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CORAL ASSEMBLAGES OF INTERTIDAL REEF FLATS AT KO PHUKET; THAILAND

by

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CORAL ASSEMBLAGES OF INTERTIDAL REEF FLATS AT KO PHUKET; THAILAND

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CONTENTS

ABSTRACT

The coral assemblages of intertidal reef flats surrounding the southeast corner of Ko Phuket, Thailand are described in terms of their diversity, coral cover and species dominance. Differences observed between reef flats are discussed with respect to the influence of the reversing monsoon and resultant wave energies impinging on the reefs. Sediment characteristics (mean grain size, sorting) of reef flat sediments support the exposure ranking of the reefs which is reflected in the dominance of certain coral species at each site.

I INTRODUCTION

The intertidal reef flats of Ko Phuket have already been qualitatively described by Ditlev (1978); the aim of the present survey was to produce quantitative information on coral cover, diversity and species dominance on reefs around the sheltered south-east corner of the island, with respect to natural environmental influences.

II MATERIALS AND METHODS

Study Site and Location of Transects

Description of the situation of Ko Phuket has already been given by Ditlev (1978) and so only brief details will be presented here.

The island of Ko Phuket is situated on the West coast of Thailand in the Eastern Indian Ocean (Fig. 1). Reef flats occur all around Ko Phuket but are especially well developed around the Laem Pan Wah peninsula. Ten traverses were established across reef flats in this area, at locations shown in Figure 1. After establishing an adequate length of transect line, by constructing a species-area curve, ten metre transect lines were placed at 5 or 10 metre intervals across the reef according to the methods described by Loya (1972). Measurements of live and dead coral cover were monitored along each transect line, together with the length of each species underlaying the line: selected transects being photographed to provide a permanent record of coral cover at each site.

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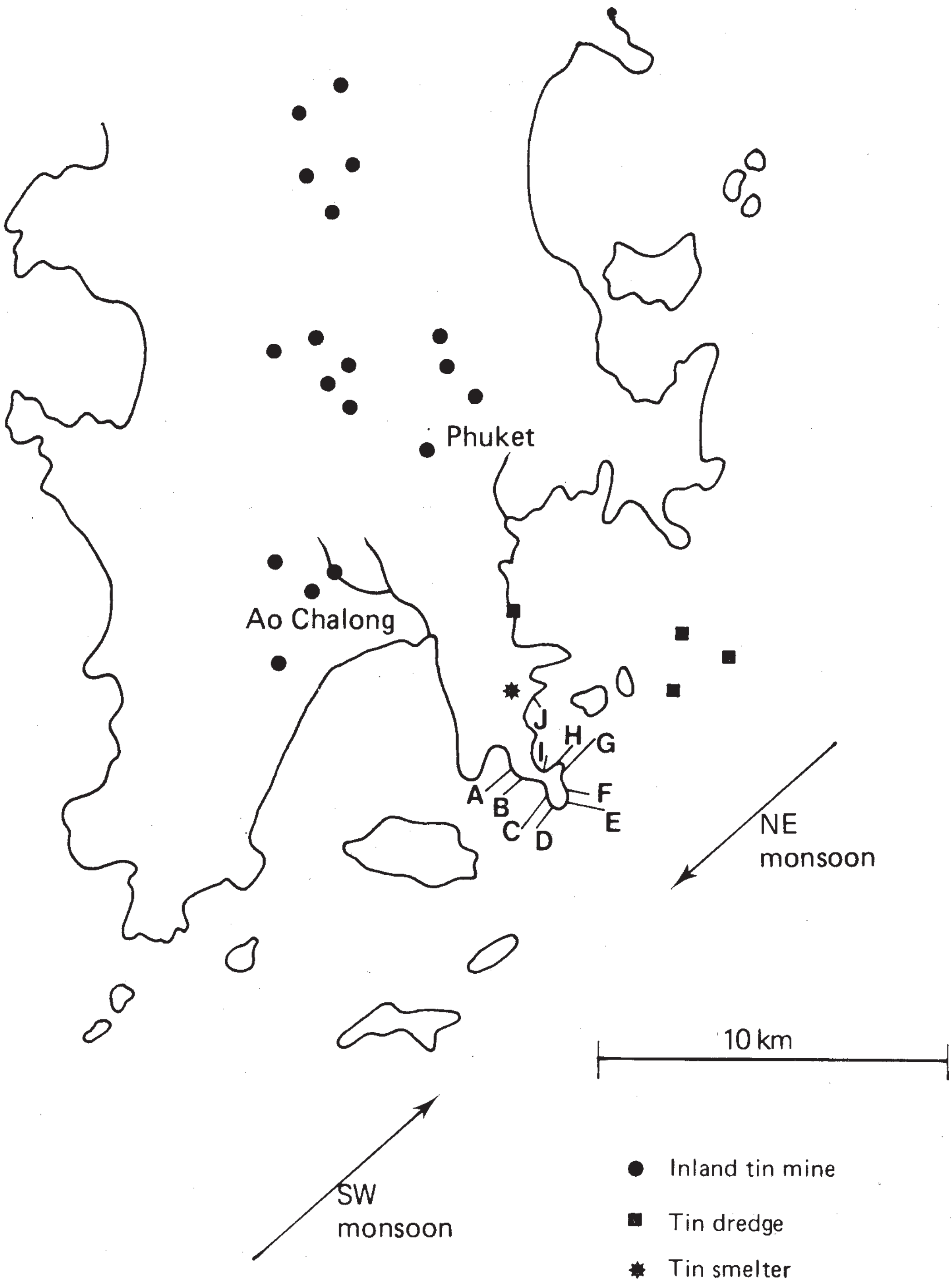

Fig. 1. Situation of Ko Phuket in the Eastern Indian Ocean and location of traverses A - J on the reef flats around Laem Pan Wah peninsular.

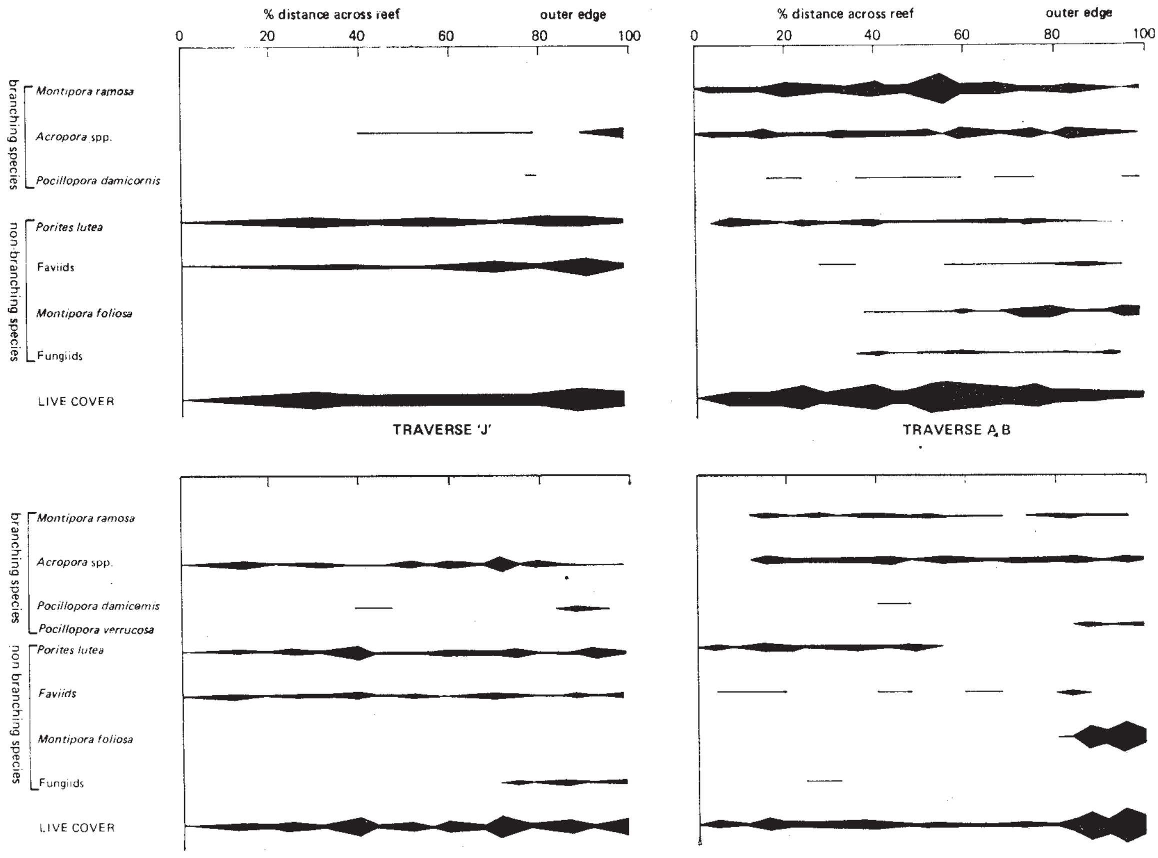

Fig. 2. Distribution and abundance of coral species on reef traverses AB; EF; GH; and J.

Sediment Sampling

Sediments were collected from the inner and outer reef flat and also from below the reef edge at four sites C, E, G and J. The sediments were collected by hand in self-sealing polythene bags, the samples being oven-dried at 100°C immediately on return to the laboratory. After transportation to the United Kingdom 50 g samples were sieved for 5 minutes on a Ro-Tap machine using a series of sieves graded at $\frac{1}{2}$ ϕ intervals.

III RESULTS

Analysis of data collected at each site reflected marked differences between reef flats around the Laem Pan Wah peninsula. Diagrams showing the dominant coral species and their cover across the reef are illustrated in Figure 2, where data for parallel traverses on the same reef are averaged because of their similarity.

The most outstanding feature is the reduced occurrence of *Montipora ramosa* from traverses J and GH. Although isolated stands of *Montipora* were present at these sites no colonies were recorded on any transect. *Montipora ramosa* is dominant on the reef flat at AB, occurring at all transects across the reef together with *Acropora* spp. (mainly *Acropora aspera* and *Acropora pulchra*). At EF the reef flat is dominated by *Acropora* spp. and *Montipora ramosa* with *Porites lutea* restricted to the inner reef flat. The reef edge is dominated by *Montipora foliosa*, together with

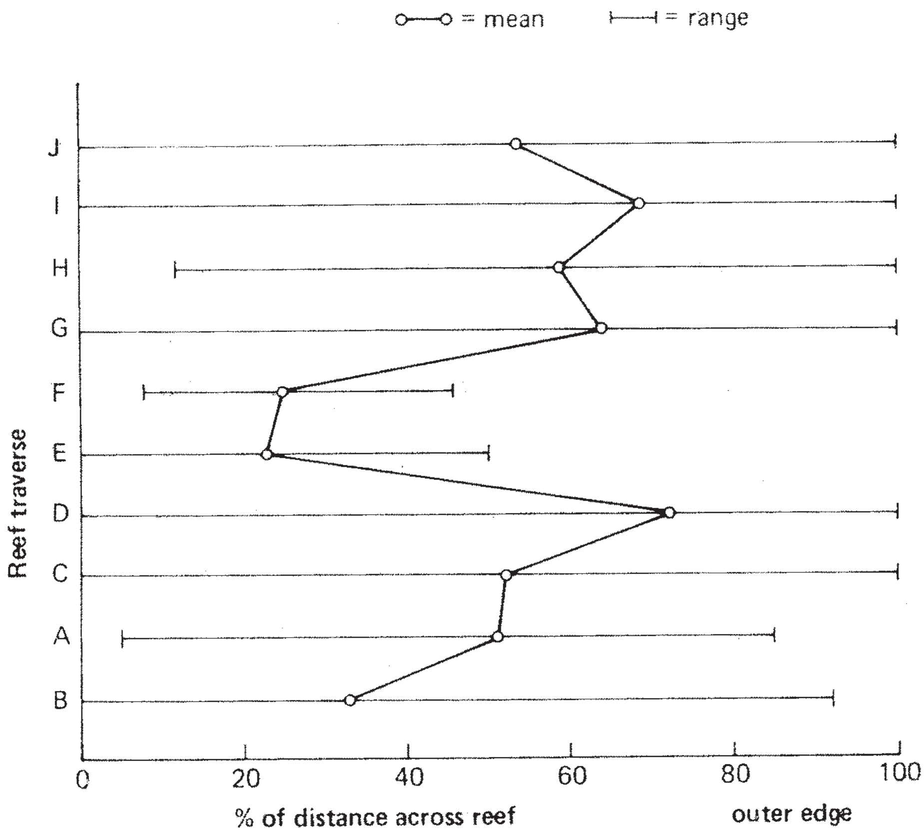

Fig. 3. Distribution of *Porites lutea* (mean value and range of extent) as percentage of total distance across the reef.

conspicuous stands of *Pocillopora verrucosa*. Faviids (including *Favia pallida, Favites abdita, Favites chinensis, Goniastrea retiformis, Goniastrea edwardsii* and *Platygyra daedalea*) were recorded on all reefs but principally at sites J and GH. A species list of corals occurring on transects at each site is shown in Table 1.

The distribution of *Porites lutea* across each traverse shows interesting trends (Fig. 3) with *Porites* being restricted to the inner reef flat at traverses E and F. This species extends over a much greater proportion of the reef flat at all other sites visited.

Considering total coral cover (both living and dead) then traverses EF show a markedly reduced cover when compared with other sites (Fig. 4). This is in part due to the high proportion of branching coral rubble present at EF. The highest dead coral cover was observed at GH (≏ 73%) followed by J (≏ 57%), AB (≏ 35%) and EF (≏ 33%). A plot of average percentage live cover against the Shannon Weaver diversity index (H^1_c) and 'evenness' ($H^1_c/H_{max.}$) recorded at each site (Fig. 5), after Loya (1972), indicates a negative correlation between cover and species diversity ($p < .02$) reflecting the dominance of *Montipora ramosa* and *Acropora* spp. at A, B and C, D. The number of species recorded on transects A - I varies between 10 and 14. Site J is distinguished by a relatively higher species diversity (17 species) attributable to an increased number of faviid species (see Table 1).

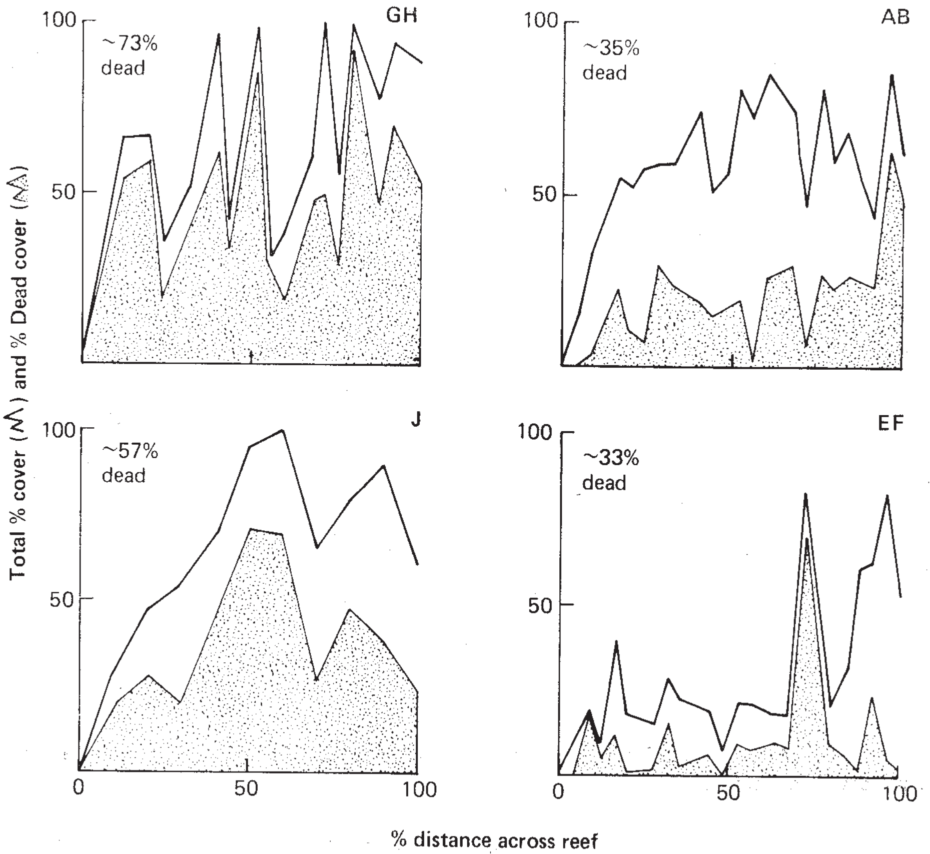

Fig. 4. Total coral cover (both living and dead) as percentage of total distance across the reef.

Sediments

Sediment size analysis revealed some interesting trends across the reef at sites C, E, G and J (Fig. 6). Sediments from the inner and outer reef flat varied from fine to coarse sands (M_z range 2.35 to 0.29). Samples from below the reef edge consisted of coarse sediments (M_z range -0.6 to 1.06) with a considerable coarse fraction consisting of coral fragments and mollusc shells.

An improvement in sorting characteristics from poorly sorted reef edge sediments to moderately well sorted inner reef flat sediments was observed at sites C and E; the improvement being most marked at E. At sites G and J no improvement in sorting characteristics was obvious across the area, sediments from both the inner and outer reef flats being poorly sorted.

IV DISCUSSION

It is clear from the foregoing data that the species diversity of intertidal reefs surrounding Laem Pan Wah is generally low being restricted to 15 genera of scleractinian corals. Such results are not surprising considering the physical extremes to which intertidal reefs are exposed and other workers have demonstrated similar low diversities for intertidal reefs at Eilat in the Red Sea (Loya 1976), Tulear, Madagascar (Pichon 1964) and Mahé in the Seychelles (Taylor 1968).

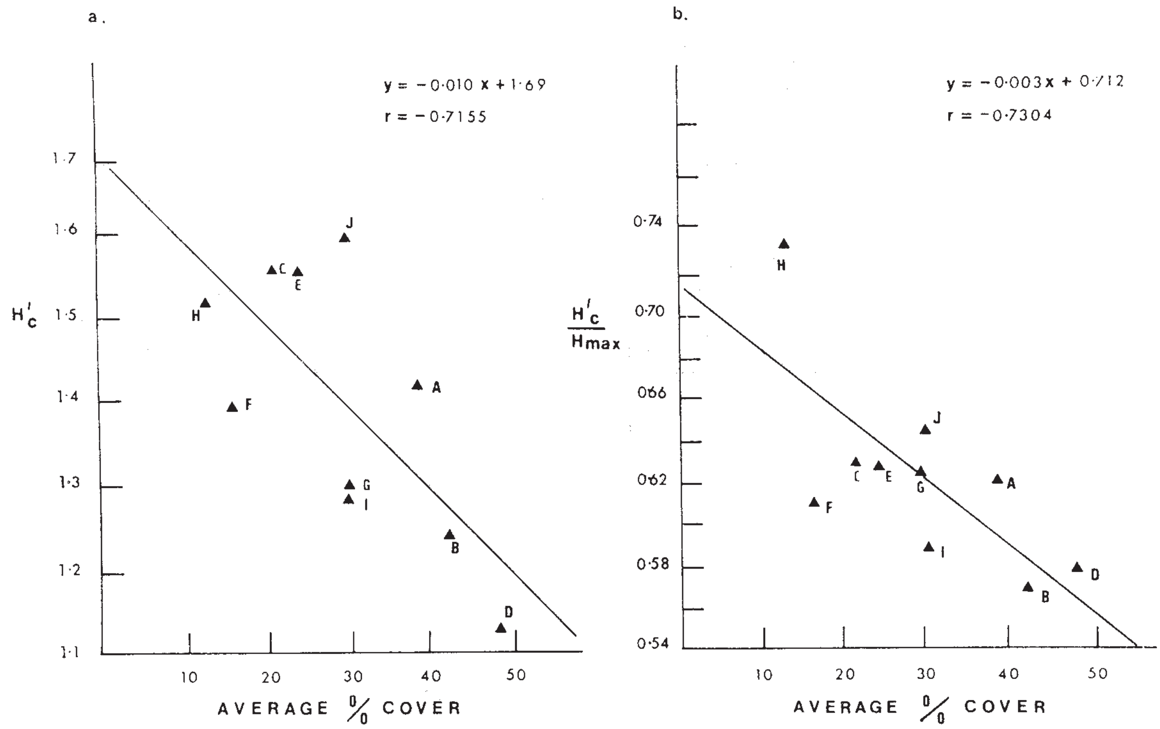

Fig. 5. a) Shannon Weaver diversity index (H'_c) and b) 'evenness' plotted against average percentage live coral cover for traverses A - J.

The reefs around the Laem Pan Wah peninsula show several striking differences in species composition when compared one with another, a fact not mentioned in earlier studies at Ko Phuket (Ditlev 1978). The most obvious difference is the markedly reduced coverage of *Montipora ramosa* on intertidal reefs at J and GH where *Porites lutea* and Faviids assume dominance. This pattern of coral distribution can best be explained by considering the exposure of different reef flats around the peninsula to the influence of local currents. If the reef flats were to be ranked, based on their site location with respect to the influence of the reversing monsoons, then the sequence of exposure would be EF > CD & AB > J & GH. Such a sequence is further supported by sediment data, where the influence of water movement over the reef appears to be greatest at E, F, with much imporved sorting of sediments over the reef flat. In contrast, the poorly sorted, coarse sediments recorded at J and GH reflect the relatively sheltered conditions at these sites. Although the relationship of texture and sorting of sediments to environmental factors may be complex it is widely recognised that the influence of reef morphology, source, currents and waves may be reflected by these parameters (Orme et al 1974; Clack and Mountjoy 1977; and Brown and Dunne 1980).

Other factors which also point to increased wave exposure at EF include the presence of conspicuous stands of *Pocillopora verrucosa* at the reef edge; the high cover of coral rubble and broken coral branches; and the relatively low cover of living coral. The scheme adopted by Rosen (1975) to explain the coral distribution on Indo-Pacific reefs would account for the occurrence of *Pocillopora verrucosa* on the edge of this exposed reef flat and also for the dominance of *Porites lutea* and Faviids on the more sheltered

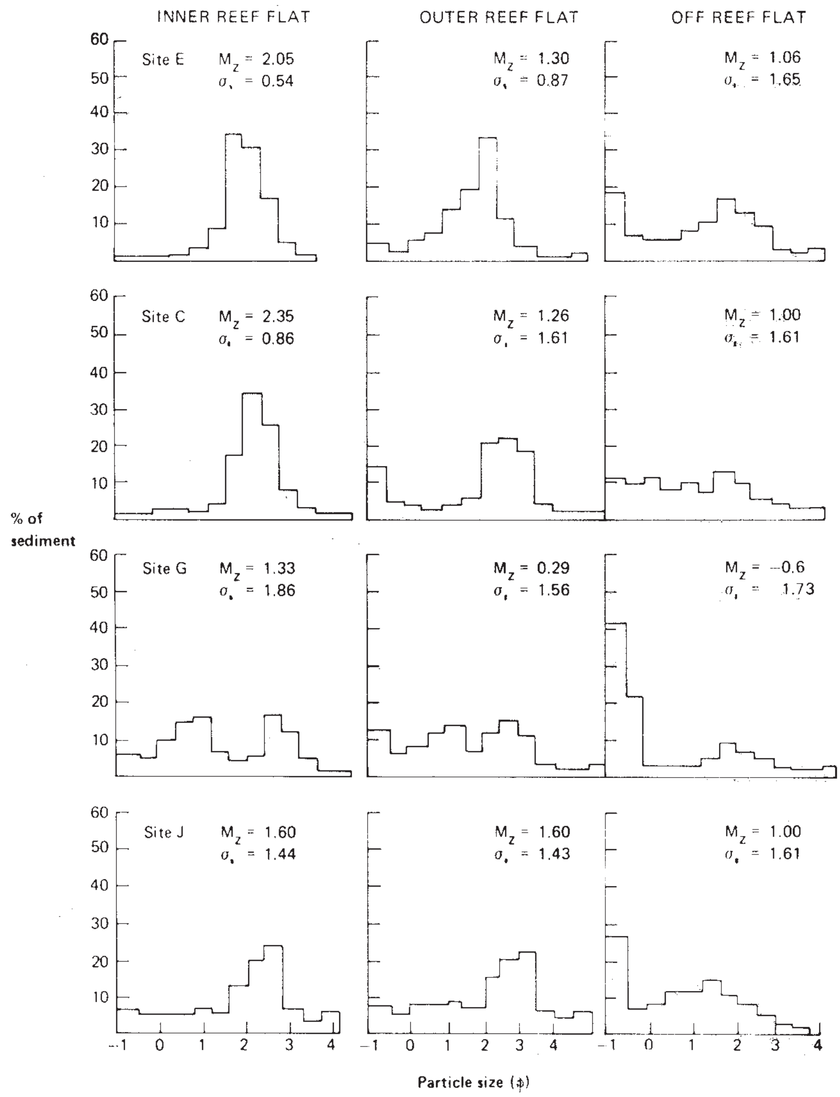

Fig. 6. Histograms showing sediment size distribution for inner reef flat, outer reef flat and reef edge sediments with values for graphic mean (M_z) and inclusive graphic standard deviation (σ_I)

reefs at J and GH. It is also interesting to note that in the present study *Porites lutea* is limited to the inner reef flat at the most exposed site EF and that with increasing shelter comes to occupy an increasingly greater extent of the reef. The mean distribution point of the coral also moves towards the outer reef flat with a corresponding increase in the degree of shelter encountered at the site. Such results would support the widely held view that *Porites* favours more sheltered sites while *Pocillopora verrucosa* characterises a high energy location (Rosen 1972; 1975).

The distribution pattern of *Montipora ramosa* appears less clear from the existing literature (Manton 1935; Umbgrove 1939, 1947; Wells, 1954) but in the present study this coral is restricted

TABLE I SHOWING CORAL SPECIES RECORDED ON TRAVERSES A-J.

Coral species	Traverse									
	A	B	C	D	E	F	G	H	I	J
Genus *Acropora*										
A. pulchra (Brook 1891)	+	+	+	+	+	+	+	+	+	+
A. aspera (Dana 1846)	+	+	+	+	+	+	+	+	+	+
A. vaughanii (Wells 1954)					+					
A. millepora (Ehrenberg 1834)				+						
A. formosa (Dana 1846)					+					
Genus *Montipora*										
M. foliosa (Pallas 1766)	+	+			+	+	+			
M. ramosa (Bernard 1897)	+	+	+	+	+	+			+	
Genus *Fungia*										
F. fungites (Linnaeus 1758)	+	+	+	+	+		+	+	+	+
Genus *Goniopora*										
G. stokesii Edwards & Haime 1851								+		+
Genus *Porites*										
P. lutea (Edwards & Haime 1851)	+	+	+	+	+	+	+	+	+	+
Genus *Favia*										
F. pallida (Dana 1846)	+		+					+	+	+
F. matthai Vaughan 1918		+								+
F. amicorum complex										+
Genus *Favites*										
F. chinensis (Verrill 1866)									+	
F. abdita (Ellis & Solander 1786)		+		+	+		+	+		+
Genus *Goniastrea*										
G. retiformis (Lamark 1816)	+	+	+	+	+	+			+	+
G. edwardsii (Chevalier 1971)	+		+	+	+	+		+	+	+
G. aspera (Verill 1865)		+		+		+	+	+		
G. favulus (Dana 1846)								+		+
G. pectinata (Ehrenberg 1834)		+								
Genus *Platygyra*										
P. sinensis (Edwards & Haime 1849)	+		+			+	+	+	+	+
P. pini Chevalier 1975						+	+			
P. daedalea (Ellis & Solander 1786)							+			+
Genus *Diploastrea*										
D. heliopora (Lamarck 1816)										+
Genus *Hydnophora*										
H. exesa (Pallas 1766)							+			
Genus *Coeloseris*										
C. mayeri (Vaughan 1918)							+	+		+

TABLE I (Cont'd)

Coral species	Traverse									
	A	B	C	D	E	F	G	H	I	J
Genus *Galaxea*										
G. fascicularis (Linnaeus 1758)	+									
Genus *Millepora*					+					
Genus *Pocillopora*										
P. damicornis (Linnaeus 1758)	+	+	+	+	+	+	+	+	+	+
P. verrucosa (Ellis & Solander 1786)					+	+				
TOTAL NO. OF SPECIES	12	12	10	11	14	12	13	13	11	17

to the more exposed reef flats. *Montipora ramosa* characterises the 'moat' of windward reefs at Low Isles, Great Barrier Reef (Manton 1935) and also in the Bay of Jakarta (Umbgrove 1939, 1947) but at Santa Maria Island, New Hebrides, a richly developed *Montipora ramosa* zone is found much further behind the windward reef margin (Wells 1954).

Undoubtedly many factors, both biological and physical, affect the distribution of reef corals but as shown in several recent studies, wave energy and resulting current strength are probably of fundamental importance in determining both reef morphology and reef composition (Hubbard 1974; Roberts et al 1977; Geister 1977; Brown and Dunne 1980). The present study clearly indicates that although the reefs around Laem Pan Wah are not widely separated in space, their aspect, with respect to the prevailing monsoon, results in quite different reef types dominated by coral assemblages characteristic of either exposed or sheltered conditions.

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REFERENCES

BROWN, B.E. and DUNNE, R.P. (1980) Environmental controls of patch reef growth and development. Mar. Biol. **56** : 85 - 96.

CLACK, W.J. and MOUNTJOY, E.W. (1977) Reef sediment transport and deposition off the East coast of Carriacou. W.I. Proc. 3rd Int. Symp. Coral Reefs **2**: 98 - 103. (Ed. by D.L. Taylor. Miami : School of Marine and Atmospheric Sciences, University of Miami).

DITLEV, H. (1978) Zonation of corals (Scleractinia: Coelenterata) on intertidal reef flats at Ko Phuket, Eastern Indian Ocean. Mar. Biol. **47** : 29 - 39.

GEISTER, J. (1977) The influence of wave exposure on the ecological zonation of Caribbean coral reefs. Proc. 3rd Int. Symp. Coral Reefs **1** : 23 - 29. (Ed. by D.L. Taylor. Miami: School of Marine and Atmospheric Sciences, University of Miami).

HUBBARD, J.A.E.B. (1974) Scleractinian coral behaviour in calibrated current experiment: and index to their distribution patterns. Proc. 2nd Int. Symp. Coral Reefs **2** : 107-126. (Ed. by A.M. Cameron et al. Brisbane: Great Barrier Reef Committee).

LOYA Y. (1972) Community structure and species diversity of hermatypic corals at Eilat, Red Sea. Mar. Biol. **13** : 100 - 123.

LOYA, Y.(1976) Recolonisation of Red Sea corals affected by man made perturbations and natural castastrophies. Ecol. **57** : 278 - 298.

MANTON, S.M. (1935) Ecological surveys of coral reefs: Great Barrier Reef Exped. 1928-29, British Mus. (Nat. History) Sci. Repts. **3** (10): 273 - 312, 2 figs. 16 pls.

ORME, G.R., FLOOD, P.G. and EWART, A. (1974) An investigation of the sediments and physiool graphy of Lady Musgrove Reef - a preliminary account. Proc. 2nd Int. Symp. Coral Reefs **2**: 371-386. (Ed. by A.M. Cameron et al. Brisbane: Great Barrier Reef Committee).

PICHON, M. (1964) Contribution a l'etude de la répartition des madréporaies sur le récif de Tulear. Madagascar. Recl. Trav. Stn. mar. Endoume (Fasc. hors-sér. Suppl.) **2** : 81-203.

ROBERTS, H.H., MURRAY, S.P. and SUHAYDA, J.N. (1977) Physical processes in a fore-reef shelf environment. Proc. 3rd Int. Symp. Coral Reefs **2** : 507-515. (Ed. by D.L. Taylor. Miami: School of Marine and Atmospheric Sciences, University of Miami).

ROSEN, B.R. (1972) Recent reef corals of the Seychelles with particular reference to the island of Mahé. Unpublished Ph.D. thesis, University of London, 583 pp.

ROSEN, B.R. (1975) The distribution of reef corals. Rep. Underwater Ass. **1** : 1-16.

TAYLOR, J.D. (1968) Coral reefs and associated invertebrate communities (mainly molluscan) around Mahé, Seychelles. Phil. Trans. R. Soc. (Ser. B) **254** : 129-206.

UMBGROVE, J.H.F. (1939) Madreporaria from the Bay of Bataria, Rijksmuseum Natuurlijke Histoire Leiden Zool. Meded. **22**: 1-64, pls. 1-18, 1 map.

UMBGROVE, J.H.F. (1947), Coral reefs of the East Indies. Geol. Soc. Am. Bull. **58** : 729-778, 24 figs. 1 map, 7 pl.

WELLS, J.W. (1954) Recent corals of the Marshall Islands. Prof. Pap. U.S. geol. Surv. **260 (I)** i-iv: 385-486, pl. 94-185.

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