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Length-Weight Relationships of Yellowfin Tuna *Thunnus Albacares*, Skipjack Tuna *Katsuwonus Pelamis*, Yaito Tuna *Euthynnus Yaito*, and Blue Round Scad *Decapterus Maruadsi* from Mischief Reef, South China Sea

Zhenhua Ma[1, 2], Gang Yu[1, 2], Qiaer Wu[1, 2*], Shengwei Ma[1], Shaosen Wu[1], Xu Chen[1]

[1] South China Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, Guangzhou, China

[2] Key Laboratory of South China Sea Fishery Resources Exploitation and Utilization, Ministry of Agriculture, Guangzhou, China

**wqe66@163.com*

Abstract: *This study reports length-weight relationships of yellowfin tuna Thunnus albacares, skipjack tuna Katsuwonus pelamis, yaito tuna Euthynnus yaito, and blue round scad Decapterus maruadsi from Mischief Reef, South China Sea caught by light falling-net fishing method. A total of 311 individuals were sampled in this study. The length-weight relationships of yellowfin tuna, skipjack tuna, yaito tuna and blue round scad can be expressed as* $W_{yellowfin} = 0.0096 \times L^{2.548}$ ($R^2 = 0.9243$), $W_{skipjack} = 2.7593 \times L^{1.4437}$ ($R^2 = 0.8468$), $W_{yaito} = 0.0079 \times L^{3.1983}$ ($R^2 = 0.9087$), $W_{blue} = 0.0049 \times L^{3.3415}$ ($R^2 = 0.8924$), *respectively. To the authors' best knowledge, this study presents the first references on the length-weight relationships of the collected species in Mischief Reef, South China Sea. Results from the present study will provide biological information to conserve the natural resource of these species in South China Sea.*

Keywords: *Length-weight relationships; yellowfin tuna (Thunnus albacares); skipjack tuna (Katsuwonus pelamis); yaito tuna (Euthynnus yaito), blue round scad (Decapterus maruadsi); Mischief Reef, South China Sea.*

1. INTRODUCTION

Size in fishes is generally more biologically relevant than age, because several ecological and physiological factors are more size-dependent than age-dependent [1]. Therefore, variability in size has important implications for diversity aspects of fisheries science and population dynamics [2]. As one of the most frequently used tools, length-weight relationships have important implications in fisheries assessment, fish biology, physiology, and ecology. In fisheries studies, length-weight relationships have been implicated to estimate weight from length [3], estimate the weight-at-age [4]. In biological studies, length-weight relationships allow variations in fish growth to be tracked, the calculation of condition indexes, and morphological difference between populations from different regions to be compared [5, 6, 7].

Yellowfin tuna *Thunnus albacares* are distributed across the Pacific Ocean, and most catches are located in its eastern and western boundaries [8]. Recent stock assessment for yellowfin tuna in the eastern Pacific Ocean indicates that the recent fishing mortality rates are close to those corresponding to the maximum sustainable yield [9]. The skipjack tuna *Katsuwonus pelamis* and yaito tuna *Euthynnus yaito* are the most caught fishery species in Pacific Ocean. Blue round scad *Decapterus maruadsi* is mainly distributed in Indo-West Pacific: South China Sea to the Mariana Islands.

Mischief Reef (Fig. 1) locates in South China Sea (9^o 54 ' 00 " N, 115^o32' 00 " E), is the traditional fishery zone in China. In Mischief Reef fishery zone, commercial fishery species include yellowfin tuna, skipjack tuna, yaito tuna, blue round scad, and flying squid *Sthenoteuthis oualaniensis*. Evidence

indicates that Mischief Reef sea area is the spawning ground for commercial pelagic fish in South China Sea [10, 11]. Our recent survey confirmed that Mischief Reef area is the spawning and nursery ground for yellowfin tuna, skipjack tuna, yaito tuna, and blue round scad (unpublished data). In this study, we estimated the length-weight relationship of wild caught yellowfin tuna, skipjack tuna, yaito tuna, and blue round scad from the Mischief Reef sea area, South China Sea, aiming to provide biological information to conserve the natural resource of these species in South China Sea.

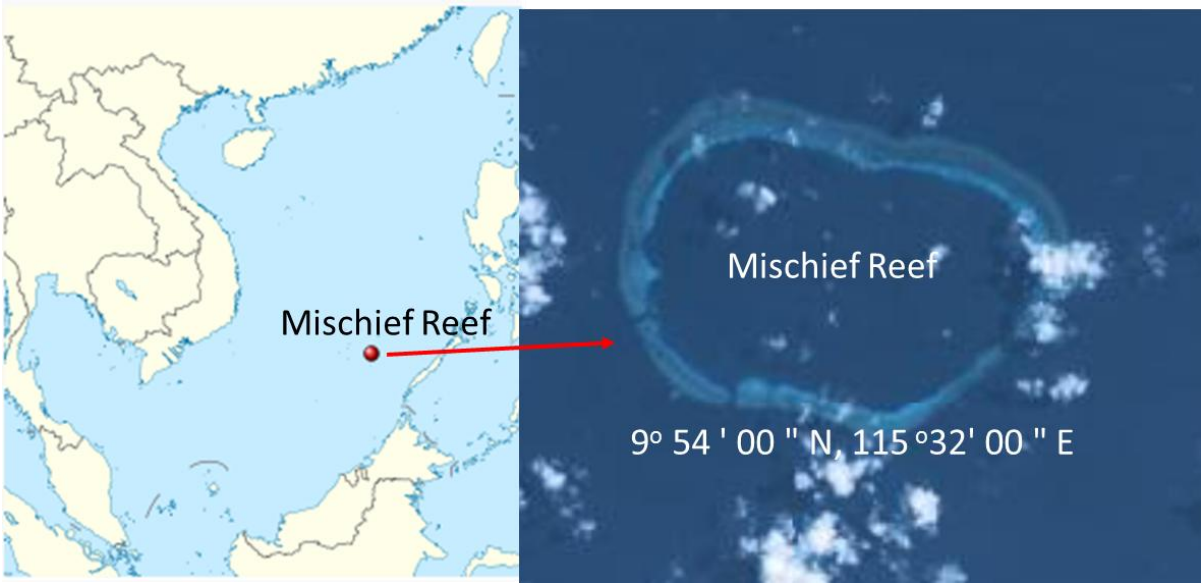

Fig1. *Map of Mischief Reef in South China Sea*

2. MATERIALS AND METHODS

As a part of Mischief Reef Fishery Experimental Research Project, this study was conducted in May 2016 according to the migration of juvenile fishes. Fish samples were caught by light falling-net fishing method with 1.0 cm mesh in Mischief Reef Area (9° 51 ' 5.98 " N, 115 °30' 4.34 " E). The average depth of net cover was 50 m, and the cover area of the net was 3,150 m^2. Fish samples were randomly collected upon caught, and fish species were directly identified and measured. A total of 311 individuals were sampled in this study. Total length of fish was measured by using a ruler accurate to 1 mm, and the wet weight of fish was measured by a top loading digital balance accurate to 0.1g.

The relationship between total length (L, cm) and wet weight (W, g) were calculated by power regression $W = a \times L^b$ (IBM SPSS Statistics 21.0). The association degree between L and W was calculated by the determination coefficient (R^2). In the length-weigh relationship, value of exponent b provides information on fish growth. When $b = 3$, the increase in weight is isometric. The increase of weight is positive allometric if $b > 3$, while the increase of weight is negative allometric if $b < 3$ [12]. In this study, the b value for each species was tested by a t-test at the 0.05 significance level to verify if it was significantly different from 3.

3. RESULTS AND DISCUSSION

In China, yellowfin tuna, skipjack tuna, yaito tuna, and blue round scad are the economic significance offshore fishing species in South China Sea [13]. Biological information of these species has never been estimated in Mischief Reef area. The sample size, the minimum, maximum and mean lengths (±S.D.), and maximum and minimum weights used in the analysis for each species as well as the parameters a and b of the length-weight relationships, and the coefficient of determination R^2 are presented in Table 1. The sample size ranged from 32, for *T. albacares*, to 109, for *D. maruadsi*. The length ranged from 15.54 to 21.79 cm for *T. albacares*, from 21.3 to 35 cm for *K. pelamis*, from 18 to 32.5 cm for *E. yaito*, and from 13.4 to 20.6 for *D. maruadsi*. The R^2 values ranged from 0.8468, for *K. pelamis*, to 0.9243, for *T. albacares*, and all regressions in this study were highly significant ($P < 0.01$). The values of b ranged from 1.4437, for *K. pelamis*, to 3.3415, for *D. maruadsi*, whereas the b values of *E. yaito* and *D. maruadsi* are > 3.

Factors such as temperature, salinity, food (quantity, quality, e.g.), sex, time of year, and stage of maturity may affect the parameters in length-weight relationship among seasons and years [14, 15]. In the present study, the *b* value of *T. albacares* was 2.5480, which was different from other studies [16, 17]. The *b* value of *K. pelamis* in the present study was 1.4437, which was significantly lower than the result reported by Nakamura and Uchiyama (1966) (*b* = 3.36836) [18]. Such different may cause by the size different. In Nakamura and Uchiyama (1966)'s study, the length of fish ranged from 26.3 to 75.7 cm, which was significantly bigger than we collected in this study. In the present study, the *b* values of *E. yaito* and *D. maruadsi* were > 3, suggesting the increase of weight in these species were positive allometric.

Table1. *Length-weigh relationship of yellowfin tuna (Thunnus albacares), skipjack tuna (Katsuwonus pelamis), yaito tuna (Euthynnus yaito), and blue round scad (Decapterus maruadsi) from Mischief Reef, South China Sea*

		Length characteristics (cm)				**Weight characteristics (g)**		**Parameters of the relationship**		
Species	n	Mean	S.D.	Min.	Max.	Min.	Max.	*a*	*b*	R^2
Thunnus albacares	32	16.19	2.16	15.54	21.79	44.5	294	0.0096	2.5480	0.9243
Katsuwonus pelamis	65	28.3	2.35	21.3	35	120.5	478.5	2.7593	1.4437	0.8468
Euthynnus yaito	105	23.1	2.83	18	32.5	83	578	0.0079	3.1938	0.9087
Decapterus maruadsi	109	15.6	1.45	13.4	20.6	39.9	123.8	0.0049	3.3415	0.8924

4. CONCLUSIONS

In this study, length-weight relationship of yellowfin tuna, skipjack tuna, yaito tuna, and blue round scad from Mischief Reef, South China Sea were estimated. The length-weight relationships of yellowfin tuna, skipjack tuna, yaito tuna and blue round scad can be expressed as $W_{yellowfin} = 0.0096 \times L^{2.548}$ ($R^2 = 0.9243$), $W_{skipjack} = 2.7593 \times L^{1.4437}$ ($R^2 = 0.8468$), $W_{yaito} = 0.0079 \times L^{3.1983}$ ($R^2 = 0.9087$), $W_{blue} = 0.0049 \times L^{3.3415}$ ($R^2 = 0.8924$), respectively. Results from the present study will provide biological information to conserve the natural resource of these species in South China Sea.

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