of *G. fruticosa*.

Goniopora fruticosa Saville-Kent, 1893

MATERIAL STUDIED

334 / Ad.III, Rf, 2.5 / br,wh.gr-polyp (Fig. 160, 161)

335 / Ad.I, Rf, 2.5 / br,wh.gr-polyp

336 & 337 / Ad.

CHARACTERS

Coralla are digitate, with branches of about 6-18 mm thick. Branches are highly anastomosed. In this case, part of the corallum may become submassive. Calices are round or become oval near branch tips. Calice diameter ranges from 1-2.5 mm but mostly are 2 mm. The calicular wall is about 0.6 mm with a flat top. It consists of rows of exserted septa from adjacent corallites which meet, but do not join, on top of the calicular wall. Septation is rather irregularly developed. Sometimes the evidence of gonioporoid pattern appears. Septal dentations are also irregularly developed. Each calice consists of about 6 irregular-shaped paliform lobes which are fused by a synapticular ring and all are fused with the broad columella tangle.

DISCUSSION

The specimens represented as *G. fruticosa* in this collection are very different in thickness of branches. Calicular structures of specimen no. 335 correspond well with those described for Australian *G. fruticosa*, by Veron & Pichon(1982) , ie., septa are usually distinguished in 2 orders and their fusion in gonioporoid pattern are present but not distinct. In contrast, specimen nos. 334 and 337 have branches which are more fragile and the calicular structures are not easy to discern since their elements are rather coarse in structure and irregularly developed. The latter case corresponds with that described for Malaysian *G. fruticosa*, by Betterton (1981).

Goniopora sp. 2

MATERIAL STUDIED

339 / Ad.III, S1, 4.5 / yel.gr (Fig. 166, 170)

CHARACTERS

Corallum is massive, with lobulate head. Corallites are polygonal to round, with calices about 1 mm deep and 2.5 mm in diameter. The walls are thin, highly perforated, consisting of an Alveopora-like lattice of trabeculae and synapticulae. Septa which are primarily developed in 2 cycles, are almost always 12 in number, of equal size. Occasionally, small septa which may be defined as third cycle septa appear to fuse with septa of lower cycle. All septa plung steeply into calice to the level of columella then long septal dentations become more extended and often fuse in pairs around the centre. About 6 plate-like paliform lobes are present where septa fuse. Septal dentations and paliform lobes are serrated or granulated on their margins. Paliform lobes are connected to each other by synapticular rings which are raised slightly over columellae. Columellae are small, consisting of a few fused synapticulae connected to septal structures.

DISCUSSION

This single specimen does not resemble any species of Australian water or even Malaysian water. More specimens of this type are needed for study.

Goniopora sp. 3

MATERIAL STUDIED

340 / Ad.I, Rf, 3 / wh.gr,d.br (Fig. 167, 171)

CHARACTERS

Corallum is primarily encrusting, on a dead branch of *Acropora*, then showing a columnar growth form. Corallites are polygonal to rounded, with calices about 2 mm deep and 3.5 mm in diameter. Walls are thin and highly perforated, consisting of septal plates linked by synapticulae. Septa are in three irregular cycles, of which the third may be absent. All septa have relatively long seated-tip spines. These spines may be branching at tips and usually fuse irregularly to spines of adjacent septa or even of the same septa. Six paliform lobes are usually hard to distinguish from irregular projections of septal spines and columella trabeculae. Septa fuse with each other by incomplete synapticular rings that usually appear in three planes from walls to the level of pali. This character makes the calicular structures spongy in appearance similar to *Alveopora*.

DISCUSSION

This single specimen has general characters similar to those of *Goniopora sp. 2* described by Veron & Pichon (1982). However their description is not clear enough for a comparison with this specimen.

Goniopora sp. 4

MATERIAL STUDIED

338 / Ad.III, S1, 4.5 / yel.gr (Fig. 168, 172)

CHARACTERS

Corallum is submassive to massive with slightly explanate periphery. Corallites are polygonal or nearly round, with shallow calices of about 2.3 mm diameter. Giant corallites of up to 4.5 mm diameter occur occasionally. Septa may be 3 cycles, but they are often subequal or equal, especially those of the first and second cycle. They usually fuse in gonioporoid pattern but not completely through the whole calice. All septal margins have irregular dentations. Each calice consists of about 6 relatively large paliform lobes that may be seen as a neat crown by the naked eye. Columellae are usually small, consisting of a few, elaborately fused synapticulae connected to septal structures. Corallite wall is ridged, usually ill-defined and is composed of loosely anastomosed septa and one plane of synapticular network.

DISCUSSION

This single specimen has characters similar to those of *G. stutchburyi* Wells, especially when compared to the photograph in the literature. However there is some confusion to identify this specimen as *G. stutchburyi*. Veron & Pichon (1979) described *G. stutchburyi* as having septa not arrange in cycle or order but

fused in groups from 2-6. In contrast, the specimen of this collection shows 3 cycles of septal arrangement, although those in some corallites are not clear and they usually fuse in groups of 3 or 4 to show gonioporoid pattern. However, comparing this specimen to *G. stutchburyi* from the PMBC, this specimen has slightly larger corallites. The corallite walls are more poorly-defined and the calices appear in shallow cone shapes instead of flat bottoms which is a character of *G. stutchburyi*. This specimen may be a separate species.

GENUS ALVEOPORA DE BLAINVILLE, 1830

Alveopora is similar to *Goniopora* but its skeletal structures are extremely porous. Septa reduce to fine spines which may meet in the centre to form a columella tangle.

Alveopora sp. 1

MATERIAL STUDIED

487 / Ad.I, Rf, 2.5 / yel.gr,pur.br (Fig. 173)

488 / Ad.XI, Rf, 3 / gr

489 / Bs.I, Rf, 0.5 / d.br,g,d.gr (Fig. 174)

490 / Bs.I, Rf, 0.5 / d.br,wh.pur,yel.gr

CHARACTERS

Coralla are small knobs (1.5-5 cm diameter), with surface divided into irregular lobes. Corallites are 1.8-2.2 mm (or

occasionally up to 3 mm) diameter. They are hexagonal in shape. Their walls consist of a palisade of regular trabecular pillars and synapticular linkages with oval pores accounting for 50-60 per cent of surface area. Septa are in 2 cycles (12 irregularly vertical rows of spines). Septa of both cycles are very irregular in length. Those of first cycle are more elongate and may be fused deep within calices, their tips usually flattened and broad. There is almost no development of columellae, other than a slight elaboration of the tips of the lower septal spines.

DISCUSSION

The series of specimens in this collection have close affinity to *A. fenestrata* Lamarck but their characters are not exactly the same, ie., the average size of corallite diameter is smaller than the 2.1-3.0 mm diameter which Veron & Pichon (1982) described.

Specimen no. 487 was found encrusting on coral debris in turbid water. Its skeleton structures are the same as others except they are more solid and thicker.

Polyps of all specimens extend during the day. Shape of polyps looks similar to that of *A. fenestrata* and *A. tizardi* as shown in monograph (Veron & Pichon, 1982).

FAMILY AGARICIIDAE GRAY, 1847

Colonial and hermatypic. Colonies are formed by intra- and extratentacular budding. Walls are synapticulothecate appearing fenestrate or solid,or may be absent. Columellae are trabecular

or absent.

GENUS PAVONA LAMARCK, 1801

Colonies are massive, laminar or foliaceous, the latter usually being bifacial.

Corallites have poorly-defined walls. They are small shallow depressions, usually with a central columella, sometimes separated by ridges. Corallites are interconnected by prominent septo-costae.

Pavona explanulata (Lamarck, 1816)

MATERIAL STUDIED

139 / Ad.III, Sl, 6 / br

140 / Ad.VI, Sl, 10 / gr.br (Fig. 82)

141 / Jb., Sl, 4 / yel.gr (Fig. 84)

142 / Ad.XI, Sl, 10 / br

143 / Ad.XI, Rf, 3 / d.br,d.gr-stom (Fig. 83)

144 / Ad.VI, Bt, 14 / br,cr (Fig. 85)

145 / Ad.XI, Sl, 10 / br

CHARACTERS

Coralla are primarily encrusting or laminar. The laminar plate may fold back to back. Encrusting colonies are usually developed into very solid, massive form with irregular, short columns. Calices may be circular, about 2-3 mm diameter or oval, about 2-5 mm. Corallites on laminar plates tend to be arranged in rows parallel to peripheries

while those on encrusting coralla are irregularly scattered. Septa are in 2 orders. First order septa are more exsert and more granulated, giving thicker appearance than those of the second order. Upper septal sides are covered with crenellated ridges running downwards. Septocostae may branch and fuse with more than one adjacent corallite or sometimes terminate in small alveoli especially where adjacent corallites are far apart. Each columella usually appears as a single thick trabecula. Thecae are primarily synapticulothecate.

DISCUSSION

Species of this collection are probably separated into 2 groups corresponding to their habitats, ie., massive form from shallow water (in this case the depth ranges from 3-10 m from outer reef flat to slope) and laminar form from deep water (on bottom areas,14 m) . Thickness and formation of septa of specimens are very variable. Those of specimen no. 140 are relatively thin while those of the others, especially of laminar coralla are very thick and usually form 3 ridges, ie., 2 lateral ridges and 1 medial ridge running along the upper septal margins. Specimen no. 143, which was found on a reef flat, may be considered to be at the extreme end of variation if it indeed, it is true *P. explanulata.* Its septa are usually petalloid but some are very similar to those of specimen no. 141 (from strong current habitat) which has compact corallites, relatively thin septa and very distinct synapticulothecate walls. On the underside corallites and septa show the typical structures of the species.

Pavona varians (Verrill, 1864)

MATERIAL STUDIED

146 / Ad.III, Sl. 6 / d.br,wh-edge

147 / Ad.VI, Sl, 10 / br,gr (Fig. 86)

148 / Ad.XI, Rf, 3 / d.br,or.br

CHARACTERS

Coralla are primarily encrusting, forming irregular shapes. Corallum surfaces are covered with low irregular collines which vary greatly from monticule structures to ridges of 1.5 cm long. Corallites are distributed irregularly or form short series on valley floors. Calices are about 1 mm diameter. Septa are in 2 orders, those of the first order are more exsert and slightly thicker. Septa (septo-costae) of third and fourth order may develop on upper margins of collines. Septal sides are covered with relatively prominent pointed granules. Each columella usually appears as a single thick trabecula which is ridged or granulated. Columella in oblong calice may consists of a series of a few trabeculae.

DISCUSSION

(see p.125)

Pavona venosa (Ehrenberg, 1834)

MATERIAL STUDIED

149 / Ad.III, Sl, 2.5 / br (Fig. 87)

150 / Ad.I, Rf, 3 / br,wh-tentacle

CHARACTERS

Coralla are primarily encrusting, tending to form irregular, massive columns. Corallites are mostly discrete or sometimes arranged in short valleys. Valleys usually contain no more than few centres which are separated by low walls and few trabecular linkages. Calices are about 2 mm diameter. Septa are in 3 regular orders, those of the first order extend deeply within calicular centres and often fuse with columella bases. Third order septa develop only on upper calicular walls. All septa are equal or subequal in thickness. Septal sides are covered with pointed granulations. Each columella appears as a single flattened trabecula. They are granulated like the septa.

DISCUSSION

Specimens identified as for *P. venosa* are very similar to those of *P. varians* (see p.125). According to Veron & Pichon (1979), *P. venosa* has sharp collines, 3 orders of septa and little or no development of columellae and for this collection corallites are slightly larger than those of *P. varians*. However, on undersides of some colonies, skeletal structure looks identical to that of *P. varians*. This probably shows the close relationship between this two species.

Since outline characters of these two species are obviously different (eg., discrete corallites in *P. venosa* and very irregular distribution in *P. varians)*, thus they are not considered as an ecomorph of a single species even though some features are identical.

Pavona decussata (Dana, 1846)

MATERIAL STUDIED

151 / Ad.XII, Ed, 3 / br

152 / Ad.III, Sl, 3 / yel.br,wh-tentacle

153 / Ad.I, Rf, 2 / br,cr

154 / Ad.I, Rf, 3 / br

155 / Ad.

156 / Ad. (Fig. 88)

CHARACTERS

Coralla are primarily encrusting. The adult colonies usually form vertical, anastomosing bifacial fronds which are about 7 mm thick and have sharp edges. Generally corallum surfaces are smooth, with evenly spaced corallites. Corallites may be circular (about 2 mm diameter). Those on fronds, are often oblong (about 1-3 mm across) and are usually arranged in rows parallel to frond edges. Septa are in 2 orders, those of the first order are much more extended and thicker than those of the second order which are very thin. When observed with the naked eye, first order septa are relatively widely spaced. All septal sides are granulated. Columella development varies from a junction of the inner edges of the first order septa to a vertical, ridge-like single pillar.

DISCUSSION

Besides the variation of growth forms found in this series of specimens, the calicular structure which is obviously variable is

the second order of septa. In specimen nos. 155 and 156, second order septa, especially of those of corallites on fronds,are simply developed as small ridges on calicular walls or sometimes absent, giving the outline appearance of one order of septa. In this case columellae are very poorly developed, ie., they mostly appear as a solid junction of the inner edges of first order septa. Other specimens are somewhat similar to specimen no. 141 which is identified as *P. explanulata*. This species may be distinguished from *P. decussata* by its well developed columellae and more exserted second order septa.

Pavona clavus (Dana, 1846)

MATERIAL STUDIED

157 / Ad.XI, Rf, 3 / pur.br,cr (Fig. 89)

CHARACTERS

Corallum is submassive, with partly encrusting and explanate periphery. Surface is generally smooth. On explanate part, low carinae are developed and regularly arranged parallel to growing periphery. Corallites on corallum head are usually polygonal or subcircular, about 1.5-3 mm diameter, those on explanate part are elongate, with very shallow calices of smaller size. In the latter case corallites usually form short valleys between carinae and the adjacent corallites are linked by septa (which are turned at right angles) and trabeculae linkages, in contrast with the former case in

which corallites are completely separated by synapticulothecate walls. Septa are in 2 orders of equal thickness, but those of the first order are more exsert and adjoined with the columellae. Septa on corallum head are less compact than those on explanate plate since those on explanate plate have very thick bases (however their margins are still thin). Septal sides are covered with pointed granulations. Columellae are poorly developed. They just appear as small flattened trabeculae or simply appear as solid floors especially those on explanate part.

DISCUSSION

This single specimen of this collection is representative of *P. clavus*. This is one of the uncommon species in the area.

GENUS LEPTOSERIS EDWARDS & HAIME, 1849

Colonies are foliaceous, sometimes laminar or encrusting, the former usually being unifacial. They frequently have a distinctive central corallite.

Corallites have poorly-defined walls. They are small shallow depressions with a central columella, usually separated by ridges and interconnected by fine septo-costae.

Leptoseris mycetoceroides Wells, 1954

MATERIAL STUDIED

168 / Ad.VI, Rf, 3 / r.br (Fig. 92)

169 / Ad.III, Sl, 8 / or.br (Fig. 93)

170 / Ad.

171 / Ad. (Fig. 94)

CHARACTERS

Coralla are thin, laminar, and flat or undulated. Carinae tend to be arranged parallel to peripheries but on the inner areas they are usually short and irregularly fused, giving monocentric corallites and a series of corallites in short valleys. Septo-costae are equal in thickness but sometimes they reach centres alternately. They are closely packed since septal granules are densely developed. Columella appears as a single or a few pinacle-shaped trabeculae, or a prominent plate-like structure. It does not fuse with inner septal margins. The adjacent columellae in the same valley are separated by inner septal edges which turn at right angles. On undersurface, costae are very fine, equally developed or sometimes alternate in 2 orders. Their margins are covered with fine spines.

DISCUSSION

In this species, the variation among specimens, especially the degree of fusion of carinae and size of calicular centres, is very distinct. Carinae of specimen nos. 168 and 170 are well developed and fused in very irregular directions, while those of specimen no. 171 are very low or hardly developed on some parts of corallum surfaces. These appearances may be considered as the extreme ends of variations.

Considering the arrangement of carinae of specimen no. 169, it

may be rated as the intermediate variant. However its carinae are larger than those of the previous three specimens. In addition, this specimen has larger calicular centres (about 0.7 mm diameter) while those of others are just seen by the naked eye. This may be a different species. Since there are not the exact details of diameter of the centre in the available literature and the corelation between skeleton structures and environment is not obvious, the author placed this specimen in the species *L. mycetoceroides*.

GENUS GARDINEROSERIS SCHEER & PILLAI, 1974

Gardineroseris is a monospecific genus, so characters of the genus are given in the species description below.

Gardineroseris planulata (Dana, 1846)

MATERIAL STUDIED

172 / Ad.I, Rf, 2 / d.br,gr-stom (Fig. 97)

173 / Ad.XII, Rf, 3 / cr,yel.gr (Fig. 96)

174 / Ad.XI, Rf, 3 / cr,br.g (Fig. 95)

CHARACTERS

Coralla are usually massive, with encrusting to explanate peripheries. Polygonal corallites have very sharp edges, slightly curved, giving corallite angles which point upwards in outline. Corallites are about 3-6 mm across and 2-4 mm deep and are monostomodial or polystomodial (usually up to 3 or 4 centres). In the

latter case budding can occur on corallite floor or on endothecal side. The young centres are connected to the major ones by trabecular linkages and low, thin synapticulae may developed between them. The development of septa and columellae are very variable among different coralla (see discussion).

DISCUSSION

Although it was noted by Veron & Pichon (1979) that *Gardineroseris* is a distinct monospecific genus, it consists of many ecomorphs having rather unique characters as shown by Ditlev (1980) (in Fig. 197-200 of his text). The 3 specimens in this collection are highly variable in character, especially septal development. Specimen no. 174 has septa which are extremely neat in appearance. They are equally prominent, but of different length, being separated into 2 orders. First order septa reach the centre while secondary septa are slightly shorter, with the exception, that where endothecal walls do not steeply slope or at the corallite corners, septa are not arranged in distinct orders, but are of irregular length. The shortest ones may only terminate on upper walls. For this exceptional case the shorter septa may fuse with the longer ones. In another two specimens, nos. 172, 173 first order septa become more prominent towards the centre, giving an appearance close to the pavonoid pattern of septa. The flattened spines on septal sides of specimen no. 174 are more densely developed, making septa extremely compact and also its columellae, although also poorly developed (it consists of a few twisted, ridged trabeculae) are more spongiose (those of specimen nos. 172, 173 may be absent). Of the

latter two specimens, number 172 was collected from a turbid habitat and is probably at the extreme end of variation of the species. This is because the corallite walls (collines) are not continuous but irregularly developed. To the naked eye it resembles *Pavona decussata* Dana, except that this species does not develop ridged collines and its septa are slightly thicker and completely in the pavonoid pattern. This doubful specimen is probably the true *G. planulata*, since some corallites which are completely enclosed by ridged walls are identical to those of specimen no. 173 which is identical to the ecomorph *ponderosa* Gardiner photographed by Ditlev. However, Veron suggested that there may have been two species of *Gardineroseris* in this region (personal communication). Further investigation is needed.

GENUS COELOSERIS VAUGHAN, 1918

Coralla are cerioid with colonies formed by monostomodeal budding. Columella are absent and the axial space open.

Coeloseris mayeri Vaughan, 1918

MATERIAL STUDIED

302 / Ad.XI, Rf, 3 / yel.gr,g.br (Fig. 98)

303 & 304 / Ad.

CHARACTERS

Coralla are massive, with smooth or undulating surfaces. Cerioid corallites are polygonal, about 3-4 mm across. Septa are in 3 orders.

Those of the first two orders exsert and join above walls. Second order septa are usually slightly smaller than those of the first, or sometimes can not be separated from them. Third order septa terminate on thecal rims and sometimes are absent. The first two orders of septa descend gently on upper parts and become subvertical or plunge deeply towards centres. Septal margins are generally smooth. Septal sides are ornamented with small pointed granulations. Walls are thin except those on lower, or underparts of coralla, become thick. Columellae are absent.

DISCUSSION

One character which is remarkedly different from that described by Veron & Pichon (1979) is the size of calice. Calices of specimens from Australian waters are on average 6 mm in diameter while none of the calices in this collection reach that size. According to those authors, this genus is believed to be monopecific, thus the different character above may be concerned with geographical variation of the species.

GENUS PACHYSERIS EDWARDS & HAIME, 1849

Colonies are laminar and unifacial, to branching and bifacial. Branches are usually highly contorted. The surface is a series of concentric ridges parallel with the margins. Colices are indistinct pavonoid in structure but do not radiate from centres.

Pachyseris rugosa (Lamarck, 1801)

MATERIAL STUDIED

158 / Rw.VI, Sl, 2 / br

159 / Ad.VI, Bt 14 / br

160 / Ad.XI, Rf, 3 / gr.g,yel.br-edge

161 / Ad.VI, Sl, 7 / br (Fig. 90)

162 / Tr.IV, Sl, 3.5 / d.gr.br

163 / Ad.VI, Sl, 10 / br,cr-edge

CHARACTERS

Coralla are encrusting, with laminar peripheries or may be completely laminar. They usually form irregular knobs (or columns) in central areas. Calicular centres on laminar plates run along the valleys which are arranged irregularly concentric to corallum centre. Valleys may be very short or long up to 5 cm. They are separated by carinae which run parallel and fuse in an irregular manner. Short and irregular carinae are often formed on knobs. Consequently monocentric corallites usually appear in these areas. Carinae are about 1.5-3 mm wide at bases and 2 mm high. They usually have steep sides except those on columns may have one side gently slope and the other adjacent side descend vertically. Septa are equally developed and evenly spaced. Those of adjacent valleys join over thecae. They have crinkled margins and granulated sides. Their inner margins link with contorted horizontal subcontinuous plates which support the discontinuous vertical plates functioning as columellae. On the

undersurface, costae appear as fine ridges with fine spines or granules.

DISCUSSION

Specimens of this collection show variation of growth forms and development of carinae. These are within the range of variations described by Veron& Pichon(1977) with the exception that septa of any specimens are not two orders, as found in Australian specimens.

Pachyseris speciosa (Dana, 1846)

MATERIAL STUDIBD

164 / Ad.XI, Sl, 3 / br,yel-edge (Fig. 91)

165 / Ad.XI, Rf, 3 / g.br

166 / Tr.IV, Sl, 5 / br,cr-edge

167 / Ad.VI, Sl, 4 / d.br,yel.cr-edge

CHARACTERS

Coralla are laminar and usually grow in an oblique to vertical plane. The laminar plates are unifacial and may fold back to back. Carinae are arranged parallel to the corallum edges. They are very long since their fusion rarely occurs. They face their acute edges towards corallum periferies. The development of septo-costae are the same as for *P. rugosa* (see p.134). The inner septal margins usually fuse with subdiscontinuous horizontal plates lining valley floors or sometimes inner septal margins themselves extend as flattened horizontal plates, and fuse with valley floors. Columellae appear as

vertical plates, but are rarely present. On undersurfaces, costae may be equally developed on peripheries and become alternated into two orders towards central areas. They may also alternate into two orders on peripheries although septa on uppersurfaces are in one order. They are ornamented with granules or spines which may become a series of flattened vertical plates in the direction of costae (in the absence of costae).

DISCUSSION

In this collection, the three specimens from the reef slope have higher carinae when compared with those low or nearly flattened carinae of specimen no. 165 which was collected from the reef flat. These appearances do not really contrast to the description given by Veron & Pichon (1977) ie., that coralla from more exposed biotopes (eg. reef flat) usually develop high carinae. Specimen no. 165 was found growing in a coral crevice which already received less light intensity.

FAMILY FUNGIIDAE DANA, 1846

Solitary or colonial and fixed or free living. The free living species are discoidal or elongate, with flat or concave aboral side. Fixed colonies have flat foliaceous growthform. Colonies are formed by intratentacular polystomodeal budding. In general colonial genera have septo-costal structures corresponding to those of a solitary genus. These septo-costae radiate from the mouth fossae on the oral surface (as septa) and from the centre of the aboral surface (as costae).

GENUS FUNGIA LAMARCK, 1801

Coralla are solitary, free-living (except for juvenile), flat or dome-shaped circular or elongate in outline, with central mouth. Septa have large or small, rounded to pointed teeth. Costae consist mostly of rows of spines. The disc (wall) is perforated in small corallum and sometimes in large specimens of some species.

SUBGENUS FUNGIA LAMARCK, 1801

Coralla are discoid. Costae bear coarse spines (5-12/cm). They are equal to subequal, reduced and bearing nearly equally tall, smooth or distally spinulose spines.

Fungia (Fungia) fungites (Linnaeus, 1758)

MATERIAL STUDIED

357 / Tr.II, Sl, 8 / br

358 / Ad.VI, Sl, 5 / cr,pur-edge,pur-stom

359 / Ad.XI, Rf, 2 / br,pur

360 / Ad.III, Sl, 3 / br (Fig. 176)

361 / Ad.

CHARACTERS

Coralla are subcircular to circular. They are usually contorted and may be flat or arch in a cone shape. Septal development is highly variable from one specimen to another. Septa may be in 4-6 orders with 30-50 first order septa. Septa are subequal on outer part of

corallum and those of higher orders become less exsert towards the centre. The two higher orders of septa usually do not fuse with the next lower one but they insert into the wide, deep alveoli. Septal dentations are usually triangular and ridged or thickened at apex. However, dentations vary greatly in shape (see discussion). Septal sides are sparsely granulated. Costae are subequal and laminar on outer part of disc. Costal margins have pointed dentations (spines) which are ornamented with small granules on their tips. Corallum wall is slightly perforate but having many alveoli. The evidence of a scar of attachment is not distinct.

DISCUSSION

Although this species has well defined characters, it includes of 15 varieties (Veron & Pichon,1979).Generally each variaty is characterised by its septal dentations. For this collection, the small specimens, nos. 357 and 358 which are about 6 cm diameter, have up to 17 small triangular dentations per cm. Specimen no. 361 has pointed dentations which are usually arranged in groups, each consisting of a few dentations sitting on irregular lobes. This gives septal margins which are separated at irregular intervals (see fig. 360). Specimen nos. 359 and 360 which are mature, up to 21 cm diameter, have rather regular, triangular dentations of about 7 in number per cm. The first 3 specimens above usually have 4-5 septal orders, with 30-32 first order septa while the latter two have 5-6 septal orders with 45-50 first order septa, and their septa tend to fuse and form secondary centres. Furthermore, the first 3 specimens have costal spines which are prominent on outer parts of

coralla and becoming smaller at central areas. This contrasts with the case of the two latter specimens of which their costal spines become larger and may branch at the central area. However, the outline characters which are unique for this specimen is probably that the septa are almost equal and the higher order septa usually terminate in the deep alveoli.

SUBGENUS VERRILLOFUNGIA WELLS, 1966

Coralla are discoid. Costae bear coarse spines (5-12/cm). They are unequal cyclically and all spinulose.

Fungia (Verrillofungia) granulosa Klunzinger, 1879

MATERIAL STUDIED

349 / Ad.I, Rf, 0.5 / br

350 / Tr.II, Sl, 8 / ? (Fig. 177)

351-353 / Tr.II, Sl, 8 / ?

354 / Ad.

CHARACTERS

Coralla are circular,up to 11.5 cm diameter. The discs are flat, or usually irregularly convex in young coralla. Central area of oral side arches around axial fossa. Septa are wavy in outline. They are usually in 5 or 6 orders, with 24 first order septa reaching the mouth fossa. Sometimes first order septa tend to separate into 2 cycles, of 12 each. The first 3 orders of septa are equally exsert

and are 2-3 mm higher than the rest. Septa of higher orders usually fuse in series. Septal margins have fine ridged dentations which are subtriangular to lacinate and ragged in outline. Dentations and upper septal sides are usually ornamented with comparatively large, horizontal-flattened granules which are covered with very small granules which extend to lower parts of septal sides. Thick tentacular lobes are present although they may be weakly developed in some coralla. Costae are thin. Those of the first two orders are subequal and slightly more prominent than others. Costal margins have fine denticules which are covered with very small granules, giving a cauliflower-like appearance. At inner area costae disappear gradually and are replaced by rows of granules. The evidence of scar of attachment is present but it has already been covered with small granules. Corallum wall is perforate.

DISCUSSION

The six specimens in this collection range from 5.5-11.5 cm diameter. The three small ones are very similar to *Cycloseris costulata* Ortman, of which genera, according to Veron & Pichon (1979), *Verrillofungia* was probably derived from. Nevertheless, they are probably *F. granulosa* since their corallum wall are perforate, characters which are not present in *Cycloseris*. Variation between different specimens also appears; ie., specimen nos. 353 and 354 have rather delicate septa, since septal granulations do not densely develop, making them similar to *F. scabra*. However, the presence of corallum wall perforations is probably used to separate

them from the latter species.

Fungia (Verrillofungia) repanda Dana, 1846

MATERIAL STUDIED

355 / Tr.II, Sl, 8 / ? (Fig. 178)

356 / Ad.VI, Sl, 5 / br,pur-edge,yel.br-edge

CHARACTERS

Coralla are subcircular to circular, about 12 cm diameter. The outline features and septation are same as those of *F. concinna* (see p. 142) except the septal dentations which are coarser (about 3-6 dentations per cm) in *F. repanda*. Irregular lobate margins also appear. On undersurface costal development and ornamentations are generally the same as those of *F. concinna*. Corallum wall is well perforated even in the thick corallum.

DISCUSSION

In this collection, the two specimens show variation in skeletal solidification. It may due to environmental influences. Dense bushes of soft coral colonies limited light penetration to no.355. As a result, skeletal structure of the latter is more solid than no. 356 which was collected from a protected site, but in shallower water. Costal spines of specimen no. 355 are smaller, up to 0.8 mm diameter, while those of another specimen are up to 1.5 mm.

Fungia (Verrillofungia) concinna Verrill, 1864

MATERIAL STUDIED

357 / Ad.VI, Sl, 5 / br,cr

358 / Ad.I, Rf, 3 / br,cr,br.yel.gr-stom,wh.br-stom (Fig. 175)

359 / Ad.I, Rf, 3 / br,cr,gr.yel-stom,br-stom

CHARACTERS

Coralla are subcircular to circular, about 10 cm diameter, 1.1-1.3 cm thick at peripheries. They are usually flat and contorted, with slightly covex surfaces around mouth fossa. Septa are usually in 6 orders, with 24 first order septa. The first 3 order septa are equally exsert and 3-5 mm higher than the rest. Septa from third to sixth order are fused in series. Margins of septa of lower orders (ie. first-third) are variable in feature, ie., they may consist of irregular, triangular dentations ranging from, a few to 17 per cm, or they may be irregularly lobulate or subentire. Margins of septa of higher orders usually consist of very thin, long , lacinate spines. These septa are perforate. The upper parts of septal sides are covered with wavy, flattened ridges while the lower parts are covered with small spines. The axial fossa is elongate, narrow and deep. Costae are laminar on the outer part of corallum. Those of the first three order are equal and more prominent than other. Costal margins are covered with small, blunt dentations or spines which are covered with fine granules. In central part of corallum, spines are scattered over the site of scar of attachment which can not be seen. Corallum wall perforation is not present.

DISCUSSION

By and large, it is easy to separate this species from *F. granulosa* Klunzinger since septa of *F. concinna* are not spongiose and compact as found in *F. granulosa*. For this reason, specimens of *F. concinna* are rather easily damaged, thus giving irregular lobulate septal margins. However, it relates closely to *F. repanda*. These two allied species have the same common characters except coarser dentations and perforations of corallum wall which are characteristic of *F. repanda*.

SUBGENUS CTENACTIS VERRILL, 1864

Coralla are similar to *Pleuractis* except septal dentations are large (4-6/cm). Costae are unequal, with spinulose spines.

Fungia (Ctenactis) echinata (Pallas, 1766)

MATERIAL STUDIED

362 / Ad.VI, S1, 5 / br,wh,yel.gr.br (Fig. 184)

CHARACTERS

Corallum is elongate, 10.5 cm long and 5.5 cm wide. It is gently arched from periphery to centre. Septa are in 4 orders, with 50 primary septa being the most exsert. Second order septa exsert as much as primary ones but their terminal ends near the centre slope down. Third and fourth order septa are comparatively thin. Margins of first two order septa have large subtriangular dentation, 3-7 in number per cm.

Dentation sides have sharp ridges which irregularly extend to dentation tips, making dentations echinulated in appearance Margins of higher order septa have irregular dentations which are more echinulated than those of the former case. These dentations are irregularly fused, giving perforate septa. All septal sides are covered with granules which may be flattened. The central mouth fossa is as long as the width of the corallum. Costae are subequal, and covered with granulated spines with spinulose tips. Scar of attachment is not present. Corallum wall perforations are visible near periphery.

DISCUSSION

This single specimen is a good representative of *F. echinata* since this species is an easily recognised and this specimen does not contain any variations which differ from the literature .

Amount of primary septa described above is not constant but highly variable due to the length of corallum.

SUBGENUS PLEURACTIS VERRILL, 1864

Coralla are elongate or elliptical. Costae are reduced. Wall is perforated. Septal dentations are small (1-3/mm). Costae are equal, with small spines.

Fungia (Pleuractis) pawmotensis Stutchbury, 1833

MATERIAL STUDIED

341 / Ad.VI, S1, 5 / br

342 / Ad.I, Rf, 3 / yel.br (Fig. 179)

343 / Ad.I, Rf, 3 / yel.br

344 / Ad.I, Rf, 3 / br,wh,cr

346 / Tr.II, Sl, 5 / br (Fig. 181)

CHARACTERS

Coralla are elongate and may be rather flat or arch up to 3 cm high on oral side. They are heavy and thick, about 1.5 cm at peripheries. Septa are in 5 or 6 orders but there may be up to 7 orders in irregular specimens. First 3 orders of septa have the same thickness and height. However, only the first can reach the centre, second almost reach the centre; and third about 4/5R. Fourth order septa are slightly thinner than the first three, and they reach about 1/2R from periphery to centre. The pairs of thin fifth order septa run parallel with the fourth which terminate with descending ends, then, each pair of the fifth fuse with each of the fourth and form a single septa running between second and third order septa to nearly reach the centre. Sixth order septa sometimes appear at corallum periphery. All septal margins have small triangular, irregular dentations or may be ragged or even smooth on some parts. Undersurface has well developed, equal or subequal laminar costae. They are usually discontinuous at central area. Their upper margins have thick, swollen granules. No scar of attachment is apparent even in a specimen of 7.5 cm long. Corallum wall perforations are visible on the outer parts of coralla.

DISCUSSION

The description above is given for the normal coralla in this collection. The two coralla nos. 342 and 343 which are both found in turbid water, may be considered as abonormal individuals since their septation is very irregular and more complicated, ie., the outer terminal ends of the lower order septa often do not reach the corallum periphery as all septa nearly always do in the normal cases. In addition septa of higher orders are usually irregularly fused. This usually creates many centre-like structures or supernumerary second centres as mentioned by Veron & Pichon (1979).

Fungia (Pleuractis) moluccensis van der Horst, 1919

MATERIAL STUDIED

247 / Tr.II, Sl, 5 / ? (Fig. 180)

348 / Tr.II, Sl, 5 / ?

CHARACTERS

Coralla are elongate, about 13 cm long and 7.5 cm wide. They are strongly arched, about 5 cm high around the central fossa. Coralla peripheries are about 1 cm thick. Septa are usually in 4-5 orders. Those of the first order are most exsert, thick and spongiose in structure. The higher order septa are fused with the lower ones in series. Septal margins of first order septa have dentations which are very fine and triangular in shape. Those of the other orders are usually ragged in appearance. Septal sides are covered with flat

granules that become larger on higher order septa. Granules may be arranged in vertical series and perforations may occur between. Supernumerary centres are usually present. Costae are subequal to unequal. Those of the first order are most prominent and wavy in outline. Costal margins are finely, irregularly dentate. Costal sides and dentations are covered with granules which make costae ragged in appearance. A scar of attachment is apparent but it is covered with wavy granules. Corallum wall is perforate.

DISCUSSION

Other than the outline shape of coralla, the pattern of septal arrangement is probably a unique character of this species. From these two specimens, it is found that septa of three orders, ie., first, second and the long, thin one(which is developed after serial fusion of third, fourth and fifth order septa) usually reach the central mouth fossa. When perpendicular to the mouth fossa, however, only 2 alternating orders of thick spongiose septa reach the fossa. These are first order septa and septa developed after fusion of the second, third, fourth and fifth orders.

A distinct variation between the 2 specimens is also found. Only specimen no. 347 develops tentacular lobes, a character of which has not been mentioned in any literature.

GENUS HERPETOGLOSSA WELLS, 1966

Coralla like those of *Fungia (Ctenactis) echinata* in septal

structures, but with more centres developed along axes of coralla.

Herpetoglossa simplex (Gardiner, 1905)

MATERIAL STUDIED

363 / Ad.I, Rf, 3 / D.br,br.yel.gr,g (Fig. 186)

364 / Ad.I, Rf, 3 / br,cr,wh.yel.gr

365 & 366 / Ad.

CHARACTERS

Coralla are elongate with length/width ratio about 2-3.3. They can be flat or markedly arched. Septation is in the same manner as *Fungia echinata* Pallas (see p.143) but primary septa are not equal in number (see discussion). First two orders of septa have large, well defined triangular dentations of about 3-7 per cm. Those of higher order septa, dentations are smaller and irregular, giving septal margins a ragged appearance and are perforate through septal sides. All septal sides are covered with pointed spines. Very often on the tips of large dentations, sharp ridges are irregularly formed. The axial furrow consists of many centres. On the undersurface, skeletal features are apparently the same as those of *F. echinata*.

DISCUSSION

As mentioned by Wells (1966) this species is separated from *F. echinata* Pallas by using its major character of polycentric axial furrow (Veron & Pichon,1979).Other characters in detail which are also

different are that dentations of *H. simplex* are triangular and wide-based, while those of *F. echinata* are rather subtriangular to rod-like and thickened on their axes.

In this collection, variation between different coralla within species is seen, eg., the amount of septa which are variable due to the length of corallum. The shortest corallum, 12 cm long, has 74 first order septa while the longest corallum, 24 cm long, has 108.

GENUS HERPOLITHA ESCHSCHOLTZ, 1825

Like *Fungia (Pleuractis)* spp. in septal and costal structures. Coralla are strongly elongate, with linear series of centres along the corallum axes. The small secondary centres develop on either side of the axial furrow.

Herpolitha limax (Houtluyn, 1772)

MATERIAL STUDIED

367 / Ad.XII, Sl, 5 / br.gr (Fig. 185)

368 / Ad.VI, Sl, 4 / br,gr

369 / Ad.XI, Ed, 3 / br

CHARACTERS

Coralla are primarily elongate but sometimes may be irregularly curved or have more than two ends because of regeneration from damage. Corallum has many primary centres aligned in axial furrow. Septa are not arranged in regular order especially in mature corallum, since the

highly exserted septa, probably defined as primary septa, are not continuous from axial furrow to periphery. They are irregularly arranged and terminated when each of them reach approximately 1.7 cm in length. Between primary septa, thin secondary septa run parallel and fuse with each other to form an indistinct secondary centre at the terminal end of primary septum. At this fusing point, skeletal structure becomes spongiose. Septal margins are finely, irregularly dentate. Dentations are usually compressed perpendicular to septa. These dentations are granulated on their margins. Septal sides are covered with spines which are usually flattened and ornamented, with small granules at tips. These spines are arranged in regular rows along dentation trabecular axes. On undersurface, costae are equally developed and their margins being covered with granulated spines of regular size. The scar of attachment is not visible. Corallum wall is perforate only at periphery.

DISCUSSION

This is a well defined species, thus there is no difficulty in species identification, especially when dealing with mature specimens. The marked variation between coralla, which is apparent in this collection is a feature of growth form, ie., the small specimen, no. 369 has 3 ends, while the other two have 2 ends. Although specimen no. 367 is elongate, with 2 ends, a series of centres occur in two perpendicular furrows.

GENUS POLYPHYLLIA QUOY & GAIMARD, 1833

Coralla are strongly concavo-convex, mostly elliptical or elongate, with linear series of centres along the axes. Secondary centres are numerous and equal or nearly equal in size to those of the axial furrow, which may become obscure. Septal and costal characters are similar to those of *Fungia (Pleuractis) paumotensis*.

Polyphyllia talpina (Lamarck, 1801)

MATERIAL STUDIED

370 / Ad.XII, Rf, 2 / gr,br (Fig. 183)

371 / Ad.XII, Rf, 2 / gr,br

372 & 373 / Ad.

CHARACTERS

Coralla are primarily irregularly elongate but may be irregularly discoid. They may be slightly or strongly arched. The linear series or axial centres are distinguished on elongate corallum but they may be indistinguishable in discoid corallum. Secondary centres are numerous and are scattered irregularly on corallum. Septa are in 2 orders. Those of the first are spongiose, pettaloid in outline, and those of the second one are relatively thin and less exsert, alternating with the first. Secondary septa connect to each other, giving the feature which encloses the the primary septa. Septa of each axial centre are completely and cyclically arranged around the centre, while those of secondary centre partly or almost half radiate downwards

from each centre. At corallum periphery, all septa develop sub-equally and are thiner than primary and thicker than secondary septa of the inner part of corallum. They run perpendicularly to periphery. The margins of primary septa have dentations which are variable in development (see discussion) but they are primarily, transversely compressed and covered with ridges or spines or granules, which extend to septal sides. Secondary septal margins are also variable between different coralla. On undersurface, costae are visible for a short distance on the periphery. Their margins also have compressed dentations. Spines with echinulated or granulated tips are arranged in rows along the traces of old costae and are irregularly scattered at the central area. The evidence of a scar of attachment may be visible, even in a mature coralla. The wall perforations are scarce but the deep, irregular alveoli are numerous.

DISCUSSION

Other than growth form variation, the ornamentation of septal margins are also found markedly variable in different specimens. The margins of primary septa of specimen no. 371 have dentations which are branching in various planes, giving highly spongiose septa. Its secondary septal margins also have dentations but the latter are in one plane. Its septal sides are perforate and also densely granulated as are the primary septa. This specimen may be defined as one extreme variation while another, no. 370, which was collected in the same locality is probably another extreme. The latter specimen has its primary septal margins dentate in one regular plane and secondary

septa have almost smooth margins and smooth sides. Since these two specimens were found in the same locality, they should be considered to have genotypic variation.

GENUS PODABACIA EDWARDS & HAIME, 1849

Coralla are polycentric, explanate or foliaceous. They are fixed to substratum in the adult stage. Septo-costal structures are similar to those of *Fungia (Verrillofungia)* spp.

Podabacia crustac a (Pallas, 1766)

MATERIAL STUDIED

374 / Ad.III, Ed. 2.5 / br.yel (Fig. 182)

375 / Ad.I, Rf, 2 / br,yel

376 / Ad.XI, Rf, 3 / yel.br,d.br-edge

377 / Ad.VI, sl, 5 / br.yel

378 / Ad.VI, Sl, 10 / br,gr,yel

379 / Bs.I, Rf, 2 / br

CHARACTERS

Coralla are explanate, with folded margins which may irregularly fold upwards or downwards over the attached substrates to form irregular cup-shaped coralla. They are about 10 mm thick at centre and 3 mm at periphery. Each corallum consists of a single large central corallite which is readily distinguished, and numerous secondary centres of smaller size, scattered around or tending to be arranged

into concentric rows near the central corallite. Septa (septo-costae) run parallel from one centre to another perpendicular to corallum periphery. They are in 2 orders, with about 12-16 septa per secondary corallite. The septa are more numerous in the central corallite. Primary septa are thicker and more exsert than secondary ones. Where corallites are crowded, such as near the centre, primary septa are petalloid in shape. Primary septal margins are dentate with dentations shaped as echinulated, ridged rods. Secondary septal margins also have dentations of the same shape but they are relatively smaller. However, parts of septa that slope towards calicular centres are not dentate (sometimes they just have rough surfaces). Columellae are poorly developed or spongy or absent. Synaticulae are numerous and conspicuous. On undersurface, costae are low and equal. They are covered with numerous fine granulations. Corallum wall is perforate.

DISCUSSION

The character which is markedly variable among specimens of this collection is the degree of development of epitheca on the undersurface of corallum. It seems that this is more directly related to the age of the corallum rather than to environmental influences.

Another skeletal structure which is usually found on undersurfaces which are not covered with epithecae, are the large warts, about 3 mm across, bearing spinulose projections. This character was mentioned by Crossland (1952).

FAMILY OCULINIDAE GRAY, 1847

Colonial, hermatypic or ahermatypic. Colonies are ramose, encrusting or submassive, with plocoid corallites formed by extratentacular budding. Septa are very exsert. Columellae are trabecular, papillose or absent.

GENUS GALAXEA OKEN, 1815

Colonies are massive, columnar, encrusting or irregular. Corallites are cylindrical, thin walled, separated by a blistery coenosteum. Columella are weak or absent. Septa are very exsert.

Galaxea fascicularis (Linnaeus, 1767)

MATERIAL STUDIED

389 / Ad.VI, Bt, 14 / gr.br (Fig. 197)

390 / Ad.III. Sl, 3 / br (Fig. 197)

391 / Hn.I, Sl, 2 / br,gr-stom

392 / Jb. Sl. 1.5 / yel.gr,br-stom

393 / Ad.VI, Sl, 10 / gr,br

394 / Ad.XI, Ed. 5 / br

CHARACTERS

Coralla usually form the convex clusters which may be cushion-like especially when they are primarily encrusting on dead branches of corals (eg. *Acropora* branch). Some large coralla may have flat surfaces. Corallite characters are very variable between those of different

coralla or even in an individual corallum. In outline appearance, these well-defined plocoid corallites may be rounded, hexameral or irregularly ovulate, about 3-10 mm across and 5-13 mm high. Septa are usually in 3 orders, of which the first two are highly exsert over walls (those of the first order may reach 5 mm high) and tapering towards their inner margins. Septa are gently curved at their tips then descending with a steep slope just below the wall level, before abruptly falling into calicular centres. Only first order septa reach the columellae. Sepal margins are generally smooth or slightly rough since septal sides are ornamented with granulations and very often ridges which are perpendicular to septal margins. Near columellae first order septal margins are thick and twisted and ornamented with horizontal, flattened trabeculae which extend and intermix with poorly developed columellae. Columella consists of irregular, fused, flattened trabeculae or irregular, fused, thick masses. Costae are slightly exsert from walls but they are thick and correspond to septa which are also thick at the walls. Exothecae are very blistered.

DISCUSSION

This species is commonly found in a wide range of environmental conditions, even in highly variable conditions such as shallow pools of mangrove water inlets or even in dark, deep conditions. By and large, colonies from deep water, eg., specimen no. 389 has very small corallites which highly contrast to those large corallites of specimen no. 394 collected from the reef front.

Every specimen usually has small corallites which sometimes appear

as slender, contorted tubes, on corallum peripheries. This event simply shows the tendency of budding on corallum peripheries.

Crossland (1952) stated that *G. fasciculatis* has no columellae at all. However Veron & Pichon (1979) mentioned the poor development of columellae in which was also the case in this collection.

Galaxea astreata (Lamarck, 1816)

MATERIAL STUDIED

395 / Ad.VI, S1, 10 / gr,br (Fig. 198)

CHARACTERS

Corallum is encrusting, partly with a laminar periphery. Corallites are rounded, 2.5-3 mm diameter, 2 mm high and about 2 mm apart. Bases are slightly broader than tops. Septa are in 3 orders, usually with 6 first order in each corallite. Septa of the second and third order are usually incomplete in each cycle. Those of the first order exsert up to 1 mm over walls while those of the second order exsert to half of the first ones or may be subequal to the first. Those of the third order are slightly exsert. Septal margins are almost entire. Septal sides are almost smooth or rarely ornamented with granulations. Columella may be absent or present as a single conical rod which is separated or partly fused with primary septa. The ridge-like costae are relatively thick but only slightly extend on upper parts of walls. Coenosteum is blistered.

DISCUSSION

The single specimen of this collection has characters corresponding well with those described for *G.* cf. *astreata* by Veron & Pichon (1979). However, the authors adopted this name for specimens of the present series, although taxonomic status of this species is uncertain. Many authors used the name *G. clavus* Dana for this species and also Chevalier (1771) separated it from *G. clavus* even though the taxonomic rules are not clear. In addition, the characters described above do not fit well with those described for *G. clavus* collected from Malaysian waters by Betterton (1981).

FAMILY MERULINIDAE VERRILL, 1866

Colonial and hermatypic. Colonies are formed by intratentacular polystomodeal budding. Skeletal structures are faviid-like but without paliform lobes. Valleys are superficial or may become obscured because of fanwise spreading or contortions at corallum periphery.

GENUS MERULINA EHRENBERG, 1834

Coralla are thin, irregular foliaceous and meandroid. Twisted bifacial fronds develop irregularly. Columellae are trabecular, generally fused into a continuous mass.

Merulina ampliata (Ellis & Solander, 1786)

MATERIAL STUDIED

380 / Ad.III, S1, 3 / br,pur-edge (Fig. 187)

381 / Ad.III, Rf, 2.5 / br

382 / Ad.I, Rf, 1 / yel.br

383 / Rw.VI, Rf, 3 / br (Fig. 188)

384 / Ad.XI, Sl, 5 / br

385 / Ad.XI, Rf, 3 / br,yel.cr (Fig. 189)

386 / Ad.VI, Sl, 10 / br,wh

CHARACTERS

Coralla are primarily encrusting, with horizontal plates which usually grow overlapping with increasing age. Central parts of plates usually become hillocky with the hillocks subsequently developing into irregular branches. These branches may be thick and are highly anastomosed and are associated with thick basal plates or may have thin branches, as bifacial fronds with expanded tips, associated with frangile basal plates. In the latter case valleys which generally radiate from the centre of the plate, and are perpendicular to plate margins, are usually separated by very thin sharp collines. In the first case these collines are thick (up to 3 mm) and rounded. These valleys, up to 4 mm across, diverge or converge in an irregular manner. Septa are usually in 2 regular orders especially on thick collines. However, septation may be discernable on thin collines. Septa on thin collines have slightly serrated and ridged margins while those on thick collines have a strongly dentate margin. Each dentation may be termed compound dentation, (Veron et al, 1979) since its margin is finely dentate. At calicular centres, dentations develop into paliform lobes. Septal sides are granulated. Columellae near branch tips consist of elongated

twisted dentations. Elsewhere they are spongy or fused into one unit along with the inner margins of primary septa.

DISCUSSION

From the above description, it is obvious that there are 2 types, ie. fragile colonies with thin collines and thick colonies with thick, rounded collines. Formerly the fragile ones were named *M. ampliata* Ellis & Solander and the thick ones were considered by the same authors to be of different species, *M. vaughani* van der Horst (after Faustino, 1927, quoted by Betterton, 1981). However, the latter name was used as a synonym Veron & Pichon (1979).For this collection specimens of both types could be found in the same habitat. Thus, if they are certainly of the same species, the difference should be genotypic variation.

GENUS SCAPOPHYLLIA EDWARDS & HAIME, 1848

Like *Merulina* but massive-columniform.

Scapophyllia cylindrica (Edwards & Haime, 1848)

MATERIAL STUDIED

387 / Ad.XI, Ed, 5 / yel.br (Fig. 190)

388 / Ad.XII, Sl, 5 / cr,d.gr-stom

CHARACTERS

Coralla are very dense, in columnar form. Sometimes their bases are formed by thick laminar plates. The columns in each colony

tend to be flattened in one plane and they may fuse into thick (eg. 4 cm), vertical, laminar columns. Valleys, about 4 mm across and 4 mm deep, are usually sinuous on columns but tend to run parallel towards plate margins. Septa are in 2 distinct orders. Those of the first order become thicker towards centres while those of the second become tapered. All septal margins are subentire or are irregularly twisted, or have long dentations especially near centre floors. Septal granulations become more dense at the bases of septa. Columellae usually appear as thick masses developed from fusion of thick bases of primary septa and these may be intermixed with septal dentation, especially those at the growing tops of columns.

DISCUSSION

Apart from the great difference in growth form when considering the outline appearance of corallum collines, this species is very similar to *Merulina* spp., especially *M. ampliata* Ellis & Solander, a type that has thick, rounded collines. However, septa of the latter species are less spaced and more neatly arranged. In addition, their valleys are shallower.

Variation in species is also apparent, ie., specimen no. 387 which was found at wave exposed zone is of thick columns, while specimen no. 388 which was found on the lower slope has its base as laminar plates, and collines and septal structures are thinner.

GENUS HYDNOPHORA FISCHER DE WALDHEIM, 1807

Colonies are distinctly characterised by the presence of hydnophores (monticules), the wall structures that reduce to conical mounds totally surrounded by centres. Sometimes walls fuse to form short meandroid structure.

Hydnophora microconos (Lamarck, 1816)

MATERIAL STUDIED

305 / Ad.XI, Sl, 5 / yel.br,d.br,d.gr

306 / Hn. (Fig. 191)

307 / Ad.III, Sl, 3 / br,pur

308 & 309 / Ad.

CHARACTERS

Coralla are massive with encrusting or explanate peripheries. They are rounded or lumpy in shape. The monticules are mostly regularly conical, about 2 mm across at the base. Occasionally they are elongate, about 3.5 mm in length. They are 3 mm high. The tops of the monticules are about 3.5 mm apart. Septa are in 2 orders. The conical monticule usually has 11-12 first order septa while the elongate one usually has 15 of them. Second order septa are extremely reduced, incomplete and sometimes absent. From the top of the monticules, first order septa gently descend then drop steeply towards the valleys. They are thin on the monticules and become thicker on lower parts. Septal dentations become distinct towards the valleys. Septal sides consist of scattered

granules, those which appear near septal margins may fuse to form trabecular ridges running to the dentations. The columellae are of a lamellar type, continuous, encircling the monticules.

DISCUSSION

In general this species is easy to separate from others since it has the smaller conical monticules which are regularly arranged on even surfaces of a massive coralla. The variations between different specimens are not significant in this collection.

Hydnophora exesa (Pallas, 1766)

MATERIAL STUDIED

310 / Ad.XI, Sl, 10 / br,gr

311 / Ad.XI, Sl, 5 / pur.cr,wh-tentacle tip,wh.gr-stom

312 / Ad.VI, Sl, 3.5 / d.br (Fig. 194)

313 / Ad.VI, Sl, 11 / br,yel.gr-tentacle

314 / Rw.VI, Sl, 3 / br,d.gr

315 / Ad. (Fig. 195)

316 / Ad.VI, Rf, 3 / d.br,d.gr (Fig. 196)

CHARACTERS

Coralla are foliaceous, encrusting or massive. Peripheries of encrusting and massive coralla are usually explanate and solid irregular branches may develop. Monticules are variable in both width and height from one corallum to another or even in individual corallum. They may develop in cone shape or ridges or collines which arise from the fusion of

adjacent monticules. Septa are in 2 orders. In general they develop in the same manner as those of *H. microconos* (see p.162) but structures of *H. exesa* are generally larger. Columellae are irregularly developed or may be absent. Each of them consists of a few twisted trabeculae, so corallite centre is indistinct. Thin laminae may partly or wholy surround monticules.

DISCUSSION

This species shows the great variations of growth forms and monticule appearances. Wijman-Best (1972) described the 4 ecotypes of *H. exesa*, in this collection specimens are rather well fitted to these. The massive specimen, no. 316 has branches and high conical monticules which well correspond to the *gyrosa*-type. This type is also likely to be applied to specimen no. 312 of which monticules are conical, up to 7 mm high, or they become ridges, about 10 mm long with the same height. However, its massive corallum does not tend to form branches. Furthermore, this type is also resembles specimen no. 311 which already forms branches but the corallum is encrusting. The *maldivensis*-type may be represented by foliaceous specimens nos. 314 and 315 of which monticules are broad and formd ridges on peripheries. However, the colony plates are rather thinner (about 6 mm) than the *maldivensis*-type. Specimen no. 310 is also foliaceous and thick, up to 4 cm at central part but monticules are conical and prominent, up to 5 mm high, therefore it could not be defined as *maldivensis*-type. Specimen no. 313 is encrusting with a mixture of flat and conical monticules, and those monticules near the periphery

form ridges.

Hydnophora rigida (Dana, 1846)

MATERIAL STUDIED

317 / Ad.XI, Sl, 2.5 / br,bl

318 / Ad.III, Sl, 5 / br,wh,gr

319 / Ad.III, Sl, 3.5 / g.cr,d.br

320 / Ad.VI, Rf, 3 / d.br,d.gr

321 / Ad. (Fig. 193)

322 / Ad.III, Ed, 3 / br,gr (Fig. 192)

CHARACTERS

Coralla are ramose. The diameter of branches vary greatly among different coralla. Branches may be cylindrical along their hole length or slightly flattened in different coralla. The ends are usually tapered. Monticules tend to be arranged in irregular rows along the branches. They have a circular or slightly elongate section but in some coralla they are very flat to the branch surfaces. In general they are more conical towards the branch tips and their axes tend to be inclined in that direction. They usually fuse with each other to form ridges along branch tips thus appearing as angular terminations. Septa are in 2 orders as in the other *Hydnophora*. The first order septa reach the tops of monticules while the second ones are reduced or may be absent. The columella centres are distinct, with 6-8 thick septa meeting at each solid centre. These centres are in circles around

monticules when they are distant from each other, or centres are arranged in a line along valleys when these appear. Septal dentations appear in the same manner as other *Hydnophora*. Septal sides and columella structures are granulated.

DISCUSSION

In this collection of *Hydnophora*, specimen no. 322 shows the most distinct typical characters of *H. rigida*. Others show some variations which were not clearly mentioned in the literature. For instance, the encrusting part of the corallum is found at the base of specimen no. 317 but the author places this specimen in *H. rigida* since other characters fit well with those of the species. Speciman no. 319 and 321 have thick, broad, somewhat massive parts of anastomosed branches at the bases of coralla. This could easily be confused with the ramose form of *H. exesa*, nevertheless these two specimens also have other typical characters of *H. rigida*. Every specimen, except no. 322 has flattened branches and also flattened monticules on the side of branches exposed to less light intensity. However, they all have the well recognised character of this species, ie., the well defined centres (but this should not be given as the definit rule for identifying this species since distinct centres are also found in specimen no. 315 of *H. exesa)*.

FAMILY MUSSIDAE ORTMANN, 1980

Solitary or colonical and hermatypic. Colonies are formed by intratentacular budding, forming into meandroid to flabelloid structures.

Lamellar linkages between the centres are predominant. Septa consist of large triangular or lobate dentations.

GENUS LOBOPHYLLIA DE BLAINVILLE, 1830

Coralla are phaceloid to flabellate, formed by intratentacular budding. Centres have lamellar linkages and are mostly laterally free.

Lobophyllia hemprichii (Ehrenberg, 1834)

MATERIAL STUDIED

396 / Ad.XI, Sl, 3 / br (Fig. 199)

397 / Ad.III, Sl, 6 / wh.cr,d.gr-stom

398 / Ad.XI, Rf, 3 / yel.br,d.gr-inner wall,d.br-stom

399 / Ad.VI, Bt, ll / br,gr

400 / Ad.VI, Rf, 3 / br, d.gr,cr-stom,wh.gr-groove

401 / Ad.III, Sl, 3.5 / yel.br

402 / Ad.VI, Sl, 8 / yel.br

403 / Ad.XII, Sl, 6 / br,yel.gr

404 / Ad.XII, Rf, 3 / br,yel,d.gr

405 / Ad.VI, Sl, 8 / yel.br

406 / Ad.VI, Sl, 7 / r.br,yel,yel.br-r.br-yel.gr-stom

CHARACTERS

Coralla are flabellate and mono- to polycentric. The old colonies usually attain several metres in diameter. Valleys are about 2 cm across and 1 cm deep. However, they are very variable among different

coralla. They usually have expanded ends which may contain many new developing centres. Septal order varies, even in individual corallum, from 2-4 orders. First order septa usually exsert 5 mm or may be up to 1 cm over walls. They become thinner towards centres. Other septa are less exsert, very thin and do not reach the centres. Septa have irregular echinulated dentations of about 1 mm thick. Dentations are very prominent on the upper margins of first order septa. Septal margins are partly serrate and septal sides are granulated. Columellae are trabecular and partly intermixed by inner septal dentations. They are linked to each other by a few laminae which are thin and have lobate margins. Endothecae are vesicular. Costae are distinct on upper parts of walls and those of the first order are echinulated. On lower parts of walls, costae diverge and appear as fine, low,parallel ridges.

DISCUSSION

The collection contains both young and old colonies. The influence of competition for space between individual branches of the same colony, or those of adjacent colonies in close proximity, affects the growth form (Veron & Pichon,1979). Age of colony also shows an effect on growth form. The young colonies usually have short branches attached tightly to the substrate. Valleys are extremely contorted, giving coralla a hemispherical appearance. Old colonies have long branches which loosely stick together so colonies are rather easily damaged due to the falling apart of branches. Valley surfaces are rather flat and adjacent valleys are closer than those in young colonies. Soft parts

of polyps of old colonies extend about 1 cm on outer walls (exothecae) while those in young colonies extend to the bases of branches (about 3.5 cm).

Lobophyllia cf. *hattaii* Yabi, Sugiyama & Eguchi, 1936

MATERIAL STUDIED

407 / Ad.VI, Rf, 3 / br,cr-stom,wh.gr-groove (Fig. 200)

CHARACTERS

Corallaum is meandroid with flabellate periphery. Valleys are about 2.5 cm across and 1 cm deep. Adjacent valleys are separated by grooved collines which are about 5 mm thick on their tops. Walls may slope gently or steeply to valley floors. Septa are not arranged in consistent orders. Primary septa are thick, up to 1.5 mm at their upper parts, and become thin towards centres. They exsert up to 5 mm above walls. Other septa may be thick at their upper parts or may be completely thin and may reach centres. Septa of adjacent valleys are separated by grooves on collines. Septal dentations may be echinulate or lobate as those in *L. hemprichii* Ehrenberg. Septal margins are partly serrate and septal sides are granulated. Columellae are poorly developed, sometimes consisting of few inner septal dentations. Adjacent columellae are linked together by thin laminae as those of *L. hemprichii*. Endothecae are vesicular. Costae are present as low ridges which are not continuous on the exothecae. Costal spines are never prominent. Soft parts of polyps extended in a short distance, about 2-10 mm, on exothecae.

DISCUSSION

The single specimen has the outline appearance of that of *L. hattaii*. However there is some confusion when considering calicular structures in detail. According to Veron & Pichon (1979), *L. hattaii* has skeletal structures as follows:septa are usually in 3 distinct orders, large dentations of first order septa are present like paliform lobes near columellae, laminae linked between columellae have identical structures to first order septa, and costal spines are greatly elongated. This description contrasts to that above. When compared with a specimen which Veron labeled as *L. hattaii*, at PMBC, there are still some problems as the latter specimen has large septal dentations like a paliform crown around the well developed, spongiose columellae. Since there are difficulties in observing the variations of species when there is only single specimen in this collection, the author confers his specimen to *L. hattaii* at present.

GENUS SYMPHYLLIA EDWARDS & HAIME, 1848

Like *Lobophyllia*, but adjacent valleys are united by a common wall.

Symphyllia cf. *agaricia* Edwards & Haime, 1849

MATERIAL STUDIED

408 / Ad.VI, Rf, 3 / r.br

409 / Ad.III, Sl, 6 / wh.cr,yel.gr,d.br-stom (Fig. 202)

CHARACTERS

Coralla are dome shaped. Valleys radiate irregularly with indefinite length. They are about 2.0-4.5 cm across and 1.0-2.5 cm deep. Collines are about 0.7-1.5 cm thick, with shallow notches where adjacent septa meet at their tops. Septa are variable in arrangement between different coralla or even in an individual corallum (see discussion). The primary septa are about 1 mm thick and 3 mm thick and 3 mm exsert over walls. Other septa are thin and less exsert. Septal dentations and granulation are the same as other *Symphyllia* spp. Columellae are rather well developed. They are arranged in two rows along the valleys. The adjacent columellae are linked together with about four laminae which may be identical to primary septa or those of septa of higher orders. Costae appear as low ridges with few echinulations.

DISCUSSION

The two specimens of this collection show the outline characters of *S. agaricia* Edwards & Haime, ie., they have indefinitely long valleys with double rows of centres. However, skeleton structures of specimen no. 408 are much larger than specimen no. 409, ie., the maximum sizes of valley and colline structures above are normal for the first specimen and the minimum sizes normal for the second specimen. Furthermore, septa of specimen no. 408 are usually in two alternating orders and first order septa are equally thick from their tops to lower parts. Septa of specimen no. 409 are of primary septa (which

are thick on their tops) alternated with a set of 4-6 thin secondary septa, with adjacent primary septa spaced about 8 mm apart. The difference may be a case of variability of two extremes, ie., specimen no. 408 was exposed to strong wave action and specimen no. 409 was in a well protected area. The specimen of *S. agaricia* at PMBC shows mixed or intermediate characters of the above.

Symphyllia cf. *valenciennesii* Edwards & Haime, 1849

MATERIAL STUDIED

410 / Ad. (Fig. 203)

411 / Ad.III, Ed, 3 / br.gr

412 / Ad.I, Rf, 2 / yel,cr,yel.gr,pur.br-groove,pur.br-stom

CHARACTERS

Coralla are dome-shaped. They are meandroid with flabellate peripheries. In outline, valleys radiate from central area. Valleys are about 2.5-4 cm across and 1.5-2.5 cm deep. Valley walls are steep, except those of corallum peripheries where there are many young centres in each lobed valley. The common walls (collines) which separate valleys, have grooves on their tops, but sometimes they themselves tend to be divided into separate walls. Septa are in 2-4 orders. Primary septa are about 1.5 mm thick and 4 mm exsert over the walls. They have large echinulated dentations on upper parts and dentations become lobed and smaller towards the centre. Other septa are smaller and have relatively small and more numerous dentations. All

septal sides are granulated. Columellae are trabecular, poorly developed and intermixed with inner septal dentations. They are linked together by 4-6 laminae which have identical structures as the thin, lower part of primary septa. There is a tendency to form double rows of centres. Costae irregularly appear as low ridges (few millemetres to 4 cm long) extending down the corallum periphery. Costal spines are sparsely present.

DISCUSSION

The character of centres as two rows along the valley floors may create confusion between *S. valenciennesii* and *S. agaricia*. However, the character of valleys radiating from the central area of coralla and other details are different between the two species. Variations among specimens are also found. Primary septa of specimen no. 410 are more irregularly exsert and have irregular dentations. This makes this specimen ragged in appearance when it is compared with specimen no. 411. Although specimen no. 412 is still young, it has the characters of *Symphyllia* cf. *valenciennesii* described by Veron & Pichon (1979).

Symphyllia cf. *recta* (Dana, 1846)

MATERIAL STUDIED

413 / Ad.VI, Bt, 11 / pur.br,yel.gr-septal spine (Fig. 204)

414 / Ad.XII, Rf, 1 / cr,d.br-stom

CHARACTERS

Coralla are dome-shaped or nearly flat. Valleys are irregularly sinuos . They are not very long as those of other *Symphyllia*, and are sometimes mono-to tristomodial. Valleys are about 8 mm across and 5 mm deep. Collines are about 5 mm thick, with thin grooves along their tops. Septa are in 2 alternating orders or may be in 3 indistinct orders, especially those of corallites near corallum peripheries. First order septa are thick on upper parts and become thin towards centres. They have relatively large echinulated dentations (about 0.8 mm thick) on upper parts which become smaller below. Second order septa are thin and less exsert. They do not reach the centres but usually end abruptly and sometimes fuse with first order septa near centres. Margins of second, or those of the thin parts of first order septa, are finely serrate. Septal structures are slightly ornamented with granulations. Columellae are rather small and intermixed with inner septal dentations. They are linked together by laminae which are identical in structure with those thin parts of first order septa. Costae extend 2 mm down corallum edge.

DISCUSSION

These two specimens have skeleton structures well matched with those described for *S.* cf. *recta* by Veron & Pichon (1979). The authors conferred their specimens to the species *S. recta* because the holotype was greatly damaged and subsequent identification was done with uncertainty.

Symphyllia radians Edwards & Haime, 1849

MATERIAL STUDIED

415 / Ad.XII, Rf, 3.5 / wh,d.br,d.gr

416 / Ad.XII, Rf, 3 / yel.br,wh.gr

417 / Ad.XII, Rf, 3 / cr,gr-stom

418 / Ad.VI, Sl, 10 / pur.br,wh,g,yel.gr-stom

419 / Ad.XII, Rf, 3 / yel.br,br-stom,gr-groove

420 / Ad.VI, Bt, 11 / pur.br,r.br,gr-groove

421 / Ad.VI, Sl, 10 / d.br,yel.gr,pur.br-stom,gr-groove (Fig. 205)

CHARACTERS

Coralla are dome-shaped to flat. Valleys are sinuose on inner areas and have a tendency to readiate in a straight manner on outer parts of coralla. They are about 1.5-2 cm across and 8 mm deep. Calices are about 0.5-1 cm thick. Grooves on collines are just visible because septa of adjacent valleys leave notches when they meet over collines. Septal arrangement, ornamentation and other claicular structures are the same as those of *S.* cf.*recta* (see p.174), but they are relatively larger.

DISCUSSION

The series of specimens of this species are similar to those of *S.* cf. *recta*. As already mentioned above, these specimens have larger structures, although the young specimens may give rise to some confusion.

Variation among specimens of this collection is not remarkable except those specimens from deeper water at site VI, have dentations which are more prominent and irregular, compared with those from the shallow site XII, of Adang Island.

FAMILY PECTINIIDAE VAUGHAN & WELLS, 1943

Colonial (except one solitary fossil genus) and hermatypic. Colonies are basically laminar, composed of thin plates formed by intratentacular polystomodeal budding. Walls are absent or formed into non-porous costate laminae. Columellae are trabecular or absent.

GENUS ECHINOPHYLLIA KLUNZINGER, 1879

Colonies are encrusting semi-solid, laminar or foliaceous. Calices are round or oval in shape, immersed to tubular, not strongly inclined on the corallum surface. Septa are numerous. Columellae are well developed. Coenosteum is pitted at the insertion of new septo-castae.

Echinophyllia aspera (Ellis & Solander, 1786)

MATERIAL STUDIED

434 / Jb, Sl, 4 / wh.bl,br

435 / Ad.Vl, Sl, B/ gr.br.g

436 / Ad.VI, Ed, 3 / br,gr,br.or (Fig. 209)

437 / Ad.III, Bt, ll / r.br

438 / Ad.XI, Bt, 10 / br,r

439 / Ad.XI, Bt, 10 / br.gr,r-stom

CHARACTERS

Coralla are irregular plates or encrusting with explanate peripheries. The encrusting peripheries may extend upon the undersurfaces of surstrates. Coralla vary from almost ceroid to highly plocoid of about 8-12 mm diameter. Those being found on hillocky surfaces usually highly protrude. Large cerioid corallites (which may be defined as central corallites) may appear in some coralla. Most of corallites incline towards peripheries. Septa may be in 2 orders. Those of first usually reach the columellae and are highly exsert, up to 4 mm above thecae. They vary greatly in number (11-24) in each calice. Second order septa often appear in the form of irregular ridges. Dentations, particularly of first order septa, appear as long pointed spines. Some of the inner most ones, may act as paliform pinnacles. Septal sides and dentations are granulated. Costae are in 2 orders, corresponding to septa. They are usually thicker than septa. Costae on corallite walls and those in the form of septo-costae have dentations in the same manner as those of septa. Granulations are usually found on their dentation tips. Septo-costae tend to run perpendicularly to peripheries. If they do not join those of adjacent corallites, they usually insert into exothecal alveoli which are scattered irregularly around corallites. Columellae develop well and are spongiose. Exothecal dissepiment may be solid or blistered. On undersurface of peripheries, septo-costae appear as subequal low ridges. These septo-costae may diverge and dentate but mostly smooth and granulated.

DISCUSSION

The series of specimens of this collection have characters which match well with those described for *E. aspera* by Veron & Pichon (1979). The variable characters which appear are degrees of skeleton calcification and corallites protrusion. The strongly calcified specimen, no. 436 corresponds well with its exposed habitat. Specimen no. 435 has corallites which protrude highly, as described for *E. orpheensis* (Veron & Pichon,1979) with detail structures close to *E. aspera*.

Echinophyllia echinata (Saville-Kent, 1871)

MATERIAL STUDIED

440 / Ad.VI, Bt, 10 / d.gr.br (Fig. 210)

CHARACTERS

Corallum is a thin irregularly hump shaped plate. The central corallite which is completely cerioid is about 12 mm diameter. Its septa are in 3 irregular orders. Secondary corallites are arranged in irregular circular rows around the primary one. These secondary corallites are superficial,elliptical, with a diameter of up to 7 mm. They incline towards the periphery. Septa are in 2 irregular orders. First order septa appear about 7-8 in number and those of the second are small or abortive, especially those on corallum surfaces (the opposite side to the distal wall). First order septa exsert about 2 mm above walls or corallum surface. Their inner margins are

smooth , or slightly rough or irregularly dentate. Dentations are well developed from costae to septo-costae. They appear as fine pointed spines with small granules on their tips. Septo-costae of 2 orders run perpendicularly to corallum periphery. Septal-and costal structures are ornamented with very small granules. Exothecal alveoli with septo-costal insertion rarely appear. Columellae are poorly developed. Each consists of a few trabeculae, the structures of which are identical to costal spines. Exothecal dissepiments are solid. On undersurface, septo-costae are round, low and granulated. They run correspondingly to those on upper surface.

DISCUSSION

The outline appearance of this single specimen seems identical to Fig. 535 *(E. echinata)* in the monograph series by Veron & Pichon (1979). However, the detailed characters described above are somewhat different from those described by Veron & Pichon. According to these authors , specimens of this rare coral do not fully represent the species at present. Consequently the specimen described above is very valid and probably one of the variations.

GENUS OXYPORA SAVILLE-KENT, 1871

Similar to *Echinophyllia* but folia are thinner, septa are few and columellae are poorly developed. Holes or grooves are distinguishable on the epitheca.

Oxypora lacera (Verrill, 1864)

MATERIAL STUDIED

441 / Ad.VI, Bt, 14 / br,wh-edge (Fig. 211)

442 / Ad.VI, Rf, 3 / d.gr.br

443 / Ad.

CHARACTERS

Coralla are explanate, flattened, usually with thin peripheries. Central corallites may exist but usually do not appear in central areas of coralla. Secondary corallites are arranged in irregular rows around the primary one. They are superficial, circular or elliptical , about 8 mm diameter. They do not incline as those of *Echinopora*. Septa tend to be arranged into 2 orders but are very variable in development. The number of septa in each corallite ranges from about 13-16, ie.,each order consists of about 8 septa. First order septa are highly exsert with vertical dentations up to 4 mm from the columella level. Septo-costae develop correspondingly to septa and run perpendicularly to peripheries. Their margins consist of dentations which are very pointed in outline and usually have clusters of spinules or ridges at their tips. Fine seration is developed through septa and septo-costal margins. Both septal-and septo-costal sides are granulated. Columellae are spongiose. On undersurfaces of coralla, costae are subequally developed and very smooth in outline. On close observation, however, they are densely covered with very small granules.

DISCUSSION

This species is somewhat similar to *Echinopora aspera* Ellis & Solander. However, in outline appearance it is well separated by it superficial corallites and the prominent pointed dentations with clusters of spinules on tips.

Some important characters which Veron & Pichon (1979) described ie., the slit-like pores between costae (septo-costae), do not appear in any specimens of this collection. Also undersurface costae are not dentate as they are in the Australian specimens. This situation is probably a variation of species. However, the slit-like pores do appear in some specimens deposited at Phuket Marine Biological Center.

GENUS MYCEDIUM OKEN, 1815

Like *Echinophyllia* but forms folia which are flat or sometimes contorted with protuberant, nariform, outwardly inclined calices. Pits at the insertion of the costae are absent.

Mycedium elephantotus (Pallas, 1766)

MATERIAL STUDIED

430 / Rw.VI, Sl, 3 / br

431 / Ad.XI, Rf, 3 / cr,d.br,yel.gr-edge,d.gr-stom

432 / Ad.III, Rf, 2.5 / br,cr-edge (Fig. 208)

433 / Ad.XI

CHARACTERS

Coralla consist of many foliacious plates tending to grow vertically and having their bases anastomosed. Corallites are arranged in irregular rows parallel to the corallum peripheries. They are usually inclined by projecting only their distal walls from corallum surfaces towards corallum peripheries. Calices are about 8 mm diameter. Septa are of 2 irregular orders. Each order consists of 9-10 septa. First order septa which are one the distal sides (projected walls) are more exsert than the inner ones. Second order septa are slightly exsert and do not reach the centres as do the first. Septal margins are irregularly dentate. Granulations which appear as small pointed spines are usually ornamented on septal margins. Costae are also in 2 orders. Those of first order are usually long and become septa of first order again, by extending into an adjacent calice sitting below. Costal margins may be smooth or-dentate and ornamented as septal margins. Columellae consist of long twisted trabeculae. Exothecal dissepiments are vesicular.

DISCUSSION

In this collection there is a great variation among specimens of this species. Specimen no. 430 has its corallum plates much thicker than those of other specimens. Specimen no. 432 is very ragged in appearance because of irregular ornamentations of septa and costae. The young specimens nos. 431 and 433 have the growth form of a single horizontal plate with irregularly curved peripheries. It is not possible to interpret the relationship of characters to habitats since there are

few specimens for study.

According to Veron & Pichon (1979) this variation appears to have a largely genotypic origin.

GENUS PECTINIA OKEN, 1815

Colonies are laminar to subarborescent, covered with high, thin, acute, irregular walls usually arranged as short wide valleys. Valleys may be as short as they are wide and the walls may form tall spines, becoming subarborescent.

Septo-costae are continuous between centres. Coenosteum is vesicular.

Pectinia paeonia (Dana, 1846)

MATERIAL STUDIED

422 / Ad.VI, ed, 3 / br,gr-stom (Fig. 206)

423 / Tr.IV, Bt, 10 / br,d.gr-stom

424 / Ad.VI, Bt, 14 / d.br

425 / Ad.

CHARACTERS

Coralla are explanate plates with thin plate-or large pinnacle-like collines, projecting irregularly up to 5 cm high. Centres are not arranged into long series but are irregularly scattered between collines or sometimes extended to colline bases. Septa on collines are not distinguished into order. Some are very exsert. The margins of these prominent septa and those of the vertical edges of collines are strongly

dentate. Dentations are granulated and tend to be horizontally flattened. Other septal margins are smooth. Septal sides are slightly granulated. From the centre, septa may extend to the tips of collines or just diffuse on colline wall.Some join adjacent centres. Columellae may be spongiose and well developed or just consist of a few trabeculae or be absent. Calicular floors and collines are strongly vesicular.

DISCUSSION

Variation among specimens of the collection is remarkable. Specimen no. 422 has its collines in the form of closely packed, twisted plates that may join together in irregular directions, appearing like *P. lactuca* Pallas, but valleys do not extend as in the latter species. On the other hand, other specimens usually have collines in the form of pinnacle-like structures, or a mixture of pinnacle-and plate-like structures. According to Veron & Pichon (1979), they described the first growth form as relating to colonies from very protected biotopes and the latter cases were from protected but more expose biotopes. However, this criteria does not fit very well with specimens in this collection since specimen no. 422 is from biotope more exposed than other specimens.

Pectinia alcicornis (Saville-Kent, 1871)

MATERIAL STUDIED

426 / Ad.III, S1, 6 / yel.br,d.gr

427 & 428 / Ad.XI, S1, 10 / br,d.gr

429 / Ad.I, (Fig. 207)

CHARACTERS

Skeletal morphology of this species may be considered into 2 stages; young and adult. Young coralla basically have horizontal explanate bases and projection of collines as in *P. paeonia* Dana. Young coralla of *P. alcicornis* show specific characters, ie., there are large corallites in the central area of the coralla and there are corallites which extend on colline walls. Collines are very high. In the adult stage, collines may form circular branches of up to 4 cm diameter or vertical plates of about 12 cm high, 5 cm wide and 8 mm thick. Horizontal explanate plates may not appear in the adult stage. Septal development and septal ornamentation are the same as *P. paeonia*. Columellae are well developed and very spongiose.

DISCUSSION

P. alcicornis in this collection is represented by both growth stages and show great variation as Veron & Pichon (1979) mentioned. Specimen no. 429 was actually found on the beach at site I of Adang Island. Although its habitat is not known excactly, the extreme variation of growth form is very interesting, ie., the horizontal base is thick, up to 2.5 cm at the central area, and a single branch rising up from basal plate is 4 cm in diameter (Fig. 429)

GENUS EUPHYLLIA DANA, 1846

Colonies are flabelloid or phaceloid or flabello-meandroid. Walls are septothecate,thin and imperforate. Columellae are absent or reduced.

Septa are prominent and smooth-edged.

SUBGENUS EUPHYLLIA VERON & PICHON, 1979

Subgenus *Euphyllia* is characterized by its phaceloid growth from which is the predominant feature.

Euphyllia (Euphyllia) glabrescens (Chamisso & Eysenhardt, 1821)

MATERIAL STUDIED

444 / Bs.I, Rf, 2 / br,wh-tipped tentacle (Fig. 212)

445 / Ad.III, Sl, 3 / br,wh-tipped tentacle

446 / Bs.I, Rf, 2 / br,wh-tipped tentacle

CHARACTERS

Coralla are phaceloid and partly phacelo-flabellate, forming hemispherically, usually up to 15 cm diameter. Branches are up to 6 cm high from coralla base. Phaceloid corallites (monostomodeal) may be irregularly circular or elongate, about 1.2-2.5 cm across. Phacelo-flabellate calices have up to 4 centres (with an elongate diameter such as 4.3 cm). Adjacent corallites are about 0.8-1.2 cm apart (however distance is rather uniform in an individual corallum). Septal are usually in 4 orders but those of a fifth order may be present on upper walls. However, septation may be difficult to distinguish since sizes of septa in irregular calices are variable (vertical laminae of first order septa range from 5-8 mm wide). Septal margins are smooth, and especially those of lower orders become folded and thickened

towards centres. Septal sides are rather glabrous, or slightly ribbed on upper margins of lower order septa, and slightly granulated on folded margins. Costae simply appear as fine striae corresponding to the lower order septa. Columellae are absent.

DISCUSSION

Structures in detail above corresponded well with those described by Veron & Pichon (1979), with the exception of colouration of polyps. It should be noted here that certain species of banarcle are commonly found on calicular structures of specimens of this series.

SUBGENUS FIMBRIAPHYLLIA VERON & PICHON, 1979

According to Veron & Pichon (1979), young corallum of subgenus *Fimbriaphyllia* may be difficult or impossible to distinguish from subgenus *Euphyllia* (especially *E. glabrescens*). Larger corallum is distinguished by its flabello-mendroid feature.

Euphyllia (Fimbriaphyllia) ancora Veron & Pichon, 1979

MATERIAL STUDIED

447 / Tr.IV, S1, 10 / d.gr.cr (Fig. 213)

448 / Ad.VI, S1, 11 / cr

CHARACTERS

Coralla are flabello-meandroid. Branches of mature coralla may reach 15 cm high. Valleys are 1 cm in average width. Septation is

very variable in different, or even in a individual corallum, ie., there can be 2, 3 or 4 orders. Septa extend in the same manner as those in *E. glabrescens* (see p.186) but primary septa are more curved. Columellae are absent. Costae are present and correspond with lower order septa only.

DISCUSSION

According to Veron & Pichon (1979), this species is primarily identified by the nature of polyps. Both collected specimens above have the anchor-shaped polyps as shown in the monograph (Fig. 626) by the above authors. However, colouration is variable; polyps of specimen no. 448 have cream stalks, bright cream on caps, with white edges, while those of specimen no. 447 have a dark sheen of green on the stalks and caps, with cream edges to the caps. This colouration is also different from that recorded by Veron & Pichon.

GENUS PLEROGYRA EDWARDS & HAIME, 1848

Colonies are phaceloid, flabelloid to meandro-phaceloid with valleys more or less connected by a light blistery coenosteum. Septa are large imperforate, smooth-edged, very exsert and widely space. Walls are imperforated. Columellae are absent.

Plerogyra sinuosa (Dana, 1846)

MATERIAL STUDIED

449 / Rw.VI, Sl, 3 / br

450 / Tr.IV, S1, 10 / br (Fig. 214)

CHARACTERS

Coralla are partly phaceloid, flabelloid and flabello-meandroid. Valleys are relatively narrow, enclosed by thick (about 6 mm) blistered walls. Septa may be in 3 orders in young stomodeal corallites, however they become irregular in flabello-meandroid corallites. The primary septa, the most developed ones project up to 1 cm over walls. They are up to 1.5 cm broad and thickness is very variable, according to formation of blistered septal dissepiments. Their inner margins are folded and slightly ribbed. All septal sides are glabrous or finely granulated near margins. Columellae are absent. Costae are irregularly ridged or lobed. Exothecal walls are also strongly blistered.

DISCUSSION

Characters above corresponded well to the species description given by Veron & Pichon (1979). There is probably only a single species of *Plerogyra* in the area of the Adang-Rawi Island group as noted for the Great Barrier Reef.

GENUS PHYSOGYRA QUELCH, 1884

Like *Plerogyra* but series of valleys are closely united by walls. Endothecal dissepiments are highly vesicular.

Physogyra lichtensteini (Edwards & Haime, 1851)

MATERIAL STUDIED

451 / Tr.IV, S1, 10.5 / cr,wh

452 / Ad.III, S1, 3.5 / br (Fig. 215)

453 / Ad.

CHARACTERS

Coralla are like *Plerogyra* but the series of valleys are united by common walls. The latter usually range from 0.5 cm to 3 cm thick and valleys range from 0.5-1 cm across. Septa are not arranged into order, projecting up to 1 cm above the walls. They range from a few millemeters to 1 cm broad. They are usually slightly twisted through whole blades. Those of adjacent valleys are separated by narrow valley walls and are usually joined (or nearly so) but transversed by a low thin ridge. Septal sides are densely covered with fine granules. Exothecal and endothecal walls are highly vesicular (blistered). Columellae are absent.

DISCUSSION

The appearances of skeletons and polyps of collected specimens corresponded well with the description of the species given by Veron & Pichon (1979), with the exception that those authors did not mention the development of septal granulation, structures which are well developed in specimens here.

FAMILY DENDROPHYLLIIDAE GRAY, 1847

Solitary or colonial and mostly ahermatypic. Colonies are formed by intra-and extra-tentacular budding. Corallite walls are porous. Septa are fused in a Pourtales Plan, at least in early stages.

GENUS TURBINARIA OKEN, 1815

Colonies are massive, columnar, and laminar or foliaceous with foliae frequently centred. Corallites are round, immersed to tubular and have porous synapticulothecate walls. Poutales plan of septa is apparent only in early stages. Columellae are broad and compact.

Turbinaria peltata (Esper,1794)

MATERIAL STUDIED

454 / Tr.I, Bt, 12 / cr (Fig. 216)

CHARACTERS

Corallum is unifacial, explanate and partly folded back at margin. It is 5 mm thick at margin and 10 mm centrally. Plocoid corallites incline towards corallum margin where they become more crowded. Calices are circular or oval, about 3-4.5 mm diameter. Septa are in 4 cycles, the first two (12 septa) are equal, third cycle septa are slightly less exsert and fourth cycle septa appear as fine ridges on upper wall. Septal margins are smooth or rough according to extension of septal granulations. Each columella consists of directive ridges, to which

other trabeculae form a close network with a dome shape. Costae are equally developed on upper exothecae. Coenosteum is spongiose, but formed by solid structures. All skeleton structures are granulated. On the undersurface, appearance is the same as coenosteum but skeletal elements have more tendency to be arranged in striae.

DISCUSSION

The fragment of corallum identified here matches exactly with *T. peltata* which Crossland (1952) and Veron & Pichon (1979) described. Although those authors separated the cycle of septa in a different maner, ie. Crossland gave 6 primaries, 6 secondaries and 12 tertiaries and incomplete septa of fourth cycle, while Veron & Pichon (and also Bernard) gave 12 primaries, 12 secondaries and incomplete tertiaries, the general appearance of septa are the same. (Crossland could observe a slightly different width of first and second septa in his specimens, however the difference is not obvious in the specimen here.)

Turbinaria cf. *frondens* (Dana, 1846)

MATERIAL STUDIED

455 / Tr.I, Bt. 12 / cr (Fig. 217)

456 / Tr.I, Bt. 12 / cr

457 / Ad.XI, Sl, 8 / cr

CHARACTERS

Coralla are unifacial, explanate, about 0.25 mm and 10 mm thick,

at edges and central parts respectively. Corallites are tubular, slightly conical, may be submerged, regularly spaced (about 2 mm apart) and facing towards coralla edges. Calices are circular or slightly oval 1.2-1.8 mm in diameter. Septa range from 12-18 in number. They are usually wedge-shaped, with forked structures to calicular walls. Septal margins are smooth. Septal sides are densely granulated. Columella consists of an elongate ridge transversed with a few rows of irregular trabeculae or granules, and below these, spongy trabeculae are formed and extend as synapticulae fused with inner margins of septa. Some corallites may not develop elongate ridges but only spongy, granulated trabeculae dominated by transverse ones. Exothecal walls are covered with thin, dentate laminae. These laminae are more openly developed on coenosteum. Coenosteal floor is perforated with circular deep holes. Undersurface structures are same as coenosteum but the laminae are radiate towards corallum edge.

DISCUSSION

The characters described above fit well for specimen no. 455, a broken fragment which was found to be still growing on a sandy bottom. By and large other specimens do not markedly differ from this specimen, other than the much lesser protrusion of corallites in specimen no. 456 which was also collected from the same habitat.

The only character which varied from those Veron & Pichon (1979) described, is the number of septa, ie., they gave the range as 18-33 (Crossland, 1952, gave the msot common number as 22). Thus

there is uncertainly in placing the specimens here in *T. frondens*.

Turbinaria stellulata (Lamarck, 1816)

MATERIAL STUDIED

458 / Ad.XII (Fig. 218)

CHARACTERS

Corallum is encrusting, with irregularly scattered corallites, slightly cone shaped. Corallites tend to face towards corallum edge. Calices are about 2 mm diameter. Septa are of 2 sizes (there are very few small septa), usually 20-22 per calice. The septa slope gradually and may fuse their thin, inner margins with basal parts of columellae. Septal margins are irregularly dentate. Septal sides are rather densely granulated. Columellae are small (up to 0.5 mm diameter), consisting of few spongy trabeculae (however on their basal parts trabeculae form as floors extending to fuse with septal structures). Exothecal walls and coenosteum are of a solid spongy mass covered with forked pointed trabeculae.

DISCUSSION

With respect to a rule that Veron & Pichon (1979) used to separate this species from *T. reniformis*, this single specimen shows a marked appearance of relatively open calicular apertures (a character resulted from the occurence of sloping septa instead of the vertical septa in *T. reniformis)* and thiner calicular walls. However this specimen is

different from two specimens of *T. stellulata* in the reference collection of the PMBC, ie., the latter two have septa of rather vertical margins, characters which previous authors mentioned as appearing in *T. mantonae*, a related species that they could not definitely describe as a synonym of *T. stellulata*.

Turbinaria reniformis Bernard 1896

MATERIAL STUDIED

459 / Ad.I, Rf, 0.5 / pur.br (Fig. 219)

CHARACTERS

Corallum is partly encrusting and unifacially explanate. Corallites are conical, with broad bases, about 2.5-5.0 mm diameter, and circular calices of 1.5-2.3 mm diameter. Corallites are crowded except those on the corallum edge. Septa are wedge shaped, regular in appearance, usually well developed and up to 20 per calice. They descend vertically and slightly bend inward as notches at the level of columellae before fusing with the deep bases of this. Septal margins are straight or irregularly dentate. Septal sides are granulated. Columellae are well developed, being of thick spongy masses forming a dome shape. Exothecal walls and coenosteum are spongy, covered with forked pointed trabeculae.

DISCUSSION

This young single specimen is corresponds with *T. reniformis* Veron & Pichon (1979) described, with one exception. Plate-like

columellae, which the latter authors mentioned occur in young corallites, are not obvious here.

GENUS TUBASTRAEA LESSON, 1834

Like *Dendrophyllia* but its mature corallites do not have septa arranged according to Pourtales Plan.

Tubatraea coccinea (Ehrenberg, 1834)

MATERIAL STUDIED

460 / Jb. S1, 3 / or,yel-tentacle (Fig. 220)

461, 462 & 463 / Tr.I, Bt, 10 / or,yel-tentacle

CHARACTERS

Coralla are encrusting, tending to form submassive dome-shaped structures. Generally, mature coralla are up to about 7 cm in diameter. Mature plocoid corallites are about 8-13 mm diameter and up to 2 cm high. They tend to be united basally and become more spaced out above. Septa are in 4 cycles, the first two (12 septa) are subequal. They extend basally and reach the columellae. Their inner margins are dentate as flattened trabecular tangles which become mixed with trabecular columellae. Third and incomplete fourth cycle septa are very thin and dentate on margins and are usually fused together by dentations. Corallite walls consist of equal, fine, granulated costae. Columellae are trabucular and very spongiose.

DISCUSSION

In general specimens of this collection only differ from *T. coccinea* of the Galapagos Island (described by Wells, 1982) by having subequal septa of the first two orders, while those from the literature have unequal ones.

Variation among different specimens or even in an individual specimen here is rather obvious when columellae are taken into consideration. Columellae can be spongiose, flattened, twisted trabeculae or only a single row of upwards twisted, granulated pinacles. The first case is found in the specimen from the biotope exposed to strong current and waves (eg., specimen no. 460) and the latter case is found in specimens from under overhangs or in sheltered areas. (eg., specimen nos. 461, 462 and 463) This conclusion is probably not a rule since only a few specimens are represented here.

GENUS DENDROPHYLLIA DE BLAINVILLE, 1830

Coral is ahermatypic. Colonies are dendroid, becoming bushy by extratentacular budding. Corallites are tubular with septa fused into Pourtales Plan.

Dendrophyllia cf. *micranthus* (Ehrenberg, 1834)

MATERIAL STUDIED

464 / Gt.II, Sl, 3 / d,br.gr

465 / Tr.I, Bt, 12 / d.br.gr (Fig. 221)

466 / Ad.VI, Sl, 8 / d.br.gr

CHARACTERS

Coralla are ramose, with branches (about 1-1.5 cm thick) which tend to be flattened at their ends. Each contains an axial polyp and rows of plocoid corallites on its side. Corallites are arranged on 2 opposite sides, each of which forms a row of corallites which grow and face upwards in opposite direction and alternate. They are oval, about 7-8 mm diameter and 6-10 mm high. Septa are in 4 cycles, the first two (12 septa) are equal and reach the columella. Tertiary septa usually fuse to secondary ones at or near the columella. Septa of the fourth cycle are usually present (but not complete) and fuse with those of third cycle by extending trabeculae. Columellae appear as rather solid, perforated masses. The synapticulothecate walls (of main branches and corallites) are finely ribbed. Fine granules are scattered through all skeletal structures.

DISCUSSION

The characters above describe specimen no. 466 which is slightly different from others, especially specimen no. 465. The latter has slightly oval corallites about 5.5 mm diameter, thin, spongiose, trabecular columellae and its most marked appearance is that of a partly rough woolly surface, a character that Crossland (1952) noted for *D. micranthus* var. *grandis*.

All specimens here do not exactly fit with Crossland's description of *D. micranthus* since his specimens usually have rudimentary third cycle septa and those of the fourth cycle are absent or only appear

as traces in a few corallites of *D. micranthus* var. *grandis*. In addition specimens of this collection are brown black verged with greenish sheen and polyps are bright green. This is in contrast to Dana's description which Crossland referred to. Branches are purple black, sometimes with a brownish tinge and polyps are uniformly black. Even for *D. nigrescens*, a species which the same author believed to be synonym (Crossland, 1952), branches are green black, polyps are white and discs are bright green. Dana identified species by means of colouration (Crossland, 1959), however it seems unreliable in this case.

EVALUATION

Variation in specimens in this study were mainly related to the influence of light intensity, wave action and sometimes of turbidity. From the intraspecific variation discussed above, a generalized set of relationships can be drawn up, appliable to many species of coral.

If coral are from deeper water (such as the reef slope), they usually tend to

1. be foliaceous or partly foliaceous (such as at the corallum periphery) or more flattened or have longer, delicate branches.

2. have flat walls (monticules or carinae).

3. have delicate (thin) skeletal structures (for instance, have vesicular coenosteum).

4. have poorly-developed internal calicular structures (such as lower number of septa per corallite, weak development of paliform lobe, septal granulations and septal dentations, and a columella structure which is not compact).

5. have less corallites per unit area.

All of this variations may be viewed as adaptation strategies to the enviroment. Flattened structures increase surface area available for recieving reduced light intensity. Wijsman-best (1972) has suggested that, since light the essential factor in skeleton growth, light intensity positively correlated with skeleton deposit. This occurs because of the strong relationship between coral tissue and the symbiont, zooxanthellae. Photosynthesis in zooxanthellae is known to aid calcification process of the corals (Yonge, 1963; Muscatine, 1971; Chalker, 1983).

The delicate, poorly-developed skeletal structures are due to the low, calcification of the corals from the deep water or the turbid habitat in which light penetration is limited. Viewed from another respect, corals do not develop the strong, dense skeleton because they do not have to resist strong wave action. In some groups of corals, such as the faviids, when inhabiting the reef flat which is exposed to strong wave action, the septal dentations are well developed and usually irregular. This character is an adaptation for giving better support to the living tissue. According to Wijsman-Best (1972), the small and deep corallites also provide better framework for living tissue to face the wave action on the reef flat. The adaptation of the corals to wave action may be very obvious in branching corals, such as *Acropora formosa, A. aspera* and *Montipora digitata*. Their branches are usually short and compact on the reef flat and become longer and delicate on the reef edge to reef slope.

Some variations,however, contrast with general principles outlined above. For example, *Symphyllia radians* from the deep water, have prominent dentations and *Platygyra pini* from the shallow habitat, have large corallites. Wijsman-Best (1972) also mentioned that corallites (and also polyps) have to be larger, where water is turbid, to be able to remove the sediment. So those specimens of *P. pini* with larger corallites may reflect a habitat of turbid water. However, in the present study, the condition of the environment (especially the microenvironment) was not measured at a very detailed level.

In the same manner, the degree of exsertion of the corallites is variable. Consequently, the general principles of this feature cannot

be formulated. Wijsman-Best (1972) noted that the plocoid faviids become phaceloid (that is more exsert) in the turbid water, so as to remove sediment efficiently, but several specimens of the present collection did not behave in this way. *Cyphastrea microphthalma* on the reef flat are cerioid while those on the reef slope are plocoid (ie. more exsert). While, by contrast, *C. chalcidicum* are more exsert at the shallower water.

Genotypic variation may be the explanation for those specimens that do not follow the principles above. This source of variation was the obvious explanation for variation between 2 specimens of the same species growing close together, notably in *Psammocora contigua* (see p. 7), *Montastrea valenciennesi* (see p. 84) and *Platygyra pini* (see p. 78).

In most species, intracolonial variation was commonly observed. The top parts of the colony recieve a greater light intensity than the lateral parts. Consequently, growth rate of the top parts are higher. For instance at the lateral parts of *Goniopora* cf. *lobata*, coralla has shallower calices, with clearer gonioporoid pattern and more solid structures, or *Leptastrea* cf. *pruinosa* has shallower calices on the lateral parts, with more regular septal dentation and more dense, granulated septal sides (ie. septa are more solid) when compared to their top parts. The higher growth rate of the corallites on the top part results in more budding and the rapid raising of calicular wall, giving the incomplete structures in the deep calices. The intracolonial variations are most obvious in *Acropora*. The identification of the radial corallites is made from those on the middle of the branches on which radial corallites are fully developed and are not very old.

The characters showing intracolonial variation can be used to trace

the phenotypic variation of different specimen. However, this is not applicable to all species. Taxonomists may use outline characters of the skeleton to distinguish species . Some parts of *Pavona venosa* may be identical to *P. varians* (see p.125), however their outline characters are different.

The phenotypic and genotypic variation may be proved by experimental manipulation. Willis (1985) transplanted *Turbinaria mesenterina* and *Pavona cactus* between shallow and deep sites. He found *T. mesenterina* has phenotypic plasticity while *P. cactus* has not. That is, morphological variation of the latter species is genotypically-determined.

Very few of the corals were identified by the feature of the polyps. In this work, *Euphyllia (Fimbriaphyllia) ancora* was the only species that was identified by its polyps in situ.

From the one hundred and forty identified species, some of them still have the uncertain status. This occurs since the specimens were compared with the character description of the corals of Great Barrier Reef. Thus the range of intraspecific variation in those descriptions may not cover all the characters of the corals in Adang-Rawi region. However, most of the outline characters of the species in this collection fall within the range of variation described by Veron et al. (1976, 1977, 1980, 1982, 1984) with only minor exceptions.

Most of the specimens were compared with those from the reference collection of the PMBC. The PMBC collection was made from the Andaman Sea region. They were described briefly by Ditlev (1980). Veron and Wallace confirmed these specimens in the first coral taxonomy workshop

(Unesco, 1985)and lists 207 species from 62 genera. Species that have been identified in Adang-Rawi region but are absent from the Unesco list are: *Montipora tuberculosa, M. undata, M. efflorescens, Acropora palifera, A. valenciennesi, A. subulata, Porites australiensis, P. annae, Gardineroseris planulata, Echinophyllia echinata, Symphyllia valenciennesi, Favites rotundata, F. russelli, Echinopora gemmacea,* and *Turbinaria reniformis*.

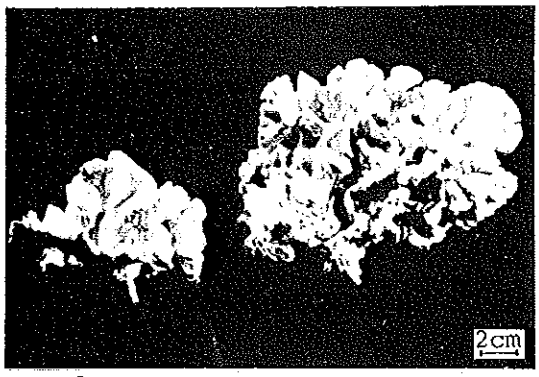


Fig.1

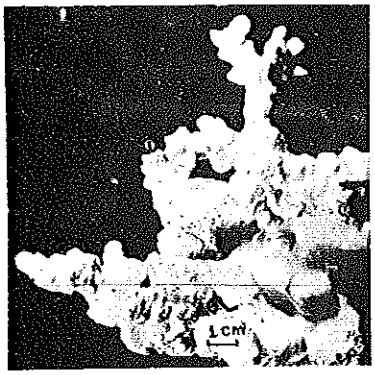


Fig.2

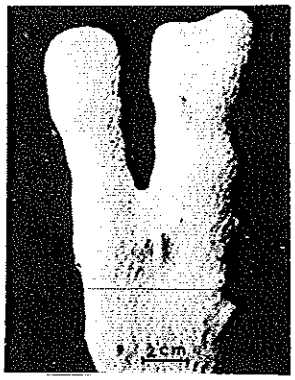


Fig.3

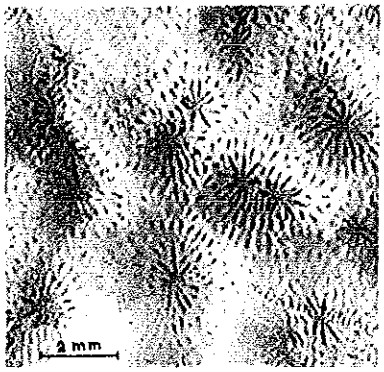


Fig.4

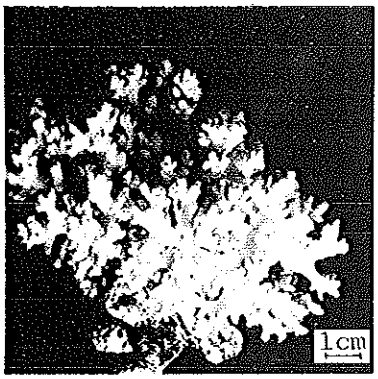


Fig.5

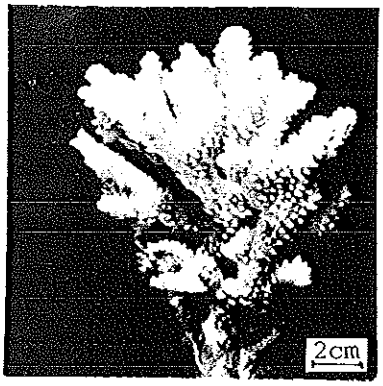


Fig.6

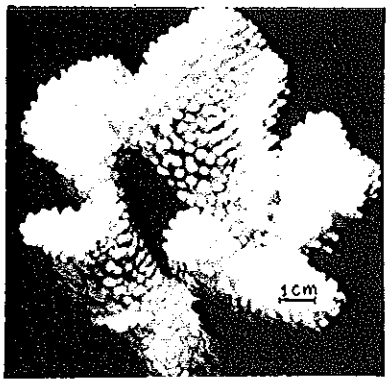


Fig.7

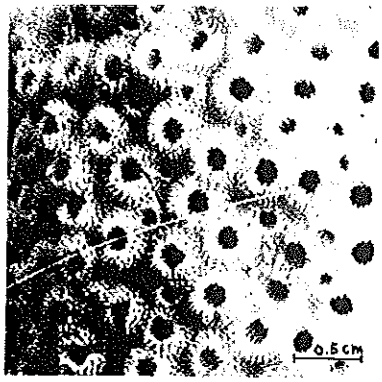


Fig.8

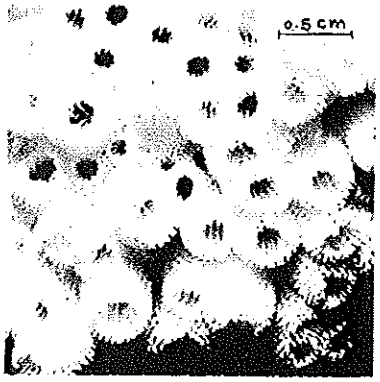


Fig.9

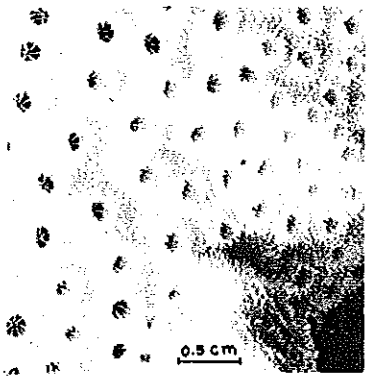


Fig.10

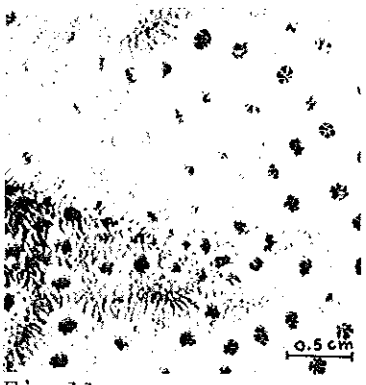


Fig.11

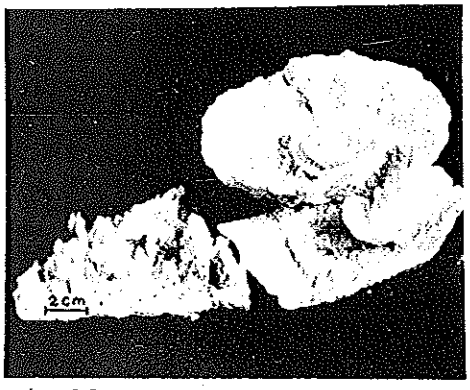


Fig.12

Fig.13

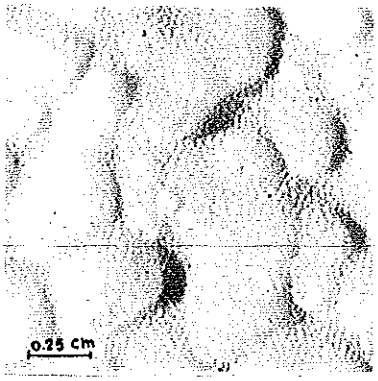


Fig.14

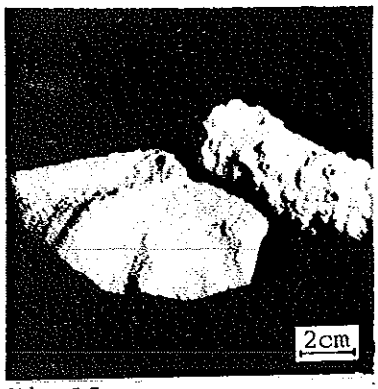


Fig.15

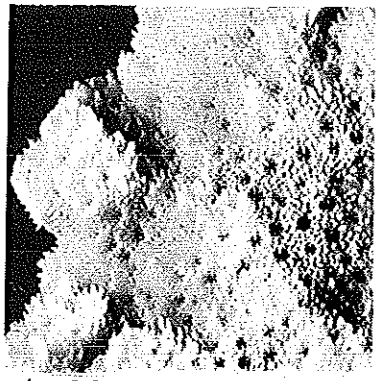


Fig.16

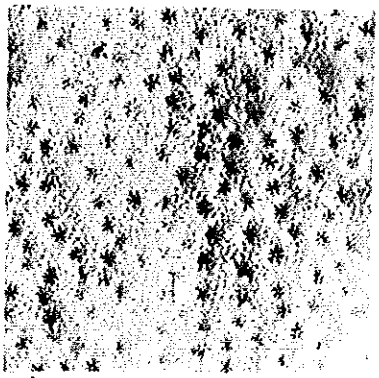
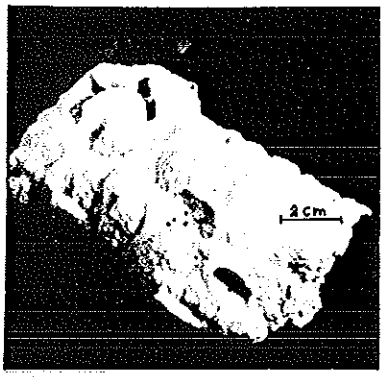


Fig.17



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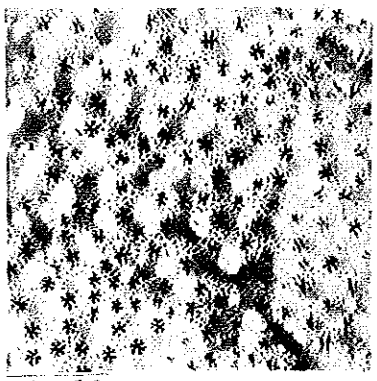

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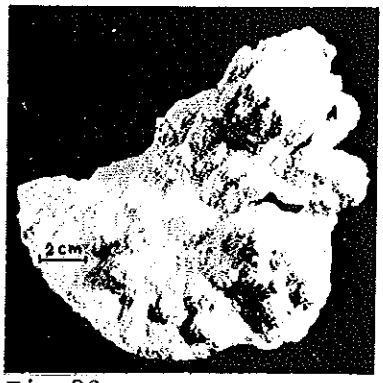

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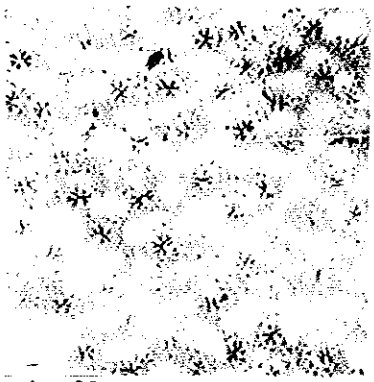

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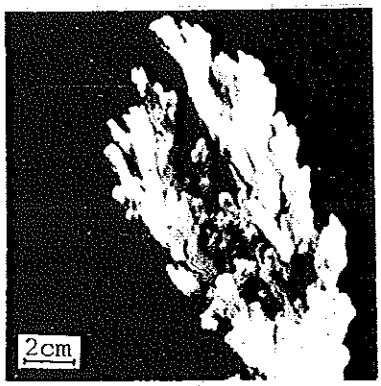
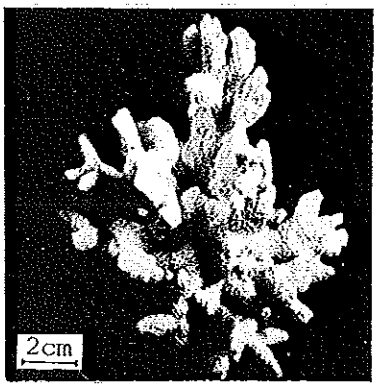


Fig.22

Fig.23



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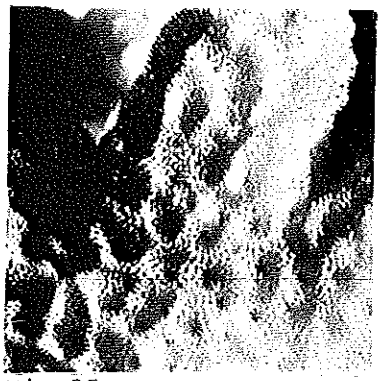

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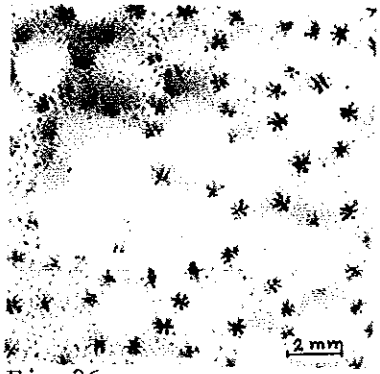

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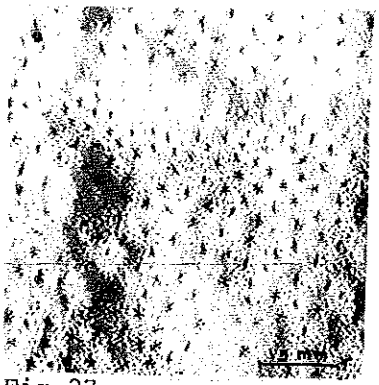

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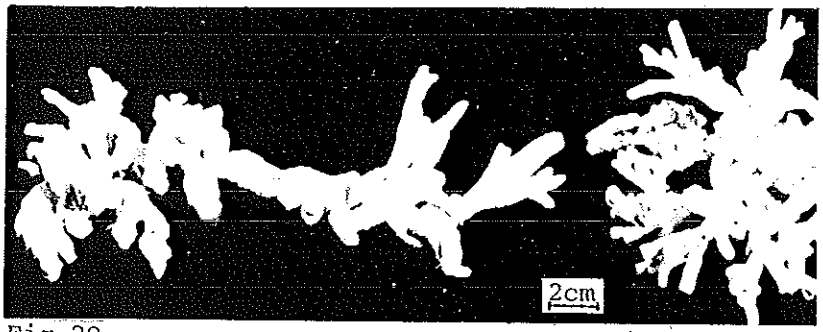

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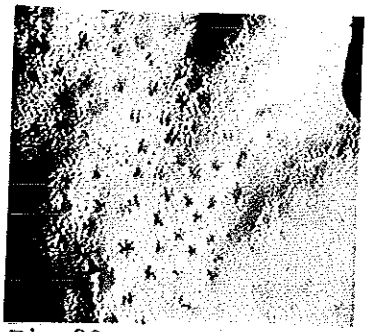

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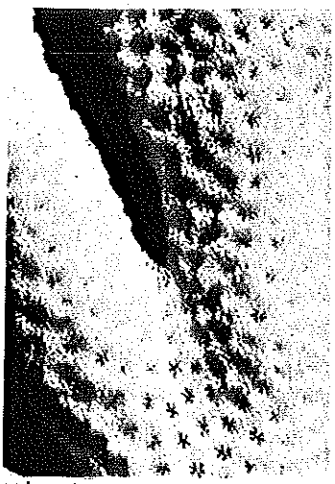
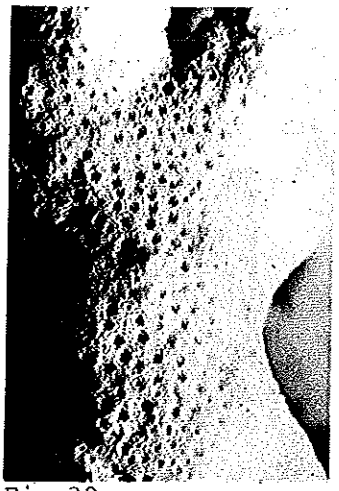


Fig.30

Fig.31



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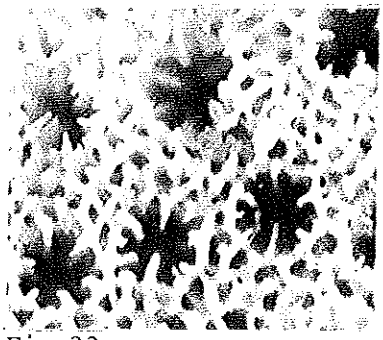

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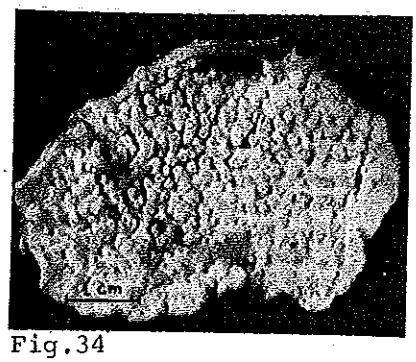

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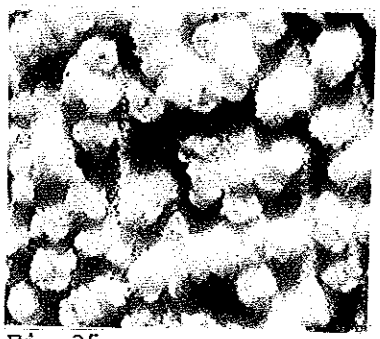
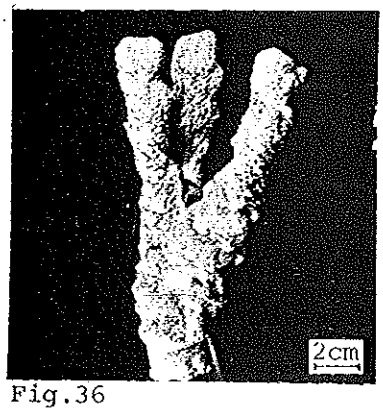


Fig.35



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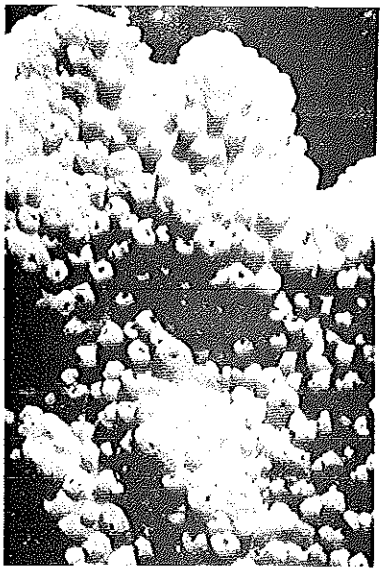
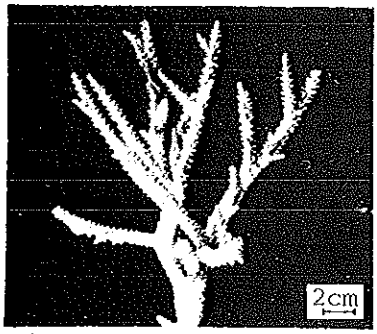


Fig.37

Fig.40



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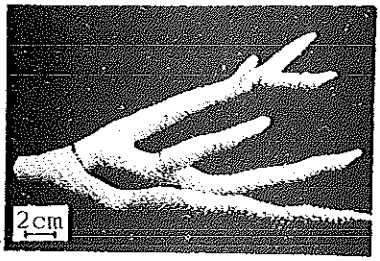

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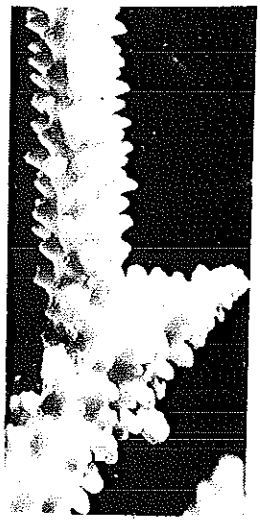

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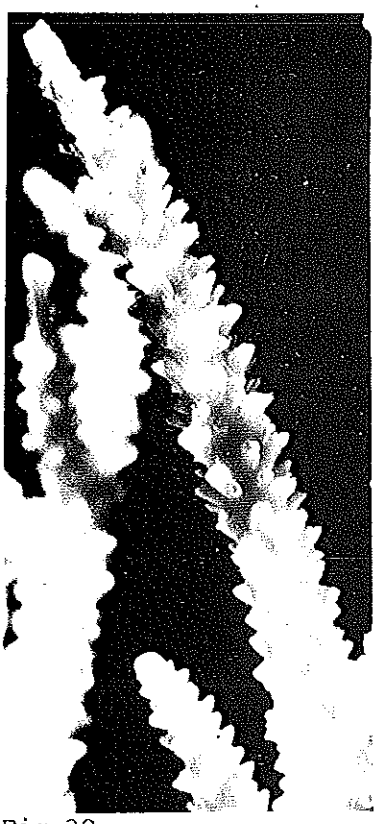

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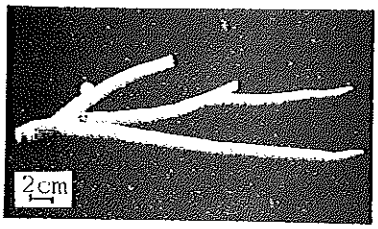

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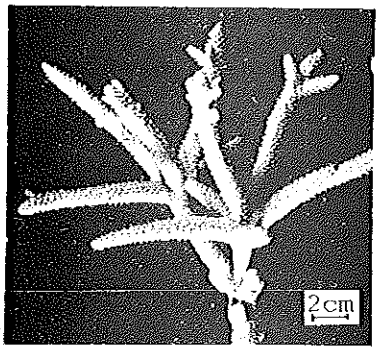

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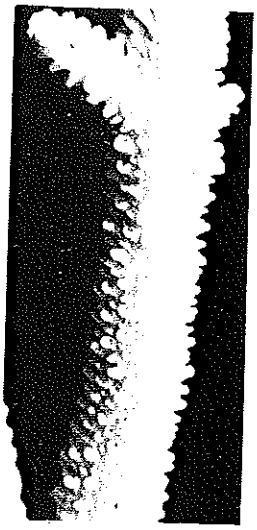

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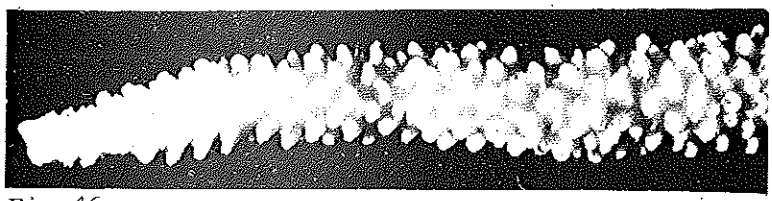


Fig.46

Fig.47 ▼

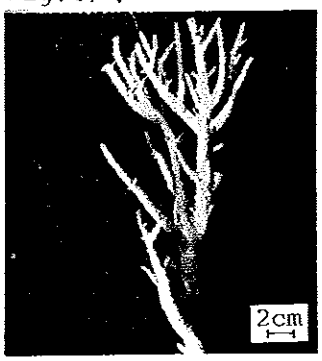


Fig.48

Fig.49

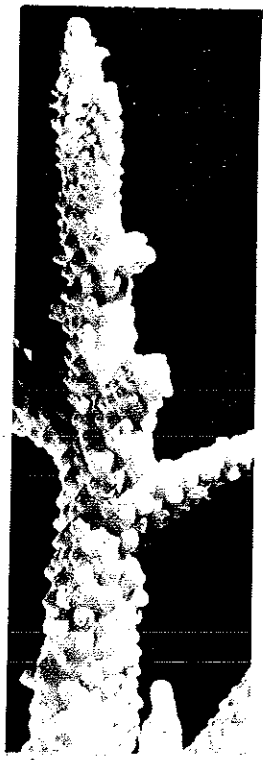
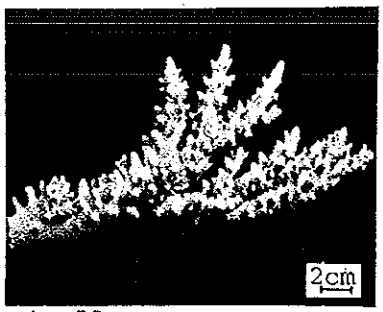


Fig.50

Fig.51▼



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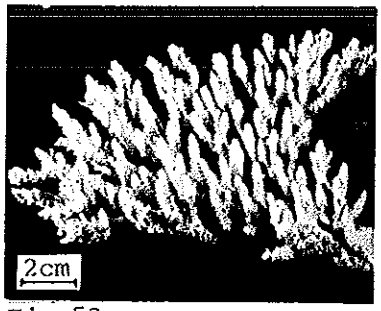

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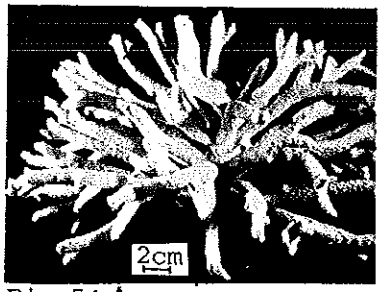


Fig.54 ▲

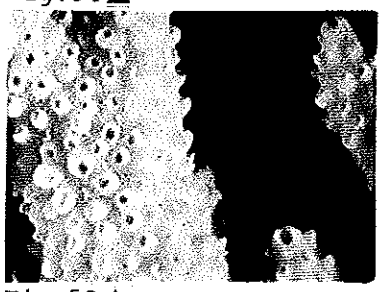


Fig.58 ▲

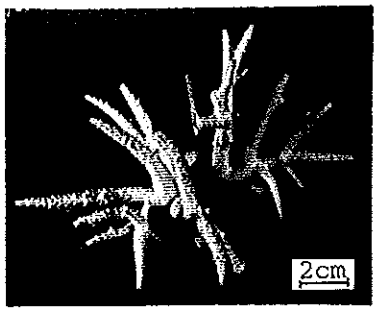


Fig.55

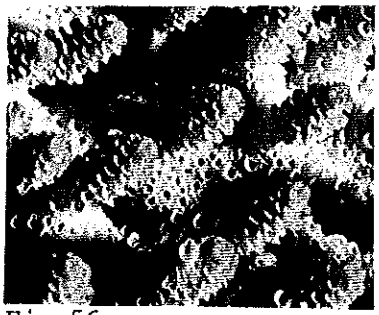


Fig.56

Fig.59

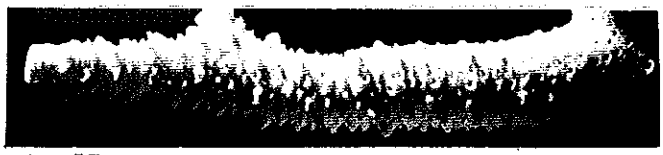


Fig.57

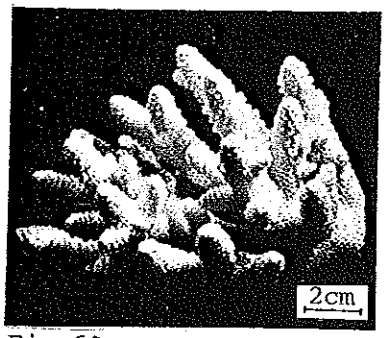


Fig.60

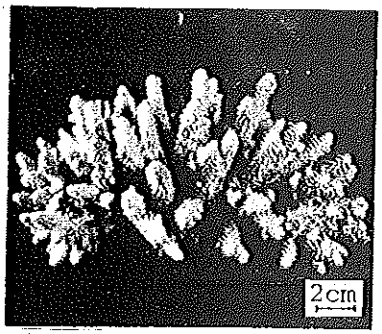


Fig.61

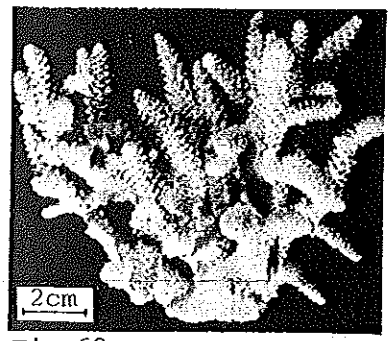
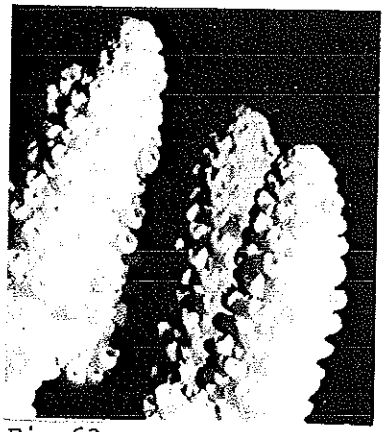


Fig.62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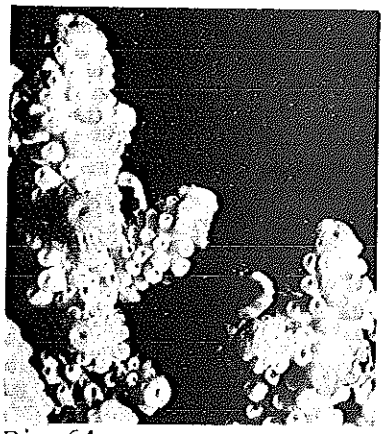
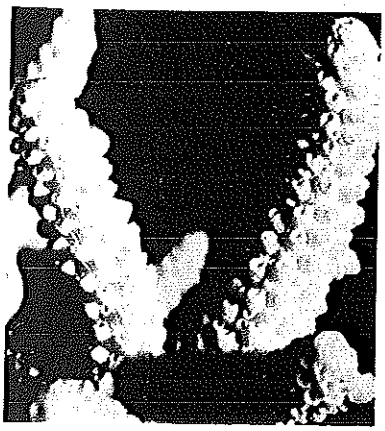


Fig.64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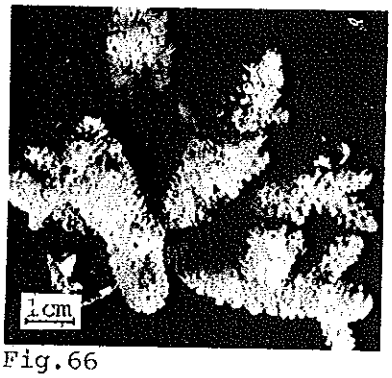


Fig.66

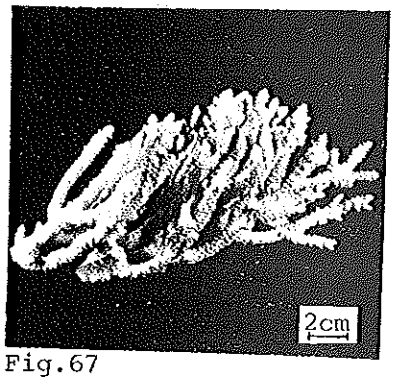


Fig.67

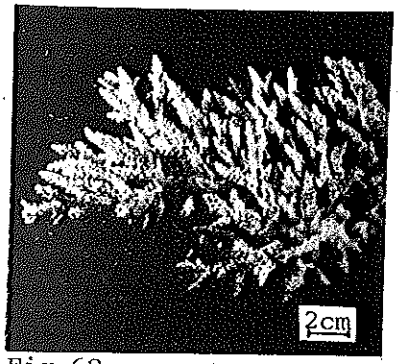
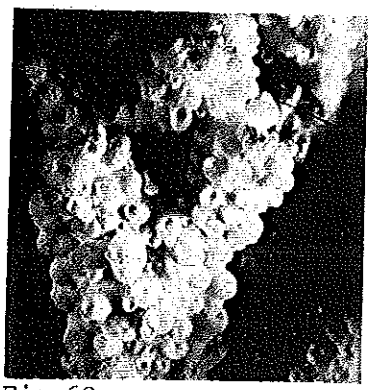


Fig.68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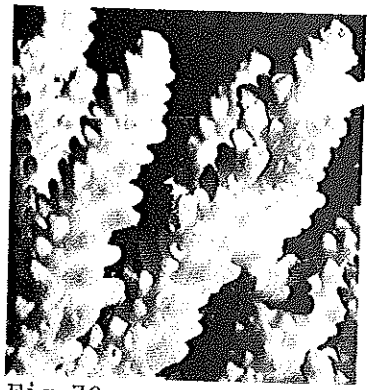
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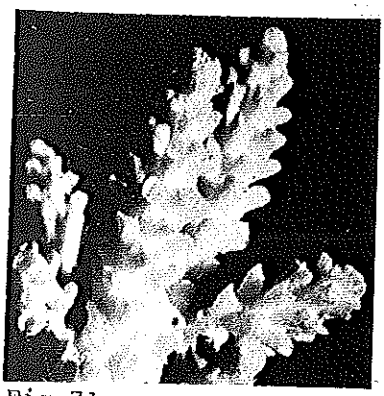
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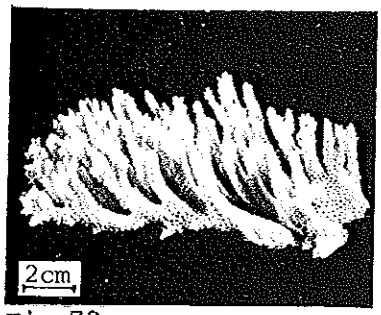
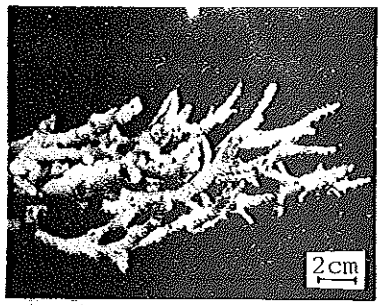


Fig.72



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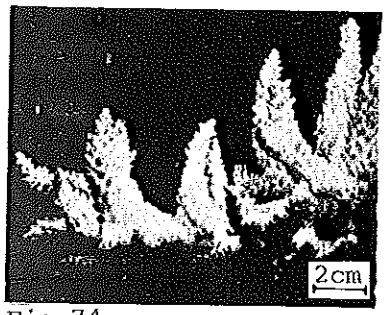
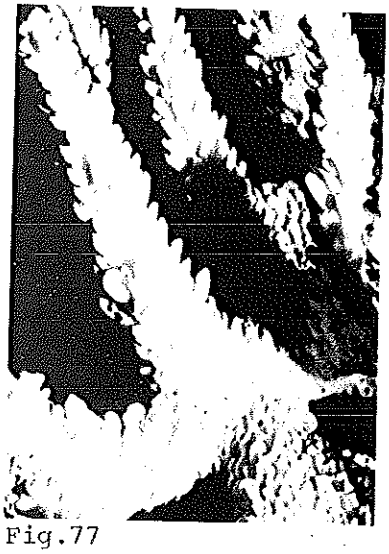


Fig.74


Fig.75


Fig.76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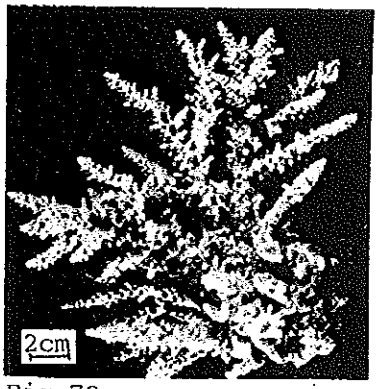


Fig.78

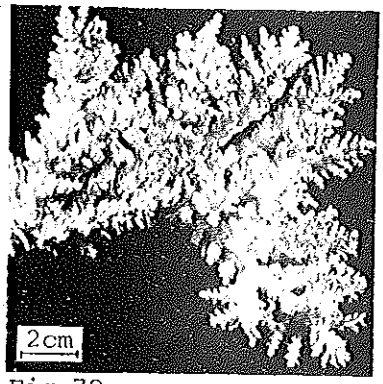
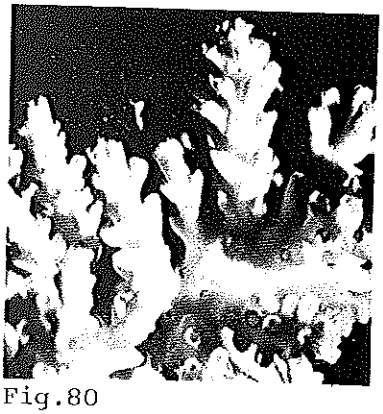


Fig.79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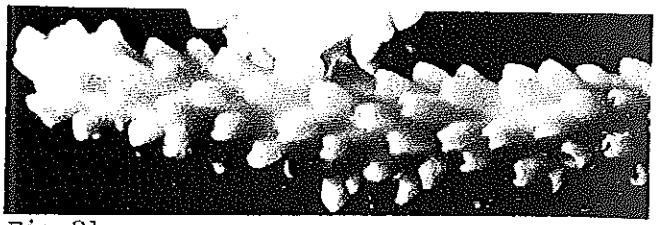
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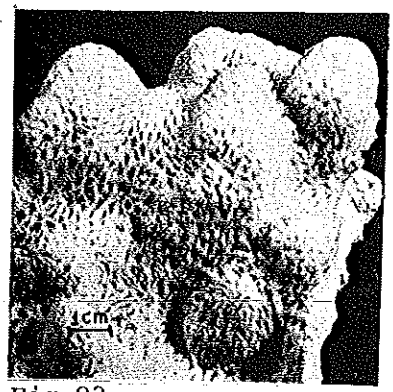

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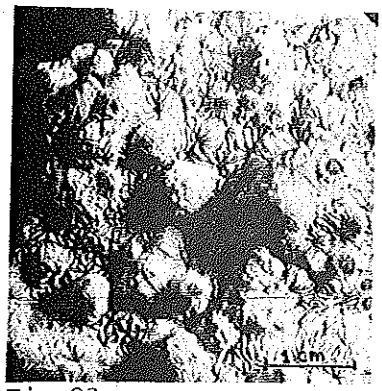


Fig.83

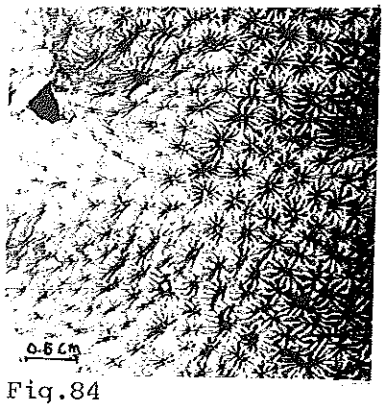
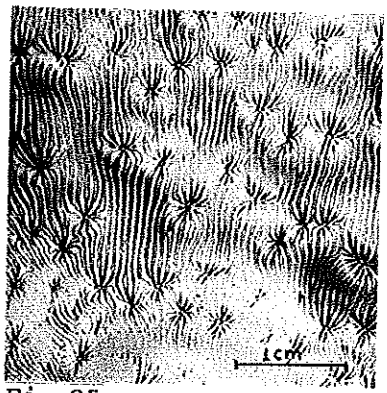


Fig.84



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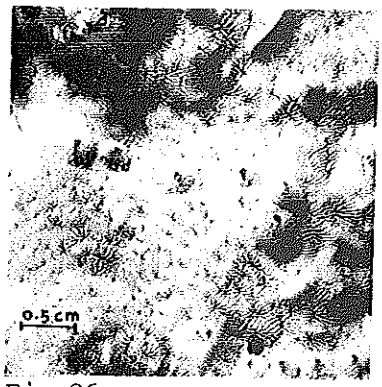

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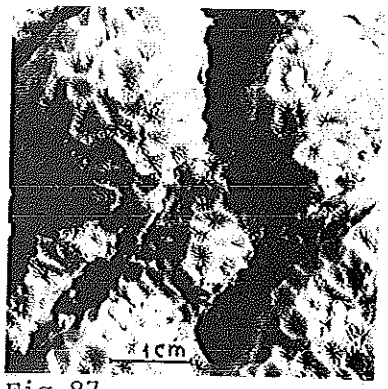

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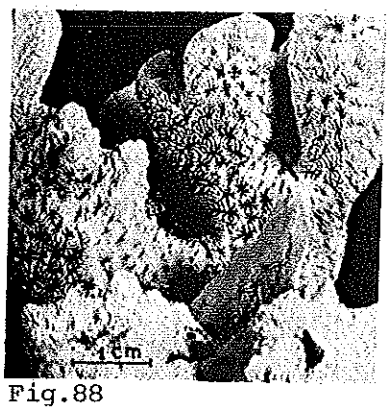

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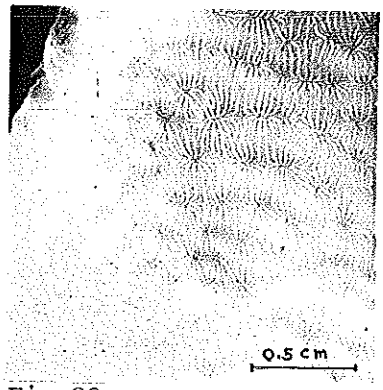
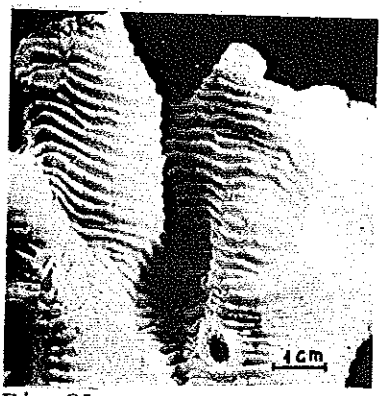


Fig.89


Fig.90



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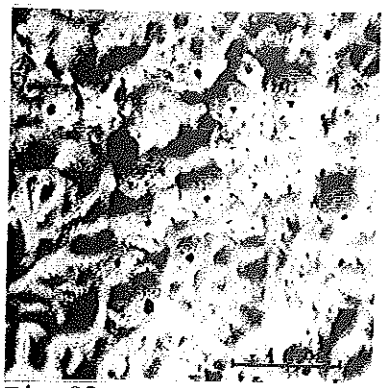


Fig.92

Fig.93

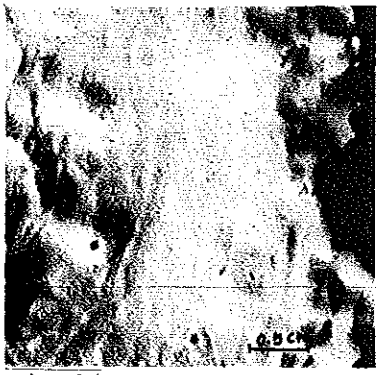
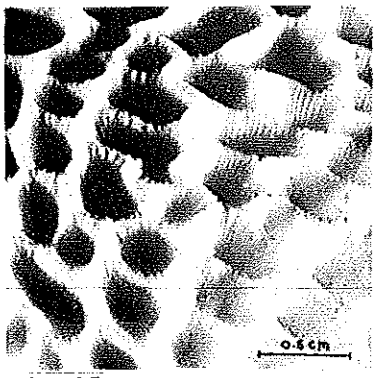


Fig.94



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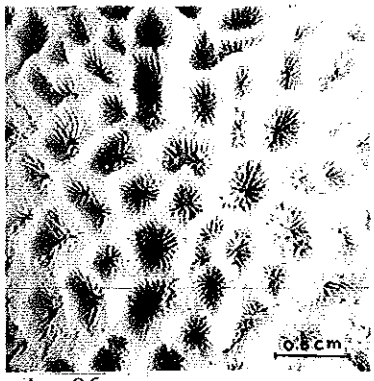

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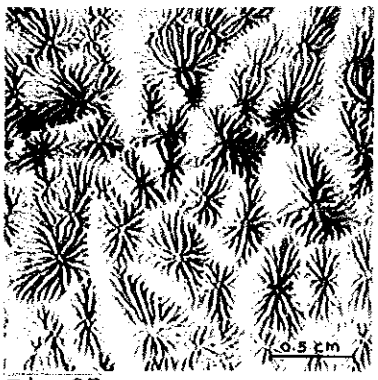

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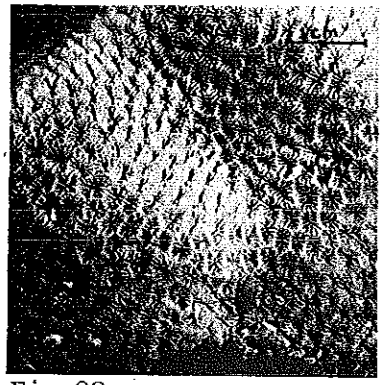

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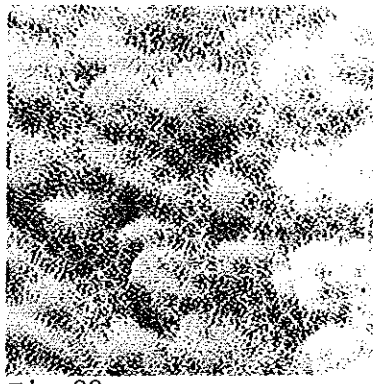
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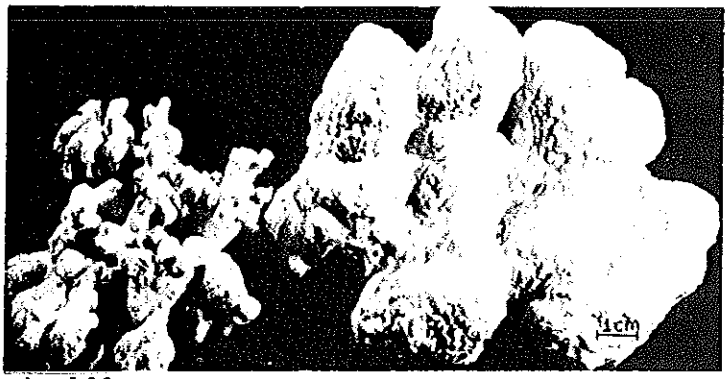

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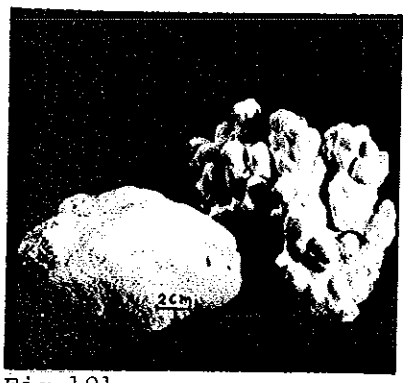

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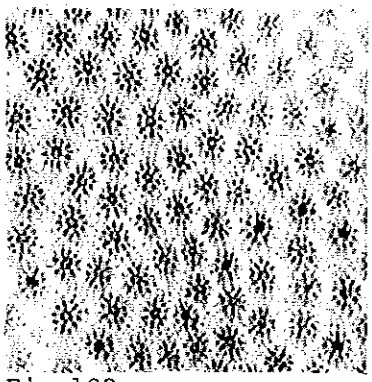
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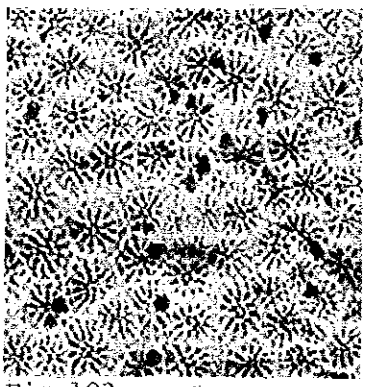
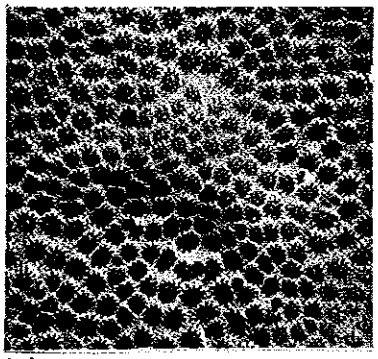


Fig.103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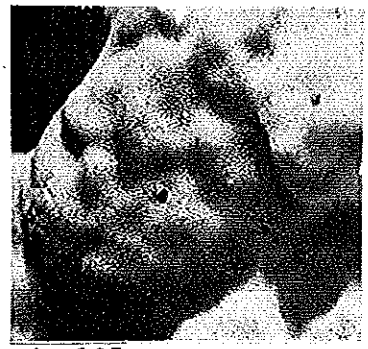
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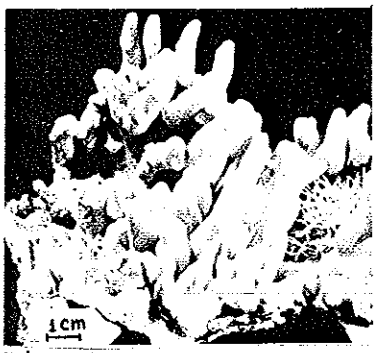

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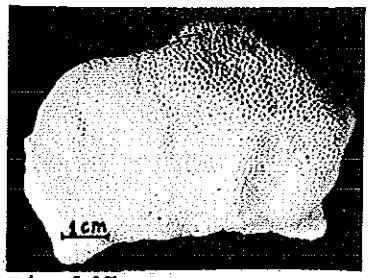

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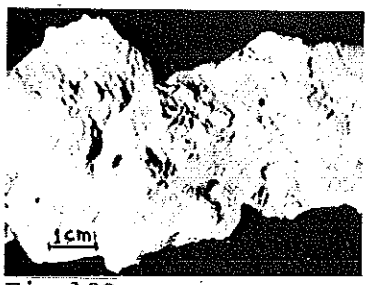

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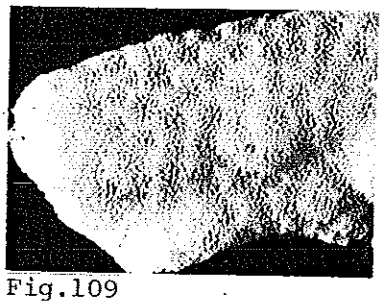
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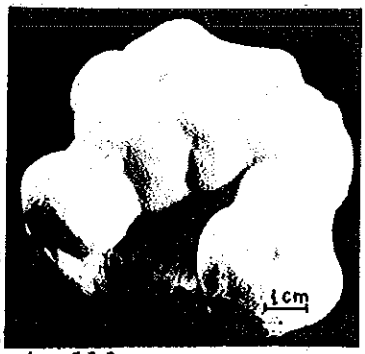

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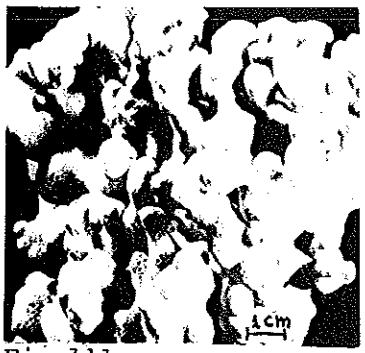

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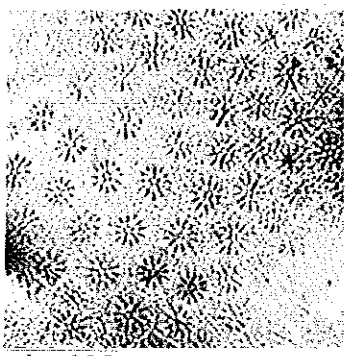
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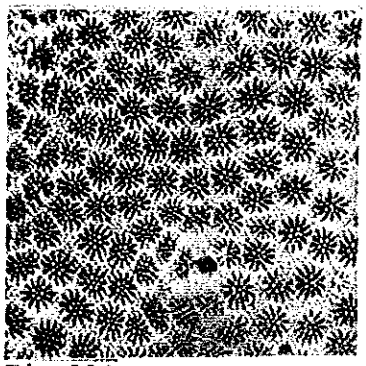
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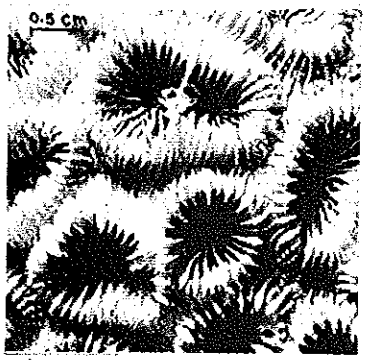

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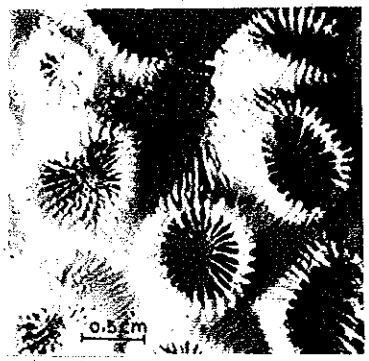

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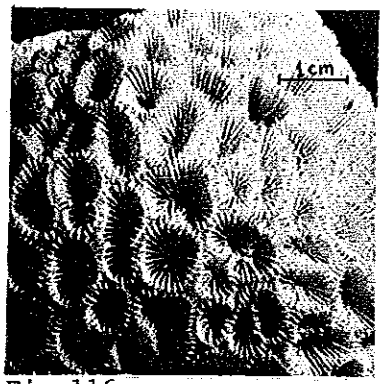

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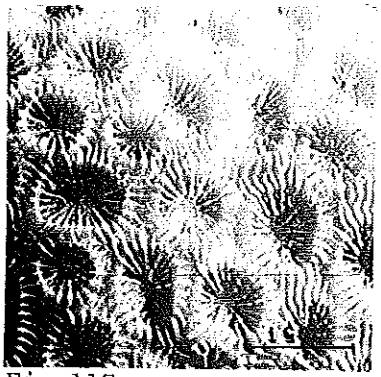
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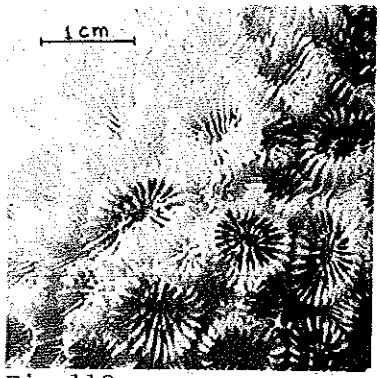

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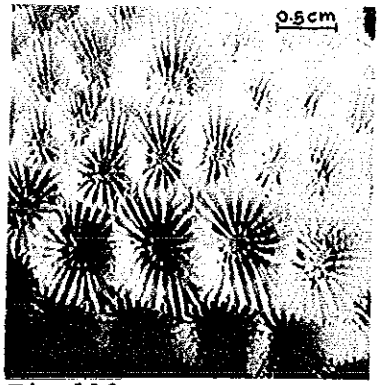

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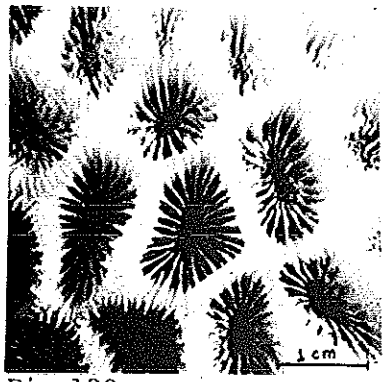

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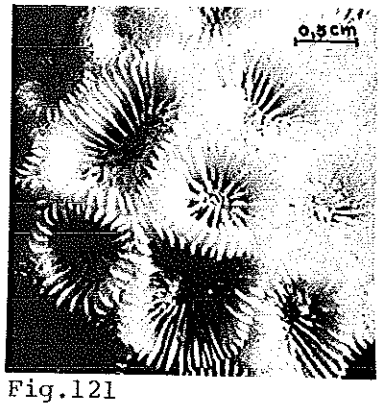

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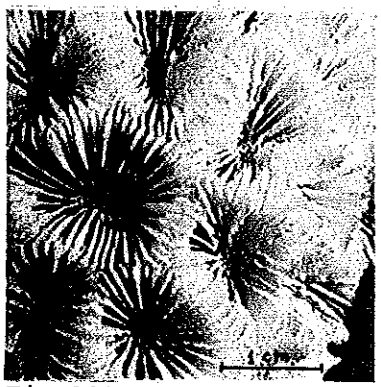

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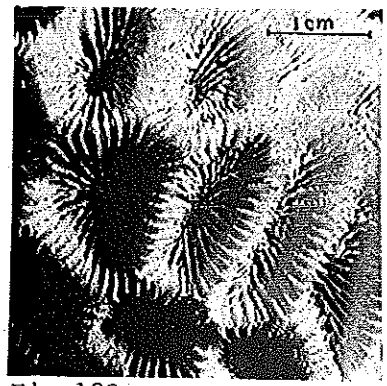

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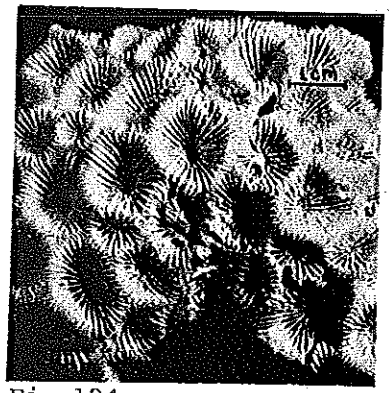

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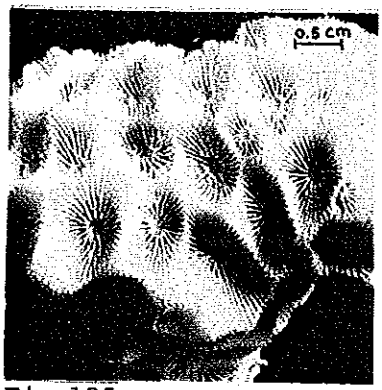


Fig.125

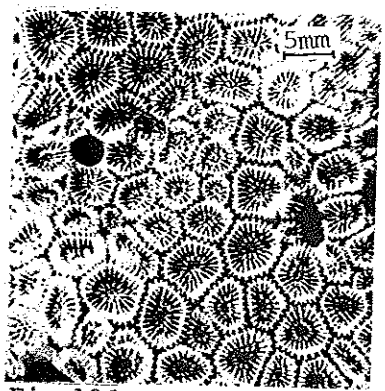
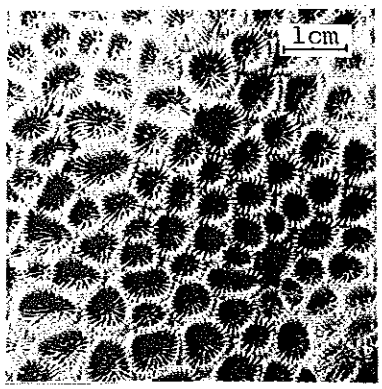


Fig.126



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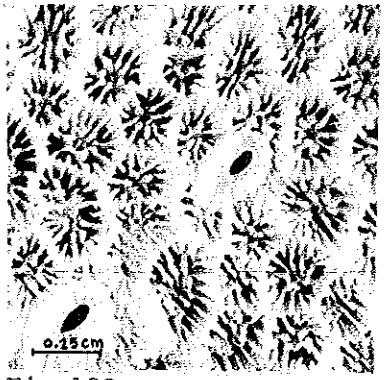
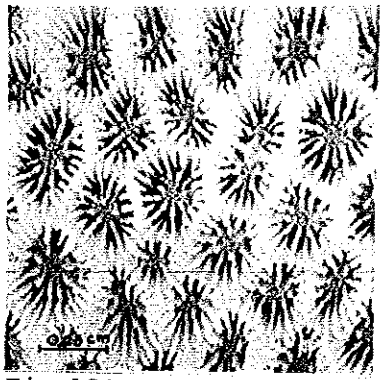


Fig.128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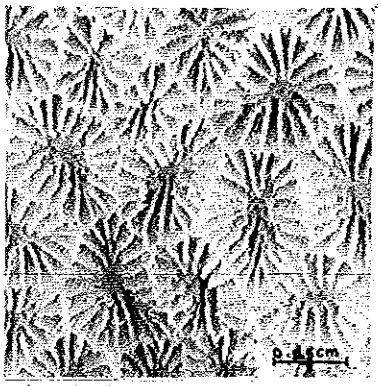
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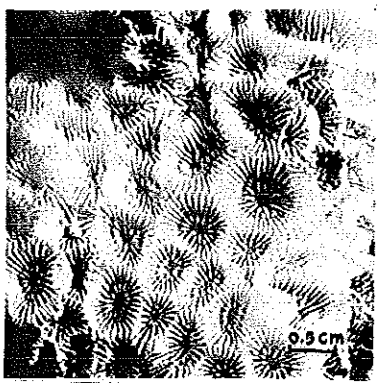

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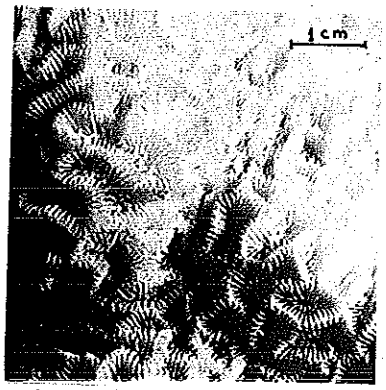

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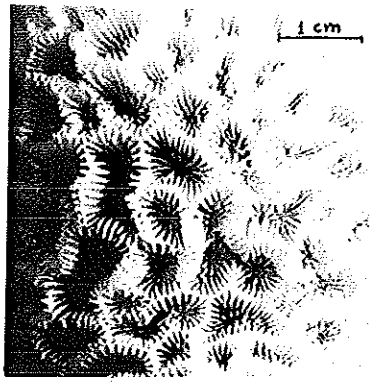

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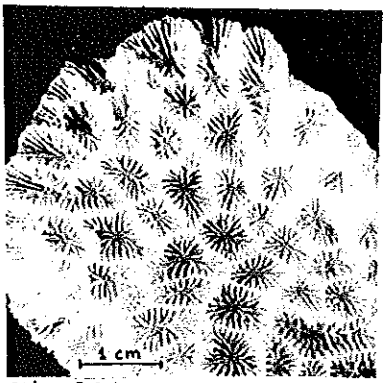

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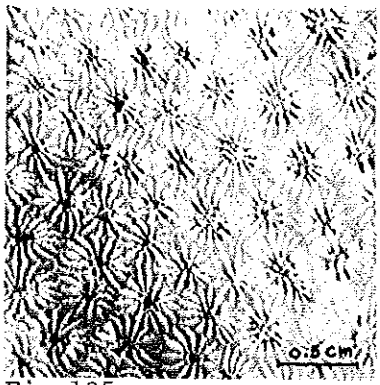

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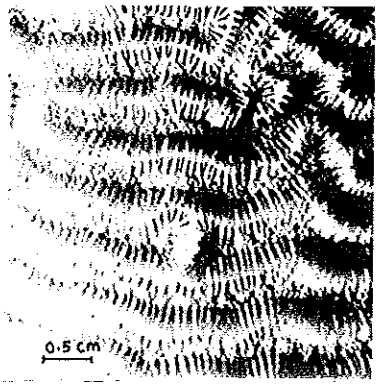

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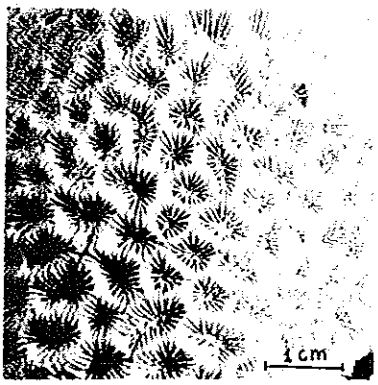

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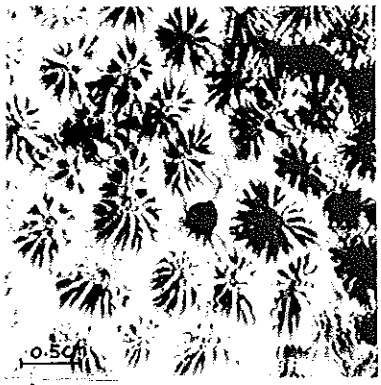

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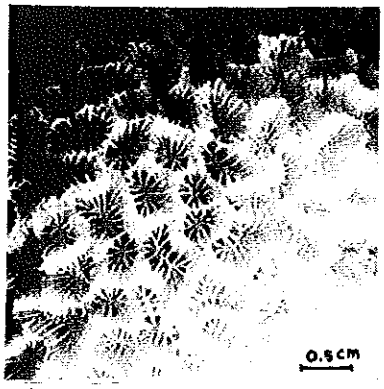

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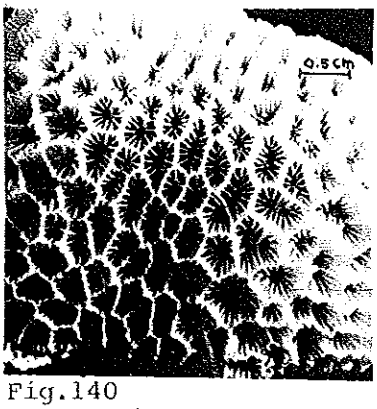
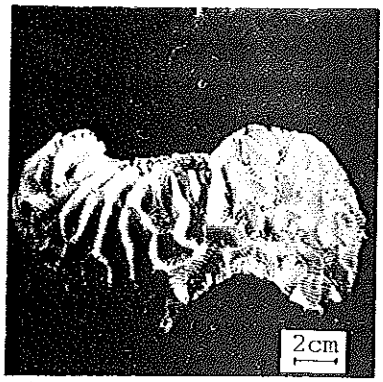


Fig.140



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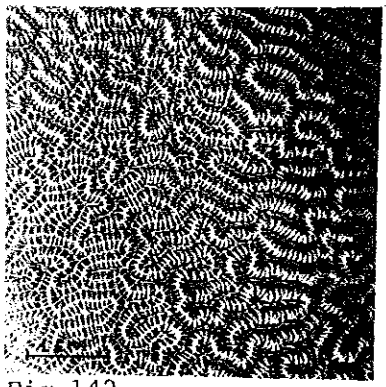
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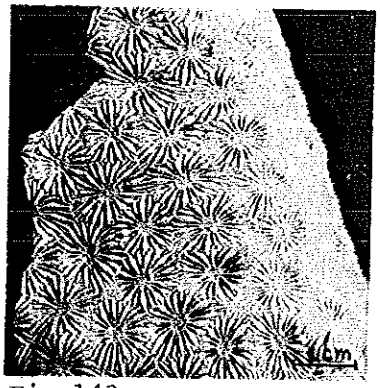
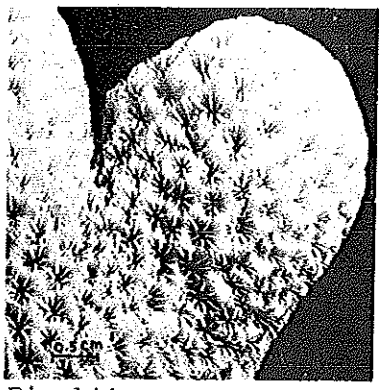


Fig.143



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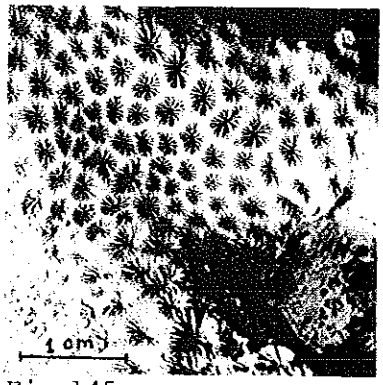


Fig.145

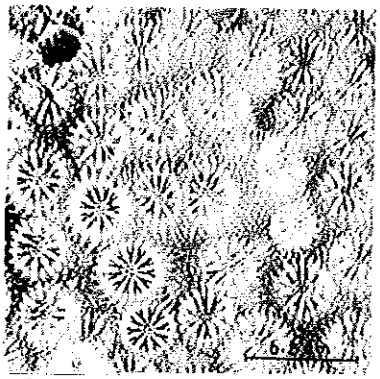
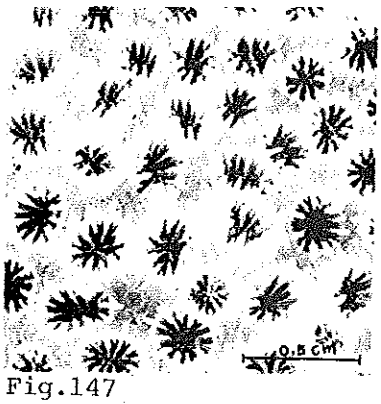


Fig.146



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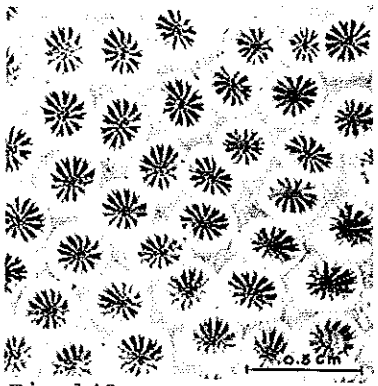


Fig.148

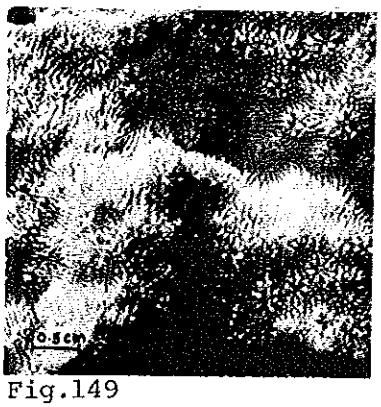
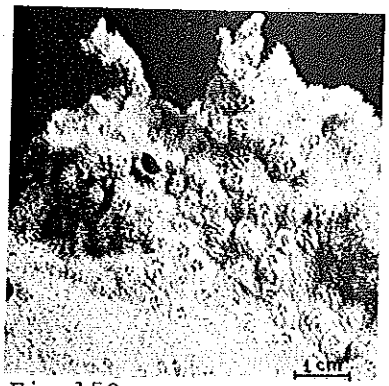


Fig.149



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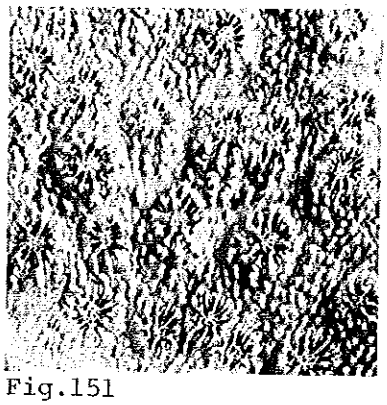
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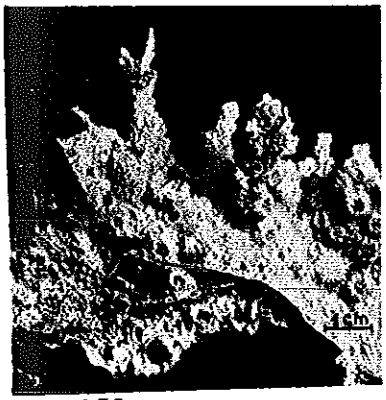
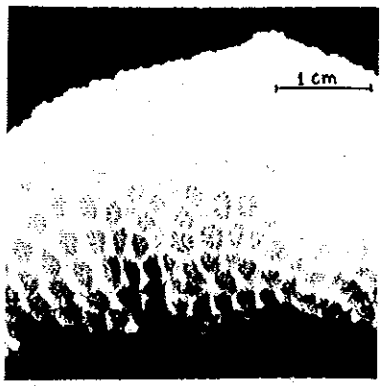


Fig.152

Fig.153



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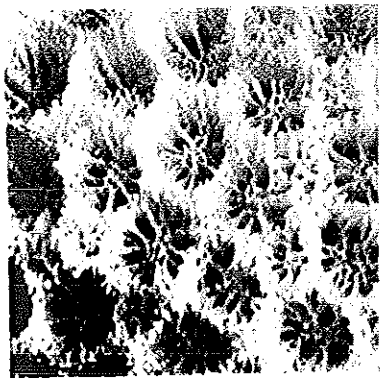
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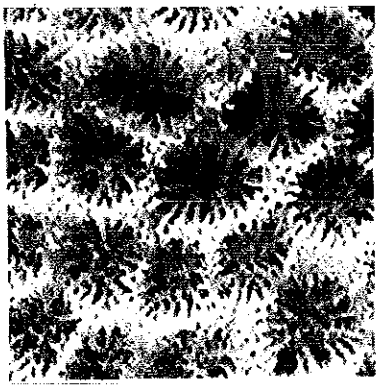
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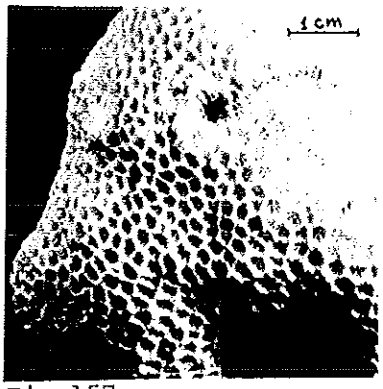


Fig.157

Fig.158

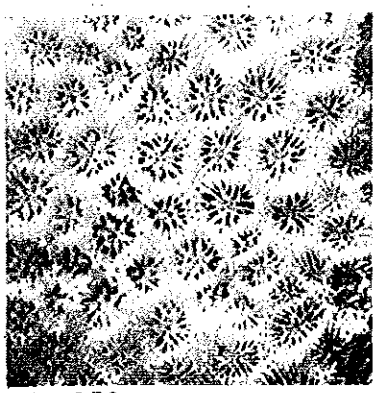
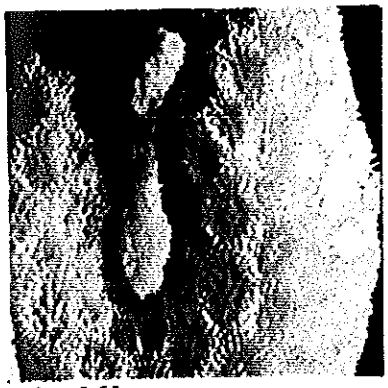


Fig.159

Fig.160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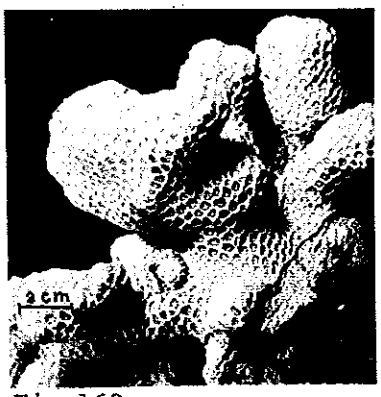

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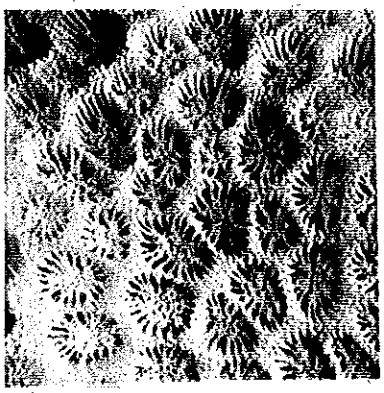
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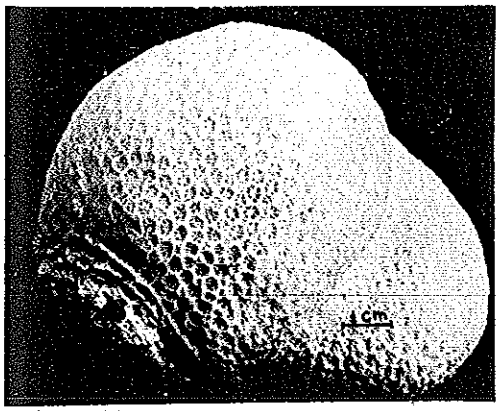

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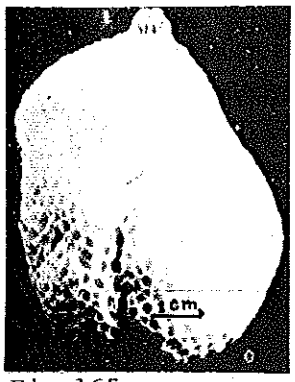

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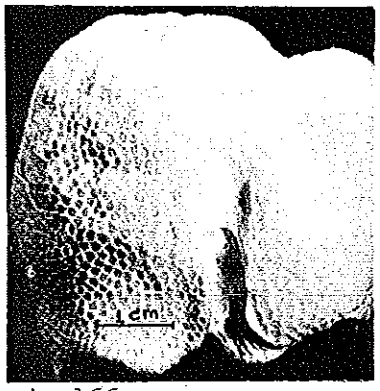


Fig.166

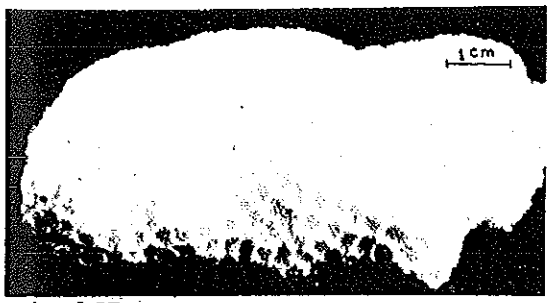


Fig.167

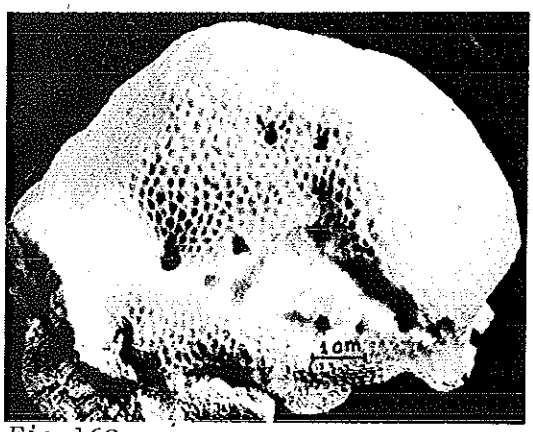


Fig.168

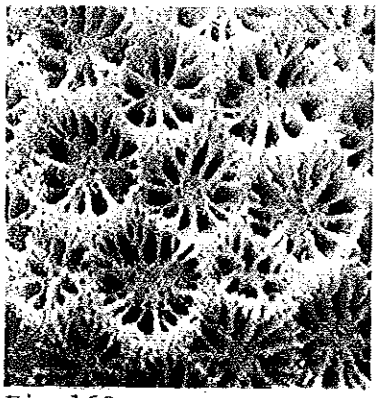
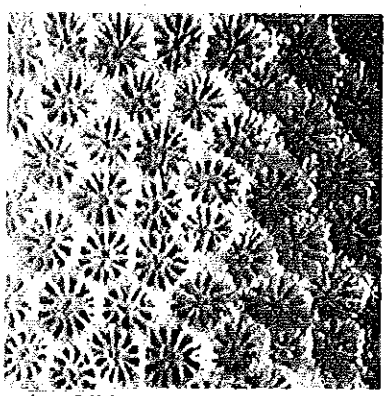


Fig.169



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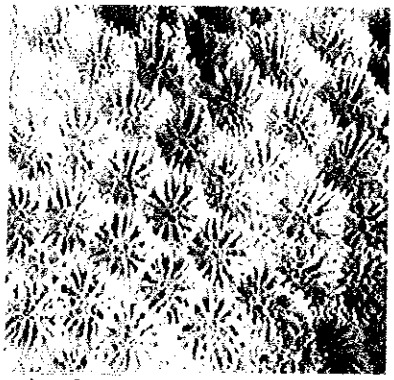

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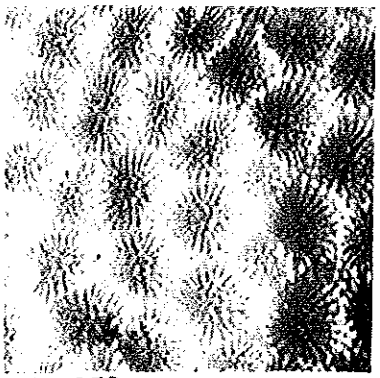

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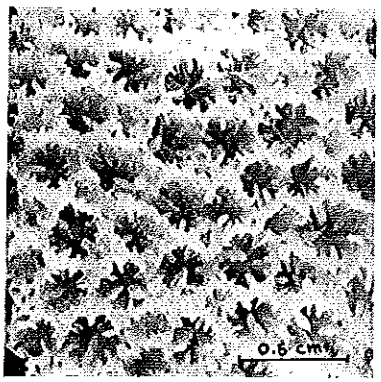

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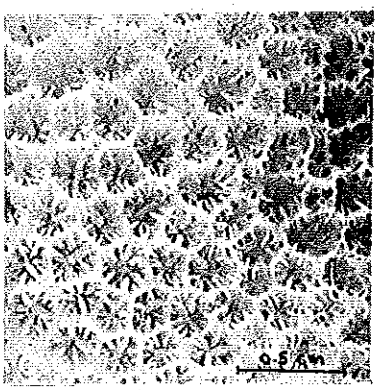

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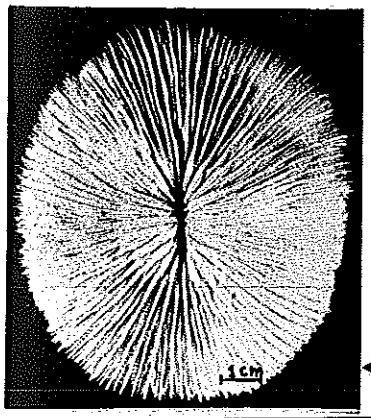
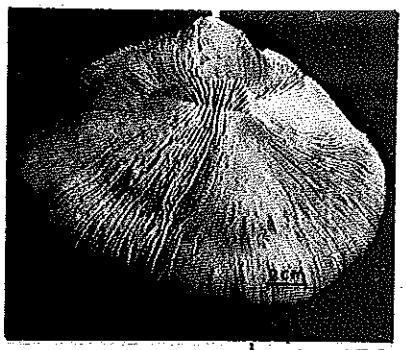
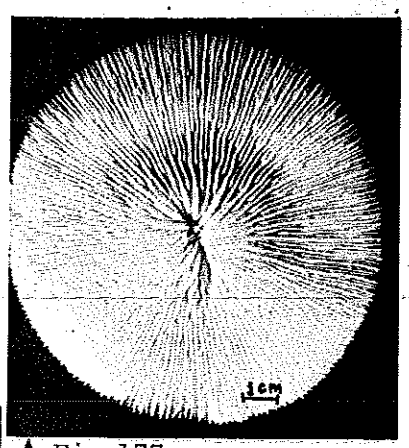


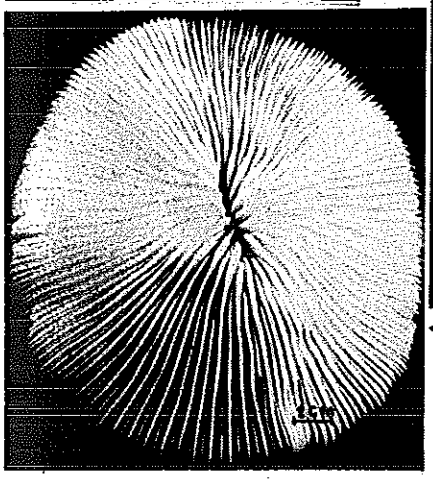
◀Fig.175



▲Fig.176



▲Fig.177



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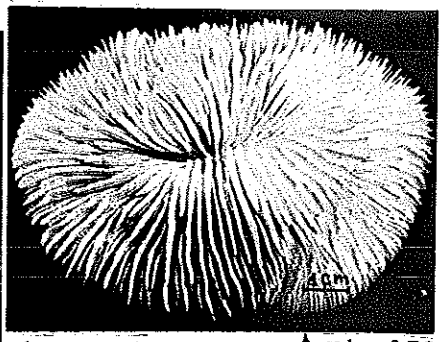

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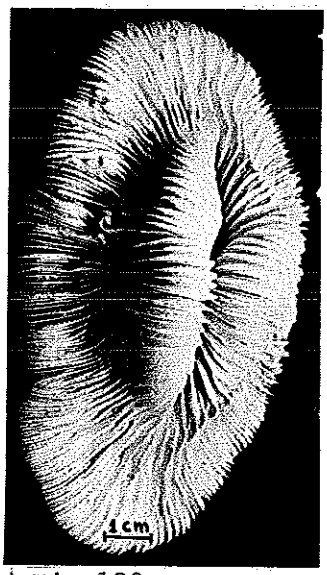
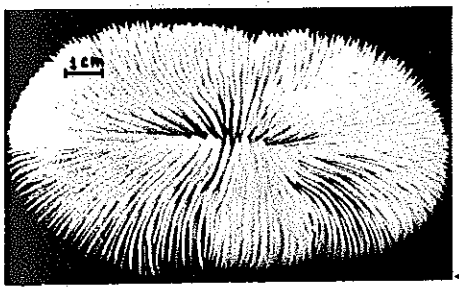
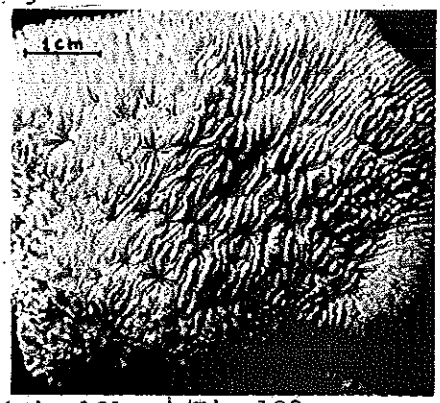


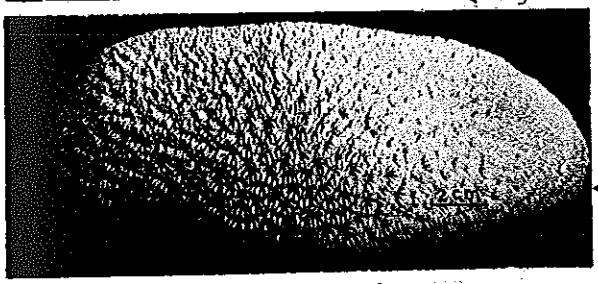
▲Fig.180



◀Fig.181



▲Fig.182



◀Fig.183

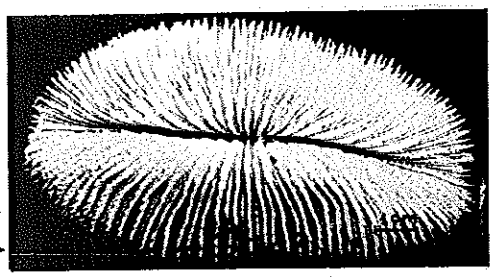
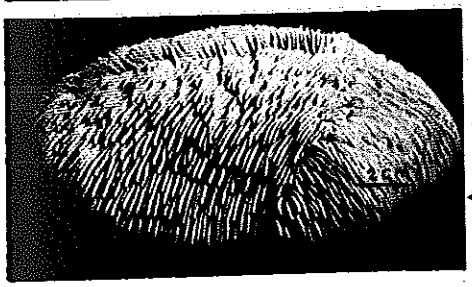


Fig.184▶



◀Fig.185

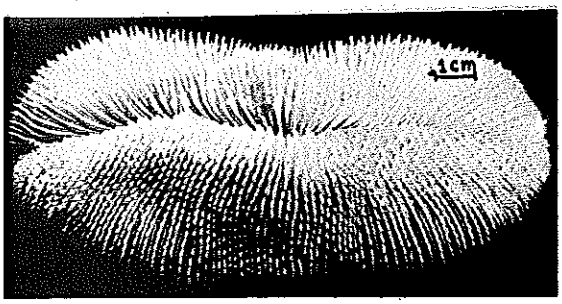


Fig.186▶

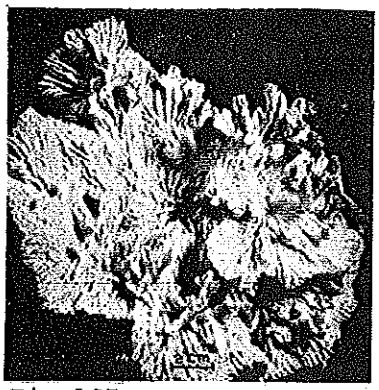
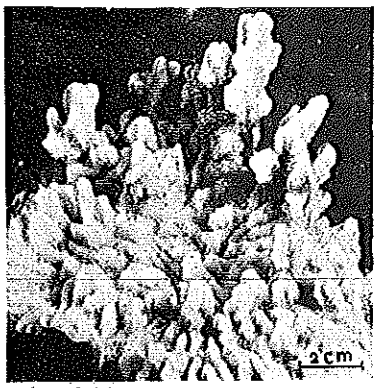


Fig.187



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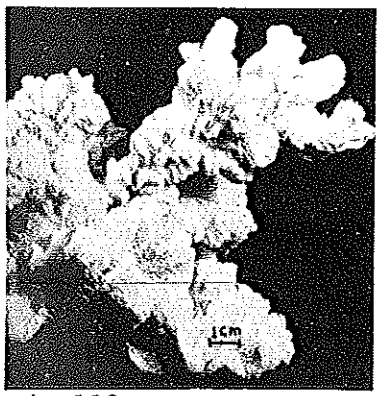


Fig.189

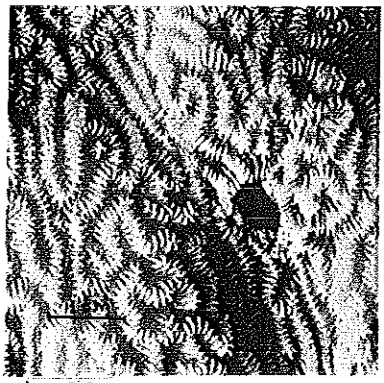


Fig.190

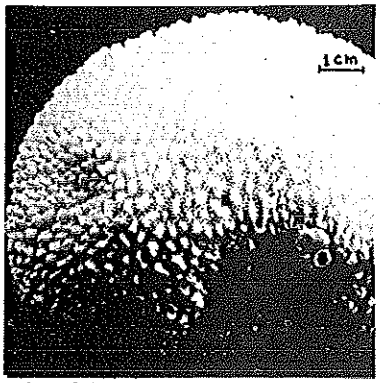


Fig.191

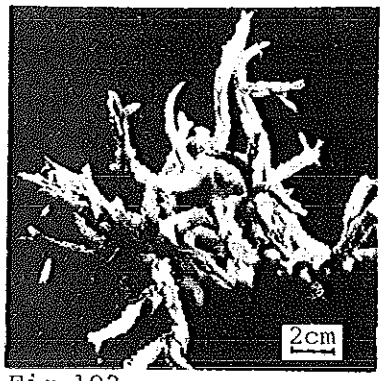
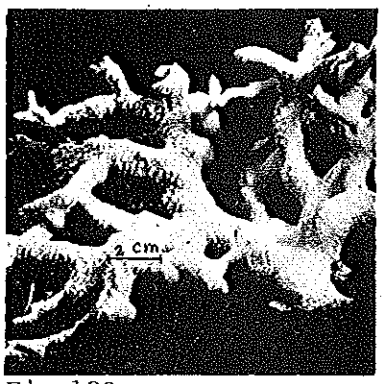


Fig.192



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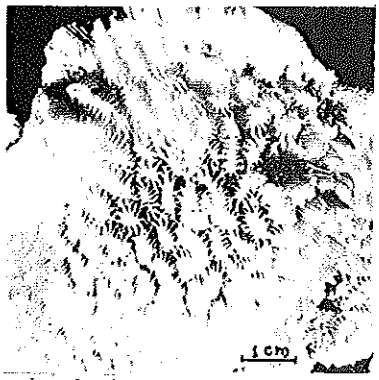


Fig.194

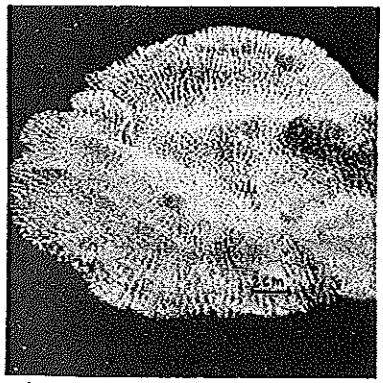


Fig.195

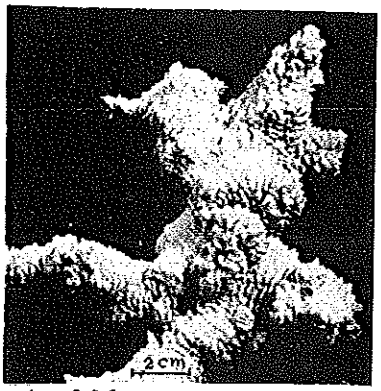


Fig.196

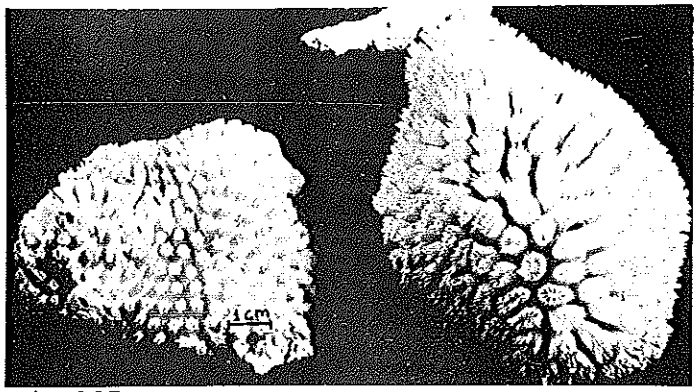


Fig.197

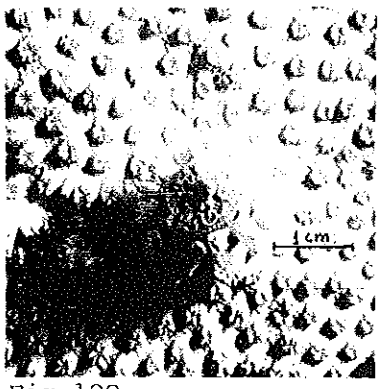


Fig.198

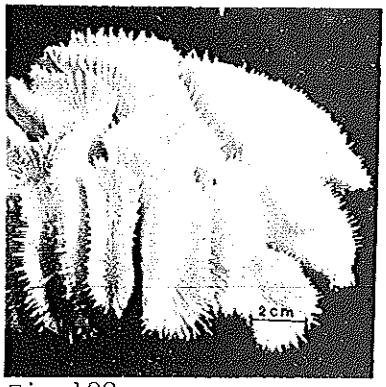


Fig.199

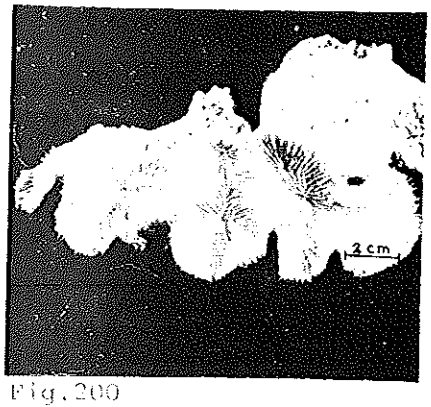


Fig.200

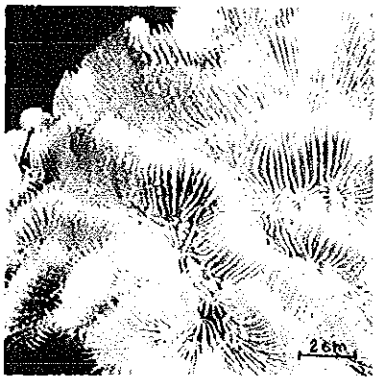


Fig.201

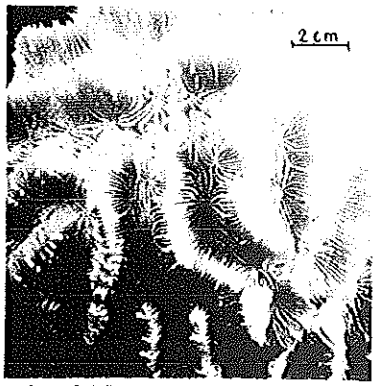


Fig.202

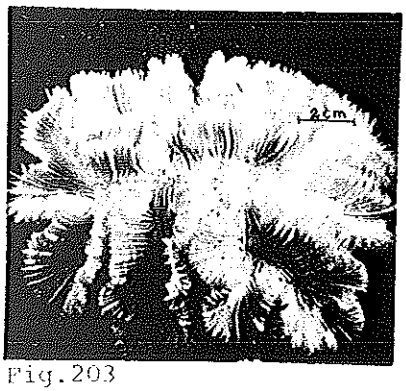


Fig.203

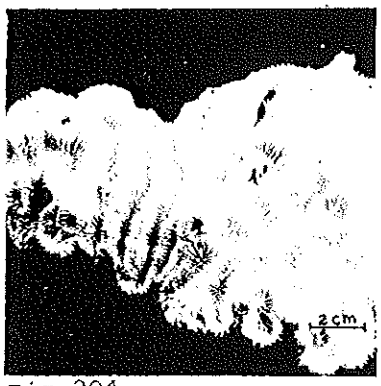


Fig.204

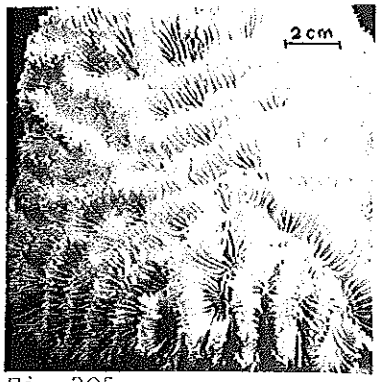


Fig.205

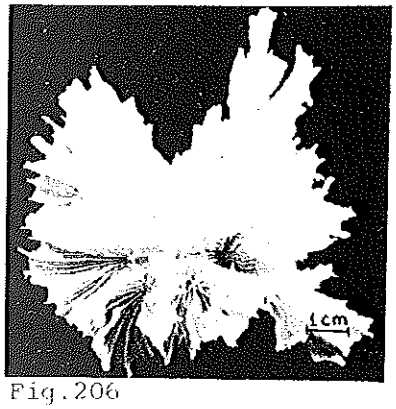


Fig.206

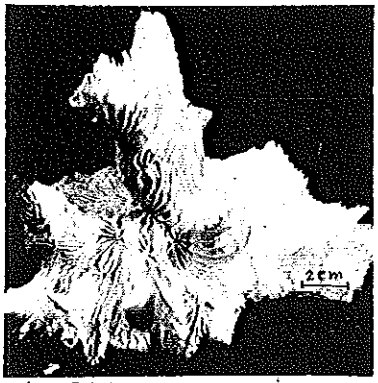


Fig.207

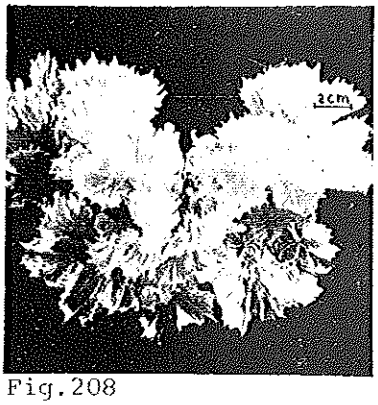


Fig.208

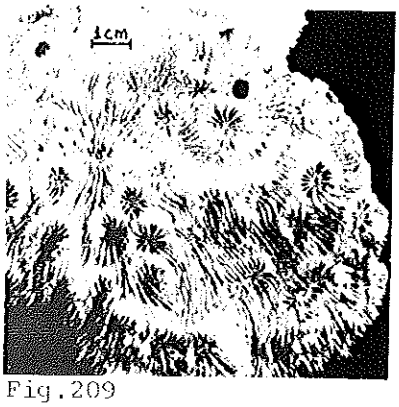


Fig.209

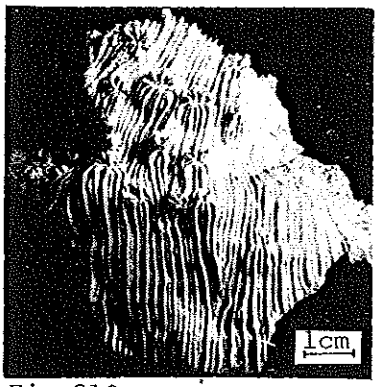


Fig.210

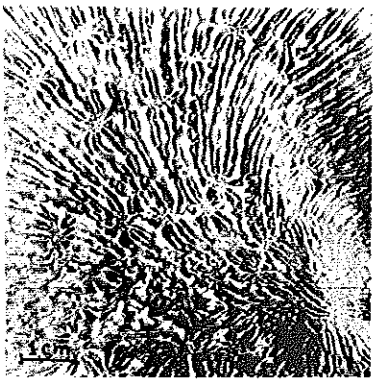


Fig.211

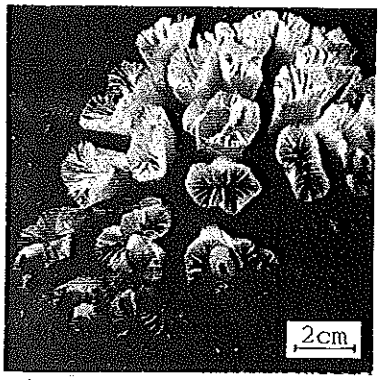


Fig.212

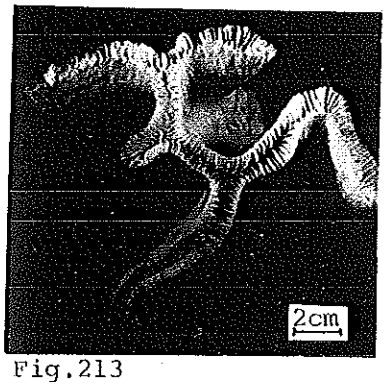


Fig.213

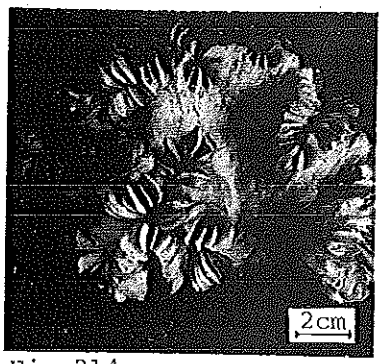


Fig.214

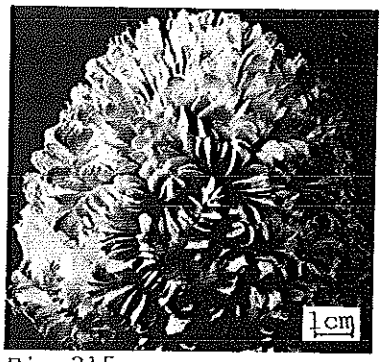


Fig.215

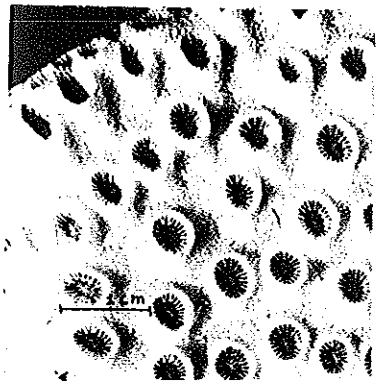


Fig.216

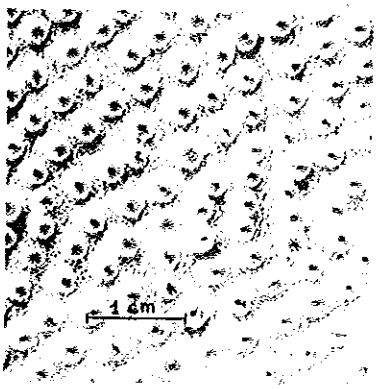


Fig.217

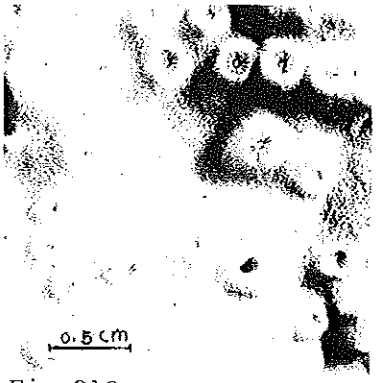


Fig.218

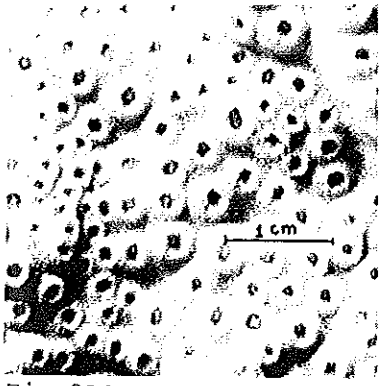


Fig.219

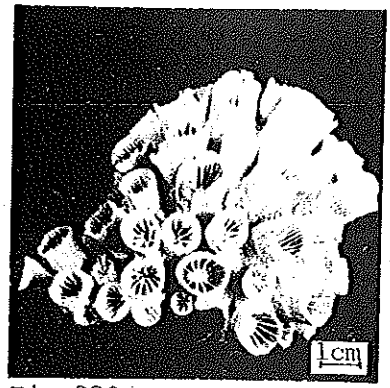


Fig.220

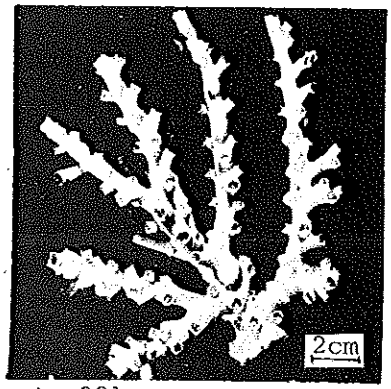


Fig.221

CHAPTER 3

CONDITION OF REEFS

MATERIALS AND METHODS

To assess the condition of reef, a rapid survey method was adapted from the manta-tow techniques (Done et al., 1981) . Two or three observers with masks and snorkels were towed by an outboard motor boat at a cruising speed of 75 m/min . Another person on the boat, besides the boat operator, maintained the direction of the tow line on the reef slope zone, to map the reef location in relation to the shoreline and to record the information from underwater observers every ten minutes. The data reported in this thesis was obtained by the author, who recorded the information approximately every two minutes on a writing pad. The information recorded was the dominant species of coral and their growth form, coverage of live and dead corals, soft corals and substrate (such as sand and rock). During each two minutes, a series of approximately ten-metre lines in various directions to the floor of the reef slope were imagined. The proportion of each line lying over the live coral , dead coral, soft coral and the substrate was then estimated. On patch reefs, or at small coral communities on rocky coasts, the proportion of cover of coral (both live and dead) to that of the substrate was often estimated more easily without using imaginary lines. The average proportion of live to dead coral within patches was then estimated on the basis of a relative area assessment.

The depth of the lower and upper limits of the slope were estimated by naked eye. Depth data were not adjusted for tidal variation. However,

it was assumed that the differences in sea level should not exceed 2 m during or between observations, as these were made at neap tide.

RESULTS

From the survey of reef condition, reefs are grouped into site as shown in Table 1 and Fig.223-226 according to the similarlity and quality of reefs (ie. distribution of coral species and coverage of live, dead corals and substrate) . They are generally classified into two types; the typical reefs and coral communities on granite rock surfaces.

The typical reef is defined as a coral reef comprising on association of a large number of genera (usually 25 more or less) of coral. Coral total cover (both living and dead coral) exceeds 70% or reaches 100% in the viewed area. This type of reef usually corresponds a reef topography which can be divided into reef flat, reef edge and reef slope. This reef pattern is found in areas where current, wind and wave action are not strong. For the Adang-Rawi Islands, typical reefs are generally represented by those along coastlines which do not directly face the southwest monsoon wind direction.

Fig. 227 shows the diagram of a typical reef with common species and growth form found in different zones. By and large, typical reefs extend within a range of about 50-300 m from shorelines and usually up to 8-12 m deep. Reef flats are usually partially exposed at low tide. They are generally dominated by microatolls of *Porites* spp., *Acropora aspera, A. pulchra, Montipora digitata, Favia* spp., *Favites* spp. *and Goniastrea* spp. Reef edges which are more exposed to wave action are dominated by large blocks of *P. lutea* (with the diameter of colonies about 3-5 m). In more sheltered areas, *P. lutea* are of smaller size and found together with other dominant species such as *P. nigrescens, P.(Synaraea) rus* (columnar and irregularly branching with plate form), *Montipora* spp. (plate

form) and *A. subulata* which forms large plates. The slope zone consists of highly diverse coral species and the most dominant species are *Lobophyllia hemprichii*, *A. formosa* and *A. florida*. The latter two species usually extend further out from reef and occur scattered on the sandy bottom.

Some reefs may be considered as typical reefs without distinct slope zones. Corals on the edge zone abruptly descend to those growing on the sandy bottom of about 3 m deep at low tide. This type of reef is noticibly found associated with a semiprotected channel coast, such as those between coastlines of the northern side of Batuang Island and the southwest side of Rawi Island, or between the northern side of Lee Pe Island and part of the southern side of Adang Island. *P. lutea* with thick ledge margins, and *A. formosa* are not always the dominant species. Those on the southwest side of Rawi Island are dominated by a single fragile species, *Echinopora lamellosa*. The southern side of Adang Island (site I and south end of site XII) is dominated with arborescent *Acropora*. In the latter three sites, sand cover is rather high (20-60%) , thus reefs of these sites may be considered as patch reefs.

The rest of the shorelines consist of coral communities growing on rocky coasts. They usually occur at rocky headlands and rocky coastlines which face strong wave action. The rocky substrate may be of large granite rock faces or large boulders of granite rock conglomerates which form steep coasts from sandy bottoms at a depth of about 10-15 m. Coral species are less diverse in this area. Their existence is probably due to their tolerance of wave action. Consequently, corals in these areas are of the encrusting type, such as most of the faviid group and *Millepora* spp., caespito-corymbose *Acropora* and small masses of *P. lutea* .

They firmly attach to rock surfaces with cover of 5-30%, and may extend sparsely on the sandy bottom for a short distance (normally not exceeding 50 m from the coastlines) . Large boulders of *Diploastrea heliopora* (about 1.5 m in diameter) may be found on the bottom.

These rocky habitats are predominant along west coasts of most islands (see Fig.223-226).However, some small enclosures (sometimes with sandy beaches) may be found. In these sheltered areas, higher coral cover can be seen. In some areas they are similar to the typical reefs, especially in the slope zone, while the upper part may have less coral cover and consist of rocky community type of corals.

In Table 1, the reefs were subdivided again into many sites according to their condition, mainly on the basis of per cent area cover of live and dead corals and substrate. The dominant species of coral on the edge to the slope are variable from place to place. A section of the edge to the slope zone was usually obvious in the typical reef, so the depth of the edge and the margin of the slope could be approximately determined. For instance, site III of Adang Island had 3 m deep edge and 7 m deep slope margin. Of some typical reefs, the floors descended gradually from shores to the outer margins, so the edges and the reef flats could not be determined.In this case,only the depth of the slope margins were given together with the mark " less than ". For instance, at site I of Adang Island, the reef appeared from the depth of 5 m up to the shore (near sea level). Similarly the edge and the reef flat did not occur at wave exposed rocky coast, but only steep slope of rocky floor, with corals scattered up to the sea level, was appeared. Consequently, only the depth of the slope margin was given together with the mark "less than".

Table 1. condition of coral reefs

site	mean of percentage cover ± standard deviation (range of min-max value)					depth of slope(m) (range from upper to lower end)	dominant species (* indicates predominantly dead species)
	live coral	dead coral	sand	soft coral	rock		
Ad.I	12.5±3.5 (10-15)	87.5±3.5 (85-90)	-	-	-	<5	*Acropora formosa** *Porites lutea*
Ad.II	12.5±10.6 (5-20)	37.5±24.8 (20-55)	50±14.1 (40-60)	-	-	<5	same as Ad.I
Ad.III	44.8±17.1 (15-85)	54.3±17.6 (15-85)	0.9±3.0 (0-10)	-	-	3-7	*A. formosa**, *A. nobilis** *A. hyacinthus**, *P. lutea* *Montipora**(f), *Lobophyllia*, *Favia*, *Porcillopora*, *Fungia*, *Hydnophora rigida*, *P.(Synaraea) rus*
Ad.IV	33.3±11.5 (20-40)	18.3±18.9 (5-40)	-	1.7±2.9 (0-5)	46.7±25.2 (20-70)	<6	Faviid group
Ad.V	27.5±17.7 (15-40)	37.5±38.9 (10-65)	35.0±21.2 (20-50)	-	-	<7	*P. lutea*, *Acropora* *Acropora* (cb-ct)

site	mean of percentage cover ± standard deviation (range of min-max value)					depth of slope(m) (range from upper to lower end)	dominant species (* indicates predominantly dead species)
	live coral	dead coral	sand	soft coral	rock		
Ad.VI	63.8±13.0 (35-85)	34.8±14.0 (15-65)	1.4±2.3 (0-5)	-	-	3-7	*P. lutea, Pectinia, Lobophyllia, H. rigida, Fungia, Synaraea, Merulina*, A. formosa*, Montipora*(f) *A. subulata**
Ad.VII	24.1±23.0 (0-85)	12.9±11.5 (0-40)	16.7±20.6 (0-60)	17.6±16.7 (0-60)	28.6±29.3 (0-85)	3-10	same as Ad.VI
Ad.VIII	11.7±5.8 (5-20)	85.5±11.7 (40-95)	2.8±10.9 (0-50)	-	-	3-10	*P. lutea*, Millepora, Fungia*, Diploastrea, Lobophyllia, Acropora*(a)
Ad.IX	28.3±17.6 (10-45)	31.7±22.5 (10-55)	-	3.3±5.8 (0-10)	36.7±35.1 (0-70)	<8	*Lobophyllia*
Ad.X	40.0±18.2 (5-60)	52.8±14.8 (40-80)	4.4±13.3 (0-40)	2.8±4.4 (0-10)	-	5-10	*A. formosa, A. subulata, P. lutea, Lobophyllia, Pocillopora, H. rigida*

site	mean of percentage cover ± standard deviation (range of min-max value)					depth of slope(m) (range from upper to lower end)	dominant species (* indicates predominantly dead species)
	live coral	dead coral	sand	soft coral	rock		
Ad.XI	68.8±6.0 (50-75)	31.2±6.0 (25-50)	-	-	-	3-10	*P. nigrescens* same as Ad.X
Ad.XII	65.7±3.4 (65-70)	27.1±3.9 (20-30)	7.1±5.7 (5-20)	-	-	<3	*Lobophyllia, A. florida A. subulata, Acropora*(a)
Rw.I	5.7±8.3 (0-20)	5.1±8.5 (0-20)	-	5.2±4.1 (0-10)	84.0±17.1 (50-100)	<10	*P. lutea, Diploastrea, Millepora, Acropora*(cb), Faviid group
Rw.II	25.0±7.1 (20-35)	58.7±20.2 (35-80)	16.2±17.0 (0-40)	-	-	6-8	*P. lutea, Pocillopora, Lobophyllia, Acropora*(t)? *Montipora*(f)*
Rw.III	16.4±14.1 (5-35)	19.5±18.2 (5-55)	11.1±14.9 (0-40)	14.1±21.6 (0-75)	38.8±37.7 (0-95)	7-8	*Lobophyllia, H. rigida, Pocillopora, Merulina, Heliopora, P. lutea, Fungia*

site	mean of percentage cover ± standard deviation (range of min-max value)					depth of slope(m) (range from upper to lower end)	dominant species (* indicates predominantly dead species)
	live coral	dead coral	sand	soft coral	rock		
Rw.IV	41.2±13.6 (10-55)	34.4±12.7 (10-50)	12.5±12.8 (0-40)	11.9±13.9 (0-40)	-	3-8	*P. lutea, Lobophyllia, Merulina, H. rigida*
Rw.V	66.8±10.5 (45-85)	21.1±5.9 (10-30)	0.4±1.3 (0-5)	11.7±12.6 (0-40)	-	3-13	*Lobophyllia, P. lutea*
Rw.VI	59.2±17.9 (25-85)	21.0±11.2 (5-55)	19.2±14.7 (0-60)	0.18±o.95 (0-5)	0.49±4.4 (0-40)	2-12	*P. lutea, Lobophyllia, H. rigida, A. florida, P.(Synaraea) rus, P. nigrescens, Echinopora lamellosa, Acropora*(a)*
Rw.VII	14.3±14.8 (0-35)	35.0±15.8 (5-75)	3.9±7.6 (0-25)	12.5±12.0 (0-35)	34.3±23.5 (0-60)	<8	*P. lutea, Acropora*(cb,t)* *Goniopora, Pocillopora, Merulina*, Faviid group
Rw.VIII	7.9±9.9 (0-30)	12.1±10.7 (5-35)	-	12.1±11.5 (0-30)	67.9±14.4 (55-90)	<12	*P. lutea, Diploastrea, Lobophyllia, Acropora*(cb)*

site	mean of percentage cover ± standard deviation (range of min-max value)					depth of slope(m) (range from upper to lower end)	dominant species (* indicates predominantly dead species)
	live coral	dead coral	sand	soft coral	rock		
Rw.IX	35.0±7.1 (30-40)	47.5±10.6 (40-55)	17.5±3.5 (15-20)	-	-	< 12	*Galaxea fascicularis* *P. lutea, Acropora*(cb), *Diploastrea, Lobophyllia*
Rw.X	12.5±3.5 (10-15)	12.5±3.5 (10-15)	-	7.5±3.5 (5-10)	67.5±3.5 (65-70)	< 12	same as Rw.IX
Rw.XI	38.0±8.4 (25-45)	46.0±5.5 (40-55)	12.0±10.9 (0-20)	-	-	3-10	*P. lutea, Acropora*(cb), *Heliopora, Lobophyllia, Acropora*(t,a)*
Rw.XII	6.7±3.5 (5-15)	6.7±3.5 (5-15)	2.2±6.7 (0-20)	8.3±7.1 (5-25)	76.1±18.3 (35-85)	< 10	*P. lutea, Galaxea, Lobophyllia,* Faviid group
Rw.XIII	37.9±2.6 (35-40)	52.1±6.9 (35-55)	10.0±7.7 (5-30)	-	-	5-10	*P. lutea, P.(S.) rus, Acropora*(t,cb)**Montipora* Fungia*, Lobophyllia, Diploastrea*

site	mean of percentage cover ± standard deviation (range of min-max value)					depth of slope(m) (range from upper to lower end)	dominant species (* indicates predominantly dead species)
	live coral	dead coral	sand	soft coral	rock		
Gt.I	30±0	10±0	20±0	40±0	-	< 8	*Lobophyllia, Heliopora, Symphyllia, Fungia A. subulata, A. formosa P. lutea, P. nigrescens Fungia*
Gt.II	73.3±17.6 (55-90)	16.7±5.8 (10-20)	6.7±11.5 (0-20)	3.3±2.9 (0-5)	-	< 8	*Millepora, P. lutea, P. (S.) rus, Echinopora, A. subulata, A. formosa, Merulina, P. nigrescens*
Gt.III	45.0±7.1 (40-50)	15.0±7.1 (10-20)	-	-	40.0±14.1 (30-50)	< 5	same as Gt.II
Gt.IV	73.3±11.5 (60-80)	16.7±5.8 (10-20)	10±10 (0-20)	-	-	< 5	same as Gt.II
Gt.V	20.0±20.4 (5-50)	6.2±6.3 (0-15)	-	37.5±37.5 (5-70)	36.2±26.6 (15-75)	< 5	*P. lutea, P. nigrescens, A. formosa*, A. florida**

site	mean of percentage cover ± standard deviation (range of min-max value)					depth of slope (m) (range from upper to lower end)	dominant species (* indicates predominantly dead species)
	live coral	dead coral	sand	soft coral	rock		
Gt.VI	28.6±25.9	25.9±22.0	32.3±29.4	11.4±15.5	1.8±6.0	3-5	*P. lutea, P. nigrescens*
	(0-80)	(0-75)	(0-100)	(0-50)	(0-20)		*A: florida*, H. rigida,*
							P.(S.) rus, A. formosa
Br.I	80	5	10	5	-	<8-10	*P.(S.) rus, A. florida*
Br.II	45	-	-	5	50	"	*P. lutea*
Br.III	35	-	-	5	60	"	*P. lutea, Millepora*
Hn.I	51.1±14.6	38.1±20.2	10.8±14.8	-	-	3-7	*P. lutea, P. nigrescens*
	(30-70)	(10-70)	(0-50)				*A. formosa*,A. subulata**
							Heliopora, H. rigida,
							Millepora
Hn.II	25.0±20.6	1.0±2.2	-	5.0±8.7	69.0±27.0	< 7	*P. lutea*
	(0-40)	(0-5)		(0-20)	(50-100)		

site	mean of percentage cover ± standard deviation (range of min-max value)					depth of slope(m) (range from upper to lower end)	dominant species (* indicates predominantly dead species)
	live coral	dead coral	sand	soft coral	rock		
Lp.I	15.4±9.5 (0-30)	8.9±8.2 (0-20)	75.7±16.2 (60-100)	-	-	< 3	*P. lutea, Acropora*(a,t), *P.(S.) rus, Milbepora, A. florida, Merulina*
Lp.II	49.1±15.1 (30-90)	50.9±15.1 (10-70)	-	-	-	3-8	*P. lutea, Acropora*(a,t), *A. formosa, Millepora, A. nasuta, Echinopora, Merulina, P. nigrescens, Diploastrea*
Lp.III	14.4±13.4 (0-40)	8.1±5.2 (0-20)	-	-	77.5±16.7 (50-100)	5-8	*P. lutea, Fungia*
Lp.IV	73.2±7.2 (65-90)	23.9±8.8 (5-35)	2.9±2.6 (0-5)	-	-	< 3	*P. lutea, Acropora*(a,t), *Lobophyllia, H. rigida*
Lp.V	50.6±8.5 (45-65)	44.4±8.5 (30-50)	3.9±2.2 (0-5)	1.1±3.3 (0-10)		6-7	*P.(S.) rus, Acropora*(a), *P. lutea, P. nigrescens, Lobophyllia, H. rigida*

site	mean of percentage cover ± standard deviation (range of min-max value)					depth of slope(m) (range from upper to lower end)	dominant species (* indicates predominantly dead species)
	live coral	dead coral	sand	soft coral	rock		
Lp.VI	49.4±1.8 (45-50)	49.4±1.8 (45-50)	1.2±3.5 (0-10)	-	-	2-7	*P. lutea, P.(S.) rus, Lobophyllia, Diploastrea, Acropora*(t)*, *H. rigida*
Tr.I	13.6±11.2 (5-30)	37.2±22.6 (10-60)	49.2±30.1 (15-90)	-	-	5-8	*P. lutea, Acropora*(a)
Tr.II	11.5±2.1 (10-13)	11.0±1.4 (10-12)	-	45.0±7.1 (40-50)	32.5±10.6 (25-40)	<13	*P. lutea, Millepora*
Tr.III	-	65.0±21.2 (50-80)	-	-	35.0±21.2 (20-50)	<12	*Acropora*(a,t)*
Tr.IV	13.3±5.8 (10-20)	86.7±5.8 (80-90)	-	-	-	5-10	*P. lutea, A. formosa, A. nobilis, A. florida, A. subulata*
Bs.I	15±0	60±0	25±0	-	-	<3	*P. lutea, A. subulata, A. florida**

site	mean of percentage cover ± standard deviation (range of min-max value)					depth of slope(m) (range from upper to lower end)	dominant species (* indicates predominantly dead species)
	live coral	dead coral	sand	soft coral	rock		
Bs.II	44.6±16.5 (15-65)	52.9±17.9 (25-85)	0.7±2.7 (0-10)	1.8±3.2 (0-10)	-	3-14	*P. lutea; Lobophyllia, Heliopora*, Fungia*, A. florida, H. rigida*
Bs.III	9.0±9.6 (0-25)	-	-	49.0±16.7 (25-65)	42.0±11.5 (30-55)	< 10	*Diploastrea*
Bs.IV	55.6±9.8 (40-70)	43.9±10.5 (30-60)	-	0.5±1.7 (0-5)	-	5-13	*Fungia, P. lutea, Diploastrea, Lobophyllia, A. formosa*, Merulina, Montipora(f)**
Ba.I	23.7±5.2 (10-30)	52.5±5.3 (15-60)	23.7±3.5 (20-40)	-	-	7-12	*P. lutea, H. rigida, Acropora(t)*, Merulina*
Ba.II	9.0±9.0 (0-40)	11.2±9.8 (0-40)	4.0±7.7 (0-30)	14.8±20.4 (0-100)	61.0±26.7 (0-100)	5-12	*Diploastrea, P. lutea, Acropora(cb)*, Symphyllia, Pocillopora*

site	mean of percentage cover ± standard deviation (range of min-max value)					depth of slope(m) (range from upper to lower end)	dominant species (* indicates predominantly dead species)
	live coral	dead coral	sand	soft coral	rock		
Ba.III	42.1±9.9 (30-60)	32.9±19.5 (10-60)	22.9±14.7 (10-50)	1.4±3.8 (0-10)	0.7±1.9 (0-5)	5-8	*Lobophyllia*,P. lutea*, H. rigida,Diploastrea**
Ba.IV	15±0	15±0	70±0	-	-	2-3	*P. lutea, Fungia, Acropora*(a)*
Ba.V	66.9±5.3 (55-70)	16.2±4.4 (10-20)	15.6±8.2 (10-30)	1.3±2.3 (0-5)	-	2-6	*P. lutea, P.(S.) rus, Fungia*, Acropora*(a)*
Ba.VI	18.3±11.5 (5-25)	11.7±11.5 (5-25)	70.0±20.0 (50-90)	-	-	2-3	*A. fomosa*, A. florida* P. lutea*, Fungia*
Ba.VII	75.0±5.8 (70-80)	10.0±5.8 (5-15)	15.0±0	-	-	2-5	*A. formosa*
Ba.VIII	48.3±9.4 (40-65)	18.2±10.9 (5-35)	33.5±7.8 (25-50)	-	-	2-10	*P. lutea, Fungia, Goniopora fruticosa,P.(S.) rus, P. nigrescens*
Ba.IX	59.1±10.2 (45-70)	18.7±8.8 (15-50)	12.2±10.8 (0-30)	-	-	4-14	*Acropora*(t)*, *P.(S.) rus P. lutea, H. rigida,*

site	mean of percentage cover ± standard deviation (range of min-max value)					depth of slope(m) (range from upper to lower end)	dominant species (* indicates predominantly dead species)
	live coral	dead coral	sand	soft coral	rock		
Lk.I	5	5	-	-	90	<12	
Lk.II	25±0	50±0	25±0	-	-	"	*P. lutea, Echinopora*
Lk.III	12.5±3.5 (10-15)	17.5±10.6 (10-25)	15.0±7.1 (10-20)	10.0±14.1 (10-20)	45.0±7.1 (40-50)	"	same as Lk.I
Lk.IV	26.3±13.8 (10-40)	56.2±19.7 (40-80)	17.5±17.1 (0-40)	-	-	"	*Lobophyllia, H. rigida, Heliopora, Acropora*(a)* *P. lutea*
Sk.	6.4±2.4	7.9±5.7	0.7±1.9	1.4±2.4	83.6±5.6	<8-12	*Millepora, Pocillopora, Acropora*(cb)*, *Diploastrea*
Bl.I	22.5±2.9 (20-25)	20.0±7.1 (10-25)	35.0±16.8 (25-60)	-	22.5±8.7 (10-30)	<10-14	*P. lutea, Millepora*
Bl.II	7.5±5.0 (5-15)	6.3±2.5 (5-10)	-	12.5±6.4 (5-20)	73.7±8.5 (65-85)	"	*P. lutea*

site	mean of percentage cover ± standard deviation (range of min-max value)					depth of slope(m) (range from upper to lower end)	dominant species (* indicates predominantly dead species)
	live coral	dead coral	sand	soft coral	rock		
Bl.III	31.7±14.4	11.7±2.9	16.6±14.4	5.0±8.7	35.0±17.3	<10-14	*Diploastrea, P. lutea,*
	(15-40)	(15-15)	(0-25)	(0-15)	(25-55)		*P.(S.) rus*
Bl.IV	5	5	-	-	90	"	-
Tk.I	-	30	70	-	-	<80-10	*Acropora*(a)*, *P. lutea*
Tk.II	11.7±14.4	6.7±4.1	-	-	81.7±17.2	"	*Galaxea fascicularis,*
	(0-40)	(0-10)			(0-100)		*P. lutea, Millepora*
Sr.I	38.3±11.5	5.0±0	-	-	56.7±11.5	<10	*P. lutea, P.(S.) rus,*
	(25-45)				(50-70)		*Goniastrea,G. fascicu-*
							laris
Sr.II	-	-	-	-	100	"	same as Sr.I
Sr.III	10.0±7.1	10.0±7.1	-	15.0±0	65.0±14.1	"	same as Sr.I
	(5-15)	(5-15)		(55-75)			
Sr.IV	-	-	-	-	100	"	-
Sm.I	58.3±12.6	5.0±5.0	-	-	36.7±15.3	< 10-14	*Millepora, P. lutea,*
	(45-70)	(0-10)	-	-	(20-50)		*H. rigida, Pocillopora*

site	mean of percentage cover ± standard deviation (range of min-max value)					depth of slope(m) (range from upper to lower end)	dominant species (* indicates predominantly dead species)
	live coral	dead coral	sand	soft coral	rock		
Sm.II	25	10	60	5	-	<10-14	*P. lutea*
Sm.III	21.7±17.6	3.3±2.9	-	15.0±5.0	60.0±25.0	"	*P. lutea, P.(S.) rus*
	(5-40)	(0-5)		(10-20)	(35-85)		
Sm.IV	25	25	25	-	25	"	*Acropora*(a)*
Sm.V	20.0±7.1	10.0±7.1	70.0±0	-	-	"	*Acropora*(p)*, *Echinopo-*
	(15-25)	(5-15)					*ra, Psammocora contigua*

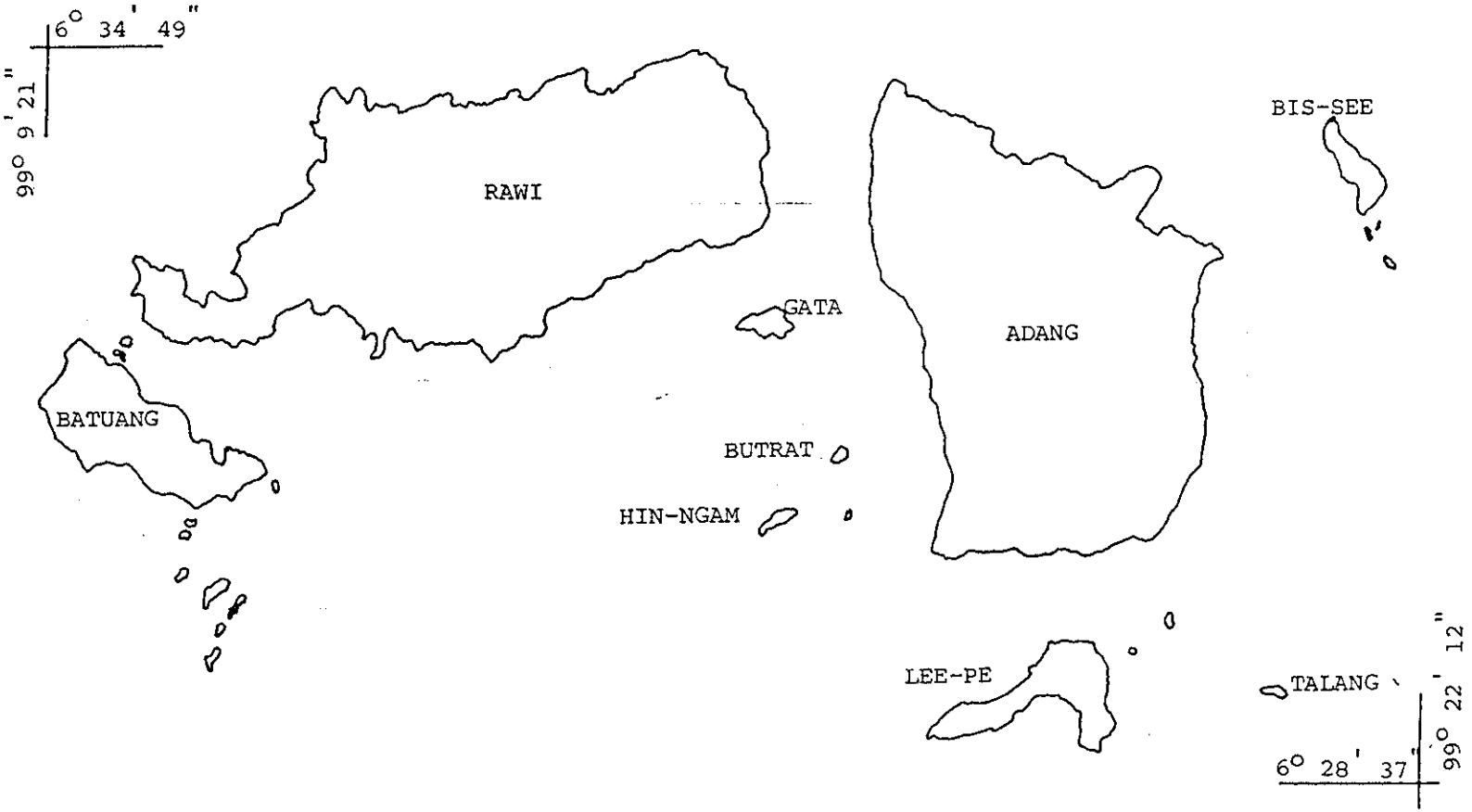


Fig.222 Map of Adang-Rawi Island group in the Tarutao National Park.

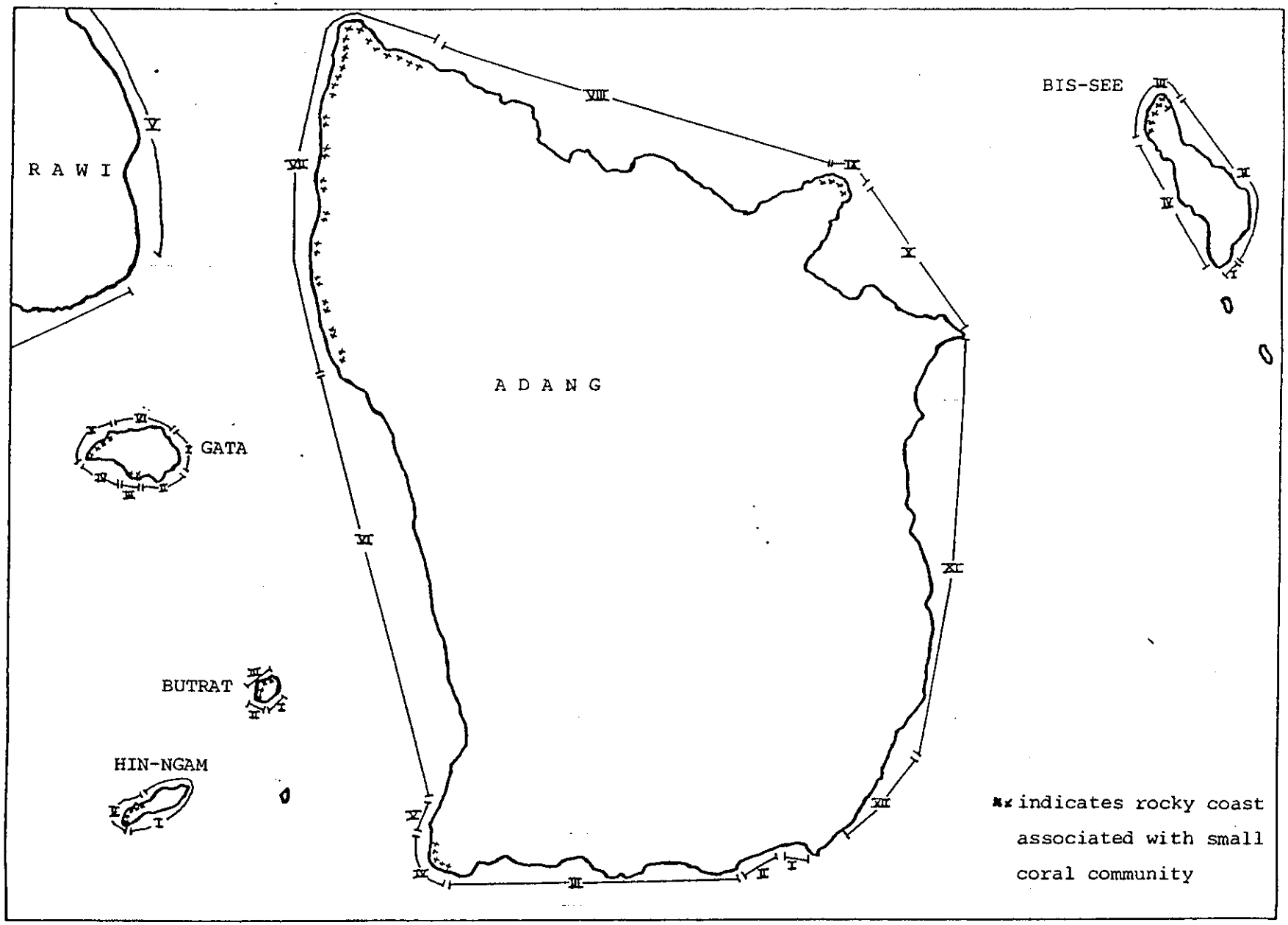

RAWI
ADANG
BIS-SEE
GATA
BUTRAT
HIN-NGAM
** indicates rocky coast associated with small coral community

Fig.223

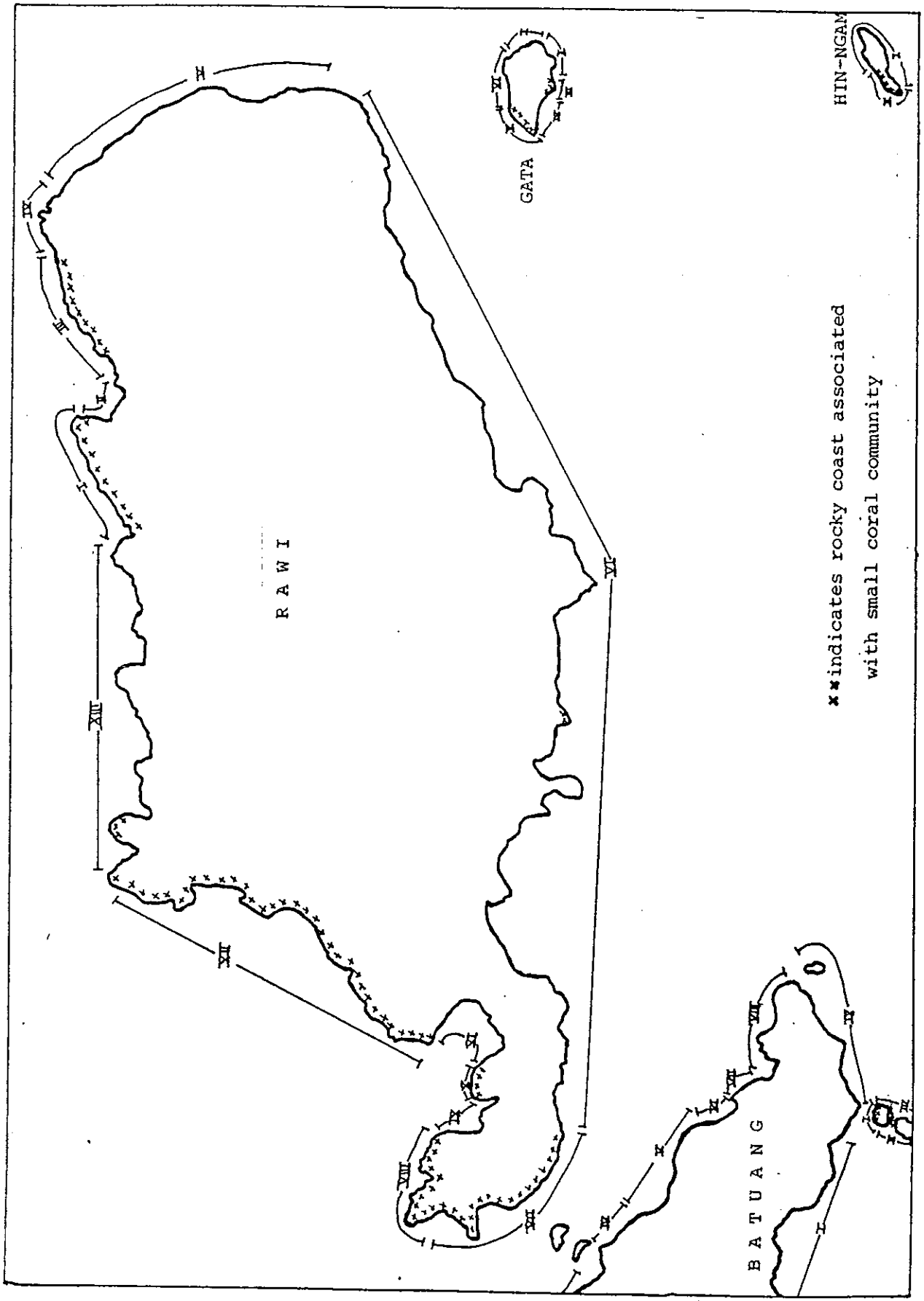
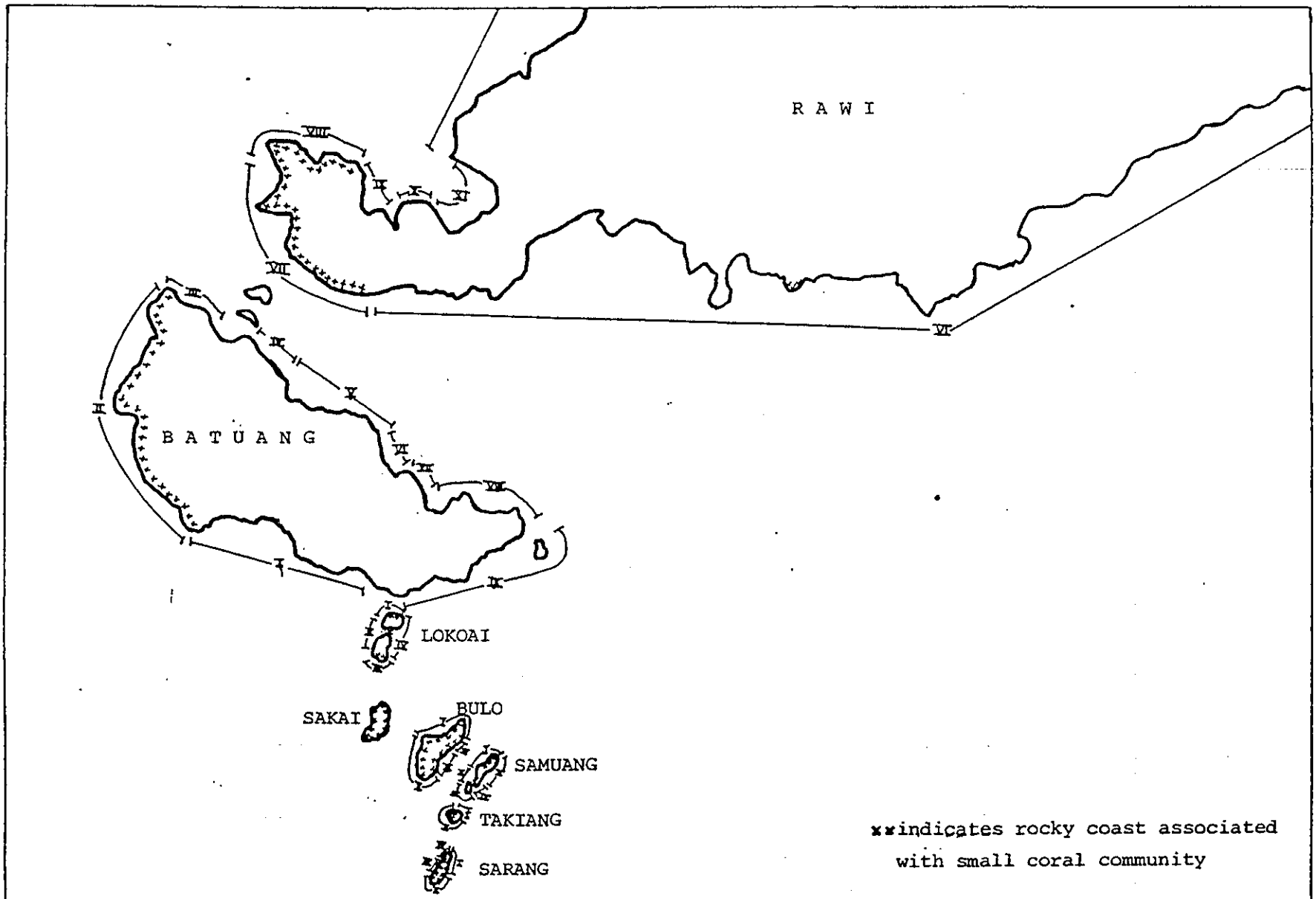

RAWI
GATA
HIN-NGAM
BATUANG
**indicates rocky coast associated
with small coral community

Fig. 224


RAWI
BATUANG
LOKOAI
SAKAI
BULO
SAMUANG
TAKIANG
SARANG
xxindicates rocky coast associated
with small coral community

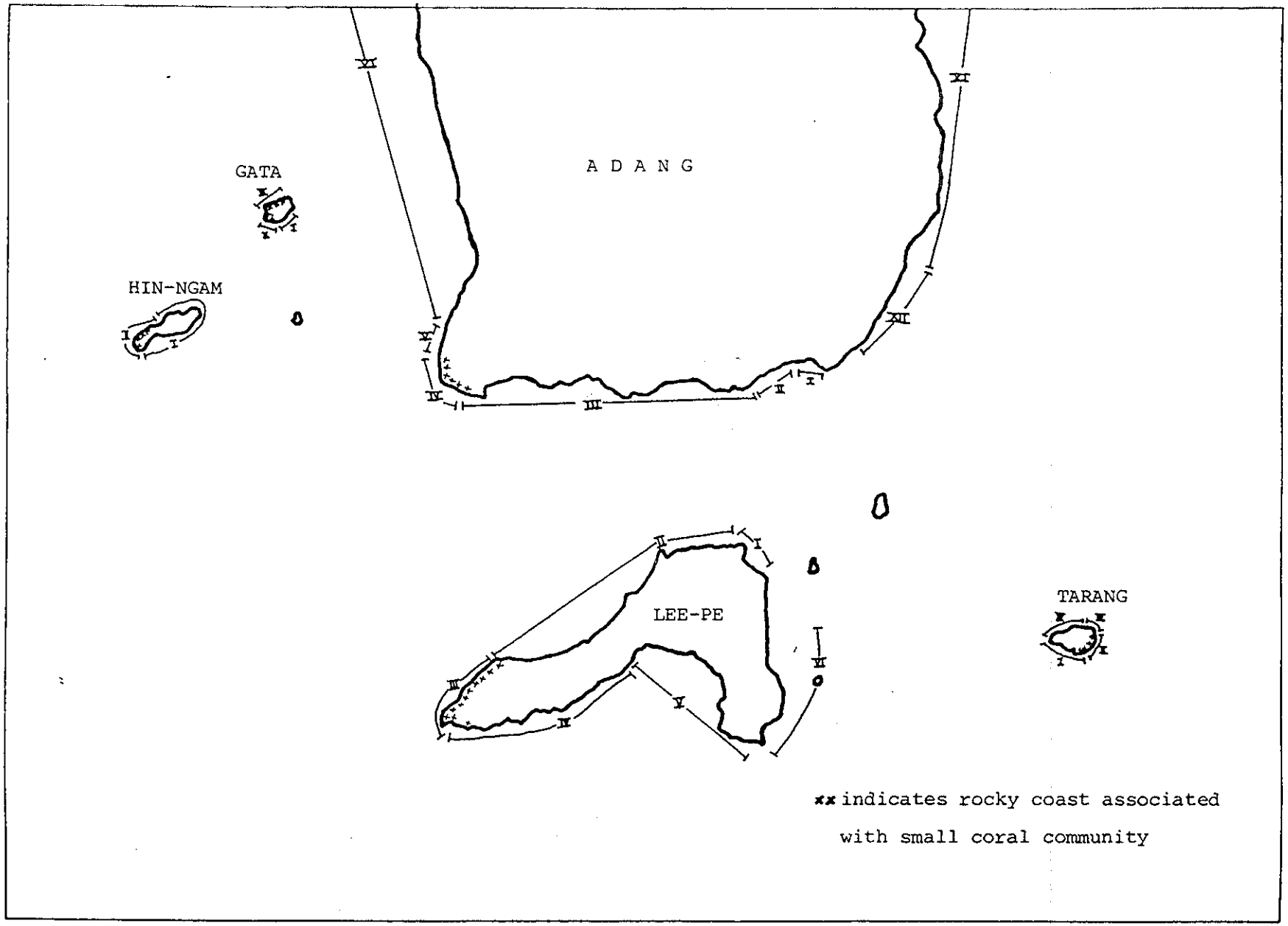

GATA
A D A N G
HIN-NGAM
LEE-PE
TARANG
xx indicates rocky coast associated
with small coral community

Fig. 226

Fig.227 The general zonation of the typical reef at Adang-Rawi Islands.

DOMINANT CORAL GROWTH FORM		
massive	massive(large)	massive(small)
branching	plate	branching(short)
(long,arborescent)	branching	
foliaceous	foliaceous	
encrusting	encrusting	
DOMINANT CORAL GENUS OR SPECIES		
Porites lutea	*P. lutea*	*A. aspera*
P. nigrescens	*P. nigresens*	*A. pulchra*
P.(Synaraea) rus	*Acropora* spp.	*Porites* spp.
Acropora formosa	*Montipora* -	*M. digitata*
A. florida	*crassituberculata*	Faviid group
Lobophyllia -		
hemprichii		
Hydnophora rigida		

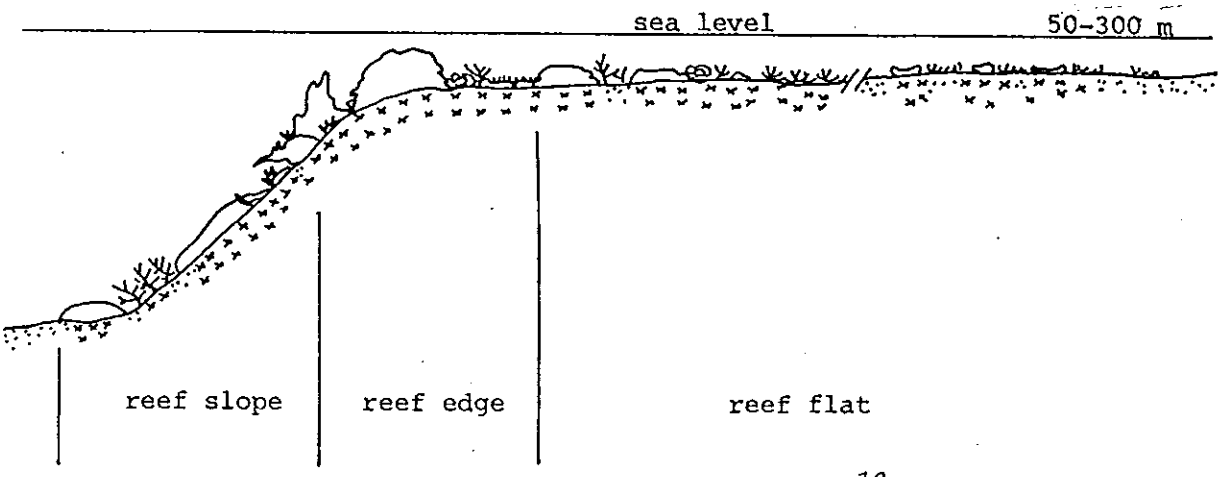


Fig.228 The general zonation of coral community on rocky coast at Adang-Rawi Islands.

DOMINANT CORAL GROWTH FORM

massive (small)

branching (caespito-corymbose)

encrusting

DOMINANT CORAL GENUS OR SPECIES

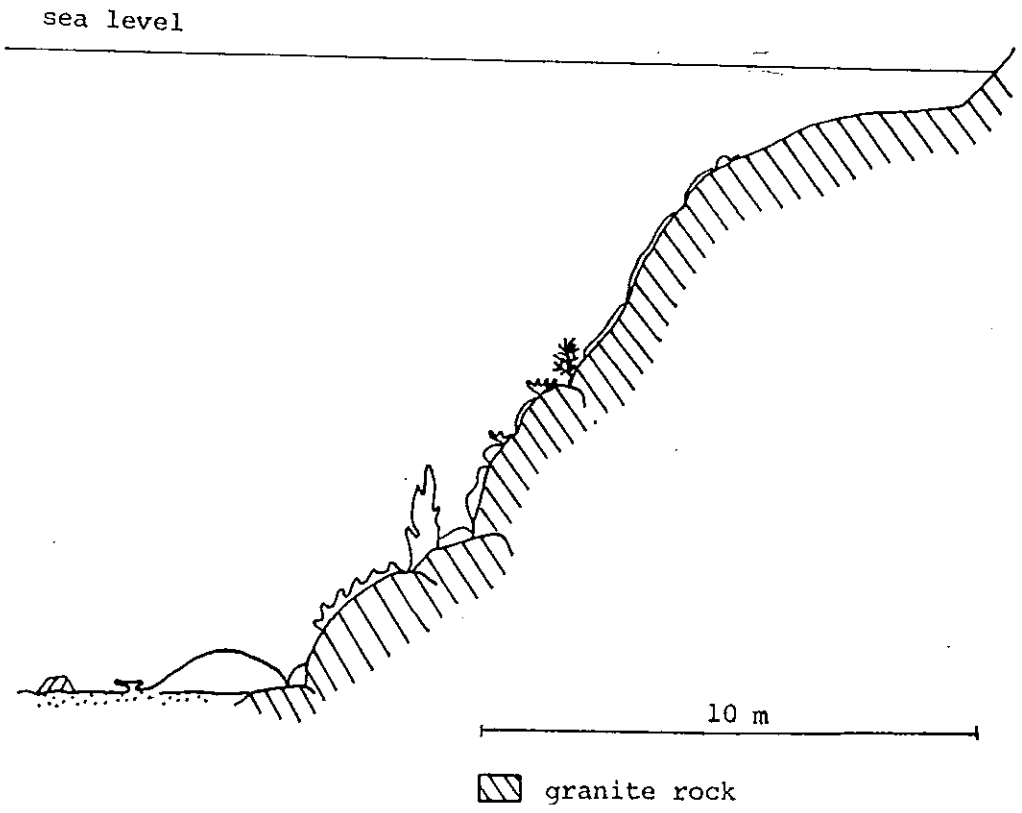
Acropora humilis group

Millepora spp.

Porites lutea

Faviid group

Diploastrea heliopora



DISCUSSION

The location of reefs found on this island group indicates the strong influence of the SW monsoon which has affected reefs on west and northwest coasts. The reefs in the sheltered sites (ie., at the east coasts or at coves), the typical reefs are the " true coral reefs ", because the coral plays a role as the dominant organism to construct its community into calcareous mound or ridges, as defined by Vaughan (1911) and MacNeil (1954) (quoted from Ladd, 1977). In contrast to those communities of coral exposed to wave action, on the west coast, the granite rock boulders are the large parts integrated into the communities, while only few corals can adapt successively in the stress condition . These communities are not considered as the " true coral reefs ". This finding is agreement with that of reefs on Phuket Island further north where reefs are found in areas sheltered from the SW monsoon wind action (Chansang et al., 1986).

The assessment of reef conditions was mainly made on reef edges and slopes. The reef flats were not included in the observations by manta-tow techniques, as a combination of coral communities can vary drastically on the reef flat depending upon the locality, in relation to tidal inundation as discussed by Done (1983). However, some information about the condition of the coral on the reef flats has been given above. This generalized information was obtained from the data noted at the time of collection of specimens on reef flats.

From Table 1, it appears that variation in coral and substrate cover are very broad.

With the respect to coral cover on the rocky coast, since most corals

are of the encrusting form , data of coral cover actually represent a much lower mass of coral than do similar data from a typical reef , where considerable vertical growth occurs.

One of the most extensively devasted areas is site VIII of Adang Island. The area consists of knolls of *Porites lutea* (with a diameter of 1-3 m) associated with other coral species. It is rather difficult in this case to determine the cause of death, because most coral colonies appear as old broken fragments covered with blue green algae. This might have been due to erosion of coral colonies after being preyed upon by *Acanthaster planci*. However, it does not rule out the dynamite blasting as a contributory cause. Although this activity is prohibited by fisheries law, it was found that the activity was common among this island group in the past. However, in recent years, the situation has improved significantly. The most urgent problem is the devastation of corals by the *A. planci* (Geater et al., 1986; Chansang, 1986).

Compared with reefs of the islands further north, especially Surin and Similan Islands (personal information), the reefs of Adang-Rawi Islands are less developed. The reefs of Surin and Similan Islands are of greater extent (descending to about 30 m depth compared with only about 8-15 m in Adang-Rawi Islands associated with generally shallower topography). The coral community at Surin and Similan Islands is also more diverse. The coral of some groups, such as *Acropora* of the bottle-brush group, *Seriatopora hystrix, Anacropora, Pavona cactus,* were not found in Adang-Rawi' s reefs. This may due to the clearer water on the reefs. When measured by the Secchi-disc, the water of Surin and Similan Islands had a visibility of about 25-28 m, while that of Adang-Rawi Islands was about 15-18 m .

CHAPTER 4

OVERVIEW

Descriptions of the skeletal structure of species in the collection and comparisons with description of coral specimens from Eastern Australia (Veron et al.,1976, 1977, 1979, 1982, 1984) has provided some indications of the variations of structure occuring both within the study region and between this and Australia.These variations have been discussed separately under the species headings. From a total of 140 species, specimens of 114 species have skeletal structures corresponding to descriptions in earlier literature, while specimens of the remaining 26 species cannot yet be classified with certainty (ten of them have structural feature not previously described).The significance of these variants is not entirely clear.It is possible that minor variations of structure within a species are specific to the region (of collection).However, it cannot be overlooked that such variants in some cases at least fall within the range of structural variation recognized by other authors, but which have not been mentioned specifically in their descriptions.

In this work, emphasis was placed on obtaining a comprehensive collection of species occurring on the reefs of this region, rather than on the species distribution or differences in species composition of different reef types. As a result firm conclusions concerning the relationship of structural variation to habitats have not been possible. In order to examine the sources and implications of structural variation, subsequent studies should be aimed at specific groups (such as a single genus) over a wider variety of reef types and habitats.

The high diversity of reef types and status in the Adang-Rawi region suggests that this would be a suitable region for such studies.

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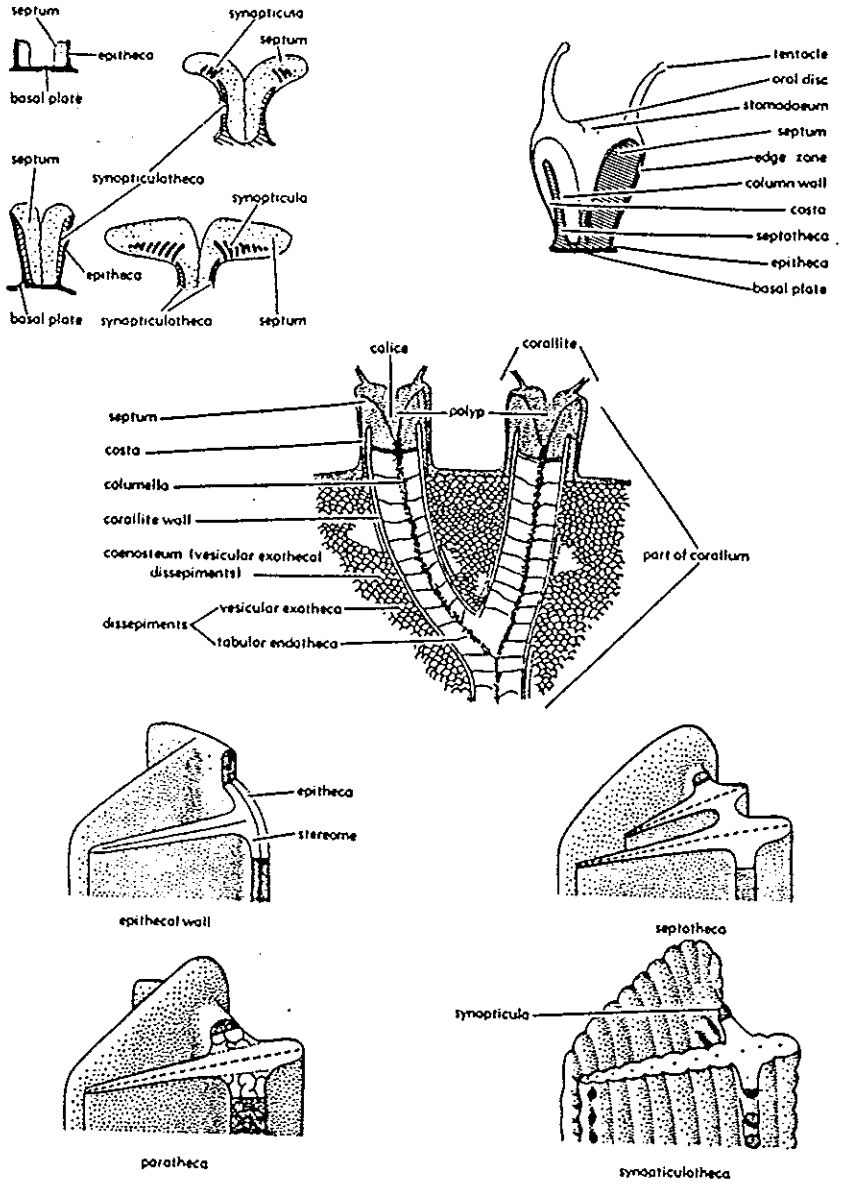
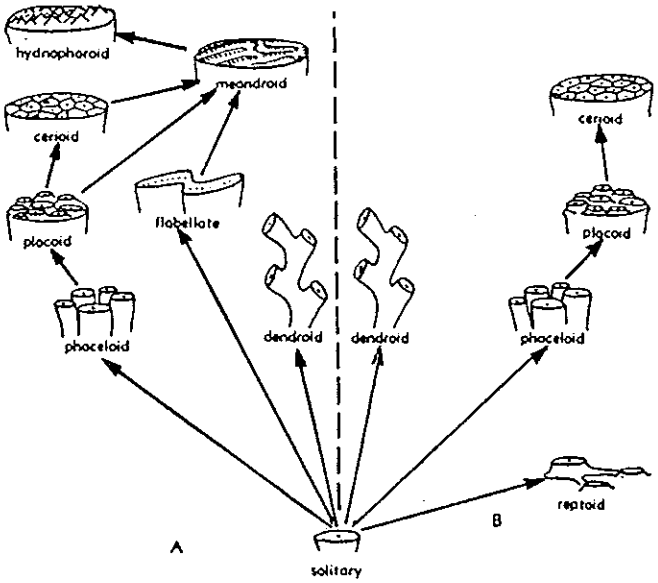
APPENDIX

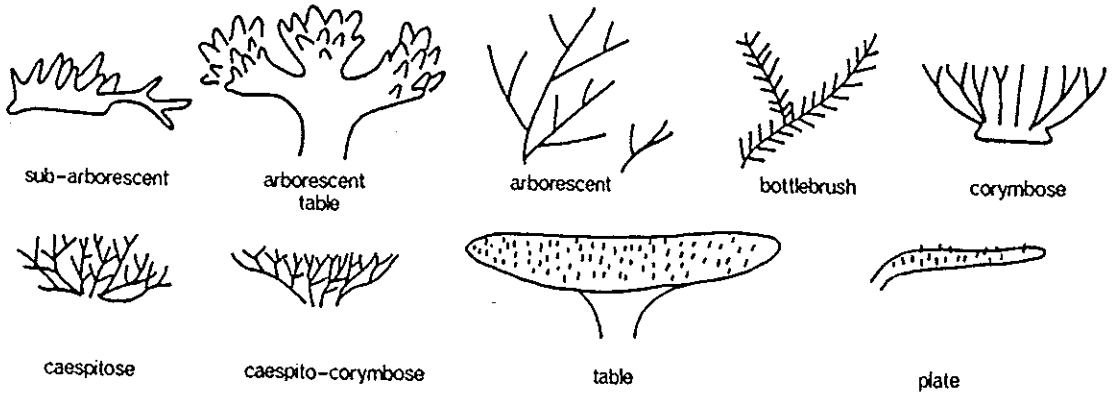
General skeletal morphology of scleractinian coral is shown as follows:



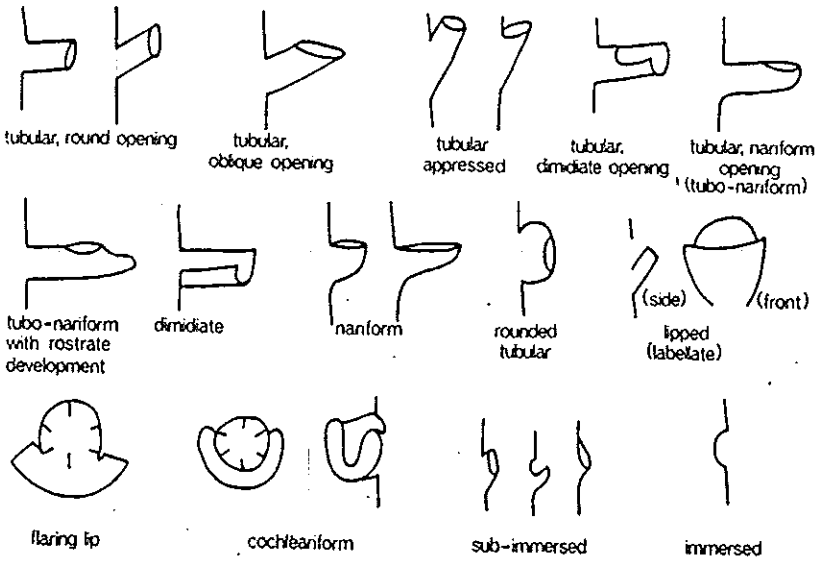
Cross section of corals showing the most important skeletal structures (after Wells, 1956 and Ditlev, 1980).



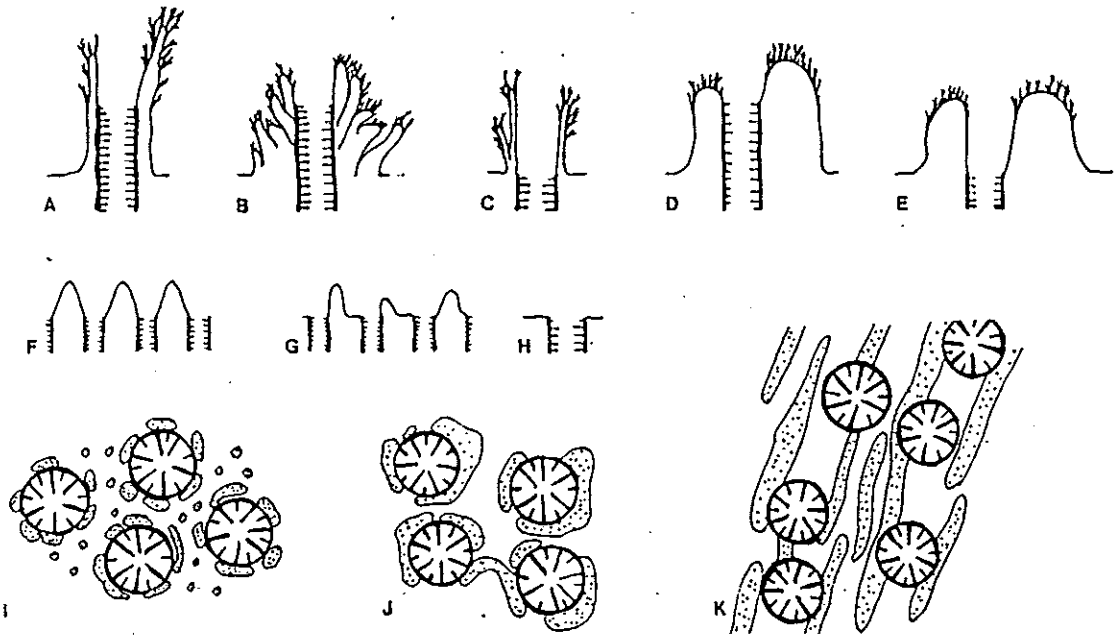
Main pattern of corallite arrangements, A: intratentacular budding; B: extratentacular budding (after Wells, 1956 and Ditlev, 1980).



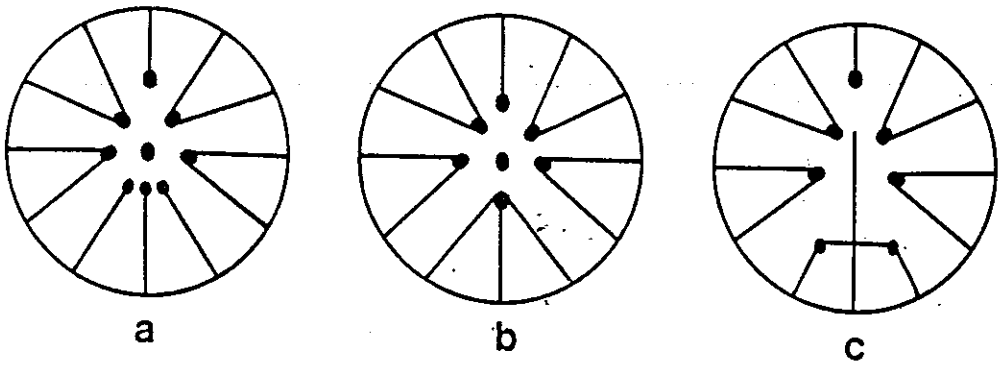
Common colony shapes of *Acropora* (after Wallace, 1978).



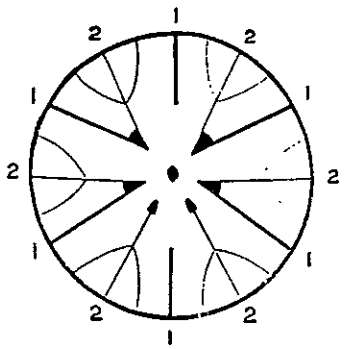
Radial corallite shapes of *Acropora* (after Wallace, 1978).



Diagrammatic transverse (A-H) and surface (I-K) views of *Montipora* corallites and associated coenostial structures. (A) simple papillae with exsert corallite, (B) compound papillae with exsert corallite, (C) simple papillae with immersed corallite, (D) tuberculae with exsert corallite, (E) tuberculae with immersed corallite, (F-H) foveolate, tuberculate and glabrous corallites (respectively), (I) corallites with thecal and reticulum papillae, (J) corallites with thecal tuberculae, (K) corallites with reticulum tuberculae forming ridges (after Veron & Wallace,1984).



Patterns of fusion of the triplet in *Porites* (a) triplet with free lateral septa and three pali, (b) triplet with lateral and ventral directive fused at their extremities, and one palus, (c) triplet with lateral septa connected to the ventral directive by a synapticular bar, the ventral directive fused with the columella, and two pali (after Veron & Pichon, 1982).



Diagrammatic of septal arrangement in gonioporoid pattern of *Goniopora* (after Veron & Pichon, 1982).