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Fish fauna in subtidal waters adjacent to the National Museum of Marine Biology and Aquarium

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Abstract

The subtidal water adjacent to the National Museum of Marine Biology and Aquarium (NMMBA), contained within the Kenting National Park (KNP) in southern Taiwan, is a typical marine ecotone composed of estuarine, sandy bottom, and reef shore habitats. In this study, we compiled a faunal checklist of fishes collected during two surveys (i.e., 1989-91 and 2009-11). Among a total of 45 families and 332 species that have been recorded, 138 fishes accounting 41.6% to the total number of species were documented across both surveys. The top 10 speciose families contributed higher than 70% of species composition. In order of dominance for both species, the most dominant families were Labridae, Pomacentridae, Gobiidae and Chaetodontidae, indicating a long-term stability of fish fauna in the subtidal area.

Key words: Ecotone, subtidal, fish checklist

Introduction

The National Museum of Marine Biology and Aquarium (NMMBA) is located on the Hengchun Peninsula in southern Taiwan and is part of the Kenting National Park (KNP). The coastal environment of NMMBA is a typical marine ecotone composed of estuarine, sandy bottom, and reef shore habitats. Adjacent water in this area is influenced by freshwater runoffs of the Baoli and Sihchong Creeks from the north and a year-round Kuroshio Branch Current from the south.

Compared to the long-term and numerous fish fauna surveys conducted within adjacent waters off the KNP (Shao

et al., 1993, Chen et al., 2010), there has been a scarcity of systematic surveys conducted on fish fauna in the NMMBA water (Jones et al., 1972). To provide baseline biological information prior to the establishment of NMMBA, Shao et al. (1991) conducted a 2-yr survey on marine biodiversity in this area. A total of 42 families and 241 species of intertidal (22 families and 56 species) and subtidal fishes (39 families and 206 species) were initially reported.

The aim of this study was to resurvey the fish fauna in the subtidal water adjacent to NMMBA, to examine the possible impact of the establishment and operation of the NMMBA on species composition from pre-establishment (years 1989-91, Shao et al., 1991) to post-establishment (years 2009-11, this study).

Materials and Methods

Four subtidal stations at 3-15 m water depth were establish in waters adjacent to the NMMBA (Fig. 1), which were similar to areas previously surveyed

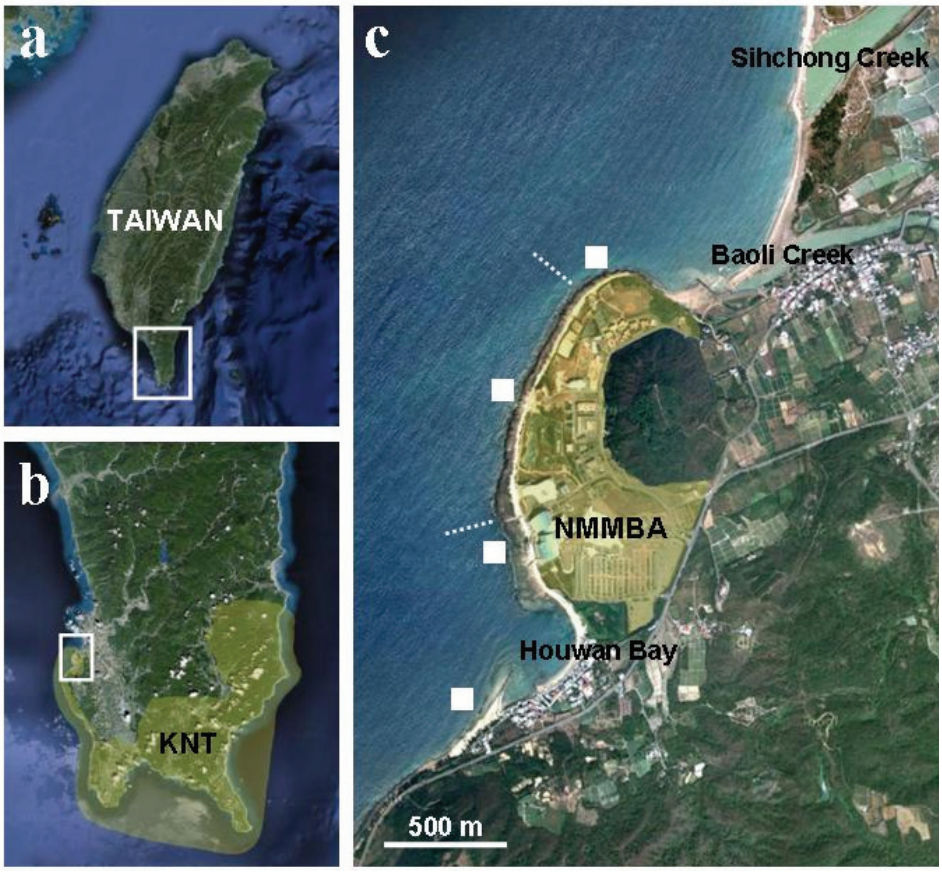

Fig. 1. Adjacent water near the National Museum of Marine Biology and Aquarium (NMMBA). (b) magnified from (a), (c) from (b). KNT: Kenting National Park. Solid square: subtidal stations in this study; dotted lines: boundaries between survey areas of Shao et al. (1991). (Images from http://maps.google.com.tw)

by Shao et al. (1991). Fish faunal surveys for each station were conducted by scuba-diving monthly between February 2009 and December 2010, with two additional surveys in March and June 2011. Fish species were identified from the underwater voucher photographs following Shao et al. (1993), Masuda and Kobayashi (1994), Chen et al. (2010), and Shao (2011). A fish checklist including both the earlier records from Shao et al. (1991) and fishes documented in this study was summarized. The synonyms and doubtful species in the former study were revised as Table 1, according to Eschmeyer (2011) and Shao (2011). Those species not identified during both surveys were excluded from the checklist.

Results and Discussion

A total of 42 families and 289 species of subtidal fishes were observed during the 2009-11 survey. In addition to the 38 families and 180 species recorded by Shao et al. (1991) from the 1989-91 survey, a cumulative faunal checklist of 45 families and 332 species in the subtidal water off NMMBA were given on Table 2. Of the fishes reported, 138 fishes accounted for 41.6% of the total number of species recorded during both surveys. Forty-three previously recorded species (13.0%) were not found. On the contrary, an additional 151 species (45.5%) were added in our survey. It is important to note that over 100 scuba-diving trips were conducted for during the 2009-11 survey in this study, which were at least 5-fold of what had been conducted for the 1989-91 survey (Shao et al., 1991). An increase of the survey duration implied a direct increase of detectability of various fishes, including the cryptic species inhabiting coral reefs (e.g., family Apogonidae) and rock crevices (Muraenidae). The differences in reported numbers of species between the two surveys may therefore be attributed to the differences in underwater durations conducted.

During the 1989-91 survey, the top 10 speciose families contributed 138 species (76.7%) to the total number of species. Labridae was the most dominant family (42 species, 23.3%), followed by Pomacentridae (21 species, 11.7%), Gobiidae (14 species, 7.8%), and Chaetodontidae (13 species, 7.2%). Similar results were also found during the 2009-11 survey, during which 203 species (70.2%) comprised the top 10 speciose families with an identical ranking order for the four dominant families (Table 3). Fishes of the other families Acanthuridae, Apogonidae, Lutjanidae, Scaridae, Mullidae, Scorpaenidae, Tetraodontidae, Balistidae, Blenniidae, and Serranidae were less dominant, but were also common in this area for both surveys (Table 3). The relatively stable family dominance for the two decades suggested that the anthropogenic impact of the NMMBA establishment and operation on the long-term fish fauna

Table 1. Synonyms and doubtful species of fishes revised from Shao et al. (1991).

Family	Name in question	Suggested correction
Muraenidae	*Gymnothorax pescadoris*	*Gymnothorax favagineus*
Mugilidae	*Mugil* sp.	?
Syngnathidae	*Dunckerocampus dactyliophorus*	*Doryrhamphus dactyliophorus*
Scorpaenidae	*Scorpaenopsis cirrhosa*	*Scorpaenopsis cirrosa*
Serranidae	*Epinephelus caeruleopunctatus*	*Epinephelus coeruleopunctatus*
	Franzia squamipinnis	*Pseudanthias squamipinnis*
Pseudochromidae	*Dampieria cyclophthalmus*	*Labracinus cyclophthalmus*
	Pseudochromis melanotaenia	*Pseudochromis tapeinosoma*
Apogonidae	*Apogon doderleini*	*Apogon doederleini*
	Archamia dispilus	*Archamia fucata*
	A. pseudotaeniatus	?
	Archamia sp.	?
Lutjanidae	*Lutjanus russelli*	*Lutjanus russellii*
Caesionidae	*Pterocaesio teres*	*Caesio teres*
Haemulidae	*Pomadasys stridens*	*Pomadasys quadrilineatus*
Mullidae	*Parupeneus trifasciatus*	*Parupeneus multifasciatus*
Nemipteridae	*Scolopsis ciliatus*	*Scolopsis ciliata*
	S. lineatus	*S. lineata*
Lethrinidae	*Lethrinus miniatus*	*Lethrinus olivaceus*
Pempheridae	*Pempherus oualensis*	*Pempheris oualensis*
Pomacanthidae	*Centropyge tibicens*	*Centropyge tibicen*
	C. vroliki	*C. vrolikii*
Pomacentridae	*Chrysiptera leucopoma*	*Chrysiptera brownriggii*
	Paraglyphidodon melas	*Neoglyphidodon melas*
	P. nigroris	*N. nigroris*
Labridae	*Lienardella fasciatus*	*Choerodon fasciatus*
	Macropharyngodon paradalis	*Macropharyngodon negrosensis*
	Cheilinus bimaculatus	*Oxycheilinus bimaculatus*
	Pteragogus flagellifera	*Pteragogus aurigarius*
	Stethojulis lineatus	?
	S. trilineatus	*Stethojulis trilineata*
	Thalassoma amblycephalus	*Thalassoma amblycephalum*
Scaridae	*Scarus sordidus*	*Chlorurus sordidus*
	Scarus sp1.	?
	Scarus sp2.	?
	Scarus sp3.	?
Pinguipedidae	*Parapercis cephalopunctatus*	*Parapercis millepunctata*
	P. polyophthalma	*P. pacifica*
Blenniidae	*Dasson trossulus*	?
	Petroscirtes argus	?
	Meiacanthus sp.	?
Gobiidae	*Amblyeleotris fasciatus*	*Amblyeleotris wheeleri*
	A. maculata	*A. periophthalma*
	Brayinops younyei	*Bryaninops yongei*
	Gnatholepis scapulosteigma	?
Ptereleotridae	*Nemateleotris magnificus*	*Nemateleotris magnifica*
	Ptereleotris sp.	?
Siganidae	*Siganus* sp.	?
Acanthuridae	*Acanthurus gahhm*	*Acanthurus nigricauda*
Balistidae	*Sufflamen chrysopterus*	*Sufflamen chrysopterum*
Diodontidae	*Diodon holacanthus*	*Diodon holocanthus*

Table 2. Fish checklist in the subtidal water adjacent to National Museum of Marine Biology and Aquarium.

Family and species	Survey		Family and species	Survey	
	1989-91	2009-11		1989-91	2009-11
Muraenidae			*E. coioides*	-	+
Echidna nebulosa	-	+	*E. malabaricus*	-	+
Gymnomuraena zebra	-	+	*Grammistes sexlineatus*	+	+
Gymnothorax favagineus	+	+	*Pseudanthias squamipinnis*	+	+
G. meleagris	-	+	**Pseudochromidae**		
Ophichthidae			*Labracinus cyclophthalmus*	+	+
Myrichthys colubrinus	+	-	*Pictichromis porphyreus*	-	+
Plotosidae			*Pseudochromis tapeinosoma*	+	-
Plotosus lineatus	-	+	**Plesiopidae**		
Synodontidae			*Assessor randalli*	+	+
Saurida gracilis	+	+	**Apogonidae**		
Synodus dermatogenys	-	+	*Apogon angustatus*	-	+
S. jaculum	-	+	*A. aureus*	+	-
S. variegatus	+	+	*A. cathetogramma*	-	+
Exocoetidae			*A. cookii*	+	+
Cypselurus poecilopterus	+	-	*A. doederleini*	+	+
Holocentridae			*A. kallopterus*	-	+
Myripristis murdjan	-	+	*A. nigrofasciatus*	-	+
Sargocentron praslin	-	+	*A. properuptus*	-	+
Syngnathidae			*A. taeniophorus*	-	+
Doryrhamphus dactyliophorus	+	+	*A. ventrifasciatus*	-	+
Trachyrhamphus bicoarctatus	-	+	*Archamia fucata*	+	+
Aulostomidae			*Cheilodipterus artus*	-	+
Aulostomus chinensis	-	+	*C. macrodon*	+	+
Fistulariidae			*C. quinquelineatus*	-	+
Fistularia commersonii	-	+	*Pristiapogon fraenatus*	-	+
F. petimba	-	+	**Carangidae**		
Centriscidae			*Caranx sexfasciatus*	-	+
Aeoliscus strigatus	+	+	*Scomberoides tol*	+	-
Scorpaenidae			**Lutjanidae**		
Ablabys taenianotus	-	+	*Lutjanus argentimaculatus*	+	+
Dendrochirus zebra	-	+	*L. bohar*	-	+
Parascorpaena mossambica	+	-	*L. decussatus*	+	-
Pterois antennata	-	+	*L. erythropterus*	-	+
P. volitans	-	+	*L. fulviflamma*	+	+
Scorpaenodes guamensis	+	-	*L. fulvus*	+	+
Scorpaenopsis cirrosa	+	+	*L. gibbus*	+	+
S. diabolus	-	+	*L. lunulatus*	-	+
Sebastapistes cyanostigma	-	+	*L. lutjanus*	-	+
Serranidae			*L. monostigma*	-	+
Cephalopholis urodeta	-	+	*L. quinquelineatus*	-	+
Cromileptes altivelis	-	+	*L. rivulatus*	+	+
Diploprion bifasciatum	+	+	*L. russellii*	+	+
Epinephelus coeruleopunctatus	+	+	*L. stellatus*	+	+

Table 2. (cont.) Fish checklist in the subtidal water adjacent to National Museum of Marine Biology and Aquarium.

Family and species	Survey		Family and species	Survey	
	1989-91	2009-11		1989-91	2009-11
L. vitta	+	+	*C. auripes*	+	+
Caesionidae			*C. citrinellus*	+	+
Caesio caerulaurea	-	+	*C. ephippium*	-	+
C. teres	+	+	*C. kleinii*	+	+
Pterocaesio digramma	+	+	*C. lunula*	+	+
P. tile	-	+	*C. octofasciatus*	-	+
Haemulidae			*C. punctatofasciatus*	-	+
Diagramma picta	-	+	*C. speculum*	+	+
Plectorhinchus flavomaculatus	-	+	*C. vagabundus*	+	+
P. lessonii	-	+	*C. xanthurus*	+	+
P. lineatus	-	+	*Forcipiger flavissimus*	-	+
P. pictus	-	+	*Heniochus acuminatus*	+	+
P. picus	-	+	*H. chrysostomus*	+	-
P. vittatus	-	+	*H. monoceros*	+	-
Pomadasys quadrilineatus	+	-	*H. singularius*	+	+
Nemipteridae			**Pomacanthidae**		
Scolopsis bilineata	-	+	*Centropyge heraldi*	-	+
S. ciliata	+	+	*C. tibicen*	+	+
S. lineata	+	+	*C. vrolikii*	+	+
S. monogramma	-	+	*Pomacanthus imperator*	-	+
S. vosmeri	+	+	*P. semicirculatus*	+	+
Lethrinidae			**Terapontidae**		
Lethrinus olivaceus	+	+	*Pelates quadrilineatus*	+	-
Monotaxis grandoculis	-	+	**Cirrhitidae**		
Mullidae			*Cirrhitichthys falco*	-	+
Mulloidichthys flavolineatus	-	+	*C. oxycephalus*	-	+
M. vanicolensis	-	+	*Cirrhitus pinnulatus*	-	+
Parupeneus barberinoides	-	+	*Paracirrhites arcatus*	-	+
P. barberinus	-	+	**Pomacentridae**		
P. ciliatus	-	+	*Abudefduf bengalensis*	-	+
P. cyclostomus	-	+	*A. notatus*	-	+
P. indicus	+	+	*A. septemfasciatus*	-	+
P. multifasciatus	+	+	*A. sexfasciatus*	-	+
P. pleurostigma	+	-	*A. sordidus*	-	+
Upeneus tragula	+	+	*A. vaigiensis*	+	+
Pempheridae			*Amphiprion clarkii*	+	+
Pempheris oualensis	+	-	*A. frenatus*	-	+
P. vanicolensis	-	+	*Chromis atripes*	+	-
Kyphosidae			*C. lepidolepis*	-	+
Kyphosus bigibbus	+	-	*C. margaritifer*	+	+
K. cinerascens	-	+	*C. ovatiformis*	-	+
Chaetodontidae			*C. viridis*	+	-
Chaetodon argentatus	+	+	*C. weberi*	-	+
C. auriga	+	+	*C. xanthura*	-	+

Table 2. (cont.) Fish checklist in the subtidal water adjacent to National Museum of Marine Biology and Aquarium.

Family and species	Survey		Family and species	Survey	
	1989-91	2009-11		1989-91	2009-11
Chrysiptera brownriggii	-	+	*C. gaimard*	+	+
C. cyanea	+	+	*Gomphosus varius*	+	+
C. rex	+	+	*Halichoeres argus*	+	+
C. unimaculata	+	-	*H. biocellatus*	-	+
Dascyllus reticulatus	-	+	*H. chrysus*	-	+
D. trimaculatus	-	+	*H. hartzfeldii*	-	+
Heniochus singularius	-	+	*H. hortulanus*	+	+
Neoglyphidodon melas	+	-	*H. margaritaceus*	+	+
N. nigroris	+	+	*H. marginatus*	-	+
Neopomacentrus azysron	+	+	*H. melanochir*	+	+
N. cyanomos	-	+	*H. melanurus*	+	+
Plectroglyphidodon dickii	+	-	*H. miniatus*	-	+
Pomacentrus lacrymatus	-	+	*H. nebulosus*	+	+
P. bankanensis	+	+	*H. nigrescens*	-	+
P. coelestis	+	+	*H. trimaculatus*	+	+
P. lepidogenys	+	+	*Hemigymnus fasciatus*	+	+
P. leucozonus	+	+	*H. melapterus*	+	+
P. nagasakiensis	-	+	*Hologymnosus annulatus*	-	+
P. nigromarginatus	+	-	*H. doliatus*	+	+
P. philippinus	+	+	*Iniistius celebicus*	-	+
P. stigma	-	+	*Labroides bicolor*	+	+
P. tripunctatus	+	+	*L. dimidiatus*	+	+
P. vaiuli	+	+	*Macropharyngodon meleagris*	+	+
Stegastes fasciolatus	+	+	*M. negrosensis*	+	+
Labridae			*Novaculichthys taeniourus*	-	+
Anampses caeruleopunctatus	-	+	*Oxycheilinus bimaculatus*	+	+
A. geographicus	+	+	*O. unifasciatus*	-	+
A. melanurus	+	+	*Pseudocheilinus evanidus*	+	+
A. meleagrides	+	-	*P. hexataenia*	+	+
A. twistii	+	+	*Pteragogus aurigarius*	+	+
Bodianus axillaris	+	+	*Stethojulis bandanensis*	+	+
B. bilunulatus	-	+	*S. strigiventer*	+	-
B. diana	+	+	*S. trilineata*	+	-
B. loxozonus	-	+	*Thalassoma amblycephalum*	+	+
B. mesothorax	-	+	*T. cupido*	+	+
B. perditio	-	+	*T. hardwicke*	+	+
Cheilinus chlorourus	+	+	*T. jansenii*	+	+
C. trilobatus	+	+	*T. lunare*	+	+
Cheilio inermis	+	+	*T. lutescens*	+	+
Choerodon fasciatus	+	+	*T. purpureum*	+	+
Cirrhilabrus cyanopleura	-	+	*T. quinquevittatum*	+	+
C. melanomarginatus	-	+	*T. trilobatum*	+	+
Coris aygula	-	+	**Scaridae**		
C. dorsomacula	-	+	*Bolbometopon muricatum*	+	-

Table 2. (cont.) Fish checklist in the subtidal water adjacent to National Museum of Marine Biology and Aquarium.

Family and species	Survey		Family and species	Survey	
	1989-91	2009-11		1989-91	2009-11
Calotomus carolinus	-	+	*F. humeralis*	-	+
C. spinidens	-	+	*F. inframaculatus*	-	+
Cetoscarus bicolor	-	+	*F. longispinus*	+	+
Chlorurus sordidus	+	+	*Gnatholepis cauerensis*	-	+
Hipposcarus longiceps	-	+	*Istigobius decoratus*	+	+
Leptoscarus vaigiensis	-	+	*I. ornatus*	+	-
Scarus dimidiatus	-	+	*Mahidolia mystacina*	+	-
S. forsteni	-	+	*Pleurosicya micheli*	-	+
S. frenatus	-	+	*P. mossambica*	-	+
S. ghobban	+	+	*Trimma naudei*	-	+
S. ovifrons	-	+	*T. okinawae*	-	+
S. rubroviolaceus	+	+	*Valenciennea puellaris*	-	+
Pinguipedidae			*V. strigata*	+	+
Parapercis clathrata	+	+	**Ptereleotridae**		
P. kamoharai	-	+	*Nemateleotris magnifica*	+	+
P. millepunctata	+	+	*Ptereleotris evides*	+	+
P. pacifica	+	+	*P. microlepis*	-	+
P. xanthozona	-	+	**Ephippidae**		
Tripterygiidae			*Platax teira*	-	+
Enneapterygius rubicauda	-	+	**Siganidae**		
Helcogramma striata	-	+	*Siganus fuscescens*	-	+
Blenniidae			*S. guttatus*	+	-
Aspidontus taeniatus	-	+	*S. spinus*	+	-
Ecsenius namiyei	-	+	**Zanclidae**		
E. yaeyamaensis	+	+	*Zanclus cornutus*	+	+
Meiacanthus atrodorsalis	-	+	**Acanthuridae**		
M. grammistes	+	+	*Acanthurus dussumieri*	+	+
Plagiotremus rhinorhynchos	+	+	*A. japonicus*	+	+
P. tapeinosoma	+	-	*A. lineatus*	+	+
Gobiidae			*A. maculiceps*	+	-
Amblygobius guttata	+	+	*A. nigricauda*	+	-
A. nocturnus	+	+	*A. nigrofuscus*	-	+
A. periophthalma	+	+	*A. olivaceus*	-	+
A. phalaena	-	+	*A. pyroferus*	+	+
A. wheeleri	+	+	*A. triostegus*	-	+
Bryaninops yongei	+	-	*A. xanthopterus*	+	+
Cryptocentrus albidorsus	+	-	*Ctenochaetus binotatus*	+	+
C. strigilliceps	+	-	*Naso lituratus*	+	+
Ctenogobiops aurocingulus	+	+	*N. unicornis*	+	+
C. pomastictus	+	-	*Zebrasoma flavescens*	+	-
Eviota afelei	-	+	*Z. scopas*	+	-
E. albolineata	-	+	**Balistidae**		
E. sebreei	-	+	*Balistapus undulatus*	+	+
Fusigobius duospilus	-	+	*Balistoides conspicillum*	-	+

Table 2. (cont.) Fish checklist in the subtidal water adjacent to National Museum of Marine Biology and Aquarium.

Family and species	Survey		Family and species	Survey	
	1989-91	2009-11		1989-91	2009-11
Pseudobalistes flavimarginatus	+	-	*A. nigropunctatus*	+	+
Rhinecanthus rectangulus	-	+	*A. stellatus*	-	+
R. verrucosus	+	-	*Canthigaster axiologus*	-	+
Sufflamen bursa	+	+	*C. bennetti*	+	-
S. chrysopterum	+	+	*C. janthinoptera*	+	+
Monacanthidae			*C. solandri*	+	+
Paraluteres prionurus	+	+	*C. valentini*	+	+
Pervagor janthinosoma	-	+	**Diodontidae**		
Ostraciidae			*Diodon eydouxii*	-	+
Ostracion cubicus	-	+	*D. holocanthus*	+	+
O. meleagris	+	-	*D. liturosus*	+	-
Tetraodontidae					
Arothron hispidus	-	+	Number of family	38	42
A. immaculatus	-	+	Number of species	180	289

Table 3. The 10 most speciose families of subtidal fishes in waters adjacent to the National Museum of Marine Biology and Aquarium. -, not included in the list of the top 10 in each survey.

Family	Survey 1989-91			Survey 2009-11			Total		
	No. species	%	Rank	No. species	%	Rank	No. species	%	Rank
Labridae	42	23.3	1	58	20.1	1	61	18.4	1
Pomacentridae	21	11.7	2	33	11.4	2	39	11.7	2
Gobiidae	14	7.8	3	21	7.3	3	27	8.1	3
Chaetodontidae	13	7.2	4	15	5.2	4	17	5.1	4
Acanthuridae	12	6.7	5	11	3.8	8	15	4.5	5
Apogonidae	5	2.8	7	14	4.8	5	15	4.5	5
Lutjanidae	9	5.0	6	14	4.8	5	15	4.5	5
Scaridae	-	-	-	12	4.2	7	12	3.6	8
Mullidae	4	2.2	10	9	3.1	9	10	3.0	9
Scorpaenidae	-	-	-	-	-	-	9	2.7	10
Tetraodontidae	5	2.8	7	8	2.8	10	9	2.7	10
Balistidae	5	2.8	7	-	-	-	-	-	-
Blenniidae	4	2.2	10	-	-	-	-	-	-
Serranidae	4	2.2	10	8	2.8	10	-	-	-
Total	138	76.7		203	70.2		229	69.0	

changes in the adjacent subtidal water is likely negligible. Nonetheless, a constant monitoring and conservation of the aquatic environment and biodiversity in this and nearby areas is still highly recommended.

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國立海洋生物博物館周邊亞潮帶海域之魚類相

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摘 要

國立海洋生物博物館周邊海域，位於台灣南部的墾丁國家公園範圍內。本海域爲一典型的海洋環境交會帶，涵蓋河口域、砂泥底及礁岩岸等棲地。本研究彙整 1989-91 及 2009-11 兩個不同年間的調查，提供國立海洋生物博物館周邊亞潮帶海域之魚種名錄。總共記錄到 45 科 332 種魚類，其中 138 種 (佔全部魚種數之 41.6%) 於兩次調查中皆可發現。前 10 順位魚種數較多的科，皆佔魚種組成的 70%以上，優勢順位依序則均爲隆頭魚科 (Labridae)、雀鯛科 (Pomacentridae)、鰕虎科 (Gobiidae) 及蝴蝶魚科 (Chaetodontidae)，顯示此亞潮帶海域魚類相之長期穩定性。

關鍵詞：交會帶，亞潮帶，魚種名錄