

## CHAPTER 4

### DISCUSSIONS

#### 4.1 Interspecific interactions

The extrusion of mesenterial filaments has not been reported in Montipora yet. Short-term laboratory experiments illustrated the initial stage of interactions among different species of Montipora (Fig. 2 and Table 1). The extrusion of mesenterial filaments was irregular in each set of the same xenogeneic pair. Moreover, bidirectional extrusion of mesenterial filaments was found in the pair of M. foliosa and M. foveolata. As was reported by Nakaya (1984) bidirectional extrusion of mesenterial filaments were also found in the pairs of Porites lutea-P. eridani and P. eridani-P. sp.2. Therefore, these events contradict the assumption of Lang (1971) that extrusion of mesenterial filaments was species specific and unidirectional. In some xenogeneic pairs, tissue at the contact area of the colonies was damaged while extrusion of mesenterial filaments was not observed. In these cases, certain interpretations should be considered. It was possible that mesenterial filaments actually extruded between the observation time and could not be detected in this experiment. According to Hildemann et al (1977 b), cytotoxic reaction may have characteristically damaged tissues. This reason seems to be possible in this experiment, but at present no evidence was found. The other possibilities, tissue was damaged due to nematocyst discharge of the opponents. At present, the mechanism

of mesenterial filaments extrusion remains unexplained. However, the response is assumed to be mainly interspecific. Here, I propose that Montipora species use mesenterial filaments for aggression, and they may use the other unknown mechanisms for this propose.

At the initial stage of xenogeneic interactions in short-term laboratory experiment, a linear ranked hierarchy was observed but this relation changed later on. It seems to be that the dominance hierarchy is not fixed and seems to conform with Bak et al (1982) and Nakaya (1984). The results from the field experiments clearly showed that there were two-way reactions in the pairs of M. foliosa-M. foveolata and M. ehrenbergii-M. foveolata. The dominance hierarchy among four species of Montipora was not clear due to the changes through time, but several trends can be expected. M. ehrenbergii seems to be at the top of the hierarchy of competitive ability while M. digitata is definitely the most subordinate of the four species studied. It was confirmed by the initial stage of interactions in short-term experiments that M. ehrenbergii used mesenterial filaments more frequently than the others. Moreover, it was obviously found that M. ehrenbergii killed the neighbor colonies of some species of faviids in natural habitat of reefs of Sesoko Island. So M. ehrenbergii should be defined as 'aggressive' in relative aggression of corals. Sheppard (1979) reported that on reefs of Chagos, Indian Ocean twelve occasions where different species of the genus Montipora touched, both colonies abutted without an aggression response. In the present study, many xenogeneic pairs among Montipora species studied from both short-term laboratory experiment and field

experiment had no apparent interactions (indifference). It was indicated that interactions among the species of Montipora were mild reactions. As was assumed by Bak and Crien (1982), mild reactions found among allogeneic and xenogeneic pairs were the strategies which were adopted by many species of corals. This assumption may be applied to explain in the case of Montipora.

Bak et al (1982) reported that some crustaceans dwelling in the spaces of colonies of a certain species of corals affected the contact reactions between colonies. Nakaya (1984), who carried out his experiments in the same study area found ascidians, crustaceans, gastropods, bryozoans, sponges dwelling and algae around the contact area of the colonies of his experiments. The gastropod, Peristerna nassatula Larmark, and algae which were found during this observation, may influence the interactions somehow.

During the long-term experimental period, the ranking was reversed only in the pairs of M. foliosa and M. foveolata. M. foveolata damaged M. foliosa in the first month. However after the first month M. foliosa were found to overgrow M. foveolata in most cases. The xenogeneic contact reactions found in the natural reefs also indicated that M. foliosa overgrows M. foveolata. It is possible that M. foliosa grows faster than M. foveolata and may successfully counterbalance mesenterial filament attacks from M. foveolata. Richardson et al (1979) reported that the reef-building coral Montastrea carvernoza Linnaeus possesses sweeper tentacles which have enlarged nematocyst batteries and appears to be used in defense of the coral's living space and may deter mesenterial filament

attacks from the more aggressive coral M. annularis. However in this study, sweeper tentacles could not be detected at all.

Comparisons of ranking of competitive ability among the four Montipora species obtained from short-term experiments, long-term experiments and field observations are given in Fig. 60. In the pair of M. foliosa-M. foveolata, the inferiority of M. foveolata during the experimental period may be related to the fact that it failed to digest M. foliosa with its mesenterial filaments and during the later stages of contact M. foliosa may produce growing edge behind the damaged region, and may overgrow M. foveolata slowly. On natural reefs, the coral colonies should come to contact rather slowly, contrary to the experimental situations. There may be differences in habitat preference among species concerning sedimentation, light and water motion, etc.



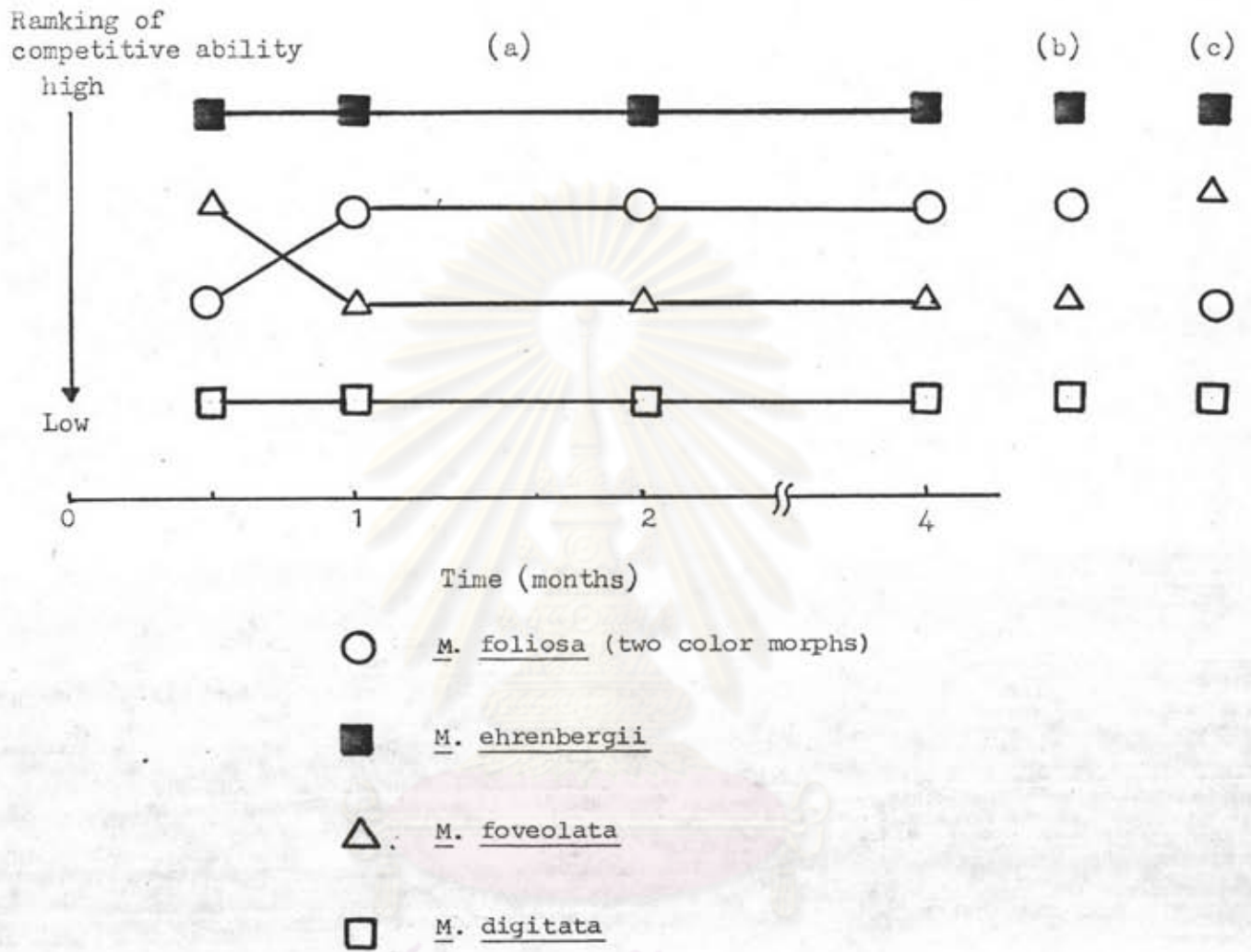


Fig. 60 Comparison of ranking of competitive ability among the four Montipora species. (a) long-term experiments (b) field observations (c) Short-term laboratory experiments.

#### 4.2 Interspecific interactions

In intra-reef allgrafts, fusion occurred at a rate of 15.4%, 13.5% and 13.5% for M. foliosa, M. ehrenbergii and M. digitata respectively. In cases of fusions, no border line was detectable between the colony pairs. The longest distance between colony pairs which were used in this experiment was less than 14m. It is obviously indicated that all three species of Montipora exhibited low rate of fusion. If the hypothesis that genetically different colonies never fuse each other (Hildemann, 1975, 1977 a, 1977 b; Bak and criens, 1982; Jokiel et al, 1983; Niegel and Avise, 1983; Hunter, 1985; Resing and Ayre, 1985) holds true, the fusion of M. foliosa, M. ehrenbergii and M. digitata can be explained by assuming that the fused colonies were produced asexually. The results from field observations showed that there were living fragments of both color morphs of M. foliosa and M. digitata but none of M. ehrenbergii. However, it is possible that there were some living fragments of M. ehrenbergii which could not be detected by the observations. The formation of new colonies by the fragmentation of established colonies is known to be an extremely important mode of reproduction among some species of reef corals (Highsmith, 1982). I propose that M. foliosa and M. digitata reproduce asexually by fragmentation. Because the colony shape of M. ehrenbergii is encrusting and massive form, they were hardly broken into fragments by external force. However I found the partial mortality of M. ehrenbergii frequently and the processes of partial mortality may be an important mode of establishment of new colonies in this species. The histoincompatibility response noted in Montipora foliosa, M. ehrenbergii and M. digitata are consistent with that of M. verrucosa

(Johnston et al., 1981; Jokiel et al, 1983), Porites lutea, P. eridani (Nakaya, 1984) and Montastrea annularis (Logan, 1985).

In inter-reef allografts, the distances between two coral aggregate area are more than 500 m. so there are few chances for colony fragments to move from one reef to another. In sexual reproduction, some species of Montipora including M. foliosa, M. ehrenbergii and M. digitata are reported to be hermaphroditic species and release gametes (Heyward, 1985; Heyward and Collins, 1985; Babcock et al, 1986; Yeemin and Yamazato, manuscript in preparation). Recently, Heyward and Babcock (1986) have been reported that M. digitata are cross fertilized exclusively. For inter-reef allografts of the three Montiporo species studied, no fusion pairs were observed at all. This can be probably explained by assuming that there is no possibility that the fragments move from one coral aggregate area to another and cross-fertilization of gametes precludes the identical genotypes of offsprings from parent colonies. It is interesting that in M. digitata, damage in one and both colonies were occurred while these interactions did not show in intra-reef allografts. These results support the assumption of Nakaya (1984) that the severeness expressed as tissue damage increased, as the distance between the reefs where the colonies were collected for the experiments increased.

It was assumed that the colonies on the other side of the island belong to genetically different groups. Neighther the differences in aggressiveness between the colony pairs from the two areas of M. foliosa, M. ehrenbergii and M. digitata were not obviously detected nor no fusion pairs were observed at all. These results

are consistent with that of inter-reef allografts. According to Nakaya (1984) across-island allografts of Porites iwayamaensis, P. lutea nad P. eridani showed overgrowth without damage in most cases. In this study, across-island allografts of M. foliosa, M. ehrenbergii and M. digitata exhibited high rate of overgrowth without damage, indifference and filling respectively. Tissue injury in allografts of M. digitata was observed only in inter-reef allografts. This result contradicts Nakaya (1984) that he found tissue damage of Porites eridani more often in across-island allografts than inter-reef allografts and represented that genetic distance expressed as severeness in reactions is related to the geographical distance.

In M. foliosa, two different morphs are clearly recognized and fusions were not seen in all inter-morph grafting pairs. Rinkevich and Loya (1983) reported that Stylophora pistillata from Red Sea exhibits two basic color morphs, in which purple colonies are found to be superior to yellow morphs and competitively exclude them, even when they are not physically touching. However, in this study the aggressive ability of the two morphs of Montipora foliosa did not show the difference remarkably.

Because the type of interactions observed in allografts were not definitely fixed, an attempt to explain the variation by certain factors, that is, fragment size and region of colony in contact on allograft interactions, was carried out. The results did not indicate the tendency that a large fragment overgrew a small one and region of colonies from which the fragments were taken did not play any



role in interactions of allografts. However, Rinkevich and Loya (1983) stated that bigger colonies were superior to smaller colonies (in the range of 2 - 3 orders of magnitude) and Nakaya (1984) found the tendency that the larger fragments overgrow smaller ones. Whereas, Hildemann et al (1977 b) accomplished allografts in the pairs of Montipora verrucosa at tissue mass ratio of 2:1, 4:1, and 8:1 and found little or no effect on the direction or timing of allograft reactivity. Bak et al (1982) reported that contact locations of colonies of Montastrea and Agaricia agaricites affect interactions with Madracis mirabilis significantly but Nakaya (1984) could not find significant effect of this factor on the interactions in allografts of seven species of the genus Porites.

Potts (1976) argued that aggressive behavior in intraspecific interaction was not important. Some authors observed extrusion of mesenterial filaments between the different colonies within a species of Porites eridani, P(s) iwayamaensis, P. lutea and Montastrea annularis (Nakaya, 1984; Logan, 1985). These contradict the description by Lang (1971) in which the extrusion of the mesenterial filaments never occurred among the same species colonies (in Scolymia). In this study, I could not observe the extrusion of mesenterial filaments of the Montipora species studied in both short-term and long-term experiments.

Allogeneic interactions in natural reefs are shown in Table 10. The type of interaction observed most often was overgrowth, the next was filling followed by fusion and indifference. In general, intraspecific interactions of Montipora are rare in

natural reefs. Since several decades, certain discussions have made on the significance of interactions among coral colonies. While Sheppard (1979) argued that interspecific aggression is related to colony zonation, Bradbury (1983) concluded that coral interactions can play only a minor role in coral community structure. In this study, it is difficult to conclude the role of interactions in coral community structure. Surveys of interactions continuously in order to clarify the significance of competition among corals in community structure are still required. However I suggest that interaction among corals is important in small-scale coral community structure.



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#### 4.3 Processes of interaction

Several types of interactions were recognized in the grafting experiments and field observations, namely, overgrowth without damage, overgrowth with damage, unidirectional and bidirectional damage, filling, indifference and fusion. During the experimental period, it was found that many pairs changed the type of interactions. The probable course of the change is given in Fig. 61. Since the process of interaction is complicated, it is quite difficult to illustrate the end results of pairs at the initial stage. Some colony pairs showed different types of interactions in replicates such as overgrowth, filling and indifference; overgrowth with and without damage. Although there was a tendency that the types of interactions were dependent on the species and colony combinations, the interactions of coral colonies were always exclusively definite. When only one colony produced a growing edge at the contact area, it resulted in overgrowth and when both colonies produced them, it resulted in filling. It seems that overgrowth or filling were dependent on the growth rate at the contact area. Tissue damage of one or both colonies were found in some pairs no matter whether overgrowth took place or not. In the natural reefs, the colonies do not come to contact suddenly, but approach each other slowly, as they grow before making contact. The processes of interactions in natural reefs may be much different from those of grafting experiments. Bak et al. (1982) stated that the reactions between two species of corals were different in relation to the distance between the corals. Isografts which were conducted in both field and laboratory experiments showed

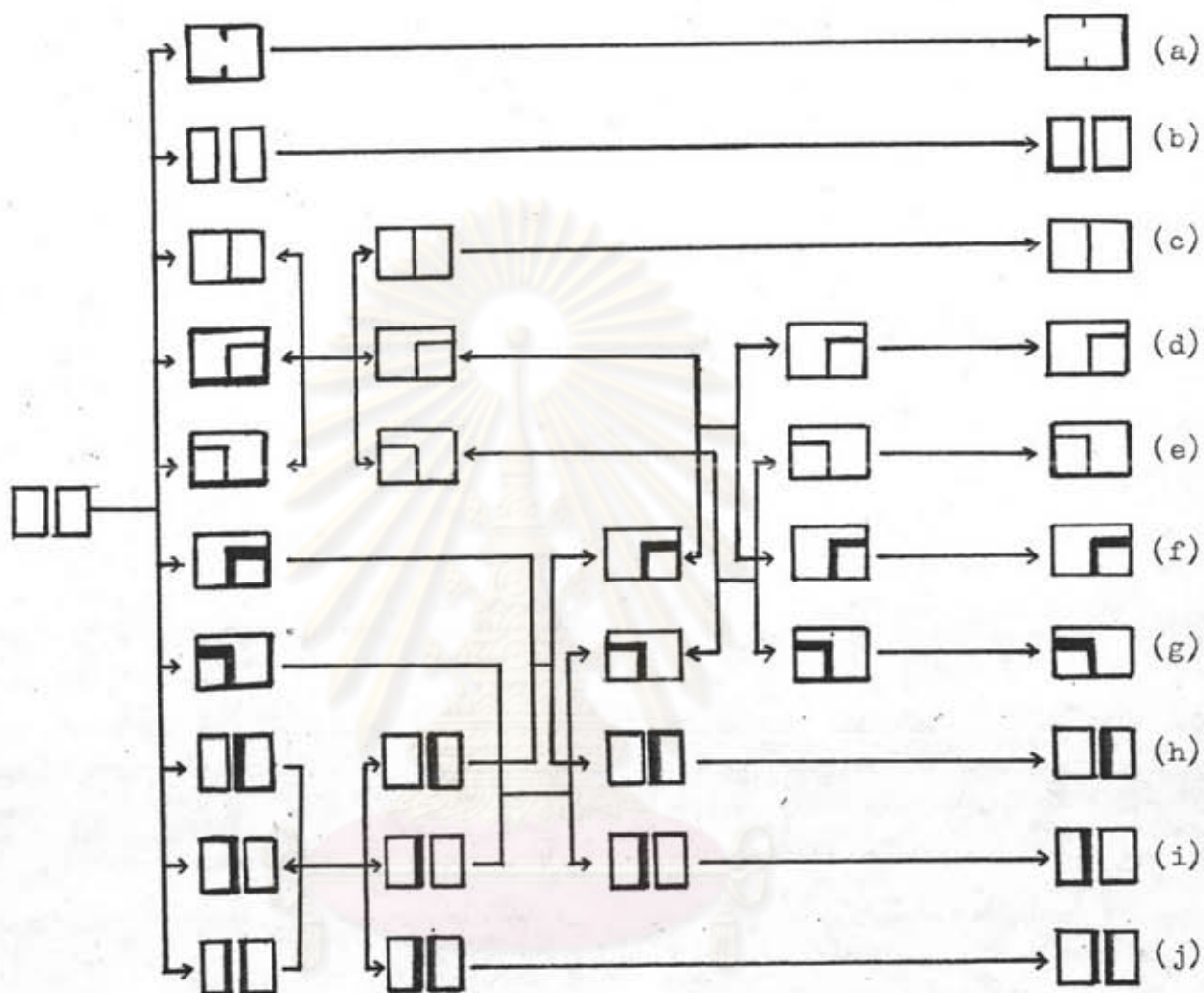


Fig. 61 Diagram showing the processes of interactions and the probable course of the changes in interactions;

(a) fusion (b) indifference (c) filling (d) and (e) overgrowth without damage; (f) and (g) overgrowth with damage (h) and (i) one colony damage (j) both colonies damage.

complete fusion of tissue and skeleton. These results confirm the fact that any interactions except fusion have resulted from the contact with different colonies.



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