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Species composition and sizes of fish in the lagoon of Dongsha Island (Pratas Island), Dongsha Atoll of the South China Sea

Chih-Wei Chang[1,2,*], Chao-Sheng Huang[2] and Shao-I Wang[1]

[1] National Museum of Marine Biology and Aquarium, Checheng, Pingtung 944, Taiwan, R.O.C.

[2] Institute of Marine Biodiversity and Evolutionary Biology, National Dong Hwa University, Checheng, Pingtung 944, Taiwan, R.O.C.

*Corresponding author. E-mail: changcw@nmmba.gov.tw

Abstract

The Dongsha Island is a coralline island within the Dongsha Atoll located in the South China Sea. Seagrass beds dominate the lagoon surrounding the island. Species composition, spatio-temporal distribution, and sizes of fish in the Dongsha Island lagoon were documented via trammel net surveys and visual censuses in July and September 2010. A total of 20 families and 31 species of fish were recorded during the two surveys. A higher diversity and abundance of fish was found near the exit of lagoon. The top six dominant species, accounting for 83.3% of total number of fish collected, were ranked by *Lethrinus nebulosus* and *L. harak* (Lethrinidae), *Negaprion acutidens* (Carcharhinidae), *Chelon macrolepis* (Mugilidae), *Arothron hispidus* (Tetraodontidae), and *Leptoscarus vaigiensis* (Scaridae). Total lengths of the fish ranged from 7.3-cm TL for *Zanclus cornutus* (Zanclidae) to 69.5-cm TL for *N. acutidens*. Life-history stages of the fish were determined to be juvenile and adult, indicating that the seagrass beds in the Dongsha Island lagoon served as suitable habitat for nursery habitat for young fishes in terms of refuge from predation and increased foraging opportunities.

Key words: fish fauna, size composition, seagrass beds

Introduction

The Dongsha Atoll (20°35'-47'N and 116°41'-55'E) is a remote area in the northern region of the South China Sea approximately 450 km away from Taiwan. It is comprised of an atoll, two underwater reef flats (Beiweitan [North Vereker Bank] and Nanweitan [South Vereker Bank]), and the Dongsha Island (Pratas Island). The atoll is perfectly round in shape, with a diameter of 25 km, 46 km in length and 2 km in width, and is only visible during the ebb tide. Within the atoll is a large lagoon less than 30 m in depth (Fig. 1a). The two underwater reef flats depart from each other for 9.3 km and are 80-km north of the Dongsha Island. The Dongsha Island is a coralline island, located in the center of a natural opening in the western side of the atoll. It is the largest island in the South China Sea; the island is 2.8-km long and 0.865-km wide with its highest peak measuring roughly 7.8 m above sea level with an approximate area of 174 ha. Shaped like a crab's claw, the island is larger on the east with two sandy ridges extending along the western shore like a wrench. The two "claws" surround to form a small lagoon measuring 64 ha in area (Fig. 1b). With Dongsha Atoll as the core component and extending 12 nmi into the surrounding waters, a total area of 353,668 ha has been managed since 2007 as the Dongsha Atoll National Park, which represents the first marine national park established in Taiwan (Lee 2009).

Marine ecosystems are remarkably diverse in the Dongsha Atoll. With the exception of the massive coral reefs spread outside the Dongsha Atoll, many scattered coral colonies and shallow reefs have since recovered from the 1998 El Niño mortality event induced by elevated water temperature within the atoll lagoon.

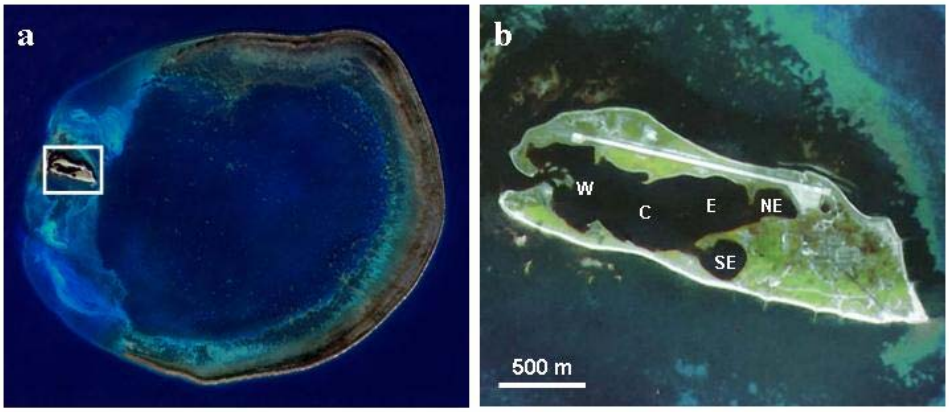

Fig. 1. The Dongsha Atoll (a) and Dongsha Island (b) in the South China Sea showing the five sampling stations for fish fauna surveys in 2010. (b) magnified from (a). W: west; C: central; E: east; NE: northeast; SE: southeast. (Images from the Marine National Park Headquarters)

There is a small range of mangrove habitat dominated by *Avicennia marina* in the eastern and southern lagoon areas of the Dongsha Island. In addition, within the lagoon and surrounding the Dongsha Island are large beds of seven species of seagrass that cover an area of over 1,185 ha, which approximately 20-times more than all seagrass beds found around Taiwan (Lin et al. 2010).

Coastal waters adjacent to the Dongsha Atoll have long been known as both good fishing grounds for a variety of fisheries and as an important hotspot for marine biodiversity studies (Yang et al. 1975, Fang and Lee 1994, Fang 1998, Dai 2006, Chen et al. 2011). Nine grouped investigations focusing on the marine environment, ecology, and biota of the Dongsha Atoll were conducted between 1975 and 2010. Regarding the fish fauna recorded in the Dongsha Atoll, a total of 72 families and 646 species of fish were cumulatively documented (Chen et al. 2005, 2011). Five major habitat classifications within the atoll with distinct components were recognized that may facilitate such high diversity of fish assemblages, i.e. deep outer atoll, shallow outer atoll, northwestern atoll, inner atoll, and seagrass beds around the island (Chen et al. 2011).

Most fish fauna surveys were previously conducted using an underwater visual census. Although supportive information on species composition and spatio-temporal distribution of the fish assemblages was readily available, information on the size distribution of the fish was not always easy to obtain unless the fish could be collected and rigidly measured. Fang et al. (1994) had preliminarily attempted to collect the fish in the Dongsha Island lagoon using gill nets. The sizes of the fish collected, however, were not the main objective at that occasion and the information was therefore not reported. The present study aimed to survey species composition and distribution of the fish, and to provide primary information on size composition of the fish collected in the Dongsha Island lagoon using trammel nets as the primary sampling gear.

Materials and Methods

Two surveys related to the abiotic (water quality and sediment condition) and biotic components (phytoplankton, zooplankton, mollusk, and fish) of the Dongsha Island lagoon were conducted in July and September 2010, which was supported by the Marine National Park Headquarters. Five common sampling stations across the Dongsha Island lagoon were chosen; namely west (W), central (C), east (E), southeast (SE), and northeast (NE) portions of the lagoon. Stations W, C, and E represented the main water masses of the lagoon, with W the nearest site closest to the exit of lagoon where water exchange was higher than any other station. Stations SE and NE were in relatively small and poor-exchanged water masses far removed from the exit of lagoon (Fig. 1b).

The lagoon water temperatures and salinities on the flood tide ranged from 33.7 to 36.2ºC and from 32.8 to 35.3 psu in July (15:00 hr), and from 27.6 to 28.9ºC and from 32.7 to 33.1 psu in September (08:30 hr), respectively; those on the ebb tide ranged from 31.0 to 32.9ºC and from 32.6 to 35.4 psu in July (11:00 hr), and from 30.6 to 32.5ºC and from 32.1 to 32.7 psu in September (13:30 hr), respectively. Diurnal variation in water temperatures was dramatic, and tidal variation in salinities was low (Ko et al. 2010).

A three-layer trammel net (length = 45 m, height = 1.8 m, inner mesh = 4 cm, outer mesh = 22 cm) was set for 30 min to collect fish at each station. In addition, underwater photos of the fish in the lagoon were randomly taken by visual census. Species identification of the fish, either specimen collected or voucher photos, followed Lin et al. (2010) and Chen et al. (2011). Total length (TL) of the collected fish was measured to the nearest 0.1 cm to evaluate their size composition. Maximum length and the length at first maturity of the various fish species were obtained from the FishBase (Froese and Pauly 2012) so that the life history stage of the collected fish could be estimated.

Results and Discussion

A total of 66 fish belonging to 11 families and 13 species were collected by trammel netting in the Dongsha Island lagoon (Table 1). Twenty fish of 6 families

Table 1. Species composition of the fish collected in the Dongsha Island lagoon in 2010. W: west; C: central; E: east; NE: northeast; SE: southeast. A dash indicates that the fish species was not detected in a particular habitat.

Family	Species	July 2010					September 2010					No. fish	Percentage
		W	C	E	NE	SE	W	C	E	NE	SE	collected	(%)
Carcharhinidae	*Negaprion acutidens*	2	3	-	-	2	-	-	1	-	-	8	12.1
Chanidae	*Chanos chanos*	-	-	-	-	-	-	-	-	-	2	2	3.0
Mugilidae	*Chelon macrolepis*	2	-	-	-	-	1	-	-	-	2	5	7.6
Carangidae	*Carangoides orthogrammus*	-	-	-	-	-	1	-	-	-	-	1	1.5
Lutjanidae	*Lutjanus argentimaculatus*	-	-	-	1	-	-	-	-	-	-	1	1.5
	Lutjanus fulviflamma	-	-	-	-	-	1	-	-	-	-	1	1.5
Gerreidae	*Gerres oyena*	-	-	-	-	-	1		1	-	-	2	3.0
Lethrinidae	*Lethrinus harak*	2	-	-	-	2	3	1	-	2	-	10	15.2
	Lethrinus nebulosus	1	-	2	-	-	14	4	-	1	1	23	34.8
Terapontidae	*Terapon jarbua*	-	-	-	-	-	2	-	-	1	-	3	4.5
Scaridae	*Leptoscarus vaigiensis*	1	-	-	-	-	2	-	1	-	-	4	6.1
Zanclidae	*Zanclus cornutus*	-	-	-	-	-	-	-	-	1	-	1	1.5
Tetraodontidae	*Arothron hispidus*	-	1	1	-	-	1	1	-	1	-	5	7.6
Total		8	4	3	1	4	26	6	3	6	5	66	100

and 7 species were identified from the July samples, whereas 11 families, 12 species, and 46 fish were identified from the September surveys. The spatial distribution of fish was uneven in the Dongsha Island lagoon. Specifically, nine families, ten species, and 34 fish were collected in the station W, which represented a higher taxonomic diversity than the summation of the other four stations in the lagoon (Table 1). The high catch in station W was attributed to the close proximity of this site to the exit of lagoon being that allowed for high amounts of water exchange as well as fish movements in and out of the lagoon.

The six most dominant species accounted for 83.3% of the total number of fish collected in both surveys. Ranked in order of most to least dominant, these species were *Lethrinus nebulosus* and *L. harak* (Lethrinidae), *Negaprion acutidens* (Carcharhinidae), *Chelon macrolepis* (Mugilidae), *Arothron hispidus* (Tetraodontidae), and *Leptoscarus vaigiensis* (Scaridae). The remaining fishes collected were occasionally found in one of the two samplings, including *Terapon jarbua* (Terapontidae), *Chanos chanos* (Chanidae), *Gerres oyena* (Gerreidae), *Carangoides orthogrammus* (Carangidae), *Lutjanus argentimaculatus* and *L. fulviflamma* (Lutjanidae), and *Zanclus cornutus* (Zanclidae).

In addition to the fish collected with trammel nets, the visual census identified another 9 families and 18 fishes, including *Acanthurus xanthopterus* (Acanthuridae), *Chaetodon lunula* and *C. vagabundus* (Chaetodontidae), *Amblygobius phalaena* and *Fusigobius neophytus* (Gobiidae), *Stethojulis strigiventer* (Labridae), *Echidna nebulosa* (Muraenidae), *Scolopsis bilineata* and *S. trilineata* (Nemipteridae), *Abudefduf sexfasciatus*, *A. vaigiensis*, *Chrysiptera unimaculata*, *Dischistodus prosopotaenia*, *Pomacentrus grammorhynchus*, *P. moluccensis* and *P. pavo* (Pomacentridae), *Pseudochromis fuscus* (Pseudochromidae), and *Sphyraena barracuda* (Sphyraenidae).

The lagoon within and waters surrounding Dongsha Island were dominated by seagrass beds where 27 families and 75 species of fish had previously been recorded (Lin et al. 2010). According to Chen et al. (2011), at least 23 families and 56 fishes were documented to occur within the Dongsha Island lagoon. However, the present study only recorded 20 families and 31 fishes in the lagoon. Although the present study documents a slightly higher in diversity than the previous 12 families and 16 fishes found in Fang et al. (1994), both studies may have documented higher diversities through increased sampling effort (e.g., number of locations and increased sampling duration). Nevertheless, all fish species compiled by Fang et al. (1994) and the present study have been documented similarly by Lin et al. (2010) and Chen et al. (2011).

Total length of the fish collected with trammel nets ranged from 7.3 cm for *Z. cornutus* to 69.5 cm for *N. acutidens*, yet the TL range was species specific (Table 2). Lengths for most fishes slightly increased from July to September, showing a gradual growth of the fish in the lagoon. A comparison of the fish sizes recorded in this study to either maximum length or the length at first maturity cited from FishBase (Froese and Pauly 2012) indicated that the life history stage of *C. macrolepis*, *G. oyena*, *L. harak*, *T. jarbua*, and *L. vaigiensis* were in the adult stage because their sizes were larger than those at first maturity or were 50% and above the maximum recorded lengths. The other majority of fishes that were smaller than those at first maturity, ranging from 12.4% (*L. argentimaculatus*) to 36.3% (*L. fulviflamma*) of the maximum recorded lengths, were in deemed to be in the juvenile stage (Table 2). This coincided with the finding that the seagrass beds in the Dongsha Island lagoon served as suitable habitat for nursery habitat for young fishes in terms of refuge from predation and increased foraging opportunities (Lee and Lin 2009, Lin et al. 2010).

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Table 2. Total length range of the fish collected in the Dongsha Island lagoon from 2010. *Data obtained from FishBase (Froese and Pauly 2012).

Family	Species	Total length (cm)		Maximum*	Maximum	Length at first*
		July 2010	September 2010	length (cm)	proportion (%)	maturity (cm)
Carcharhinidae	*Negaprion acutidens*	59.8-69.5	64.0	380.0	18.3	-
Chanidae	*Chanos chanos*	-	32.0-34.0	124.0	27.4	91.8
Mugilidae	*Chelon macrolepis*	19.7-22.4	20.6-28.5	60.0	47.5	23.0
Carangidae	*Carangoides orthogrammus*	-	24.7	75.0	32.9	-
Lutjanidae	*Lutjanus argentimaculatus*	18.6	-	150.0	12.4	57.0
	Lutjanus fulviflamma	-	12.7	35.0	36.3	13.0
Gerreidae	*Gerres oyena*	-	15.4-15.7	30.0	52.3	-
Lethrinidae	*Lethrinus harak*	16.2-24.1	17.1-27.3	50.0	54.6	-
	Lethrinus nebulosus	14.8-16.2	16.0-28.7	86.0	33.4	45.3
Terapontidae	*Terapon jarbua*	-	22.6-25.7	36.0	71.4	13.0
Scaridae	*Leptoscarus vaigiensis*	17.8	20.9-21.1	35.0	60.3	-
Zanclidae	*Zanclus cornutus*	-	7.3	23.0	31.7	-
Tetraodontidae	*Arothron hispidus*	24.3-34.8	20.9-44.0	50.0	88.0	-

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南中國海東沙環礁東沙島潟湖之魚種組成與體型

張至維[1,2,*] 黃朝生[2] 王劭頤[1]

[1]國立海洋生物博物館

[2]國立東華大學海洋生物多樣性及演化研究所

*changcw@nmmba.gov.tw

摘　要

東沙島爲位於南中國海東沙環礁中之珊瑚島，島內之潟湖主要爲海草床棲地。本研究利用三重刺網採集及潛水目視調查，進行島內潟湖之魚種組成、時空分布與體型之研究。2010 年兩次的調查共記錄到 20 科 31 個魚種。鄰近潟湖出口之水域，呈現較高的魚類多樣性及豐度。前 6 優勢魚種佔全部採獲數量之 83.3%，依序爲龍占魚科 (Lethrinidae) 的青嘴龍占 (*Lethrinus nebulosus*) 及單斑龍占 (*L. harak*)、白眼鮫科 (Carcharhinidae) 之犁鰭檸檬鮫 (*Negaprion acutidens*)、鯔科 (Mugilidae) 之大鱗鯧 (*Chelon macrolepis*)、四齒魨科 (Tetraodontidae) 之紋腹叉鼻魨 (*Arothron hispidus*)，以及鸚哥魚科 (Scaridae) 之纖鸚鯉 (*Leptoscarus vaigiensis*)。潟湖內出現魚類的全長介於角蝶魚科 (Zanclidae) 角鐮魚 (*Zanclus cornutus*) 之最小值 7.3 cm，與犁鰭檸檬鮫之最大值 69.5 cm。各魚種之生活史階段爲稚魚或成魚，顯示東沙島潟湖之海草床提供一個適合魚類哺育、避敵與覓食之棲地。

關鍵詞：魚類相，體型組成，海草床。