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## Changes in the Coral Community at Dong-Sha Atoll, South China Sea from 1975 to 1998

Jan-Jung Li<sup>1</sup>, Tsai-Fu Lee<sup>1</sup>, Kwee Siong Tew<sup>2</sup> and Lee-Shing Fang<sup>1,2\*</sup>

<sup>1</sup> National Museum of Marine Biology and Aquarium, No. 2, Houwan Road, Checheng, Pingtung 944, Taiwan, ROC.

<sup>2</sup> Institute of Marine Resources, National Sun Yat-sen University, Kaohsiung 804, Taiwan, ROC

### ABSTRACT

Coral species at Dong-Sha Atoll, the only atoll in the northern part of the South China Sea, has been surveyed since 1990. In the most recent expedition, 14 families, 26 genera, and 61 species of coral were recorded in April 1998, which included ten families, 20 genera, and 49 species of scleractinians; three families, five genera, and eight species of octocorals; and one family, one genus, and four species of hydrocorals. The major components of the coral community were hermatypic corals, especially *Acropora* spp. and *Porites* spp. The number of species of corals decreased from 137 species in 1994 to 61 species in 1998, a decline of 55.5%. Up to 90% of the reef communities have possibly been destroyed by the extensive use of poisons and explosives in illegal fishing practices. It is necessary to take immediate actions to protect and conserve the reef system in this atoll.

**Key words:** Dong-Sha Atoll, Coral community, *Acropora*, *Porites*.

### INTRODUCTION

Dong-Sha Atoll (or Pratas Islands) is located at 20°35' to 20°47'N, 116°41' to 116°55'E in the South China Sea (Fig. 1). The atoll covers more than 300 km<sup>2</sup> with a lagoon 10 m deep. In the west side of the atoll there is a 1.74-km<sup>2</sup> small island which rises 2 m above sea level, called Dong-Sha Island. The island is completely composed of sandy coral debris. The surface water temperature in Dong-Sha Atoll reaches approximately 30 °C in summer, decreasing to 21 °C in winter. The current flows northeast in summer with a velocity of 0.2~0.5 knots. In winter, the current changes to northwest. The exchange of water circulation in the lagoon is mainly through an opening of the atoll on the west side.

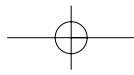
A number of studies on the species and ecology of corals around Dong-Sha Island have been conducted. Ma (1937) studied the growth rate of reef-building corals there. Yang

*et al.* (1975) recorded 17 genera and 45 species of corals. Fang *et al.* (1990) recorded 28 genera and 63 species. Dai *et al.* (1995) recorded a total of 43 genera and 137 species of corals. These studies all showed that *Acropora* and *Porites* were the most abundant genera in this area. The objective of this study was to investigate the current status of coral communities in Dong-Sha Atoll in the South China Sea.

### METHODS AND MATERIALS

Nine stations were surveyed in April 1998. The locations and depths of these stations, as well as the time of investigation, are listed in Table 1.

The coral species and the characteristics of the community were investigated by scuba diving with an underwater camera and video camera. Coral species were identified in the field. A piece of coral was detached and brought to the laboratory whenever a species was unable to be identified on the spot. The



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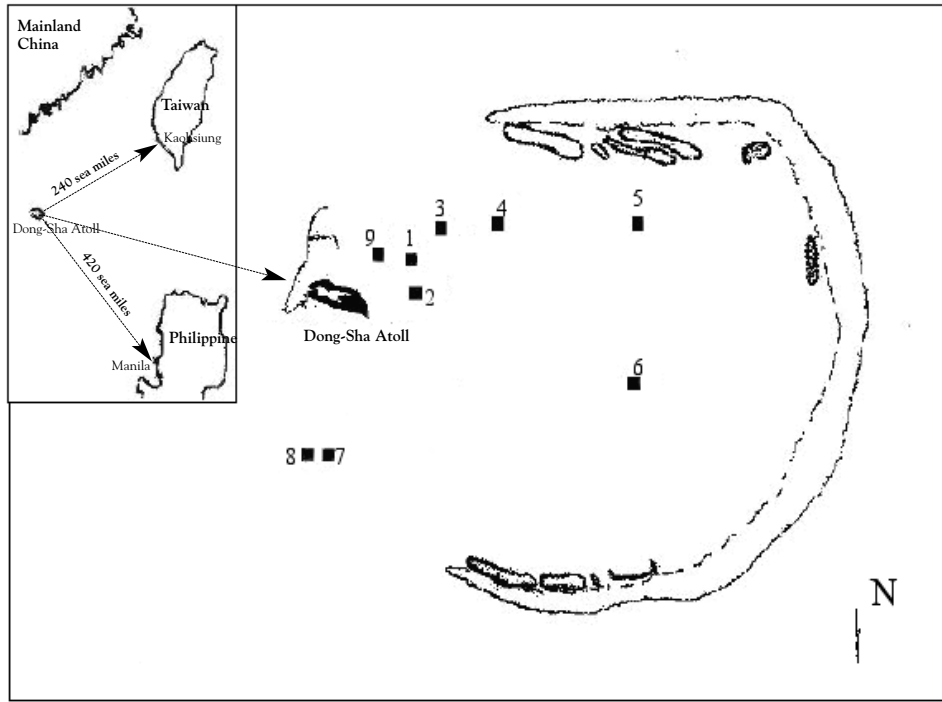


Figure 1. Localities of investigated stations at Dong-Sha Atoll.

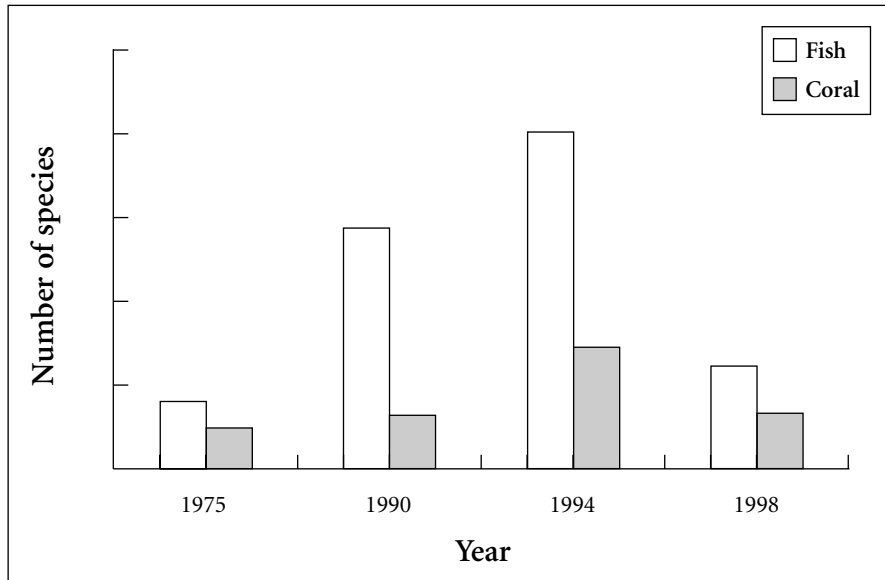
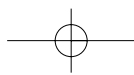


Figure 2. A comparison of total coral and fish species in previous surveys at Dong-Sha Atoll.



## Changes in the Coral Community at Dong-Sha Atoll

**Table 1.** Location, date, time of investigation, and depths of each station during the survey at Dong-Sha Atoll in 1998.

Station	Location	Date/Time	Depth
1	116°45'092"E 20°42'992"N	4/23 p.m.	1.5-4 m
2	116°45'094"E 20°42'194"N	4/23 p.m.	3-6 m
3	116°45'882"E 20°43'920"N	4/24 p.m.	2-5 m
4	116°47'700"E 20°43'918"N	4/24 p.m.	6-8 m
5	116°51'761"E 20°43'896"N	4/24 p.m.	3-7 m
6	116°51'591"E 20°39'450"N	4/24 p.m.	2-12 m
7	116°42'595"E 20°37'953"N	4/25 a.m.	3-9 m
8	116°42'272"E 20°37'809"N	4/25 a.m.	12-19 m
9	116°43'922"E 20°43'388"N	4/25 a.m.	1-2 m

identification of species was based on Veron *et al.* (1977), Veron and Pichon (1980, 1982), Veron and Wallace (1984), Veron (1986, 1992), Dai (1989, 1991) and Hoeksema and Dai (1991). The survey methods were similar to those described by Dai *et al.* (1995). The area of living corals was estimated visually among the area of all coral reefs within a station. The percentage of dead coral can thus be estimated by subtracting the percent of living coral from 1.

## RESULTS

There were 26 genera and 61 species belonging to 14 families found during the 3-d survey. Among them, 20 genera and 49 species in ten families were scleractinians, five genera and eight species in three families were octocorals, while one genus and four species in one family were hydrocorals (Table 2). The result revealed that hermatypic corals, especially *Acropora* spp. and *Porites* spp., still dominate the coral community in Dong-Sha Atoll.

The mortality rates of coral communities at each of the stations are shown in Table 3, and the status of the community is described.

### STATION 1:

Coral debris was seen everywhere on the sandy bottom substrate of the area. Broken

pieces were mostly branching corals, such as *Acropora* spp., *Pocillopora* spp., *Porites* spp., and *Pavona clavus*. Seven genera and 11 species in six families were recorded from the remaining living coral. Seventy percent of the surviving corals were branching corals, with six species belonging to the genus *Acropora*. Most of the coral communities were small and newly established. Broken pieces on the sea-floor were covered by algae, polychaetes, sponges, or bryozoans. Only a handful of fish were seen in this seeming graveyard of corals.

### STATION 2:

Eleven genera and 21 species in eight families were recorded, of which 40% were branching coral. There were eight species belonging to the genus *Acropora*, and four species belonging to the family Poritidae. The substrate and the size of the coral communities were similar to those at S1, only that *Fungia repanda* was more abundant at this station. Like at S1, the broken coral debris was mostly composed of branching corals, and was covered by algae and other organisms. Fish were rare at this station.

### STATION 3:

Coral reefs were severely damaged at this station. Only six genera and eight species in six families were recorded. Most of the *Porites*

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**Table 2.** Species of coral and their relative abundance at Dong-Sha and adjacent areas during a survey in 1998. (\* rare, \*\* rich but not dominant, \*\*\* dominant)

Species	Station								
	1	2	3	4	5	6	7	8	9
SUBCLASS ZOANTHARIA									
ORDER SCLERACTINIA									
THAMNASTERIIDAE									
<i>Psammocora contigua</i>	*								
<i>P. digitata</i>			*						
POCILLOPORIDAE									
<i>Pocillopora damicornis</i>						**	**		
<i>P. eydouxi</i>	*	*		*	*	*	**	*	
ACROPORIDAE									
<i>Acropora monticulosa</i>							*	*	
<i>A. humilis</i>	*	**					*	*	
<i>A. robusta</i>		*					*		
<i>A. nobilis</i>	*	*		*			*		
<i>A. grandis</i>				**					
<i>A. formosa</i>	**	**		*	*	*			
<i>A. aspera</i>	**	**	*	*	*				*
<i>A. tenuis</i>	*								
<i>A. cytherea</i>							**	*	
<i>A. hyacinthus</i>		*					**	**	
<i>A. clathrata</i>							*		
<i>A. cardnus</i>			*						
<i>A. florida</i>		*				*	*		
<i>A. sp.</i>									*
<i>Astreopora sp.</i>					*	*	*	*	
<i>Montipora monasteriata</i>							*		
<i>M. turgescens</i>							*		
<i>M. verrucosa</i>					*	**		*	
<i>M. digitata</i>	*	*		*	**	**			
<i>M. foliosa</i>		*				*		**	
<i>M. aequituberculata</i>					*	**	*		
<i>M. sp.</i>							**	*	
AGARICIIDAE									
<i>Pavona clavus</i>	*	*	**	*	*	**			
<i>P. decussata</i>		*			*	*			
<i>Coeloseris mayeri</i>							*	*	
FUNGIIDAE									
<i>Fungia (Verrillofungia) repanda</i>			**		*	**			
<i>Sandalolitha robusta</i>		*			*	*			
PORITIDAE									
<i>Goniopora columna</i>	*	*			*	*	*	*	
<i>Porites (P.) lobata</i>		*		*		*	*	*	

## Changes in the Coral Community at Dong-Sha Atoll

Table 2. (continued)

Species	Station								
	1	2	3	4	5	6	7	8	9
<i>P. lutea</i>	*	*	*	*	*	**	**	*	*
<i>P. cylindrica</i>		*	*	*	**	**			
FAVIIDAE									
<i>Cyphastrea microphthalma</i>								*	
<i>Favia pallida</i>						*	*		
<i>F. speciosa</i>								*	
<i>F. stelligera</i>					*	*	*	*	
<i>Favites abdita</i>						*			
<i>F. chinensis</i>					*	*	*	*	
<i>F. flexuosa</i>					*	**	**		
<i>Montastrea</i> sp.								*	
<i>Goniastrea retiformis</i>					*	*			
OCULINIDAE									
<i>Galaxea fascicularis</i>			*				*		
MUSSIDAE									
<i>Lobophyllia hemprichii</i>								*	
<i>Symphyllia recta</i>								*	
<i>Symphyllia</i> sp.					*	*			
DENDROPHYLLIIDAE									
<i>Turbinaria</i> sp.		*			*	***		*	
SUBCLASS OCTOCORALLIA									
ORDER ALCYONARIA									
ALCYONIIDAE									
<i>Sarcophyton crassocaule</i>								**	
<i>S. trocheliophorum</i>								**	
<i>Lobophytum sarcophytoides</i>									**
<i>L. pauciflorum</i>								*	
<i>Sinularia granosa</i>								**	
<i>S. flexibilis</i>								**	
NEPHTHEIDAE									
<i>Nephthea erecta</i>							*		
ORDER GORGONACEA									
MELITHAEIDAE									
<i>Melithaea ochracea</i>		*							
CLASS HYDROZOA									
ORDER MILLEPORINA									
MILLEPORIDAE									
<i>Millepora platyphylla</i>		*	*	*		*			
<i>M. tenera</i>					**	**			
<i>M. exaesa</i>				*	*	*			
<i>M. intricata</i>					*	*			
Total no. of species	11	21	8	13	23	28	27	27	3

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**Table 3.** Percentage of dead corals at each station during the survey at Dong-Sha Atoll in 1998.

Station	Percentage of dead coral
1	80%-90%
2	60%-70%
3	80%-90%
4	60%-70%
5	80%-90% (< 5 m); 10%-20% (> 5 m)
6	80%-90% (< 4 m); 40%-50% (> 4 m)
7	10%-20%
8	10%-20%
9	99%

spp. and *Pavona clavus* were broken in the middle, which might be a result of fishing for abalone by fishermen. Both *Acropora* and fish were rare except for some *Arca ventricosa*.

#### STATION 4:

Seven genera and 13 species in six families were recorded. Among them, 40% were branching corals, while four species of *Acropora* and three species of Poritidae were recorded. Severe destruction of coral reefs in this area could be a direct result of illegal fishing practices using explosives and poison. Some large *Acropora formosa*, more than 5 m in diameter, and *Porites cylindrica* were overturned possibly by explosions. Only a small number of fish could be seen in this area.

#### STATION 5:

Fifteen genera and 23 species in nine families were recorded. Branching corals were less common, while *Porites* spp., *Favia* spp., *Symphyllia* sp., *Montipora* spp., *Turbinaria* sp., and *Millepora* spp. comprised 70% of the total coral community. A colony of *Porites cylindrica* with a diameter of more than 5 m was overturned, probably by an explosion. At a depth of 5 m or more, healthier coral communities and greater biodiversity were found as compared to the shallower area.

#### STATION 6:

Fourteen genera and 28 species in nine families were recorded. Branching corals were less common except that *Pocillopora eydouxi*, *A. formosa*, and *A. florida* were found. Eighty percent of the communities were composed mainly of *Porites* sp., *Favia* spp., *Montipora* spp., *Turbinaria* sp., and *Millepora* spp. This was the only station where reef slope was observed. There was less coral deeper than 4 m. Foliose corals flourished on the slope.

#### STATION 7:

Seventeen genera and 27 species in eight families were recorded. The overall condition at this station was good. Branching corals (*Acropora* spp., *Pocillopora* spp., and *Porites cylindrica*), massive corals (*Coeloseris mayeri*, *Porites lutea*, *P. lobata*, and *Favia* spp.), and encrusting corals (*Montipora* spp., *Turbinaria* sp., and *Millepora* spp.) were abundant. Thirteen species of *Acropora* accounted for more than 50% of the total coral species. Several *Acropora hyacinthus* reached a diameter of more than 3 m. Fish were abundant as compared to other stations.

#### Station 8:

The water current was strong at this station. Sixteen genera and 27 species in eight families were recorded. Among them, 21 species (~77%) belonged to scleractinians of mostly *Montipora* spp. and *Turbinaria* sp. Other species such as *Favites* sp. and *Porites* sp. were sparsely distributed. Six species (~22%) of soft coral were also found. Since stations 7 and 8 are located on the main shipping route, illegal fishing practices are less common, and therefore the coral reef communities are better preserved at these stations.

#### Station 9:

Other than some *Porites* sp., almost no live corals were found in the area. The dead reefs were covered by thick layers of algae. Fish were seen only where live coral was found.

## Changes in the Coral Community at Dong-Sha Atoll

**Table 4.** Comparison of the coral species recorded at Dong-Sha Atoll in surveys conducted in different years. (\* species recorded in a survey).

Species	Year			
	1975	1990	1994	1998
SUBCLASS ZOANTHARIA				
ORDER SCLERACTINIA				
ASTROCOENIIDAE				
<i>Stylocoeniella armata</i>	*			
<i>Stylocoeniella pistillata</i>	*			
THAMNASTERIIDAE				
<i>Psammocora profundacellar</i>				
<i>Psammocora contigua</i>			*	*
<i>P. digitata</i>				*
<i>P. profundacellar</i>			*	
POCILLOPORIDAE				
<i>Pocillopora eydouxi</i>	*	*	*	*
<i>P. damicornis</i>			*	*
<i>P. meandrina</i>	*	*	*	
<i>P. verrucosa</i>	*	*	*	
<i>P. woodjonesi</i>			*	
<i>Stylophora pistillata</i>		*	*	
ACROPORIDAE				
<i>Acropora affinis</i>		*		
<i>A. acuminata</i>	*			
<i>A. sp. cf. A. arbuscula</i>	*			
<i>A. aspera</i>		*	*	*
<i>A. brueggemanni</i>			*	
<i>A. sp. cf. A. canalis</i>	*			
<i>A. cardnus</i>		*	*	*
<i>A. sp. cf. A. cerealis</i>	*			
<i>A. clathrata</i>		*		*
<i>A. cytherea</i>			*	*
<i>A. danai</i>			*	
<i>A. digitifera</i>	*		*	
<i>A. delicatula</i>	*			
<i>A. florida</i>			*	*
<i>A. formosa</i>	*	*	***	**
<i>A. gemmifera</i>			*	
<i>A. grandis</i>		*	**	*
<i>A. humilis</i>	*	*	**	*
<i>A. hyacinthus</i>		*	***	*
<i>A. microphthalma</i>		*	**	
<i>A. millepora</i>			*	
<i>A. monticulosa</i>	*	*	*	*
<i>A. myriophthalma</i>	*			
<i>A. nasuta</i>			*	

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Table 4. (Continued)

Species	Year			
	1975	1990	1994	1998
<i>A. nobilis</i>		*	***	*
<i>A. ocellata</i>	*			
<i>A. palifera</i>	*	*	**	
<i>A. palmerae</i>	*			
<i>A. sp. cf. A. paxilligera</i>	*			
<i>A. cf. pectinata</i>	*			
<i>A. pulchra</i>		*		
<i>A. robusta</i>		*	*	*
<i>A. spicifera</i>	*			
<i>A. subglabra</i>			*	
<i>A. cf. symmetrica</i>	*			
<i>A. syringodes</i>	*			
<i>A. tennis</i>		*	**	*
<i>A. valida</i>		*		
<i>A. sp.</i>		*		*
<i>Astreopora myriophthalma</i>	*		*	
<i>Astreopora sp.</i>			*	*
<i>Montipora aequituberculata</i>			**	*
<i>M. digitata</i>		*	***	*
<i>M. foliosa</i>			***	*
<i>M. foveolata</i>			*	
<i>M. informis</i>			*	
<i>M. monasteriata</i>			*	*
<i>M. turgescens</i>			*	*
<i>M. venosa</i>			*	
<i>M. verrucosa</i>			*	*
<i>Montipora sp.</i>		*	*	*
AGARICIIDAE				
<i>Coeloseris mayeri</i>			*	*
<i>Leptoseris explanata</i>		*	*	
<i>Pachyseris rugosa</i>			*	
<i>P. speciosa</i>		*		
<i>Pavona cactus</i>		*		
<i>P. clavus</i>			*	*
<i>P. decussata</i>			*	*
<i>P. explanulata</i>			*	
<i>P. varians</i>			*	
<i>P. venosa</i>			*	
FUNGIIDAE				
<i>Cycloseris cyclolites</i>		*	*	
<i>C. vauhani</i>		*		
<i>Fungia (Cycloseris) costulata</i>			*	
<i>F. (Wellsofungia) granulosa</i>			*	

## Changes in the Coral Community at Dong-Sha Atoll

Table 4. (Continued)

Species	Year			
	1975	1990	1994	1998
<i>F. (Danafungia) horrida</i>			*	
<i>F. (Verrillofungia) repanda</i>	*	*	*	*
<i>F. scutaria</i>		*		
<i>F. paumotensis</i>	*			
<i>Fungia</i> sp.		*		
<i>Herpolitha limax</i>		*		
<i>Podabacia crustacea</i>		*		
<i>Sandalolitha robusta</i>		*	*	*
PORITIDAE				
<i>Goniopora columna</i>			*	*
<i>G. minor</i>			*	
<i>Goniopora</i> sp.		*		
<i>Porites australiensis</i>	*			
<i>P. compressa</i>	*			
<i>Porites (P.) cylindrica</i>		*	*	*
<i>P. lichen</i>	*			
<i>P. (P.) lobata</i>	*	*	**	*
<i>P. cf. lobata</i>	*			
<i>P. (P.) lutea</i>		*	***	*
<i>P. (P.) solida</i>			*	
<i>P. tenuis</i>	*			
<i>Porites</i> sp.	*	*		
FAVIIDAE				
<i>Caulastrea furcata</i>			*	
<i>Cyphastrea chalcidicum</i>			*	
<i>C. microphthalma</i>			*	*
<i>C. serailia</i>			*	
<i>Diploastrea heliopora</i>			*	
<i>Echinopora gemmacea</i>			*	
<i>E. lamellosa</i>		*		
<i>Favia favius</i>			*	
<i>F. laxa</i>			**	
<i>F. pallida</i>			**	*
<i>F. rotumana</i>			*	
<i>F. speciosa</i>			**	*
<i>F. stelligera</i>	*	*	*	*
<i>Favites abdita</i>			**	*
<i>F. chinensis</i>		*	*	*
<i>F. flexuosa</i>			*	*
<i>F. russelli</i>			*	
<i>F. pentagona</i>			*	
<i>Favites</i> sp.	*	*		
<i>Goniastrea australiensis</i>			*	

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Table 4. (Continued)

Species	Year			
	1975	1990	1994	1998
<i>G. pectinata</i>			*	
<i>G. retiformis</i>			*	*
<i>Leptoria phrygia</i>			*	
<i>Leptoria gracillis</i>	*			
<i>Montastrea curta</i>			*	
<i>M. magnistellata</i>			**	
<i>Montastrea</i> sp.				*
<i>Platygyra daedalea</i>	*		*	
<i>Platygyra</i> cf. <i>daedalea</i>	*			
<i>Platygyra rustica</i>	*			
<i>P. lamellina</i>			*	
<i>P. sinensis</i>			*	
OCULINIDAE				
<i>Galaxea astreata</i>			*	
<i>G. fascicularis</i>			*	*
<i>G. Musicalis</i>	*			
<i>Galaxea</i> sp.		*		
MERULINIDAE				
<i>Hydnophora exesa</i>			*	
<i>H. microconos</i>			*	
PECTINIIDAE				
<i>Oxypora lacera</i>			*	
<i>Mycedium elephantotus</i>			*	
MUSSIDAE				
<i>Acanthastrea echinata</i>	*		*	
<i>Lobophyllia hemprichii</i>			*	*
<i>Lobophyllia</i> sp.		*		
<i>Symphyllia recta</i>			*	*
<i>S. radians</i>			*	
<i>S. vitiensis</i>			*	
<i>Symphyllia</i> sp.		*		*
CARYOPHYLLIIDAE				
<i>Euphyllia ancora</i>		*		
<i>E. glabrescens</i>			*	
DENDROPHYLLIIDAE				
<i>Turbinaria auera</i>		*		
<i>T. forndens</i>		*		
<i>T. mesenyerina</i>		*	*	
<i>T. reniformis</i>			*	
<i>Turbinaria</i> sp.		*		*

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Table 4. (Continued)

Species	Year			
	1975	1990	1994	1998
SUBCLASS OCTOCORALLIA				
ORDER STOLONIFERA				
TUBIPORIDAE				
<i>Tubipora musica</i>	*		*	
ORDER COENOTHECALIA				
HELIOPORIDAE				
<i>Heliopora coerulea</i>		*	*	
ORDER ALCYONARIA				
ALCYONIIDAE				
<i>Sarcophyton cinereum</i>			*	
<i>S. crassaule</i>		*	***	*
<i>S. elegans</i>			**	
<i>S. glaucum</i>			*	
<i>S. trocheliophorum</i>		*	*	*
<i>Lobophytum altum</i>			**	
<i>L. batarum</i>			*	
<i>L. pauciflorum</i>			**	*
<i>L. planum</i>			*	
<i>L. sarcophytoides</i>			**	*
<i>Lobophytum</i> sp.		*		
<i>Sinularia crassa</i>			*	
<i>S. cruciata</i>			***	
<i>S. erecta</i>			*	
<i>S. exilis</i>			*	
<i>S. facile</i>		*		
<i>S. flexibilis</i>		*	**	*
<i>S. grandilobata</i>		*		
<i>S. granosa</i>		*	*	*
<i>S. halversoni</i>			*	
<i>S. inelegans</i>			*	
<i>S. inexplicita</i>			*	
<i>S. leptoclados</i>			**	
<i>S. lochmodes</i>			***	
<i>S. minima</i>			*	
<i>S. nanolobata</i>			**	
<i>S. notunda</i>			**	
<i>S. parva</i>			**	
<i>S. pedunculata</i>			***	
<i>S. scabra</i>			***	
NEPHTHEIDAE				

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Table 4. (Continued)

Species	Year			
	1975	1990	1994	1998
<i>Nephthea erecta</i>		*	*	*
ORDER GORGONACEA				
MELITHAEIDAE				
<i>Melithaea ochracea</i>		*	*	*
SUBERGORGIDAE				
<i>Subergorgia</i> sp.1			*	
<i>Subergorgia</i> sp.2			*	
CLASS HYDROZOA				
ORDER MILLEPORINA				
MILLEPORIDAE				
<i>Millepora platyphylla</i>	*		*	*
<i>M. tenera</i>		*	*	*
<i>M. exaesa</i>			*	*
<i>M. sjntricata</i>				*
<i>Millepora</i> sp.		*		
Sandalolitha				
<i>Parahalomitra</i> cf. <i>sluiteri</i>	*			
<i>Phymastrea valenciencisii</i>	*			
Total no. of species	45	63	137	61

## DISCUSSION

Generally speaking, the number of species of corals in Dong-Sha Atoll increased from 45 species in 1975 to 63 species in 1990, then to 137 species in 1994 due to more intensive surveying. However, they decreased drastically to 61 species in 1998, a 55.5% drop within 4 years (Table 4). The fish community also showed a similar decline (Fig. 2) (Fang and Lee, 1994; Fang, 1998). This is undoubtedly a result of illegal and destructive fishing. According to Fang (1998), there were more than 600 and 400 fishing boats from mainland China and Hong Kong, respectively, intruding and operating around Dong-Sha Atoll in 1996. They used both cyanide and explosives to catch reef fishes. An estimated 50 tons of cyanide and 1 ton of dynamite were applied in the atoll annually. Furthermore, it was estimated that more than 9 tons of batteries used by these fishermen during diving were also discarded in this area.

This massive destruction has depleted the biota of the coral reef at an astonishing rate.

Hughes (1994, 1996) and Andres and Witman (1995) found that coral coverage in Jamaica decreased from 50% to 5% between 1978 to 1993, while the coverage of algae had increased from 5% to 95%. The benthic community shifted from coral to algae which inhibited the re-colonization of corals. Similar phenomena were observed at S9. There were 45 species of corals and 118 species of fishes recorded in 1994 at this site (Fang and Lee, 1994). However, in this survey, only three species of coral and 32 species of fish were observed. The site was completely covered by algae.

Karlson and Hurd (1993) and Hughes (1994) had pointed out that a reef community is capable of maintaining its structure under tolerable disturbance. Yet when the pressure is too high, an irreversible change or phase-shift will occur. Dai *et al* (1998) showed that the

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coral community at Nanwan Bay, Taiwan was below the threshold of serious pollution impact. The community structure would be in danger of being changed completely if the disturbance became greater. However, the reef ecosystem of Dong-Sha Atoll has obviously passed its critical threshold. The species composition of the coral community has changed dramatically and has experienced a complete phase-shift. As such a rich and valuable coral reef ecosystem in South China Sea, it deserves our immediate actions to protect and conserve this atoll for future generations.

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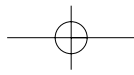
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## REFERENCES

- Andres, N. G. and J. D. Witman (1995) Trends in community structure on a Jamaican reef. *Mar. Ecol. Prog. Ser.* 118: 305-310.
- Dai, C.-F. (1989) The corals of Taiwan. Taiwan Provincial Department of Education, Taiwan, R.O.C. 194 pp. (in Chinese)
- Dai, C.-F. (1991) Reef environment and coral fauna of southern Taiwan. *Atoll Res. Bull.* 354: 1-28.
- Dai, C.-F. T.-Y. Fan and C.-S. Wu (1995) Coral fauna of Tungsha Tao (Pratas Islands). *Acta Oceanogr. Taiwanica* 34: 1-16.
- Dai, C.-F., Y.-T. Chen, K.-M. Kuo and C.-H. Chuang (1998) Changes of coral communities in Nanwan Bay, Kenting National Park: 1987-1997. Bureau of the Kenting National Park, Pingtung, Taiwan. 28 pp.
- Fang, L.-S. and C.-J. Hu (1990) A survey of the marine ecological resources of Dong-Sha Atoll. Fishery Management Department, Kaohsiung City government, Taiwan, 61pp. (in Chinese with English inventory)
- Fang, L.-S. and C.-C. Lee. (1994) The report of marine environment and ecology of South China Sea. Council of Agriculture, Taipei, Taiwan, 471 pp. (in Chinese with English abstract and inventory)
- Fang, L.-S. (1998) The marine ecology status of Dong-Sha Atoll and its management planning. National Museum of Marine Biology and Aquarium, Kaohsiung, Taiwan, 48 pp. (in Chinese with English inventory)
- Fang, L.-S. (1998) The status of marine ecology in Dong-Sha Atoll. European-Asian workshop on Investigation and Management of Mediterranean and South China Sea Coastal Zone. Nov. 9-11, 1998, Hong Kong.
- Hoeksema, B. and C. F. Dai. (1991) Scleractinia of Taiwan. II. Family Fungiidae (including a new species). *Bull. Inst. Zool. Acad. Sinica* 30: 201-226.
- Hughes, T. P. (1994) Catastrophes, phase shifts, and large-scale degradation of a Caribbean coral reef. *Science* 265: 1547-1551.
- Hughes, T. P. (1996) Demographic approaches to community dynamics: a coral reef example. *Ecology* 77: 2256-2260.
- Karlson, R. H. and L. E. Hurd (1993) Disturbance, coral reef communities, and changing ecological paradigms. *Coral Reefs* 12: 117-125.
- Ma, T. Y. H. (1937) On the growth of reef corals and its relation to the sea water temperature. *Mem. Nat. Inst. Acad. Sinica Zool.* 1, 1-226.
- Veron, J. E. N. (1986) Corals of Australia and the Indo-Pacific. Angus & Robertson, Sydney, Australia, 644 pp.
- Veron, J. E. N. (1992) Hermatypic corals of Japan. *Aust. Inst. Mar. Sci. Monogr.*, Vol. 9, 234 pp.

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- Veron, J. E. N. and M. Pichon (1980) Scleractinia of Eastern Australia. III. Families Agariciidae, Siderastreidae, Fungiidae, Oculinidae, Merulinidae, Mussidae, Pectiniidae, Caryophylliidae, Dendrophylliidae, Aust. Inst. Mar. Sci. Monogr., Vol. 4, 422 pp.
- Veron, J. E. N. and M. Pichon (1982) Scleractinia of Eastern Australia. IV. Family Poritidae. Aust. Inst. Mar. Sci. Monogr., Vol. 5, 159 pp.
- Veron, J. E. N., M. Pichon and M. Wijsman-Best (1977) Scleractinia of Eastern Australia. II. Families Faviidae, Trachyphyllidae. Aust. Inst. Mar. Sci. Monogr., Vol. 3, 233 pp.
- Veron, J. E. N. and C. C. Wallace (1984) Scleractinia of Eastern Australia. V. Family Acroporidae. Aust. Inst. Mar. Sci. Monogr., Vol. 6, 485 pp.
- Yang, R.-T, C.-C. Huang, C.-S. Lee, H.-J. Tsai and C.-L. Sun (1975) Survey report on the Dong-Sha Island and the adjacent area. Part I. Corals, fishes, and shells. Institute of Oceanography. National Taiwan University, special publication no. 8, 15 pp.
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# 從1998年東沙環礁珊瑚群聚調查紀錄探討 東沙環礁珊瑚群聚的變遷：1975~1998

<sup>1</sup> 李展榮、<sup>1</sup> 李財富、<sup>2</sup> 張桂祥、<sup>12</sup> 方力行

<sup>1</sup> 國立海洋生物博物館  
<sup>2</sup> 國立中山大學海洋資源所

## 摘要

東沙環礁的珊瑚相在1998年4月的調查中，總共記錄了14科26屬61種以上的珊瑚種類，其中石珊瑚有10科20屬49種，八放珊瑚有3科5屬8種，水螅珊瑚1科1屬4種。這次調查結果顯示東沙海域的珊瑚相以造礁石珊瑚為主，尤其以軸孔珊瑚 (*Acropora* spp.) 和微孔珊瑚 (*Porites* spp.) 最為常見，東沙環礁的珊瑚相從1994年所記錄的種類數 (137種以上) 的珊瑚種類，到1998年的61種，減少了76種，在短短的4年內少了55.5%；珊瑚群聚90%以上遭受破壞。顯示此海域的生物相已遭受到極大的迫害，而此迫害大多來自人為的因素，如毒、炸魚及廢棄電池等。

**關鍵字：**東沙環礁、珊瑚群聚、軸孔珊瑚、微孔珊瑚、*Acropora*、*Porites*

