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Biological Characteristics of Goldstripe Sardinella *Sardinella gibbosa* (Bleeker, 1849) in the Nearshore Area of Ham Thuan Nam District, Binh Thuan Province

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Abstract: The biological analyses of 240 individuals of the *Sardinella gibobosa* collected in the nearshore area of Ham Thuan Nam district, Binh Thuan province in 2014 provided some important information: the total length of *S. gibbosa* ranged from 105 mm to 170 mm, with 134.71 mm on average, but mainly from 120 to 140 mm; and their weight ranged from 10 gr to 41 gr, with 20.90 gr on average and mainly in 10 gr - 20 gr (60.83%). The equation of relationship between total length (TL) and weight (W) for the whole stock is $W = 0.6325 \times L^{2.7972}$ ($R^2 = 0.8766$). The fished stock included four age groups (0^+ to 3^+) but primarily in the 1^+ age group (53.75%). The most predominant food item group was phytoplankton and crustaceans, which were found in the gut of most individuals examined. The first and the second degree of the stomach fullness made up significant proportions with 47.92% and 45.42%, respectively, while the third degree made up only a minor proportion (4.17%). The overall sex ratio (females to males) was 1.00 : 1.07. Sexual maturity of exploited fish individuals was essentially low, mainly at the stages I (42.08%) and II (47.92%). These data show that the goldstripe sardinella has been being overexploited, because exploiting fishes were mainly on young ones, which have not yet reached sexual maturity in the studied area.

Keywords: Sardinella gibbosa, biological characteristics, growth equations, Binh Thuan, nearshore area.

1. Introduction

Goldstripe sardinella, *Sardinella gibbosa*, is a fish species of the family Clupeidae. It is native to shallow tropical waters, but possible living at depths down to 70 m, and often being associated with coral reefs. It grows maximally up to 17 cm in length, the length at first maturity is 12.7 cm, and common length is 15.0 cm. The *S. gibbosa* is a commercially important marine sardine with the average Global Capture Production of 215,917 tons during 2005 - 2014 [1]. It is a coastal pelagic species in the Indo-West Pacific: Persian Gulf, East Africa and Madagascar to Indonesia, north to Taiwan and Korea south to the Arafura Sea and northern Australia [1].

To date, there are still very few studies on biological characteristics of *S. gibbosa* in Vietnam. The aim of this study is to provide the

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first data on biological aspects of the *S. gibbosa* population inhabiting the nearshore area of Binh Thuan province.

2. Materials and methods

The study was carried out in Ham Thuan Nam district, Binh Thuan province, at the coast area near the Khe Gà lighthouse - the highest and oldest lighthouse of Vietnam. Samples were collected from September 25th to October 5th 2014 with 240 fish individuals in total. Fish samples were obtained early in the morning from fishermen working in the studied area. They used gill nets with the mesh size of 10 mm.

Age was determined on scales taken from a spot under the proximal part of the dorsal fin base and also verified by analyzing length frequency by Bhattacharya method reviewed by Sparre and Venema (1998) [2]. The growth rate was back-calculated based on annual rings on scales.

Scales were taken under the root of dorsal fin, above the lateral line and placed on the glass card with slide facing up. Ages were read by counting the number of true annuli on the scale. Scales were measured from the focus to the first annulus, first to second annulus, second to the third annulus, etc. and from the last annulus to the edge.

The length-weight relationship was presented according to the formula: $W = a L^b$, where: W = total weight (g); L = total length (mm); a and b = constant and coefficient, respectively, calculated by the least squares method.

The fish growth of length and weight was presented after the von Bertalanffy growth equations:

$L_t = L_\infty \{1-e^{-k(t-t_0)}\}$ and $W_t = W_\infty \{1- e^{-k(t-t_0)}\}^b$

Where: L_t and W_t = fish length and weight at the age t, respectively; L_∞ and W_∞ = asymptotic length and weight; k = coefficient of catabolism; t_0 = arbitrarily adopted origin of growth curve; b = exponent in the length-weight relationship.

The parameters of the above equations were found by using the methods of Berverton and Holt reviewed by Sparre and Venema (1998) [2] and calculated by the least squares method that are accompanied by a respective correlation coefficient, namely r.

The food composition and gonad maturity were determined according to analyses of alimentary tracts content and gonads of 240 studied individuals. Food was separated from guts and stomachs and observed through microscope to determine food components. The fullness of stomach and guts was presented by 5-grade scale (from 0 to 4). For fat analysis, both equations of Fulton (1902) and Clark (1928) to calculate condition factor or coefficient of condition are used:

Fulton equation (1902): $Q = \frac{W \ .100}{L^3}$

Clark equation (1928): $Q_0 = \frac{W_0.100}{L^3}$

Where Q, Q_0 = condition factor or coefficient of condition; W = the whole weight in grams; L = the fish length in millimeters; W_0 = refers to the weight without internal organs.

The sex ratio was calculated from the total number of males and females in the catches. The stages of gonad maturity were divided into 6 stages (from I to VI). Analyzing methods of reproduction of the fish in the fieldwork based on the manual "Guide to fish studies" by I. F. Pravdin (1973) [3].

3. Results and Discussion

3.1. Fish length composition in catches

The length frequency distribution of *S. gibbosa* from the nearshore area of Ham Thuan Nam district, Binh Thuan province indicated the exploitation of juveniles in large number. Fishes caught ranged from 105 mm to 170 mm and mainly from 120 - 130 mm to 130 - 140

mm, at 21.67% and 26.25%, respectively (Table 1). The mean length of *S. gibbosa* in the field survey was 134.71 ± 14.23 mm.

3.2. Fish weight composition in catches

The caught fish weight ranged from 10 - 41 gr and mainly from 10 - 20 gr (60.83% of examined individuals). The average weight of *S. gibbosa* collected from the field trip was 20.09 ± 6.65 gr. The fish length and fish weight composition in catches showed that most of caught fishes in the study were juveniles (Table 2).

3.3. Fish age composition in catches

The age of 240 collected fish individuals was studied by using the method of scale reading. Results showed that they aged from 0^+ to 3^+. Among them, individuals of age 1^+ were dominant with 129 individuals (53.75%), 2^+ age group with 80 individuals (33.33%) while the 3^+ age group, with 21 individuals, only made up 8.75% (Figure 1).

3.4. Length-Weight relationship

The resulting length-weight regressions are useful for (a) calculating total weight of fish caught from length-frequency data (thereby eliminating the need for bulk weighing of groups of fish), (b) measuring changes in the size of the population (relative to past or future samples at the same place and season), (c) determining the relative condition of small fish compared to large fish (from the slope of the regression), and (d) comparing condition of this population to the state-wide standards [4]. Relationship between total length (TL) and weight (W) is expressed by the equations (Figure 1):

For the whole stock: $W = 0.6325 \times L^{2.7972}$ ($R^2 = 0.8766$)

For males: $W = 0.3162 \times L^{2.8827}$ ($R^2 = 0.8629$)

For females: $W = 1.2649 \times L^{2.7074}$ ($R^2 = 0.8596$)

The R^2 values for the equations of males, females and the whole 240 samples in this study were higher than 0.85. Therefore, R^2 values indicated the good fits to the observed data.

The growth in length and weight of fish was not uniform through time (Figure 2). At the beginning of life (lower age), the fish mainly increased in length at faster pace, while its body weight increased more slowly. When the fish reached a certain size, the fish mainly increased in the body weight, while the growth in length slowed down. This relationship of length and weight of the fish differed between males and females.

Table 1. Length composition of *S. gibbosa* caught in the nearshore of Binh Thuan province

Group	Length group (mm)	Number	%
1	105 - 110	12	*5.00*
2	110 - 120	36	*15.00*
3	120 - 130	52	*21.67*
4	130 - 140	63	*26.25*
5	140 - 150	42	*17.50*
6	150 - 160	28	*11.67*
7	160 - 170	7	*2.92*
Total		240	*100.00*

Table 2. Weight composition of the *S. gibbosa* caught in the nearshore of Binh Thuan province

Weight (gr)	Number	%	Mean weight
$10 < W \leq 20$	146	60.83	16.22 ± 3.02
$20 < W \leq 30$	75	31.25	25.16 ± 3.12
$30 < W \leq 41$	19	7.92	34.74 ± 3.12
Total	240	100.00	20.09 ± 6.65

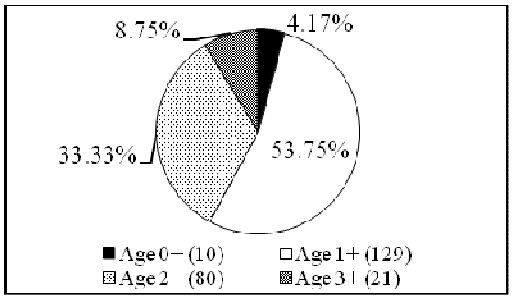

Figure 1. Number of individuals and percentage of *S. gibbosa* age composition.

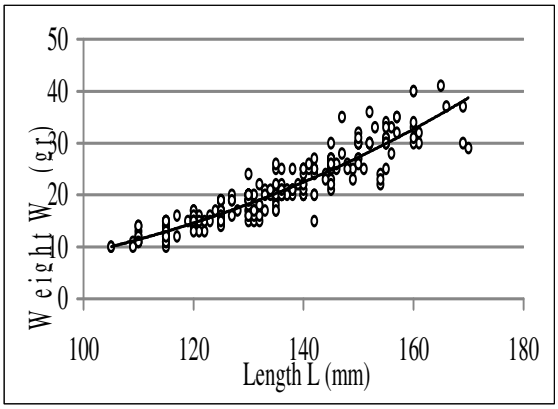

Figure 2. Length-Weight relationship of *S. gibbosa* in the whole stock.

3.5. Estimation of growth parameters

Among developed fish growth models, the mathematical model for individual growth by von Bertalanffy (1934) has been shown to conform to the observed growth of most fish species.

From the observed data, parameters of the von Bertalanffy equation for length and weight growth were estimated as follows:

L_∞ = 197.28 mm; W_∞ = 40.62 gr, k = 0.2497 and t_0 = - 0.0453

Based on the parameters above, von Bentalanffy weight and length growth equations for the caught fishes in Binh Thuan province were calculated as follow:

Length growth: $L_t = 197.28\ (1 - e^{-0.2497\ (t + 0.0453)})$

Weight growth: $W_t = 40.62\ (1 - e^{-0.2497\ (t + 0.0453)})^{2.7972}$

The value of L_∞ in this study was similar to the results of other previous studies. For example, L_∞ in the von Bertalanffy length growth equation of *S. gibbosa* from the North West Bay of Bengal was 20.7 cm [5].

3.6. Food and feeding

By studying food components in the gastrointestinal tracts of 153 individuals of *S. gibbosa*, we have identified three different groups of food, each with different proportion (Figure 3). The phytoplankton was found in the stomachs and guts of 94 individuals, accounted for 61.44%. The second group was the crustaceans, at 49.02% (found in the stomachs of 75 individuals). Sixteen individuals were found having both phytoplankton and crustaceans in their stomachs. The third kind of food, small fish and fish eggs, had the smallest proportion (4.58%). We could not analyse the stomachs of 84 individuals (36.25% of the total 240 individuals) because foods were totally digested in these individuals.

It was noticeable that the proportion of food groups changed accordingly the body length of the examined individuals. The third food group (juvenile and fish eggs) were found in slightly smaller fish, while the phytoplankton and crustaceans were found at higher proportions in larger fish. This was similar to the results in the study by S. Lazarus (1969 - 1971) [6].

Most of the analysed stomachs were in the situation of “poor” and “moderate” feeding intensity. In particular, 121 stomachs (50.42%) were in “poor” feeding intensity, corresponding to 0 or 1 fullness degree; and 109 stomachs (45.42%) were in “moderate” feeding intensity, at 2 fullness degree. Only 10 stomachs (4.17%) were in “good” feeding intensity, corresponding to 3 or 4 fullness degree (Figure 4).

3.7. Sexual ratio, gonad maturity and spawning

The sex ratio (males to females) of *S. gibbosa* in the nearshore area of Binh Thuan

province was 1.07: 1.00, with 51.80% males and 48.20% females.

The gonads of 240 examined individuals were at maturity stages from I to III (Table 3). Most of the fish specimens were at maturity stages II and I, with 47.92% and 42.08% of individuals, respectively. For gonad maturity stages I and II, fishes were considered to be immature. Therefore, the findings clearly indicated that *S. gibbosa* in the studied area were overexploited in their early growth stages.

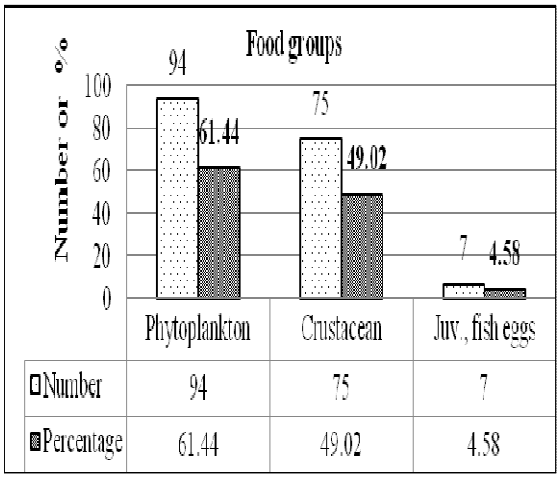

Figure 3. Food groups of *S. gibbosa* in the studied area.

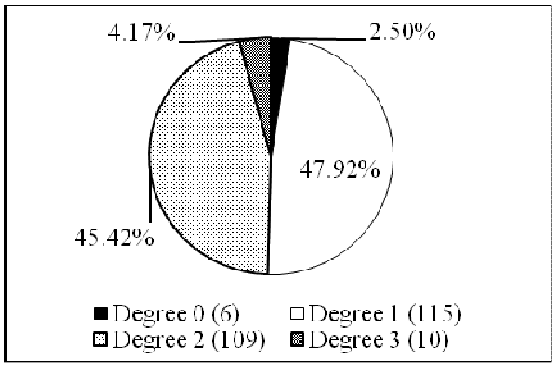

Figure 4. Number of samples and percentage of degree of stomach fullness in examined individuals.

Table 3. Gonad maturity of the examined individuals

Degree of gonad maturity	Number	%
I	101	42.08
II	115	47.92
III	24	10.00
Total	240	100.00

4. Conclusions

The biological analyses of 240 individuals of the *Sardinella gibobosa* caught by gill net in the nearshore area of Ham Thuan Nam district, Binh Thuan province from 25th September to 3rd October, 2014 resulted in the following findings:

1. The total length of *S. gibbosa* ranged from 105 mm to 170 mm, with 134.71 mm on average, mostly from 120 to 140 mm.

2. The weight ranged from 10 gr to 41 gr, with 20.90 gr on average, mostly from 10 gr - 20 gr (60.83%).

3. The fished stock included four age groups from 0^+ to 3^+, but primarily in the 1^+ age group (53.75%) and 2^+ age group (33.33%).

4. The equation of relationship between total length (L) and weight (W) for the whole stock: $W = 0.6325 \times L^{2.7972}$ ($R^2 = 0.8766$); and the von Bertalanffy weight and length growth equations for the *Sardinella gibobosa* in the studied area as follows: Length growth: $L_t = 197.28 (1 - e^{-0.2497 (t + 0.0453)})$; Weight growth: $W_t = 40.62 (1 - e^{-0.2497 (t + 0.0453)})^{2.7972}$.

5. The most dominant groups of food were the crustaceans and phytoplankton, being found in the gut of most examined individuals, whereas fish eggs were found only in the gut of

small-sized fish. The food composition changed accordingly the body length of the examined individuals.

6. The stomach fullness of examined individuals were mainly at the degrees 1 and 2, with significant proportions, 47.92% and 45.42%, respectively, while the degree 3 made up only a minor proportion (4.17%).

7. The overall sex ratio (males to females) was 1.07: 1.00. Sexual maturity of exploited fish individuals was essentially low, mainly at the stages I (42.08%) and II (47.92%).

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Đặc điểm sinh học của cá Trích xương *Sardinella gibbosa* (Bleeker, 1849) ở vùng biển ven bờ huyện Hàm Thuận Nam, tỉnh Bình Thuận

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Tóm tắt: Kết quả phân tích đặc điểm sinh học của 240 mẫu cá Trích xương thu tại vùng biển ven bờ huyện Hàm Thuận Nam, tỉnh Bình Thuận từ ngày 25 tháng 9 đến ngày 03 tháng 10 năm 2014 cho thấy: cá Trích xương được đánh bắt có chiều dài từ 105 đến 170 mm, trung bình 134,71 mm, nhưng chủ yếu tập trung vào nhóm chiều dài 120-140 mm. Trọng lượng cá đánh bắt trong khoảng 10 đến 41 gam (g), trung bình 20,90 g với ưu thế là các cá thể có trọng lượng 10 - 20 g. Phương trình tương quan chiều dài - trọng lượng của loài cá này có dạng: $W = 0.6325\ L^{2.7972}$ ($R^2 = 0.8766$). Cá khai thác bao gồm 4 nhóm tuổi (0^+, 1^+, 2^+ và 3^+) với ưu thế là nhóm tuổi 1^+ (53,75%). Thức ăn của cá bao gồm nhiều loại nhưng quan trọng nhất là thực vật nổi và giáp xác. Cá khai thác chủ yếu ở độ no bậc 1 và 2, lần lượt chiếm 47,92% và 45,42% tổng số dạ dày cá phân tích. Tỷ lệ đực cái được xác định trong nghiên cứu

này là 1 cái : 1,07 đực. Độ chín sinh dục của cá khai thác ở mức thấp, chủ yếu ở bậc I (42,08%) và bậc II (47,92%). Những thông tin này cho thấy cá Trích xương ở khu vực nghiên cứu đang bị khai thác quá mức đối với sinh trưởng. Hầu hết cá bị khai thác đều là những cá thể còn non, chưa thành thục sinh dục.

Từ khoá: Sardinella gibbosa, đặc điểm sinh học, phương trình sinh trưởng, Bình Thuận, gần bờ.