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CHECKLIST OF REEF FISHES FROM TUNGSHA TAO (PRATAS ISLAND), SOUTH CHINA SEA

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This paper reports the results of our study on the coral reef fishes in the reef area around Tungsha Tao, also known as "Pratas Island", located at 20 °35′~20 °47′ N and 116 °42′~116 °55′ E, using SCUBA diving techniques from June 20th to 24th 1994. A total of 55 families and 311 species of fishes were obtained from 7 survey stations. Together with the result of some previous investigations, a total of 62 families and 396 species have now been recorded in this area.

Among those species we found, 30 have not been recorded in the waters around Taiwan. They include 3 probably undescribed new species, 10 unidentified species, and 17 identified species. Of these 17, 5 species were underwater censused while specimens were collected for the other 12. The number of species was higher in the reef areas (stations 2,3, and 6) than in the shallow seagrass beds.

Analysis of fish species composition in this islet shows that the family of Labridae was the most speciose, Pomacentridae was the next, then Gobiidae and Chaetodontidae. The top four ranks of families at Tungsha are identical with Nansha, Green Island, and Orchid Island but quite different from the other regions of Taiwan. The results of zoogeographical analysis of all listed fishes reveal that almost all species (94.7%) are widely distributed species; only very few belong to narrowly distributed species.

The Czekanowski similarity coefficients of species composition for the different regions around Taiwan show that the most similar fish fauna to Tungsha occurs at Nansha, then Green Island, Orchid Island, Hsiao-liu-chiu, southern Taiwan, Penghu, and northern Taiwan. The lowest similarity with Tungsha occurs in western Taiwan.

In addition to the checklist of fishes and the fauna comparison with different regions in Taiwan and Nansha, the specimen photos of 19 species previously absent in Taiwan but now discovered at Tungsha are also provided.

Key words: Fish fauna, fish taxonomy, zoogeographical distribution.

Tungsha Tao, also known as Pratas Island, is located at 20 °35′~20 °47′ N and 116 °42′~116 °55′ E, i.e., at the northern part of the South China Sea. Its geographical position is about at the midpoint between Taiwan, Hongkong, and Luzon, and it functions as the southern gate of the Taiwan Strait (Fig.1). It's geographical distance from Kaohsiung is about 240 nautical miles in north-east direction. Tungsha

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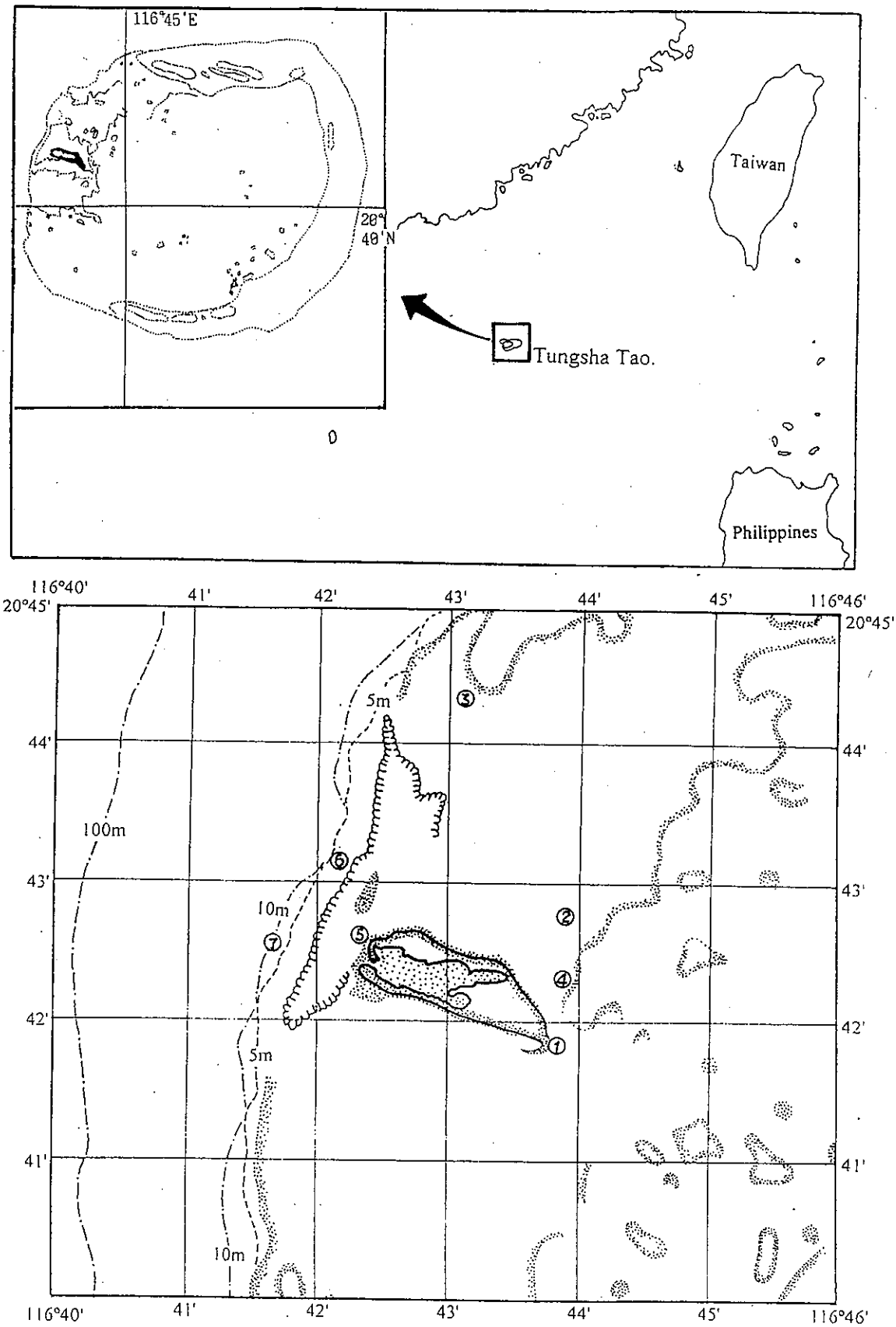
Tao is actually a small islet of 1.74 km^2 on the west arm of the large submerged atoll (100 km^2 approximately) known as Tungsha Reef (Fig.1). The islet is totally covered with sandy coral debris and traces of guano. It has a semiclosed claw shaped lake open westwardly. The climate is subtropical and oceanic. The yearly water temperature ranges from 22℃～30℃.

The waters around Tungsha Tao have long been well-known as good fishery grounds for migratory fishes, such as shark, mackerel, tuna, and bonitos ; for benthic reef species, such as groupers, sea bream, lobsters, shellfish, and seaweeds ; and for snappers and emperors on the sandy bottom. Thus, many fishing boats from mainland China, Taiwan, and Hongkong have exploited the fishery resources here, both inside and outside the atoll, by using long-lining, purse seine, or pole and dip net. Nevertheless, very few reports on the biological resources of this islet could be found. The earliest report seems to have been published in Taiwan Fisheries Magazine No. 23 in 1917 (Ta-Cheng 6th year in Japanese calender) in which 13 species including 7 unidentified species were mentioned. Professor T.Y. Ma was the first Chinese scientist who went to the islet to study the coral reefs, but no fishes were reported (Ma, 1937). After the government of Taiwan, R.O.C. retreated to Taiwan in 1949, the first expedition to the islet was made by the Institute of Oceanography, National Taiwan University in March 1975. In that cruise, only 25 species of fishes were identified from their 86 specimens collected by spearing and poisoning at 2 stations (Yang et al. 1975).

Taiwan Fisheries Research Institute (TFRI) also made several cruises, mostly bottom trawling to explore the fishery grounds in the South China Sea. Among these preliminary investigations, only Su et al (1976) and Su et al (1979), who reported 21 species and 23 species respectively were taken into account for our comparison since their survey area was very close to Tungsha Tao. Other related papers from TFRI (Wei, 1961; Tsai, 1980; Lu and Hsieh, 1981) were not compared in the present paper since their surveys covered a wider area. Later on, explorations were shifted to Nansha Tao (also known as Taiping Tao, Sprately Island, or Itu-Aba Island) rather than Tungsha (Wu, 1981; Hsieh and Hong, 1982; Chi, 1989).

As for mainland China, their fishing boats and research vessels could not operate near the shore of Tungsha since the islet is tightly controlled and protected by the military of Taiwan, Republic of China. Thus, most of their surveys were conducted in Chungsha, Xisha and Nansha Islands. Although several of their papers, titles referred to Tungsha ("Dongsha" in mainland China's spelling) (Yang & Huang, 1983; Huang & Yang, 1983), their study area was actually far away from Tungsha Tao and the water deeper than 100m. Therefore their fish lists were excluded from the checklist in the present paper.

Until recently, ecological data for Tungsha waters was very insufficient. We were first invited to join an expedition to investigate the reef fishes there four years ago in a survey supported by the Kaohsiung City Government (Fang and Hu, 1990). During that survey, 54 families and 264 species, including 21 unidentified species of reef fishes, were recorded by us (Chen et al., 1991). The present report represents the survey results of our second expedition to study the reef fishes at Tungsha Tao, sponsored by the Council of Agri-



igure 1. The map of 7 diving investigation stations (numbers in circle) around Tungsha Tao.

culture to the National Museum of Marine Biology/Aquarium (Fang & Lee, 1994) . The survey results for the fishes at Nansha from the same project will be published elsewhere (Chen et al., 1995).

STUDY AREA AND METHOD

This study was carried out in situ from June 20th to 24th, 1994 by using diving and shoreline angling. A total of seven stations around Tungsha Tao were investigated as shown in Fig. 1. Of these stations, three ranged from intertidal to reef flat; station 4 was investigited by SCUBA, 1 and 5 by snorkeling. The other four stations were subtidal and SCUBA diving was used. Each station was surveyed only once during whole study period including underwater observation, recording the species names and abundance, photography, and specimen collections.The abundance data of observed fishes were categorized as R (rare), O (occasional), C (common), or A (abun-dant) if only 1～3, 4～15, 16～63, or more than 64 individuals of that species were observed respectively during one survey. Thirteen guild types of fish diurnal activity and spatial distribution were used following Shen et al. (1990), Chen et al. (1992) and Shao et al. (1993b). Table 1 briefly describes their depths and physio-graphic features, which show that their substratum and topography were somewhat different.

RESULTS & DISCUSSION

Table 2 is the checklist of reef fish species composition in the shallow waters around Tungsha Tao. The contents and notations of each column are:

1. Family name
2. Species name
3. Literature cited: 1 to 4 representing the following four papers: Yang et al. (1975), Su et al. (1976), Su et al. (1979), and Chen et al. (1991) respectively.
4. Abundance
5. Hand lining: Specimens were caught by hand lining on the shoreline.
6. Comparison of fish fauna of Taiwan: To ascertain whether the species also occurred in Nansha Tao (NS), west Taiwan (W), Penghu (P), Hsiao-liu-chiu (H), southern Taiwan (S), northern Taiwan (N), Lanyu (L), and Green Island (G) based on our previously established fish database. Some of these regional faunistic checklists have already been published, such as: south Taiwan (Shen et al., 1990), west of Taiwan (Shao et al., 1993b), Hsiao-liu-chiu (Chen et al., 1992), and Penghu (Shao et al., 1993a). The fish checklist of other regions are still in preparation.
7. Guild types
8. World distributions: follow Shao et al. (1993b).

A . Literature review:

Of the 25 species listed in Yang et al. (1975), *Abudefduf amabilis* is endemic to Hawaii, and the corresponding species at Tungsha should be *A. saxatilis or A. sexfasciatus*; the occurrence of *Eleotris melanosoma* and *Terapon theraps* must be considered doubtful; and *Liza parva* might not be a valid species. So the total valid species in Yang et al. (1975) is taken to be only 21. Additionally, some of their misspellings and synonyms are corrected directly in Table 2.

Of the 21 species listed in Su et al. (1976), 3 were unidentified and 7 of the

Table 1. Descriptions of the underwater substratum and topography of the seven survey stations.

Station number	Location	Time(1994)	Depth(m)	Zonation and habitat
1	south-eastern corner	June 20 PM	0–4	Moving sand belt, barren without seagrasses, scattered with some discarded blocks. Coral appears in the waters deeper than 3m and 200 ~300m away from shore.
2	north	June 21 AM	3–5	Flat sandy bottom with prosperous seagrass bed near shore, in deeper waters the coral growing very well, some even reaching to the sea surface.
3	north	June 21 PM	4–8	Reef flat with some surge channels, coral growing well.
4	north	June 22 AM	0–5	From coastal seagrass bed to outer reef margin , one sunken barge emerged during ebb at about 400m~500 meter offshore.
5	north-eastern side	June 22 PM	0–1	Intertidal zone with prosperous seagrasses, mixed with many small reefs and small caves on the bottom probably made by bombing.
6	north-eastern side	June 23 AM	6–8	Mixed reefs and sandy patches; many coral mounds or boulders like isolated reefs with some caverns.
7	western side	June 23 PM	18–20	Large reef flat on the sandy bottom, the height of reef flat lower than 1m with many table-like corals; sandy slope outside the reef margin, dropping to very deep waters.

other 18 species had synonymity problems. Similarly, although Su et al. (1979) listed 23 species including one unidentified species, nearly half these species were junior synonyms.

Some synonyms also occurred in our previous checklist of 264 species (Chen et al., 1991) . In this first report we did not review the earlier literature, but in this paper we carefully checked the validity of all listed species in the above four references. Consequently, a total of 270 valid species had been obtained in Tungsha waters before the present survey.

B. Investigation results:

Table 2 lists all 62 families and 396 species of reef fishes found at Tungsha Tao of which 55 families and 311 species were observed or collected in this trip. Only 85 species were not obtained this time. Table 3 lists 30 species which have not yet been recorded in the waters around Taiwan. seven of these species have been recorded previously in Chen et al. (1991), while the other 23 species are new records. Specimens were collected for 19 of these species (photo 1-19). In Table 3 there are 13 species

Table 2–1. Checklist and the distribution of reef fishes in the waters around Tungsha Tao. For the explanation of each column, please refer to the text.

Family	Species	Liter-ature	Abundance at each station							hand line	NS	W	P	H	S	N	L	G	Guild	Geogr-aphy
			(1)	(2)	(3)	(4)	(5)	(6)	(7)											
Acanthuridae	*Acanthurus bariene*	4												*	*		*	*	4,5	IwP
	Acanthurus dussumieri	4	0	0							*	*	*	*	*	*	*	*	4,5	IwP
	Acanthurus japonica	4			R			0	R		*				*		*	*	2	WP
	Acanthurus lineatus	4			R						*		*	*	*	*	*	*	4,13	IP
	Acanthurus maculiceps	4													*		*	*	4,5	IwP
	Acanthurus nigrofuscus	4		0	0				C		*		*	*	*	*	*	*	4,5	IP
	Acanthurus olivaceus	4							R		*		*		*		*	*	4,5	WP
	Acanthurus thompsoni			R					R		*		*		*	*	*	*	1,5	IP
	Acanthurus triostegus	4			R						*			*	*		*	*	4,13	C
	Acanthurus xanthopterus	4	0	C		C	0		C		*	*	*	*	*	*	*	*	5,6	IP
	Ctenochaetus binotatus							R			*	*		*	*	*	*	*	5,6	IP
	Ctenochaetus striatus	4		C	C	C		C		*	*		*	*	*	*	*	*	5,6	IP
	Naso lituratus	4					0				*		*	*	*	*	*	*	1,5	IP
	Naso unicornis	2,4		R							*	*	*	*	*	*	*	*	1,5	IP
	Zebrasoma scopas	4			R			0	R		*			*	*		*	*	4,6	IP
	Zebrasoma veliferum	4		R	0			R	R		*			*	*	*	*	*	4,6	IP
Antennariidae	*Antennarius pictus*						R												6,10	IP
Apogonidae	*Apogon bandanensis*	1,4									*				*			*	7	IwP
	Apogon coccineus	4			0	0						*	*	*	*	*	*	*	10	IP
	Apogon cookii		R				C				*	*	*	*	*	*	*	*	6,13	IP
	Apogon cyanosoma	4									*		*	*	*		*	*	5	IP
	Apogon exostigma			0							*			*	*		*	*	5	IP
	Apogon fuscus			R							*		*		*				5	IP
	Apogon guamensis	4				C	C								*				10	IP
	Apogon melas					C									*				10	WcP
	Apogon notatus	4											*	*	*	*			2	WP
	Apogon novemfasciatus	1				C													7	WcP
	Apogon sp.	4	A	A		A			C			*	*	*	*	*	*		5	WP
	Apogon taeniophorus	4												*	*				5	IP
	Cheilodipterus macrodon	4						R	R		*	*	*	*	*	*	*	*	5,11	IwP
	Cheilodipterus quinquelineatus	4	R	0		C	0		R		*			*	*	*		*	5,11	IP
	Fowleria variegata	1		C		0									*				5	IwP
	Gymnapogon sp.			R															5	?
	Pseudamia gelatinosa	4													*	*			6,11	Iwp
	Pseudamiops gracilicauda							R			*				*		*	*	5,11	Wcp
	Sphaeramia nematoptera			R											*				7	WP

Table 2–2. Checklist and the distribution of reef fishes in the waters around Tungsha Tao. For the explanation of each column, please refer to the text.(Continued)

Family	Species	Liter-ature	Abundance at each station							hand line	NS	W	P	H	S	N	L	G	Guild	Geogr-aphy
			(1)	(2)	(3)	(4)	(5)	(6)	(7)											
Aulostomidae	*Aulostomus chinensis*	4	R	R	R	0	0	R	0			*	*	*	*	*	*	*	4,6	IpP
Balistidae	*Balistapus undulatus*	2,3			R				R		*		*	*	*	*	*	*	6	IP
	Balistoides conspicillum							R	R		*			*	*	*	*	*	4	IP
	Balistoides viridescens	4									*	*			*	*	*	*	6	IP
	Melichthys vidua	4									*			*	*		*	*	3,4	IP
	Odonus niger	3							C		*			*	*		*	*	3	IP
	Rhinecanthus aculeatus	4	0	0		R					*			*	*	*	*	*	6	IP
	Rhinecanthus rectangulus	3,4				R					*		*	*	*	*	*	*	6	IP
	Sufflamen bursa		0		0	0		R	R		*			*	*	*	*	*	6	IP
	Sufflamen chrysopterus	4					R	R			*	*	*	*	*	*	*	*	6	IP
	Sufflamen freanatus	2,3							R		*				*	*		*	6	IP
	Thamnaconus modestus	3														*			4,6	IwP
Belonidae	*Tylosurus crocodilus*	4		R						*		*	*	*	*	*	*	*	1	C
Blenniidae	*Atrosalarias fuscus holomelas*	4	0	0			R												6	IP
	Ecsenius bicolor							R			*								10	IP
	Ecsenius lineatus					R							*			*			10	IwP
	Ecsenius namiyei	4											*			*	*		10	WP
	Exallias brevis				R										*		*	*	10	IP
	Meiacanthus grammistes	4				R					*		*	*	*	*	*	*	3	WP
	Petroscrites mitratus					R	R												10	IP
	Plagiotremus tapeinosoma			R		R					*	*	*	*	*	*	*	*	10,13	IP
	Salarias fasciatus						0				*		*		*	*			10	IP
	Salarias guttatus		R			R													10	WP
Bothidae	*Bothus pantherinus*	1											*	*	*	*	*	*	5	IP
Caesionidae	*Caesio tere*								0		*	*		*	*		*	*	1,4	WP
	Pterocaesio diagramma	4									*	*		*	*	*	*	*	1,4	IwP
	Pterocaesio tile	4									*	*		*	*		*	*	1,4	IP
Caracanthidae	*Caracanthus maculatus*				R												*	*	7	WcP
Carangidae	*Carangoides fulvoguttatus*							R											4,5	IwP
	Carangoides hedlandensis									*		*	*						1,4,5	IwP
	Carangoides orthogrammus							R							*			*	4,5	IP
	Caranx ignobilis								R	*	*	*			*	*	*	*	4,5	IP
	Caranx melampygus									*			*		*		*	*	4,5	IpP
	Caranx sexfasciatus								R	*		*	*	*	*	*	*	*	4,5	IpP
	Kaiwarinus equula											*	*		*	*			4,5	IwP
	Trachinotus baillonii									*	*								1,4,5	IwP

Table 2–3. Checklist and the distribution of reef fishes in the waters around Tungsha Tao. For the explanation of each column, please refer to the text.(Continued)

Family	Species	Liter-ature	Abundance at each station							hand line	NS	W	P	H	S	N	L	G	Guild	Geogr-aphy
			(1)	(2)	(3)	(4)	(5)	(6)	(7)											
Carcharhinidae	*Carcharhinus limbatus*	4																	1	C
	Carcharhinus longimanus	4																*	1	C
	Negaprion acutidens	4																	1	IP
Chaetodontidae	*Chaetodon auriga*	4	0	0	0	C	0	0			*	*	*	*	*	*	*	*	4	IP
	Chaetodon auripes	4		R	R							*	*	*	*	*	*	*	4	JsC
	Chaetodon baronessa	4									*		*		*		*	*	4	WP
	Chaetodon citrinellus	4	R		0			0	0		*		*	*	*	*	*	*	4	IP
	Chaetodon ephippium	4		R		R						*	*	*	*		*	*	4	WcP
	Chaetodon kleinii	4	R	R	0	0		0	0		*	*	*	*	*	*	*	*	4	IP
	Chaetodon lineolatus	4					R						*	*	*	*	*	*	4	IP
	Chaetodon lunula	4		R							*	*	*	*	*	*	*	*	4	IP
	Chaetodon melannotus	4			C			R			*		*	*	*	*	*	*	4,7	IP
	Chaetodon ornatissimus								R		*		*	*	*	*	*	*	4,7	IP
	Chaetodon plebeius	4		R				R	R				*	*	*	*	*	*	4,7	IP
	Chaetodon punctatofasciatus	4			0	0		R	R		*	*		*	*	*	*	*	4	WcP
	Chaetodon rafflesi				R		R	R	R		*				*				4,7	IP
	Chaetodon speculum	4		R	R	R	R	R				*	*	*	*	*	*	*	4	WP
	Chaetodon trifascialis	4		0	C	C		0	0		*		*	*	*	*	*	*	4,7	IP
	Chaetodon trifasciatus	4		R	C	C		0			*		*	*	*	*	*	*	4,7	IP
	Chaetodon ulietensis	4													*	*	*	*	4	WP
	Chaetodon unimaculatus	4			0			0			*		*	*	*	*	*	*	4,7	IP
	Chaetodon vagabundus	4			R			0			*	*	*	*	*	*	*	*	4	IP
	Chaetodon wiebeli	4											*		*	*			4	WP
	Chaetodon xanthurus	4						0	0		*		*	*	*			*	4	WP
	Heniochus acuminatus	4	R								*	*	*	*	*	*	*	*	4,11	IP
	Heniochus chrysostomus								R		*		*	*	*	*	*	*	4,11	WP
	Heniochus monoceros	4									*		*		*	*	*	*	4	IP
	Heniochus singularius	4					R							*	*	*	*	*	4	WcP
	Heniochus varius	4			R			R			*		*	*	*	*	*	*	4,11	WcP
Chanidae	*Chanos chanos*	4								*					*	*		*	1	IP
Cirrhitidae	*Cirrhitichthys oxycephalus*							R	R		*		*	*	*		*		6	IpP
	Cirrhitus pinnulatus				R						*		*	*	*		*	*	6,13	IP
	Paracirrhitus arcatus	4									*			*	*		*	*	6,7	IP
	Paracirrhitus forsteri	4			R						*		*	*	*	*	*	*	6	IP
Congridae	*Conger cinereus*	4									*	*		*	*	*	*	*	5,13	IP

Table 2-4. Checklist and the distribution of reef fishes in the waters around Tungsha Tao. For the explanation of each column, please refer to the text.(Continued)

Family	Species	Liter-ature	Abundance at each station							hand line	NS	W	P	H	S	N	L	G	Guild	Geogr-aphy
			(1)	(2)	(3)	(4)	(5)	(6)	(7)											
Congridae	*Ganthophis nystromi*	4				R													5	JsC
Coryphaenidae	*Corypaena hippurua*	4										*	*	*	*	*	*	*	1	C
Creediidae	*Limnichthys* sp.			R				R			*								5	JT
Dasyatidae	*Taeniura melanospila*	4				R			R		*		*						5	IP
Diodontidae	*Diodon hystrix*	4					R		R					*	*	*			6,10	C
	Diodon liturosus	4							R			*		*	*	*	*	*	6,10	IP
Echeneidae	*Echeneis naucrates*	4						R							*	*			1,4	C
Exocoetidae	*Cypselurus pinnatrbarbatus japonicus*	2																	1	IpP
Fistulariidae	*Fistularia petimba*	3,4		R	0				R			*	*	*	*	*	*	*	4,5	IwP
Gerreidae	*Gerres oyena*	4		R								*	*	*	*	*		*	5	IwP
Gobiidae	*Amblygobius phalaene*	4		0	A	A					*		*	*	*	*			5	IP
	Asterropteryx semipunctatus					C	C						*		*	*			10	IP
	Callogobius sclateri			R							*			*	*			*	5	IP
	Ctenogobiops feroculus			0		A					*				*				5	IwP
	Eviota afelei	4																	10	WcP
	Eviota latifasciatus				C			A											10	WP
	Eviota prasites	4						R			*								10	WP
	Eviota gueenslandica			R															10	IwP
	Eviota sebreei			R	R			R											7	IP
	Eviota sigillata			R															10	IwP
	Eviota sp. 1							C											10	?
	Eviota sp. 2				0		0	C											10	?
	Eviota sp. 3				C		C	0											10	?
	Eviota sp. 4				R		R												10	?
	Fusigobius duospilus			C	C	C	R	R			*			*	*		*		5	WP
	Fusigobius neophytus			R							*			*	*			*	5	IwP
	Gnatholepis scapulostigma			C		0		C	0		*		*	*	*	*	*	*	5,10,13	WP
	Gobiodon citrinus	4		A		A					*		*	*	*			*	7	IP
	Gobiodon multilineatus	4																	7	JsC
	Gobiodon oculolineatus							R									*		7	WP
	Gobiodon okinawae	4		0		0								*	*				7	WP
	Istigobius ornatus														*	*	*	*	5	IP
	Istigobius rigillius			C	C				0		*								5	IP
	Lubricogobius exigus	4																	10	JC
	Paragobiodon modestus					R									*				7	IP
	Pleurosicya bilobata							R											10	JC

Table 2–5. Checklist and the distribution of reef fishes in the waters around Tungsha Tao. For the explanation of each column, please refer to the text.(Continued)

Family	Species	Liter-ature	Abundance at each station							hand line	NS	W	P	H	S	N	L	G	Guild	Geogr-aphy
			(1)	(2)	(3)	(4)	(5)	(6)	(7)											
Gobiidae	*Priolepis cincta*							R					*	*	*	*	*	*	5	IwP
	Priolepis inhace							R											5	IP
	Priolepis sp.							R											5	?
	Trimma macrophthalma					R		R										*	10	IwP
	Trimma sp. 1				0			C											10	?
	Trimma sp. 2							R											10	?
Grammistidae	*Grammistes sexlineatus*	4					0	R			*	*	*	*	*	*	*	*	5,11	IP
Haemulidae	*Plectorhynchus chaetodonoides*	2,4		R							*		*		*	*		*	5,11	WP
	Plectorhynchus cinctus					R						*	*		*	*			5,11	JsC
	Plectorhynchus diagrammus	4			R				R				*	*	*	*	*	*	11	IwP
	Plectorhynchus goldmanni	4				R									*			*	11	WP
	Plectorhynchus lineatus	4		R								*			*		*	*	11	WP
	Plectorhynchus pictus	1				R	R					*	*	*	*	*	*	*	5,11	IwP
Holocentridae	*Myripristis adustus*	1,4						C				*			*		*	*	11,13	IP
	Myripristis berndti				R			C	C		*			*	*	*	*	*	11	IpP
	Myripristis kuntee	4			R						*	*	*	*	*		*	*	11	IP
	Myripristis melanostictus								0				*	*	*				11	IP
	Myripristis murdjan	3									*	*	*	*	*	*	*	*	11,13	IP
	Myripristis violaceus	4		R											*	*	*		11	IP
	Neoniphon sammara	4		R							*			*	*	*		*	11,13	IP
	Sargocentron caudomaculatus	4			R			0	A		*			*	*		*	*	10,11	IP
	Sargocentron diadema	4							0		*	*	*	*	*	*	*	*	11,13	IP
	Sargocentron ittodai	2,4												*	*		*	*	10,11	IwP
	Sargocentron melanospilos	4			R				R					*		*			11	IP
	Sargocentron rubrum	4	R						C			*	*	*	*	*		*	10,11	IP
	Sargocentron spiniferum	2,3,4		R	R						*	*	*		*	*	*	*	10,11	IP
	Sargocentron spinosissimum	4									*			*	*	*	*	*	10,11	JT
Kyphosidae	*Kyphosus bigibbus*	4												*	*	*	*	*	4	IP
	Kyphosus cinerescens	4		R	R			R	0		*	*	*	*	*	*	*	*	4	IP
	Kyphosus lembus	2											*		*	*	*	*	4	IP
Labridae	*Anampses caeruleopunctatus*	4					R				*	*	*	*	*	*	*	*	4,5,6	IP
	Anampses geographicus	4							R		*	*		*	*	*	*	*	4,5,6	IwP
	Anampses melanurus	4							R		*		*	*	*	*	*	*	4,5,6	IP
	Anampses meleagrides	4						0			*	*	*	*	*	*	*	*	4,5,6	IP
	Anampses twiisti							R			*	*	*	*	*		*	*	4,5,6	IP
	Bodianus bilunulatus	4									*		*	*	*		*	*	6	IP

Table 2-6. Checklist and the distribution of reef fishes in the waters around Tungsha Tao. For the explanation of each column, please refer to the text.(Continued)

Family	Species	Liter-ature	Abundance at each station							hand line	NS	W	P	H	S	N	L	G	Guild	Geogr-aphy
			(1)	(2)	(3)	(4)	(5)	(6)	(7)											
Labridae	*Bodianus mesothorax*	4							R		*		*	*	*		*	*	4,11	WP
	Cheilinus bimaculatus		R			0	R		R		*		*	*	*	*	*	*	4,5	IP
	Cheilinus celebicus	4												*	*		*		6	WcP
	Cheilinus chlorurus	4	R	0	0						*		*	*	*		*	*	6	IP
	Cheilinus diagrammus	4							R		*			*	*		*	*	6	IP
	Cheilinus fasciatus	2,4		R	R						*		*	*	*		*	*	6	IP
	Cheilinus oxycephalus					0					*		*	*	*		*	*	6	IP
	Cheilinus trilobatus				R			R			*		*	*	*	*	*	*	6	IP
	Cheilinus undulatus	4							R		*				*	*	*	*	6	IP
	Cheilinus unifasciatus	4							R		*	*			*	*	*	*	4	WcP
	Cheilio inermis	1,4	R	R					R		*		*	*	*	*	*	*	4	IP
	Choerodon anchorago	4		R					R					*	*			*	5	IP
	Cirrilabrus cyanopleurus	4						R			*		*	*	*		*	*	6	WP
	Coris gaimard	4						R			*	*	*	*	*		*	*	5,6	IP
	Cymolutes torquatus	4											*						5	IP
	Epibulus insidiator	4		0	C	0		R	R		*	*		*	*			*	6,11	IP
	Gomphosus varius	4	R		0	0	R	R			*	*	*	*	*	*	*	*	6	IwP
	Halichoeres biocellatus	4									*	*	*	*	*		*	*	5,6	WP
	Halichoeres hortulanus	4					R	R			*	*	*	*	*	*	*	*	5	IP
	Halichoeres margaritaceus		0								*		*	*	*	*	*	*	5,6	WcP
	Halichoeres marginatus	4									*			*	*	*	*	*	5,6	IP
	Halichoeres ornatissimus	4									*	*			*		*	*	5	WP
	Halichoeres scapularis			C		0	R				*		*	*	*	*	*	*	5,6	IwP
	Halichoeres trimaculatus	1,4	A	A		C		0			*		*	*	*		*	*	5	IwP
	Hemigymnus fasciatus	4				R					*	*	*	*	*	*	*	*	6	IP
	Hemigymnus melapterus	4	R	R	R	R	R		R		*	*	*	*	*		*	*	5,6	IP
	Hologymnosus doliatus				0						*		*	*	*		*	*	5	IP
	Labrichthys unilineatus	4		R	0	R			R					*	*		*	*	5	IwP
	Labroides bicolor	4			R				R		*		*	*	*		*	*	6	IP
	Labroides dimidiatus	4	0	0	0		0	R			*	*	*	*	*	*	*	*	6	IP
	Macropharyngodon meleagris	4									*		*	*	*	*	*	*	5,6	WP
	Novaculichthys taeniurus		R								*	*		*	*		*	*	5	IP
	Pseudocheilinus evanidus	4							R		*			*	*		*	*	6	IP
	Pseudocheilinus hexataenia				R			R			*		*	*	*	*	*	*	6,7	IP
	Pteragogus flagellifera	4									*	*	*	*	*	*	*	*	6	IwP
	Stethojulis bandanensis	4	A	A	A	A	A	A	0		*	*	*	*	*	*	*	*	5,6	IP

Table 2–7. Checklist and the distribution of reef fishes in the waters around Tungsha Tao. For the explanation of each column, please refer to the text.(Continued)

Family	Species	Liter-ature	Abundance at each station							hand line	NS	W	P	H	S	N	L	G	Guild	Geogr-aphy
			(1)	(2)	(3)	(4)	(5)	(6)	(7)											
Labridae	*Stethojulis interrupta*	4										*	*	*	*	*	*	*	5,6	IwP
	Stethojulis strigiventer	1,4		0	R		A					*	*	*	*	*	*	*	5,6	IP
	Stethojulis trilineata	4									*	*	*	*	*	*	*	*	5,6	IwP
	Thalassoma amblycephalum	4							0		*		*	*	*	*	*	*	4,6	IP
	Thalassoma hardwickii	4				R	R	R			*	*	*	*	*	*	*	*	6,13	IP
	Thalassoma janseni	2,3,4							R				*	*	*		*	*	4,6	IP
	Thalassoma lunare	4	0		0		R	R			*	*	*	*	*	*	*	*	4,6,13	IP
	Thalassoma lutescens	4						R			*	*	*	*	*	*	*	*	4,6	IpP
	Thalassoma purpureum	4									*	*		*	*	*	*	*	4,6,13	IP
	Thalassoma quiquivittatum			R	R			R			*	*	*	*	*		*	*	4,6,13	IP
	Xyrichtys dea	2,3										*	*	*	*	*	*	*	5	IwP
	Xyrichtys pavo	4									*		*	*				*	5	IpP
Lethrinidae	*Gnathodentex aurolineatus*	3									*				*		*	*	6	IP
	Lethrinus erythracanthus	3									*								5	IP
	Lethrinus harak	3,4	C	C	0	C	C	R			*	*		*	*			*	5	IwP
	Lethrinus ornatus			0		0	0					*							5	IwP
	Lethrinus reticulatus	2,3									*				*				5	IwP
	Lethrinus variegatus	4		R					C						*				5	IP
	Monotaxis grandoculis			R							*	*		*	*		*	*	5	IP
Lutjanidae	*Aphareus rutilans*									*	*				*		*	*	5	IP
	Aprion viresceus								R		*		*		*		*	*	5	IP
	Lutjanus fulviflamma	3,4								*		*	*	*	*	*	*	*	5	IwP
	Lutjanus fulvus	4		R		A						*	*	*	*	*	*	*	5	IP
	Lutjanus gibbus		0	R		A					*	*	*	*	*	*	*	*	2,5	IP
	Lutjanus johnii	3										*							5	IwP
	Lutjanus kasmira	3,4				R		A	A		*	*	*		*	*	*	*	2,5	IP
	Lutjanus monostigma	4									*	*	*	*	*	*	*	*	5,13	IP
	Lutjanus rivulatus						R					*	*		*	*	*	*	5	IP
	Lutjanus russelli	4									*	*	*	*	*	*	*	*	5,13	IP
	Lutjanus vitta	4										*	*			*			4,5	IwP
	Macolor niger	4						R			*				*		*	*	6	IwP
Malacanthidae	*Malacanthus brevirostris*								A		*			*	*	*	*	*	5	IpP
	Malacanthus latovittatus	4						R			*			*	*		*		5	IwP
Microdesmidae	*Nemateleotris magnificus*	4						R	R		*			*	*	*	*	*	6	IP
Mullidae	*Mulloides flavolineatus*	4		0	0	R		0	C		*			*	*		*	*	5	IP
	Mulloides vanicolensis	4			R									*	*		*	*	5	IP

Table 2-8. Checklist and the distribution of reef fishes in the waters around Tungsha Tao. For the explanation of each column, please refer to the text.(Continued)

Family	Species	Liter-ature	Abundance at each station							hand line	NS	W	P	H	S	N	L	G	Guild	Geogr-aphy
			(1)	(2)	(3)	(4)	(5)	(6)	(7)											
Mullidae	*Parupeneus barberinoides*	4				R	R								*	*	*	*	5	WcP
	Parupeneus barberinus	4	C	0	0	0			0		*	*	*	*	*	*	*	*	5	IP
	Parupeneus bifaciatus	4									*			*	*	*	*	*	5	IP
	Parupeneus chrysopleuron	4											*		*				5	IP
	Parupeneus ciliatus	4	0	C	C	0	0	0			*		*	*	*	*	*	*	5	IP
	Parupeneus cyclostomus	4							R		*			*	*		*	*	5	IP
	Parupeneus indicus	1,4	0	R		0						*	*	*	*	*	*	*	5	IwP
	Parupeneus multifasciatus	2,3,4	R	R	C	C	R		0		*		*	*	*	*	*	*	5	WcP
	Parupeneus pleurostigma	4	0	0	0	0	R	0	0		*			*	*	*	*	*	5	IP
Muraenidae	*Echidna nebulosa*	1									*	*	*	*	*	*	*	*	10,13	IP
	Echidna polyzona	1						R			*		*	*	*	*	*	*	10,13	IP
	Gymnothorax berndti		0	R											*				10	WcP
	Gymnothorax fimbriatus			R							*			*	*	*	*	*	10	IP
	Gymnothorax flavimarginatus	1,4												*	*	*	*	*	10	IP
	Gymnothorax javonica		R					R			*		*						10	IP
	Gymnothorax meleagris								R		*			*	*	*	*	*	10,13	IP
	Gymnothorax undulatus	1						R						*	*	*	*		10	IP
Myliobatididae	*Aetobatus narinari*	4										*	*						4,5	C
Nemipteridae	*Pentapodus caninus*	4									*			*	*				5	WcP
	Scolopsis bilineatus		0	0	R		C				*	*	*	*	*	*	*	*	5	WP
	Scolopsis lineatus	4	0	0	0	0	C				*	*		*	*		*	*	5	IP
	Scolopsis monogramma		R												*				5	WP
	Scolopsis trilineatus	4	C	C	A	0		0											5	WP
Ophidiidae	*Brotula multibarbata*				R							*			*	*	*		10	WcP
Orectolobidae	*Nebrius concolor*	4																	1,4	IP
Ostraciidae	*Ostracion cubicus*	4				R		R	R		*		*	*	*	*	*	*	6	IP
Pempheridae	*Pempheris oualensis*	4											*	*	*	*	*	*	11	IP
Pinguipedidae	*Parapercis cylindrica*	1									*			*	*		*	*	5	IP
	Parapercis hexophthalma	4		R				R	R		*			*	*	*	*	*	5	IP
	Parapercis millepunctata	4							R		*			*	*		*	*	5	IP
	Parapercis snyderi					R	R						*						5	JsC
Plesiopidae	*Plesiops coeruleolineatus*			R	0						*			*	*		*	*	5,10,13	IP
	Plesiops oxycephalus			R								*							5,10	WP
Plotosidae	*Plotosus lineatus*	4												*	*	*		*	5,11	IwP
Pomacanthidae	*Centropyge bispinosus*	4		R	R						*			*	*		*	*	4,10	IP
	Centropyge flavicauda	4													*				4,10	IP

Table 2–9. Checklist and the distribution of reef fishes in the waters around Tungsha Tao. For the explanation of each column, please refer to the text.(Continued)

Family	Species	Liter-ature	Abundance at each station							hand line	NS	W	P	H	S	N	L	G	Guild	Geogr-aphy
			(1)	(2)	(3)	(4)	(5)	(6)	(7)											
Pomacanthidae	*Centropyge tibicens*	4							R				*	*	*		*	*	4,10	WP
	Centropyge vroliki	4			0			R			*		*	*	*	*	*	*	4,10	IP
	Pomacanthus imperator	4						R			*	*	*	*	*	*	*	*	2,10,11	IP
	Pomacanthus semicirculatus	4				R			R		*		*	*	*	*	*	*	2,10,11	IwP
	Pomacanthus sexstriatus	1,4																	2,10	WP
	Pygoplites diacanthus	1,4						R	R		*			*	*	*	*	*	2,10,11	IP
Pomacentridae	*Abudefduf coelestinus (sexfasciatus)*	4	C		A	A	A	0				*		*	*	*	*	*	3,13	IP
	Abudefduf notatus	4											*	*	*	*	*	*	6	IP
	Abudefduf sordidus	4	R			C					*	*	*	*	*	*	*	*	6,13	IP
	Abudefduf vaigiensis	4	C								*			*	*	*	*	*	3,13	IP
	Amblyglyphidodon curaco			A										*	*			*	7	IwP
	Amblyglyphidodon ternatensis	4		0															7	WP
	Amphiprion clarkii	4				0			0		*			*	*	*	*	*	9	IwP
	Amphiprion frenatus	4									*		*	*	*		*	*	9	W0
	Amphiprion perideraion										*				*			*	9	WcP
	Cheiloprion labiatus			C											*				7	IwP
	Chromis atripectoralis	4	C												*			*	7	IP
	Chromis atripes										*			*	*	*	*	*	6	WcP
	Chromis chrysura	4						R	R		*				*		*	*	4	WP
	Chromis margaritifer	4			C			C			*		*	*	*	*	*		6	WcP
	Chromis ternatensis	4													*		*	*	7	IP
	Chromis viridis		A	A	A	A					*			*	*		*	*	7	IP
	Chrysiptera unimaculata	4		C		0					*			*	*			*	5	WP
	Chrysiptera sp.	4			0			0	0		*								6	?
	Dascyllas aruanus	4	C	A		A	A	0	0		*		*		*				7	IP
	Dascyllas reticulatus	4									*		*	*	*	*	*	*	7	IP
	Dascyllas trimaculatus	4				0		C	0		*		*	*	*	*	*	*	7	IP
	Dischistodus prosopotaenia	4		0		0		0							*				6	IP
	Hemighyphidodon plagiometopon	4		C			C		0		*								6	IwP
	Neoglyphidodon nigroris	4									*			*	*			*	2,6	WP
	Plectroglypidodon dickii				C	R					*			*	*		*	*	7	IP
	Plectroglypidodon lacrymatus	4			0		0				*			*	*		*	*	6	IP
	Plectroglypidodon leucozonus							R			*	*	*	*	*		*	*	6,13	IP
	Pomacentrus amboiensis	4	R	C	0	0					*				*				7	WcP
	Pomacentrus bankanensis	4			C		C	C			*		*	*	*	*	*	*	6	WP
	Pomacentrus coelestis	4			R	R			C		*	*	*	*	*	*	*	*	6	WcP

of each column, please refer to the text.(Continued)

Family	Species	Liter-ature	Abundance at each station							hand line	NS	W	P	H	S	N	L	G	Guild	Geogr-aphy
			(1)	(2)	(3)	(4)	(5)	(6)	(7)											
Pomacentridae	*Pomacentrus lepidogenys*	4			A			C			*			*	*		*	*	6	IwP
	Pomacentrus moluccensis	4		C		C	C				*		*	*	*	*		*	7	WP
	Pomacentrus philippinus	4						R			*			*	*		*	*	2	IwP
	Stegastes lividus			C		C													7	IwP
	Stegastes nigricans	4		C		C	C		0		*			*	*		*	*	6,7	IP
Priacanthidae	*Priacanthus hamrur*	4								*					*	*	*	*	6,10	IP
Pseudochromidae	*Pseudochromis fuscus*	4		C		R	R	R			*						*		5	IwP
	Pseudoplesiops sp.			R															5	?
	Pseudochromis sp.				R														5	?
Pseudogrammidae	*Pseudogramma polyacantha*						R		R		*			*	*			*	5,13	IwP
Scaridae	*Calotomus japonicus*	1													*				4	IwP
	Cetoscarus bicolor	4		R	R						*	*		*	*		*	*	4	IP
	Leptoscarus vaigiensis	4												*	*	*	*	*	4	IP
	Scarus bowersi	4									*			*	*		*	*	4	WP
	Scarus dimidiatus	4		A	A		R	0							*		*	*	4	WcP
	Scarus forsteni				R						*		*	*	*	*	*	*	4	WcP
	Scarus frenatus			0			R	R			*		*	*	*	*	*	*	4	IP
	Scarus ghobban	2,3,4	C	C	C							*	*	*	*	*	*	*	4	IwP
	Scarus gibbus	4	A	A	A	A	0		0	*	*			*	*		*	*	4	IP
	Scarrus globiceps				0						*			*	*		*	*	4	IP
	Scarus javanicus	4																	4	IP
	Scarus longiceps	4		C	C	C					*		*		*	*			4	WcP
	Scarus niger	4							0		*		*	*	*		*	*	4	IP
	Scarus oviceps				R						*		*		*		*	*	4	WcP
	Scarus psittacus				R						*				*		*	*	4	IP
	Scarus rivulatus		R		R	0									*			*	4	WP
	Scarus rubroviolaceus	4		0	0			R			*	*	*	*	*	*	*	*	4	IwP
	Scarus schlegeli	4		C	C	0		0	C		*		*	*	*		*	*	4	WcP
	Scarus sordidus	4		C	C	C	C	C	C		*	*	*	*	*		*	*	4	IP
	Scarus spinus				R			R											4	WcP
Scomberidae	*Sarda orientalis*	2										*							1	IP
	Scomberomorus commerson									*		*	*	*	*				1	IP
Scorpaenidae	*Parascorpaena mcdamsi*			R							*	*	*		*			*	10	IP
	Parascorpaena mossambica			R			R						*	*	*	*	*	*	10	IP
	Pterois antennata	4									*		*	*	*				5,6	IP
	Pterois volitans	4	R						R		*	*	*	*	*	*	*	*	5,6,3	WcP

Table 2–11. Checklist and the distribution of reef fishes in the waters around Tungsha Tao. For the explanation of each column, please refer to the text.(Continued)

Family	Species	Liter-ature	Abundance at each station							hand line	NS	W	P	H	S	N	L	G	Guild	Geogr-aphy
			(1)	(2)	(3)	(4)	(5)	(6)	(7)											
Scorpaenidae	*Scorpaena neglecta*	1										*				*			5,10	JC
	Scorpaenodes kelloggi				R										*		*		5,6	IP
	Scorpaenopsis cirrhosa	4				0						*	*	*	*	*	*	*	5	IP
	Scorpaenopsis diabolus			R					R		*	*	*	*	*	*	*	*	5	IP
	Sebastapistes cyanostigma				R						*		*	*	*	*		*	7	IwP
	Synaceia verrucosa	4		R								*	*	*	*	*	*		5	IP
Serranidae	*Aethaloperca rogga*	4						R			*		*	*	*			*	10,11	IP
	Cephalopholis sonnerati									*			*		*			*	10,11	IP
	Cephalopholis spiloparaea	3													*				10,11	IP
	Cephalopholis urodeta	2,3						R	0		*	*	*	*	*		*	*	10,11	IP
	Cromileptes altivelis	4										*	*		*				10,11	IwP
	Epinephelus caeruleopunctatus						R					*	*		*	*	*	*	10,11,13	IwP
	Epinephelus cyanopodus					R										*			10,11	WP
	Epinephelus hexagonatus	2,3									*		*	*	*		*	*	10,11	IP
	Epinephelus maculatus	4	R									*	*		*	*	*		10,11	IP
	Epinephelus malabrica	4											*	*					10	IP
	Epinephelus merra						R				*		*	*	*	*	*	*	10,11,13	IP
	Epinephelus quoyanus	4		R							*	*			*	*		*	10,11	IP
Siganidae	*Siganus argenteus*			R	0						*		*	*	*		*	*	4,6	IP
	Siganus fuscescens		0	C		C	0		0	*		*		*	*	*	*	*	4,6	IwP
	Siganus puellus	4	0	0		0	R												4,5	IP
	Siganus punctatissimus			R											*				4,5	WP
	Siganus virgatus			0	R								*	*	*		*		4,5	IwP
Sphyraenidae	*Sphyraena barracuda*						R											*	1	C
Synagathidae	*Corythoichthys flavofasciatus*			R		C	R				*								5	IP
Synodontidae	*Saurida gracilis*	4		R			R				*	*	*	*	*	*	*	*	5	IP
	Synodus variegatus	4				0		R			*	*	*	*	*	*	*	*	5	IP
Teraponidae	*Terapon jarbua*	4								*		*	*	*	*	*			5	IwP
Tetraodotidae	*Arothron hispidus*	4									*	*	*	*	*	*	*	*	6	IpP
	Arothron manilensis	4										*				*			5	IwP
	Arothron nigropunctatus	4						R			*	*		*	*	*	*	*	6	IP
	Canthigaster janhinopterus	4									*			*	*		*	*	6	IP
	Canthigaster valentini	4			R						*	*	*	*	*	*	*	*	6	IP
Tripterygiidae	*Helicogramma striata*	4									*		*	*	*	*	*		10	WP
Xenisthmidae	*Xenisthmus polyzonatus*				R						*								5	IP
	Xenisthmus sp.				0			R											5	?
Zanclidae	*Zanclus cornutus*	4			R	0	R	0	0		*	*	*	*	*	*	*	*	6	IpP

hich appear to be previously undescribed. hey include the following three confirmed new species: *Chrysiptera* sp. also found t Taiping Tao in Nansha, *Xenisthmus* sp., nd *Priolepis* sp. The *Gymnapogon* sp. ould be new but need further verification. *'seudoplesiops* sp., *Pseudochromis* sp. and wo *Trimma* spp. need to be reconfirmed as ell. Another four *Eviota* spp. and one *imnichthys* sp. are still unidentified.

Specimens were collected for most of he other 17 known species which were not ecorded in Taiwan. The following five pecies, however, were underwater censused only: the rare species *Salarias guttatus* living in the intertidal to reef flat; the common species *Stegastes lividus* living associated with the *Acropora*; the migratory reef visitors *Scarus javanicus, S. spinus, and Siganus puellus*. Another two species, *Istigobius rigilius* and *Hemiglyphidodon plagiometopon*, were not caught since the former species has already been caught at Nansha and the latter at Tungsha (Chen et al., 1991). There are several species which were not cited in the "Fishes of Taiwan" (Shen et al., 1993) but have been found at Lanyu (Orchid Island) and Green Island.

Table 3. A list of reef fishes at Tungsha Tao which have not been reported in Taiwan and how they were recorded : F, fish specimen collected; P, photo recorded only; S, only observed.

Family	Species	Recording Method	Chen et al. (1991)	Nansha
Antennariidae	*Antennarius pictus* (Shaw & Nodder, 1794)	F		
Apogonidae	*Gymnapogon* sp.	F		
Blenniidae	*Atrosalarias fuscus holomelas* (Gunther, 1866)	F	F	
	Salarias guttatus (Cuvier & Valenciennes, 1836)	S		
Creediidae	*Limnichthys* sp.	F		
Gobiidae	*Eviota afelei Jordan & Seale, 1906*		F	
	Eviota latifasciatus Jewett & Lachner, 1983	F		
	Eviota prasites Jordan & Seale, 1906	F	F	F
	Eviota queenslandica Whitley, 1932	F		
	Eviota sp. 1	F		
	Eviota sp. 2	F		
	Eviota sp. 3	F		
	Eviota sp. 4	F		
	Istigobius rigillius (Herre, 1953)	S		F
	Pleurosicya bilobata (Koumans, 1941)	F		
	Priolepis sp.	F		
	Trimma sp. 1	F		
	Trimma sp. 2	F		
Nemipteridae	*Scolopsis trilineatus* (Kner, 1868)	F		
Plesiopidae	*Plesiops oxycephalus* (Bleeker, 1852)	F		
Pomacentridae	*Chrysiptera* sp.	F	F	F
	Hemiglyphidodon plagiometopon (Bleeker, 1852)	S	F	
	Stegastes lividus (Bloch & Schneider, 1801)	S		
Pseudochromidae	*Pseudoplesiops* sp.	F		
	Pseudochromis sp.	F		
Scaridae	*Scarus javanicus* (Bleeker, 1854)	S	P	
	Scarus spinus (Kner, 1868)	S		
Siganidae	*Siganus puellus* (Schlegel, 1852)	S	S	
Xenisthmidae	*Xenisthmus polyzonatus* (Klunzinger, 1871)	F		F
	Xenisthmus sp.	F		

They include blennies of *Ecsenias bicolor*, surgeonfish of *Acanthurus thompsoni*, and wrasse of *Cheilinus celebicus*. We have recently collected specimens of *E. bicolor*, but not of the other two species.

Additionally, several species were excluded from the checklist since they could not be identified in situ and their specimens could not be collected either. Mullets, dragonets, one *Asterroptery* sp., one *Oplopomops* sp., and one *Vanderhorstia* sp. were excluded for this reason. Another *Enneapterygius* sp., although a specimen was collected, was also excluded since its genus name was not certain. Together with some other fishes such as sharks and garden eels etc., observed by other colleagues in the same trip, we estimate the total number of reef fish species at Tungsha reefs should be at least more than 400.

C. Comparison between different stations

Most of the intertidal zone of the islet is sand. The seagrass beds grow very well on this sandy bottom, especially on the western and northern side of the islet. Nevertheless, the fish assemblage in this monotonous environment is not so prosperous as in the deeper waters of the coral reef areas. Thus, only 67 fish species were found at station 5, where the bottom is totally covered by seagrasses. The lowest number of fish species, 53, was at station 1, where the sandy bottom is very barren. Most fishes at this station were found gathering around and in some discarded artificial blocks. Station 4 is the transition zone and covers both seagrasses and coral reefs so the species diversity is relatively high, 95. The highest number of species, 119, is at station 2, where the coral growth is very strong. Station 6 is also coral reef but deeper ranging from 6 ~ 8m, 107 species were recorded here. Station 3 has an equal number of species as station 6 although it lies on the northern side of the islet and has many sandy grooves on the reef flat. Station 7 is the deepest station, 95 species were recorded here many of which were squirrelfish species hiding under table-like corals. When comparing the substratum types, it is apparently that fish assemblage at the coral areas (95-119 species at station 2,3,6, and 7) is more diversified than at the seagrass beds or over a shallow sandy bottom (53-67 species at stations 1, and 5).

A comparison of the number of fish species at corresponding stations between the present survey and the previous survey four years ago (Chen et al., 1991) shows that the number of species recorded this time are almost all greater than in the past. For example, 119 and 95 species were recorded this time at stations 2 and 4 but only 56, 90, and 88 species were found at stations 1,4 and 5 in Chen et al. (1991). At station 3, whose location was very similar in both surveys, we recorded 107 species this time and only 82 species previously. In total, the 312 reef fishes species obtained in this survey is greater than the 244 species found in the 1991 survey.

D. Comparison of species composition

Table 4 lists the ten most speciose families of fish at Tungsha Tao. From high to low, they were Labridae (54 species), Pomacentridae (35), Gobiidae (34), and Chaetodontidae (21). The top four ranks at Tungsha were identical with the ranks at Nansha, Green Island, and Orchid Island, although the exact number of species within each family varied somewhat. On the other hand, the top four ranks were quite different in other regions

Table 4. The top ten most speciose families of reef fishes at Tungsha Tao compared with those at Nansha and other regions of Taiwan. The number in parentheses indicates the original rank in that region. An asterisk (*) means that family was not included in the top ten list of that region.

Families	Tungsha	Nansha	Green Isl.	Orchid Isl.	Penghu	North T.	South Tt.	West T.	Hsiao-liu-chiu
Labridae	54(1)	73(1)	93(1)	85(1)	69(1)	49(1)	98(1)	44(1)	80(1)
Pomacentridae	35(2)	51(2)	60(2)	51(2)	28(5)	29(4)	61(3)	*	55(2)
Gobiidae	34(3)	32(3)	31(3)	31(3)	37(2)	35(2)	80(2)	23(4)	42(3)
Chaetodontidae	26(4)	21(4)	29(4)	29(4)	29(4)	23(8)	30(8)	*	26(7)
Scaridae	20(5)	15(7)	23(6)	20(8)	*	*	28(10)	*	*
Apogonidae	19(6)	15(7)	18(10)	19(9)	29(4)	27(6)	55(4)	22(5)	32(4)
Acanthuridae	16(7)	18(5)	29(4)	29(4)	*	*	28(10)	*	26(5)
Holocentridae	14(8)	10(*)	14(*)	14(*)	8(*)	14(*)	24(*)	7(*)	18(*)
Serranidae	12(9)	16(6)	23(6)	21(7)	36(3)	24(7)	53(5)	35(2)	*
Lutjanidae	12(9)	*	20(9)	*	20(8)	19(9)	36(7)	18(8)	*
Blenniidae	*	14(9)	23(6)	28(6)	16(9)	29(4)	37(6)	*	24(8)
Balistidae	*	13(10)	*	*	*	*	*	*	*
Muraenidae	*	*	*	18(10)	*	*	*	*	22(8)

of Taiwan. For example, the Gobiidae in southern Taiwan ranked second, but the Chaetodontidae, though represented by 30 species, declined to the 8th rank. This is simply due to that the butterflyfishes is the group which mostly easity to be observed rather than many cryptic species, and the southern Taiwan (Kenting National Park) being much more thoroughly studied than other regions. The rank of the Chaetodontidae at Hsiao-liu-chiu dropped to 7th while the Apogonidae occupied the 4th rank. Although same 20 species of Scaridae were recorded both at Tungsha Tao and Orchid Island, the rank of this family was raised to 5th at Tungsha because the total number of species at Tungsha was only 396 but 561 at Orchid Island. Apogonidae and Acanthuridae occupied the 6th and 7th ranks. The most unusual ranking at Tungsha must be the Holocentridae, which could not enter the top ten in other regions but ranked 8th here with 14 species. The Serranidae dropped to 9th, with only 12 species being recorded at Tungsha, which was fewer than at any other region.

E. Zoogeographical distribution

Almost all species at Tungsha Tao (375 species or 94.7%) belong to widely distributed species of circumtropical (C), Indo-pan Pacific (IpP), Indo-west Pacific (IwP), West central Pacific (WcP), and West Pacific (WP) distribution. Besides the 13 unidentified species, whose distribution could not be determined, only 8 species were narrowly distributed from Japan to the South China Sea which includes Japan to South China (JsC), Japan

and the China Sea (JC), and Japan and Taiwan (JT). *Parapercis snyderi* and *Scorpaena neglecta* are the two species with JsC distribution but they have only been reported in Penghu and northern Taiwan. The other 6 species all have records from southern Taiwan except the two species of small gobies. Only a few of these narrowly distributed species occurred in northern Taiwan.

Table 5 list the zoogeographical comparison results. Southern Taiwan shares the greatest number of species with Tungsha (324 species, which is a difference of 72). Deduct the 30 species which have not been discovered in Taiwan from these 72 species, and only 42 species have not yet been found in southern Taiwan. The number of species Tungsha has in common with Orchid Island, Hsiao-liu-chiu and Nansha range between 234 ~ 255; with northern Taiwan and Penghu 192 ~ 194; while with western Taiwan there are only 122. The Czekanowski similarity coefficients of species composition between the different regions shows that the most similar fish fauna to that at Tungsha was at Nansha (58.64%), then Green Island (54.71%) and Orchid Island (53.29 %). Hsiao-liu-chiu was the fourth (48.8 %), then southern Taiwan (44.14 %) although it shared the most species with Tungsha Tao. Penghu and northern Taiwan were next (36.78 % and 36.19 %). Western Taiwan (23.02 %) scored the lowest similarity coefficient.

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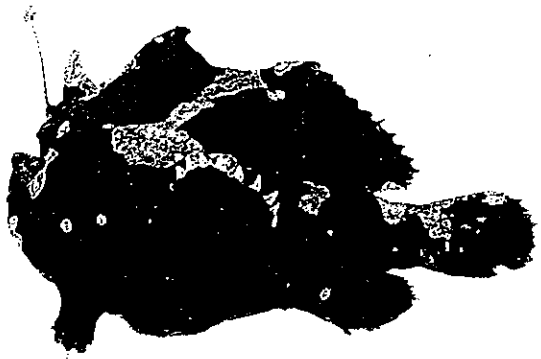
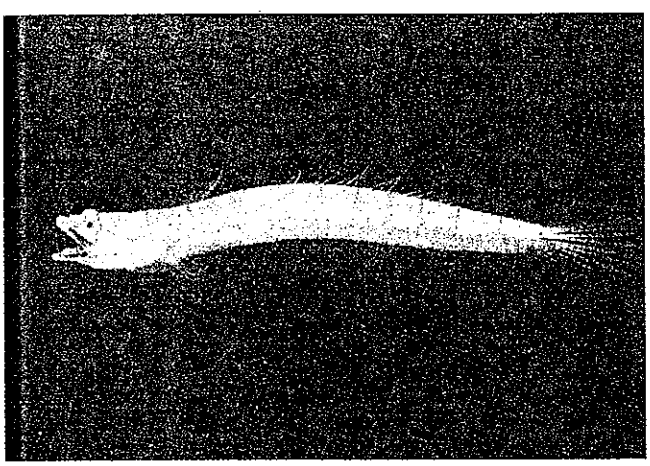
Table 5. Zoogeographical analysis of the reef fish species found at Tungsha Tao in comparison with the fish fauna of Nansha and other regions of Taiwan. Please note that only those species which also occurred at Tungsha Tao were counted and used for these comparisons.

Geographical regions	Tungsha	Nansha	West T.	Penghu	Hsiao-liu-chiu	South T.	North T.	Orchid Isl.	Green Is.
IP	214	156	69	116	157	194	117	162	172
IwP	62	24	27	28	35	47	31	31	37
WP	47	25	7	21	22	37	15	26	28
WcP	29	17	6	11	14	25	14	20	18
IpP	13	8	7	10	11	11	9	11	11
C	9	1	3	3	4	5	4	3	5
JsC	5	–	2	3	1	4	2	1	1
JC	2	–	1	–	–	–	1	–	–
JT	2	2	–	–	1	2	1	1	1
?	12	1	–	–	–	1	–	–	–
Total	396	234	122	192	245	324	194	255	273
Czekanowski's similarities		58.65%	23.02%	36.78%	48.80%	44.14%	36.19%	53.29%	54.71%



1. *Antennarius pictus*, ASIZP 057173.

2. *Gymnapogon sp.*, ASIZP 057174.



3. *Limnichthys sp.*, ASIZP 057176.

4. *Eviota latifasciatus*, ASIZP 057177.

5. *Eviota queenslandica*, ASIZP 057178.

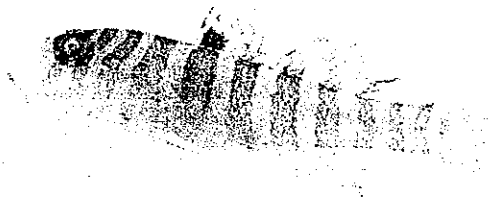
6. *Eviota* sp. 1, ASIZP 057179.

7. *Eviota* sp. 2, ASIZP 057180.

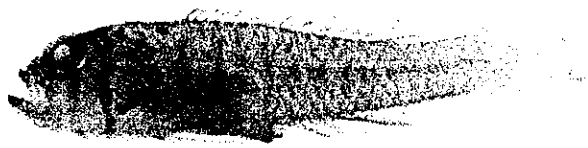
8. *Eviota* sp. 3, ASIZP 057181.

9. *Eviota* sp. 4, ASIZP 057182.

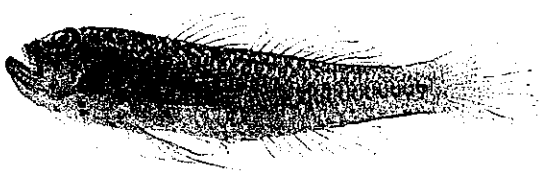
10. *Pleurosicya bilobata*, ASIZP 057183.



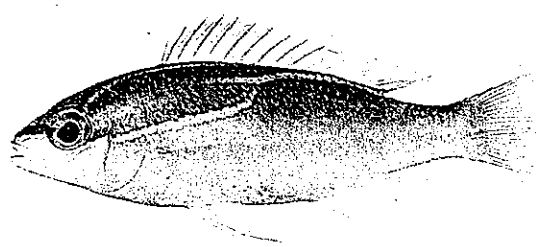
11. *Priolepis* sp., ASIZP 057184.



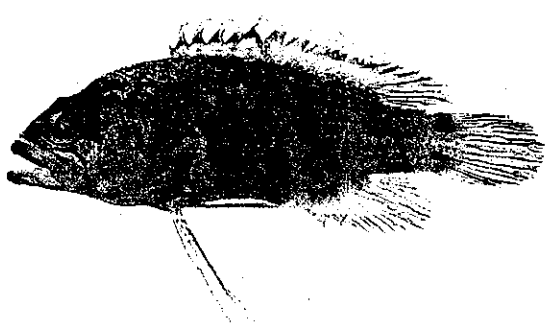
12. *Trimma* sp. 1, ASIZP 057185.



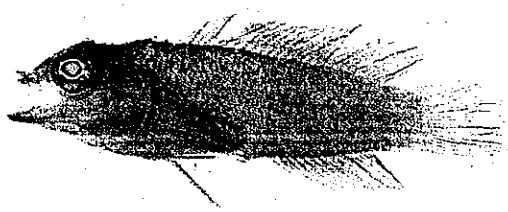
13. *Trimma* sp. 2, ASIZP 057186.



14. *Scolopsis trilineatus*, ASIZP 057187.

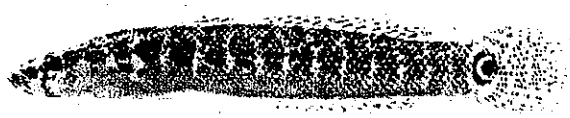


15. *Plesiops oxycephalus*, ASIZP 057188.

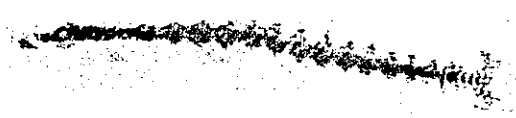


16. *Pseudoplesiops* sp., ASIZP 057130.

17. *Pseudochromis* sp., ASIZP 057129.



18. *Xenisthmus polyzonatus*, ASIZP 057189.



19. *Xenisthmus* sp., ASIZP 057191.

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REFERENCES

Bleeker, P. (1845) Species piscium bataviensium novae vel minus cognitae. Natuurkd. Tijdschr. Neder. -Indie v. 6: 191-202.

Bleeker, P. (1852) Bijdrage tot de kennis der ichthyologische fauna van Singapore. Ibid. 2: 469-497.

Bleeker, P. (1855) Bijdrage tot de kennis der ichthyologische fauna van de Batoe-eilanden. Nat. Tijdschr. Ned. Ind. 8: 305-328.

Bloch, M.E. and J.G. Schneider. (1801) Systema Ichthyologiae Inconibus cx Illustratum. 584pp. Sanderiano Commissum, Berolini.

Chen, J.P., K.T. Shao, L.T. Ho, L.S. Chen, P.H. Kao, and Y.Y. Wu (1992) Fish fauna and their geographical distribution in the coastal waters around the Hsiao-liu-chiu, south-western. Acta Zoologica Taiwanica, 3: 105-134.

Chen, J.P., R.Q. Jan and K.T. Shao (1995) Checklist of reef fishes from Nahsha Tao (Sprately Island), South China Sea. Zool. Stud. (in press).

Chen, L.S., K.T. Shao, L.S. Fang, and L.T. Her (1991) Preliminary checklist of fishes from the waters at Tung-Sha Tao (Pratas Island), South China Sea. Acta Oceanographica Taiwanica, 27: 121pp.

Chen, Z. (1983) Studies on the lanternfishes (Myctophidae) from the central waters of the South China Sea. In "Contributions on Marine Biological Research of the South China Sea". Ocean Press, pp. 199-216.

Chen, Z. and S. Wei (1983) The investigations on species composition and distribution of pelagic fish and larvae in the northeastern part of the South China Sea in summer. In "Contributions on Marine Biological Research of the South China Sea". Ocean Press, pp. 192-198.

Chi, T.H. (1989) Survey of fishery grounds in Nansha Islands. Bull. Taiwan. Fish. Res. Inst. 46: 55-69.

Cuvier G. and A. Valenciennes (1836) Histoire naturelle des poissons. Tome onzieme. Livre treizeime. De la famille des Mugiloides. Livre quatorzieme. De la famille des Gobioides. 11: 307-343.

Fang, L.S. and C.C. Lee (1994) Ecological survey of marine environment in the South China Sea. Counil of Agriculture/National Museum of Marine Biology/Aquarium. 469pp.

Fang, L.S. and J.J. Hu (1990) Marine ecological survey in the waters around Tungsha Tao. Fishery Bureau, Kaohsiung City Government. 61pp.

Gunther, A. (1866) Catalogue of fishes in the British Museum. Catalogue of the Physostomi, containing the families Salmonidae, Percopsidae, Galaxidae, Mormy-ridae, Gymnarchidae, Esocidae, Umbridae, Scombresocidae, Cyprinodontidae, in the collection of the British Museum. 6: 1-368.

Herre, A.W. (1953) Tropical Pacific gobies with vomerine teeth. Philip. Jour. Sci. 82(2): 181-188.

Hsieh, M.H. and T.L. Hong (1982) Exploi-

tation of fishing ground of Itu Aba Island on Tizard bank and reafs. Bull. Taiwan. Fish. Res. Inst. 34: 1-15.

Huang, Z. and Yang J. (1983) The deep-sea fishes from the adjacent waters of the Dongsha Islands in the South China Sea. II. Order Myctophiformes. In "Contributions on Marine Biological Research of the South China Sea". Ocean Press, pp. 234-355.

Jewett, S.L. and E.A. Lachner (1983) Seven new species of the Indo-Pacific genus Eviota (Pisces: Gobiidae) Proc. Biol. Soc. Wash., 96(4): 780-806.

Jordan, D.S. and A. Seale (1906) The Fishes of Samoa: Description of the Species Found in the Archipelago, with a Provisional Check-List of the Fishes of Oceania. Bulletin of the Bureau of Fisheries (1905), 25: 173-455.

Klunzinger, C.B. (1871) Synopsis der fische des Rothen Meeres. II. Theil. Verh. zool. -bot. Ges., Wien. 21: 441-668.

Kner, R. (1868) Uber neue Fische aus dem Museum der Herren Johann Casar Godeffroy and Sohnin Hamburg. Sitzber. Akad. Wien, 58: 26-34.

Koumans, F.P. (1941) Gobioid fishes of India. Memoirs of the Indian Museum 13: 205-329.

Lu, J.H. and E.F. Hsieh (1981) Exploitation and study of the fishery ground in South China Sea - Hook and lure efficiency experiment at Tungsha area. Bull. Taiwan Fish. Res. Inst. 33: 81-94.

Ma, T.Y. (1937) Growth and its relationship with seawater temperature of hermatypic coral. China Paleontology (class 2). Vol. 16.

Schlegel, H. (1852) Over twee nieuwe soorten van visschen, [Amphacanthus vulpinus en puellus]. Bijdr. Dierk. 1: 38-40, 1 pl.

Shao, K.T., J.P. Chen, L.T. Ho, C.P. Lin, P.H. Kao, P.L. Lin and L.S. Chen (1993a) Checklist and distributional pattern of the fishes of the Pescadore Island. 4th Indo-Pacific Fish Conf. Bangkok, Nov. 28-Dec. 5, 1993.

Shao, K.T., J.P. Chen, P.H. Kao and C.Y. Wu (1993b) Fish fauna and their geographical distribution along the western coast of Taiwan. Acta Zoologica Taiwanica 4(2): 113-140.

Shaw, G. and F.P. Nodder (1794) The naturalist's miscellany, or coloured figures of natural objects, drawn and described from nature. London: Nodder, Vol. 5, pls. 147-82.

Shen, S.C., K.T. Shao, L.S. Chen and J.P. Chen (1990) Faunistic studies of the fishes in the waters around the Kenting National Park (continued). Conservation Res. Rep. No. 68. Construction and Planning Administration, Ministry of Interior. 49pp.

Shen, S.C., S.C. Lee, K.T. Shao, H.K. Mok, C.T. Chen, and C.H. Chen (1993) Fishes of Taiwan. Dept. of Zool. Nat. Taiwan Univ. 960pp.

Su, W.C., K.H. Cheng, K.H. Chen, C.C. Yen (1976) Exploration of fishery ground at Tungsha Tao. Bull. Taiwan Fish. Res. Inst. 27: 59-63.

Su, W.C., K.H. Cheng, J.H. Lu, E.Y. Tsai, J.C. Lin, E.F. Hseih, C.H. Chen, C.T. Wu, and M.C. Wang (1979) Exploration of the fishery resources in South China Sea. Bull. Taiwan Fish. Res. Inst. 31: 119-135.

Tsai, E.Y. (1980) Survey of fishery ground in South China Sea. Bull. Taiwan Fish. Res. Inst. 32: 49-65.

Wei, S.F. (1961) Preliminary report of bottom trawlers' fishery ground in

South China Sea in 1959. Bull. Taiwan Fish. Res. Inst., 7: 95-146.

Whitley, G.P. (1932) Fisher. In Scientific Reports, Great Barrier Reef Expedition 1928-29. 4(9): 267-316.

Wu, C.C. (1981) Survey on the marine environment and biological resources at the Taiping Tao, Nansha (I). Bull. Taiwan Fish. Res. Inst. 33: 195-229.

Yang, R.T., C.C. Huang, C.S. Lee, H.J. Tsai and C.L. Sun (1975). Part I. Corals, Fishes, and Shells. In: A general survey of Tungsha Tao. ed. Yang, R.T. et al., Inst. Oceanog. NTU, Special Pub. 8: 1-15.

Yang, J. and Z. Huang (1983) The deep-sea fishes from the adjacent waters of the Dongsha Islands in the South China Sea. I. Order Salmoniformes. In "Contributions on Marine Biological Research of the South China Sea". Ocean Press, pp. 217-233.