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Length-weight relationship, shell dimension and condition factor of spider conch, *Lambis lambis* (Strombidae) in Khanh Hoa, Vietnam

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Abstract
The present study examined the length-weight, length-length relationships and condition factor (K) of spider conch, *Lambis lambis* collected in Khanh Hoa province, Viet Nam). Length - weight relationship equations were $W = 0.2088 L^{2.6116}$ and $W = 0.0932 L^{2.9826}$ for female and male spider conch, respectively. The *b* value was negative allometric for female spider conch, but isometric for male spider conch. Length – weight and shell dimension were significant correlation, with r^2 over 0.885. Female is generally bigger and heavier than male the condition factor also higher in female than in male. Condition factor (*CF*) and relative weight (W_r) significantly differ ($P < 0.001$) between male and female spider conch, with a higher value in female compared to male spider conch with significant different between two sexes.

Keywords: *Lambis lambis*, growth, sex, length-weight relationship, condition factor

Introduction
Spider conch, *Lambis lambis* is a marine mollusc belongs to the family Strombidae. They are widely distributed in the Indo-West Pacific. They live on reef or rocky shores with sandy bottoms from littoral tide depths to 5 m water depth, feeding on organic detritus and benthic algae. In Viet Nam, spider conch are very popular food in the coastal areas and the shells are used as handicrafts. The price is about USD 6-7 per kg. Because of the increasing demand for consumption, the exploitation of spider conch as well as other marine species is at risk of being overexploited.

Length – weight relationship (LWR) is a powerful tool which is widely used in fisheries research. As length is easier to measure, LWR can be used to convert calculation of fish weight, based on the known length [1, 2]. In addition, parameter computed from LWR are important information about the structure and function of populations in fisheries research [3]. LWR is also a valuable indicator to estimate the life history of fish in regarded to their habitats or regions [4]. Furthermore, knowledge of the biology of commercially important fish in economic terms (size values, i.e. minimum, maximum, and mean; and size relationships, i.e. length – weight) helps for the sustainable exploitation of the natural resources.

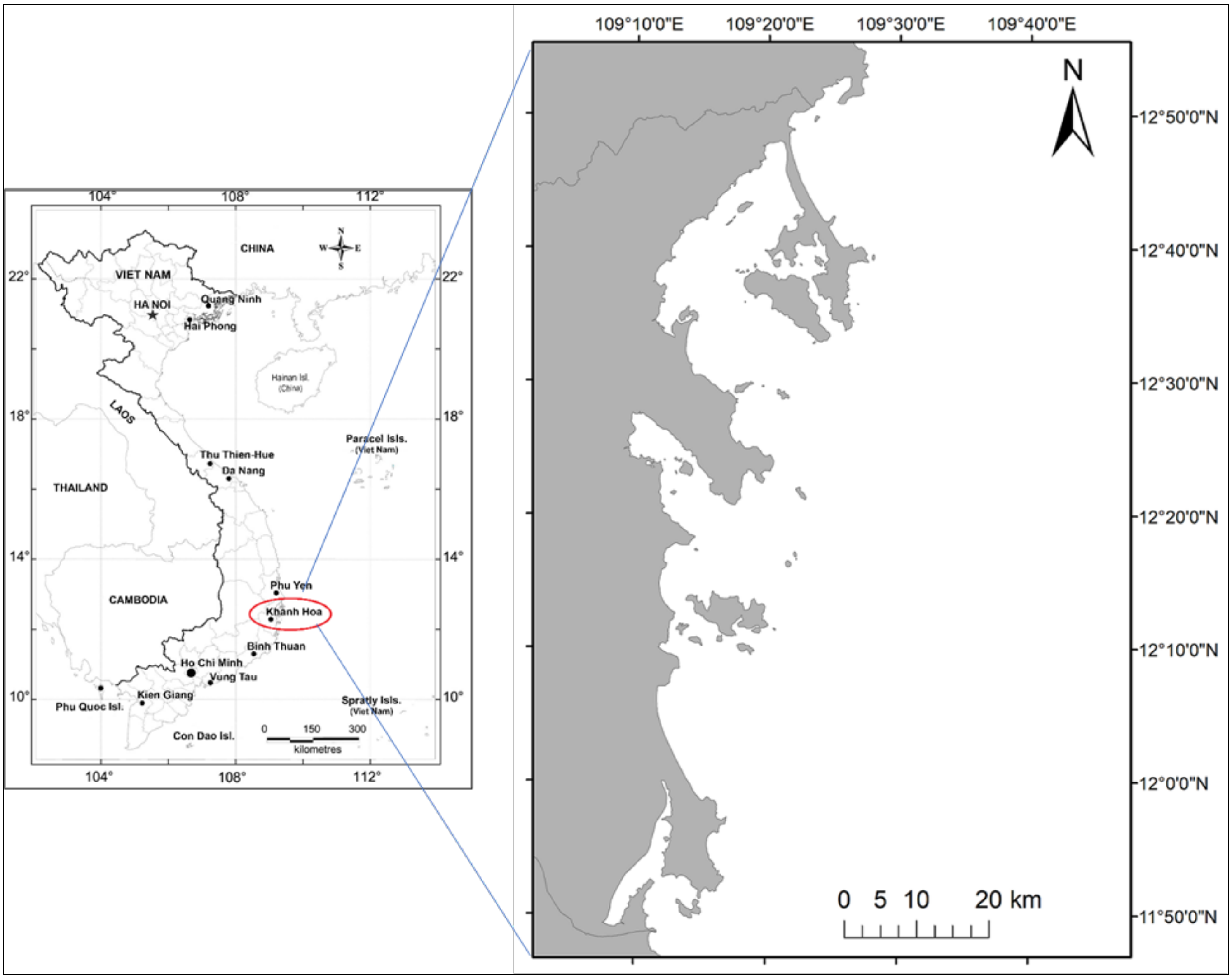
Beside the LWR, condition factor (K) is a main parameter used in fishery study, and they have been closely related since they were first proposed [5]. The value of K is calculated from the weight and length, and can be used to estimate changes in nutritional condition. Few studies in recent years have examined the K value for spider conch, *Lambis lambis*. Previous research show that the K values for other fish and mollusk change by season and locations [5, 6].

Studies have shown that spider conch have been overexploited in Singapore and the Philippines [7, 8] and this species in these two countries being listed in IUCN Red list. In Vietnam, according to the local fishermen, the number of spider conch become reduced. However, to our knowledge, there is no information on the population biology of spider conch, in Vietnam. Also, excepted some documents on taxonomy and distribution, knowledge on biology ecology of the spider conch to provide baseline data for management is still very limited. Accordingly, the aim of the present study is to provide a comprehensive analysis of biological parameters including shell size-weight relationship, shell dimension relationships, condition factor, spider conch distributed in Khanh Hoa waters. The possible regional variations of size, weight and condition factor were also examined in present study.

Materials and Methods

Sampling

Spider conch, *Lambis lambis* specimens were collected from fishermen who exploited spider conch and other mollusc in Khanh Hoa waters. (Fig. 1). Collected samples were fixed in formalin 10% before transported to the laboratory. Their shell dimensions: shell length (L), shell width (SW) and shell thickness (ST) were measured by callipers to the nearest 0.01 cm. Whole body weight and soft part weight also measured by an electronic balance to the nearest 0.01 g accuracy.



Length – Weight, Length – Length relationships and Condition factor

Fig 1: Location of sampling spider conch, *Lambis lambis* in Khanh Hoa waters, Viet Nam.

The length – weight relationship (LWR) was expressed by the equation: $W = a L^b$ [5, 9], where W: whole body weight (g), L: shell length (cm), *a:* constant (intercept), *b*: *exponent* of a length-weight relationship. The LWR equation was then transformed into a linear form: $Log\ W = Log\ (a) + b\ Log\ (L)$ (*b*: slope of regression line, Log *a*: constant). The statistical significance value of regression and coefficient of determination (R^2) were also presented. Furthermore, relationships between shell dimensions were estimated for: i) L/SW; ii) L/ST; iii) SW/ST were computed for the male and female separately. In addition, Fulton's condition factor (K) and relative weight (W_r) were calculated as the following formulas: calculated as the following formula: $CF = 100 \times W/L^3$ [5, 10]; $W_r = 100 \times W/W_s$ [11], where L: shell length (cm); W: body weight (g), $W_s = a\ L^b$, where *a* and *b* are parameters of LWR equation.

Statistical analysis

Descriptive statistics were derived using Excel (Microsoft Excel 2007) statistical functions. The analysis of covariance (ANCOVA) was performed to test the difference in length – weight relationship (LWR) between the two sexes [12]. Compared the sex ratio was compared to the natural ratio 1:1 by using Chi-square test (χ^2). Analysis of variance (ANOVA) was applied to test the difference between shell size, whole body weight and soft part and condition factor between the two sexes. t-test was applied to confirm whether calculated *b* value significantly differed from the isometric value ($b = 3$) was tested by using t-test, $t_s = (b - 3)/S_b$, where S_b is the standard error of the slope [13]. All statistic tests were performed by using SPSS 18 package software. All the statistical analyses were considered significance when $P < 0.05$.

Results

Sex ratio of spider conch, *Lambis lambis*

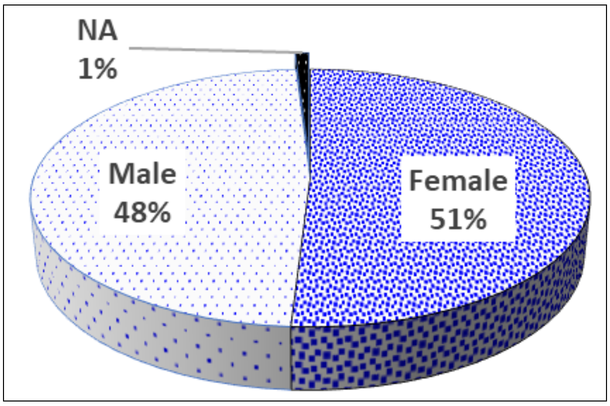


Fig 2: Sex ratio of spider conch

Sex ratio of spider conch is showed on Fig. 2. The proportions were 51% and 48% for female and male, respectively. The ratio was a 0.95:1. This was not significant difference from the natural ratio (1:1) (P = 1.349).

Length – weight relationship of spider conch, *Lambis lambis*

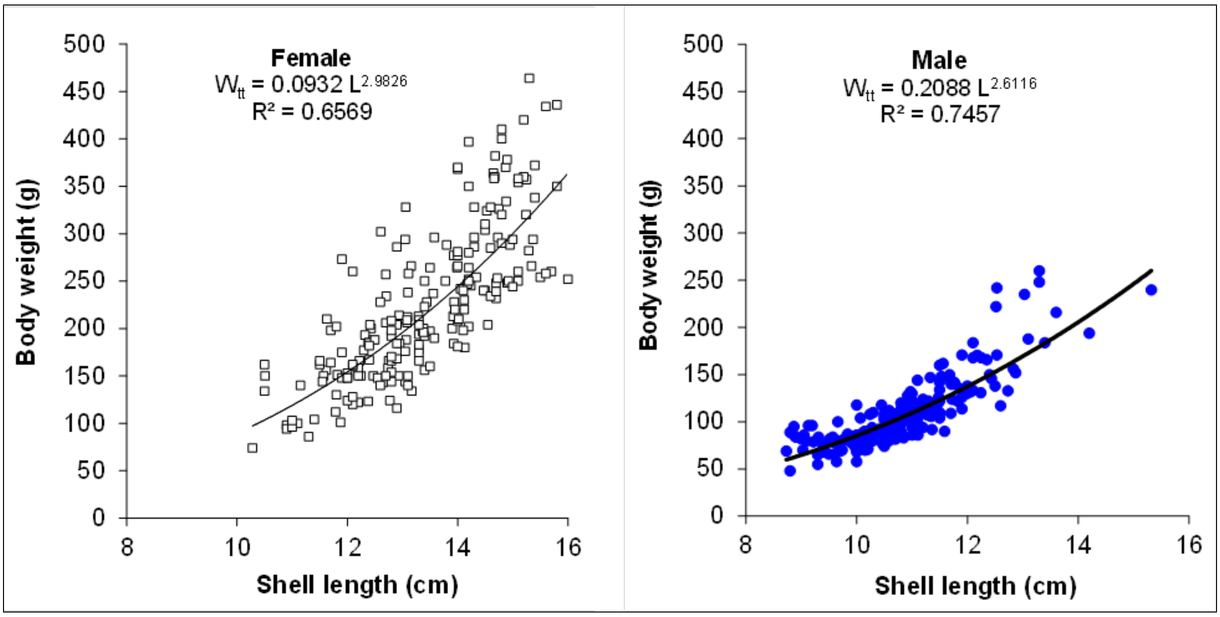


Fig 3: The relationships between shell length and whole-body weight of spider conch, *Lambis lambis* distributed in Khanh Hoa waters.

The length – weight relationship ($W = a L^b$) was analysed and gained equations: $W = 0.2088 L^{2.6116}$ ($R^2 = 0.7457$, ANOVA, $F = 304.072$, $P < 0.001$) for male and $W = 0.0932 L^{2.9826}$ ($R^2 = 0.6569$, ANOVA, $F = 390.409$, $P < 0.0001$) female spider conch in Khanh Hoa waters. The calculated value of allometric coefficients (*b*) in the length – weight relationships were 2.6116 and 2.9826 for female and male spider conch, respectively. (Fig. 3).

Linear model of length – weight relationship of spider conch with logarithm transform ($\text{Log } W = \text{Log } a + b \text{ Log } L$) for the two sexes resulted in a high R^2, over 0.801 for whole body weight (W_{tt}) (Table 1). ANCOVA analysis of length – weight relationship at logarithm transformation from showed that the slopes (*b* values) significantly differ between the two sexes ($P < 0.012$). Student's *t*-test analysis showed that *b* value of male spider conch was negative allometric growth and was significantly different from $b = 3$ ($P < 0.05$). However, *b* value of female spider conch was not significantly different from the isometric value ($P > 0.05$). (Fig 3, Table 1).

Table 1: Length – weight (LWR) and length – length relationship (LLR) of *Lambis lambis* in Khanh Hoa waters. W: whole body weight (g), L: shell length (cm), SW: shell width (cm) and ST: shell thickness (cm).

LLR	Locations	*a*	*b*	SE*a*	SE*b*	R^2	ANOVA, F test	Sig. of regression
$\text{Log } W_{tt} = a + b^* \text{ Log } L$	Female	0.669	2.601	0.164	0.001	0.801	385.432	0.000
	Male	1.034	2.983	0.131	0.001	0.830	448.355	0.000
$L = a + b^* SW$	Female	0.688	1.707	0.515	0.068	0.862	622.186	0.000
	Male	2.965	1.377	0.341	0.059	0.852	536.592	0.000
$L = a + b^*ST$	Female	3.468	1.802	0.437	0.078	0.844	531.304	0.000

	Male	3.718	1.758	0.334	0.082	0.832	457.189	0.000
ST= a + b*SW	Female	0.391	0.794	0.246	0.033	0.856	588.437	0.000
	Male	0.164	0.679	0.142	0.025	0.888	754.580	0.000

Length frequency distribution male and female spider conch

The length frequency distributions of the two sexes are showed Fig. 4. The length of *spider conch* ranged from 10.28 - 17.40 cm, and from 8.73 - 15.32 cm. Average shell length for female was 13.47 cm ± 0.09 and 10.81 cm ± 0.07 for male spider conch. The mean weights were 229.97 g ± 5.76 and 108.47 g ± 2.57 for female and male, respectively. There were significantly higher in length, weight and weight of soft part were significantly higher in female than in male (P < 0.001). (Fig. 4).

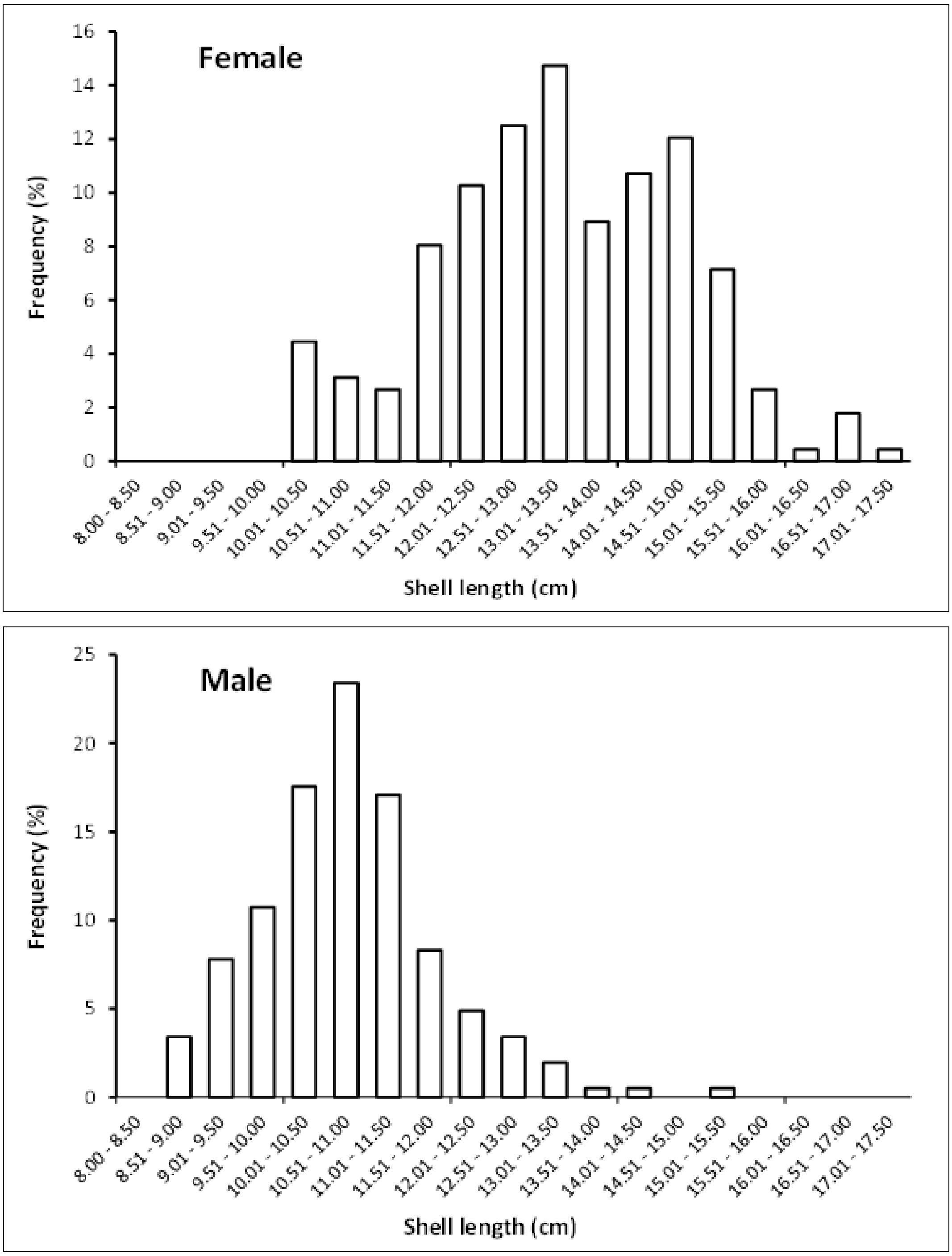


Fig 4: Length frequency distribution of spider conch, *Lambis lambis* in Khanh Hoa waters

Average shell dimensions, weight and condition factor of sider conch

The results of shell size and weight of spider conch, *Lambis lambis* for the two sexes were shown in Table 1. Shell dimensions (L, SW and ST) of spider conch were significantly higher in female than in male (t-test, P < 0.0001). In addition, the whole-body weight and soft part weight spider conch of female were significantly higher than in male (t-test, P < 0.0001). The ratio between shell sizes in the cases of L/SW, L/ST and WT/ST were significantly higher in male than in female (P ≤ 0.000). Mean condition factor (CF) were 0.912 in female and 0.840 in male. There was significant difference between them (P = 0.001) (Table 2).

Table 2: Shell size and weight (g) measurement (mm) of *Lingula* from 2 sampling locations. Mean ± SE, L: shell length (cm), SW: shell width (cm), ST: shell thickness (cm), W: whole body weight (g) and W_{soft}: weight of soft part (g), CF: condition factor. N_{female}= 217, N_{male} = 205.

		Range	Mean ± SE	P
L (cm)	Female	10.28 - 17.40	13.47 ± 0.09	0.000
	Male	8.73 - 15.32	10.81 ± 0.07	
SW (cm)	Female	5.73 - 9.22	7.49 ± 0.05	0.000
	Male	4.50 - 8.35	5.70 ± 0.05	
ST (cm)	Female	4.00 - 7.30	5.55 ± 0.04	0.000
	Male	3.30 - 6.24	4.03 ± 0.04	
W (g)	Female	74.00 - 492.00	229.97 ± 5.76	0.000
	Male	48.00 - 260.00	108.47 ± 2.57	
W_{soft} (g)	Female	17.00 - 82.00	43.39 ± 0.82	0.000
	Male	9.00 - 56.00	19.33 ± 0.46	
L/SW	Female	1.55 - 2.04	1.80 ± 0.01	0.000
	Male	1.59 - 2.29	1.90 ± 0.01	
L/ST	Female	2.03 - 2.79	2.43 ± 0.01	0.000
	Male	2.20 - 3.16	2.69 ± 0.01	
SW/ST	Female	1.18 - 1.55	1.35 ± 0.01	0.000
	Male	1.09 - 1.69	1.42 ± 0.01	

Condition factor (CF) and relative weight (W_r) of spider conch

Condition factor (*CF*) and relative weight (W_r) significantly differ (*P* <0.001) between male and female spider conch, with a higher value in female (CF = 0.912, W_r = 119.73) and lower value in male spider conch (CF = 0.840, W_r = 93.94). Condition factor (*CF*) and relative weight (W_r) was significantly different between the two sexes (P < 0.0001) and W_r values of the two sexes significantly differ from 100 (P ≥ 0.079). Table 3.

Table 3: Condition factor (CF) and relative weight (W_r) values of male and female spider conch.

		Range	Mean ± SE	Anova, F test	P
CF	Female	0.54 – 1.62	0.912 ± 0.014	17.845	0.000
	Male	0.58 – 1.36	0.840 ± 0.010		
W_r	Female	69.87 – 203.02	119.729 ± 1.795	145.816	0.000
	Male	64.73 – 151.72	93.942 ± 1.113		

Discussion

This is the first study provides useful biological information for fishery management including length – weight, length-length relationship parameters, the shell dimensions, condition factor, size and weight of spider conch in Vietnam.

In addition, although the biometric parameters and condition factors and relative weight can reflect the well-being status, feeding and physiological condition of a species, there has not been any study analysed the combination of the two indices on spider conch. In this study, the variation of length, weight and condition factors occur differently between the sexes of spider conch were detected.

Length – weight relationship is a powerful tool, popularly presented by scientists and researchers as useful tools in fishery biology [14, 15]. The parameters of length-weight relationship are beneficial to predict weight from length, computing condition index, assessing stock and estimating biomass [15]. However, LWR is influenced by various factors such as the presence of food, feeding ratio, gonad development, spawning period, season, sex and habitat [16, 17]. However, nutrition, reproduction or the environmental impact were not examined in the present study. The LWR of spider conch were highly significant and the length and weight were different between for male and female.

However, LWR of spider conch *Lambis lambis* in India was also significantly correlated, the *b* value was 2.377, significantly allometric [18]. However, the authors calculated length-weight relationship for both sexes, and the shell length 91-245 mm, and weight was 40 – 548 g. This is in accordance to study done by Anderson and Neumann [3], who stated that *b* values can vary among geographical regions.

The value of the exponent *b* provides information on the growth of spider conch. The present study revealed that *b* value of the two sexes falls between 2.5 and 3.5, indicating appropriate size range of spider conch specimens collected to obtain reliable data [19]. According to Froese [5] there are two possibilities in a population, when *b* < 3: the number of individuals increase their body size are dominant or small individuals have a better nutrition condition. This study revealed that *b* value for male spider conch was less than 3 and the size was smaller than female spider conch. This possible better somatic growth of female spider conch than the growth of male. The variation in the *b* value for the same species could be attributed to a difference in sampling, sample size or length ranges [20]. In this study, the difference of *b* value could be because the difference in size and weight of male and female spider conch. However, other environment and other factors should also be considered addressing the other impacts.

High condition factor may show suitable environmental conditions (such as habitat conditions, much prey availability) and low CF values indicate for a low optimal environment [11]. The value of CF over than 1 shows that fish to be in optimal condition. The assumption to estimate fish condition index are different. However, Fulton's condition factor assumes fish has an isometric growth (*b* = 3) [21]. Since each species of fish have different body shapes, it is difficult to compare *CF* values between fish species [3].

The relative condition factor (K_{rel}) assumed the *b* values are identical to compare condition among populations. Recently, numerous researches have proposed relative weight (*Wr*) in the management and conservation of fishes, particularly those species are threatened or endangered [24, 25]. Relative weight (W_r) has several advantages over *K* and K_{rel}. This is because *Wr* does not depend on measurement units. Also, W_r values can be compared fish at different size and among populations [10, 11]. Values of W_r falling below 100 for suggest problems such as low food availability or a high number of predators; while W_r value is over 100 showing a food surplus or low predatory density in the habitat [26].

In the present study, W_r values of spider conch did not differ from 100 for the two sexes, showing the balance habitat with food availability and low predator quantity [3]. In addition, it might be indicated that the water quality was still adequate to support spider conch. However, the female with bigger size has a higher condition factor than male with smaller size. In addition, *b* value of female was significantly lesser than 3, while *b* value of male was not different from 3.

In conclusion, this fundamental results on length-weight relationships and condition factor of spider conch, *Lambis lambis* are useful for researchers and fishery managers on population dynamic. To our knowledge, LWR and K of spider conch is the first studied in Vietnam. Therefore, these results will be useful baseline data for fishery researchers and conservationists to propose suitable regulations for sustainable fishery management and conservation wild stocks in the region and for comparison with research in the future. However, further study on seasonal variations of environmental condition, nutrition, reproduction and interaction of those of physiological characteristics between the sexes of spider conch, *Lambis lambis* should be examined.

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References

1. Morato T, Afonso P, Lourinho P, Barreiros JP, Santos RS, Nash RDM. Length-weight relationships for 21 coastal fish species of the Azores, north-eastern Atlantic. Fish Res 2001;50:297-302.
2. Stergiou KI, Moutopoulos DK. A review of length-weight relationships of fishes from Greek marine waters. Naga ICLARM 2001;24:23-39.
3. Anderson OR, Neumann RM. Length, weight and associated structural indices, p. 447-482 In: L.A. Nielsen & D.L. Johnson (Eds). Fisheries Techniques. Bethesda, American Fisheries Society 1996, 732.
4. Goncalves JMS, Bentes L, Lino PG, Ribeiro J, Canário AVM, Erzini K. Weight-length relationships for selected fish species of the small-scale demersal fisheries of the south and south-west coast of Portugal. Fish Res 1997;30:253-256.
5. Froese R. Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. J Appl Ichthyol 2006;22:241-253.
6. Tuyen HT, Hoang DH. Growth characteristics of razor clam *Solen thachi* cosel, 2002 in Thuy Trieu lagoon – Cam Lam, Khanh Hoa. Collection of Marine Research Works 2013;19:159-165.
7. Wagey B, Kreckhoff R, Bucol A. Comparison of abundance and diversity of benthic macro-invertebrates between disturbed and non-disturbed seagrass-algal beds in central Philippines. AACL Bioflux 2017, 10.
8. Hermosilia JJ, Narido CI. Population assessment of commercial gastropods and the nature of gastropod fishery in Panglao Bay, Bohol, Philippines. An Interdisciplinary Research Journal 2007;18:1-9.
9. Le Cren ED. The Length-Weight Relationship and Seasonal Cycle in Gonad Weight and Condition in the Perch (*Perca fluviatilis*). J Anim Ecol 1951;20:201-219.
10. Wege GJ, Anderson RO. Relative weight (Wr): a new index of condition of largemouth bass. In: New approaches to management of small impoundments. G. Novinger and J. Dillard (Eds). Am Fish Soc Spec Publ 5. Bethesda, MD 1978, 79-91.
11. Blackwell BG, Brown ML, Willis DW. Relative Weight (Wr) Status and Current Use in Fisheries Assessment and Management. Rev Fish Sci 2000;8:1-44.
12. Zar JH. Biostatistical Analysis. 4th edition. Prentice-Hall, Englewood Cliffs, New Jersey 1999, 929.
13. Sokal RR, Rohlf FJ. Introduction to biostatistics, 2nd Edn., Freeman Publication, New York 1987, 887.
14. King M. Fisheries biology, Assessment and management. Fishing new book. Blackwell Science Ltd: Wiley 2001, 341.
15. Petrakis G, Stergiou K. Weight-length relationships for 33 fish species in Greek waters. Fish Res 1995;21:465-469.
16. Hossain MY, Leunda PM, Ohtomi J, Ahmed ZF, Oscoz J, Miranda R. Biological aspects of the Ganges River sprat *Corica soborna* (Clupeidae) in the Mathabhanga River (SW Bangladesh). Cybium 2008;32:241-246.
17. Yilmaz S, Pola N. Length-Weight Relationship and Condition Factor of Pontic Shad, *Alosa immaculate* (Pisces: Clupeidae) From the Southern Black Sea. Res J Fish Hydrobiol 2011;6:49-53.
18. Jaikumar M. Length – Weight relationship of *Lambis lambis* (Mollusc: Gastropoda) from Tuticorin coastal waters, Gulf of Mannar, southeast coast of India. World Applied Sciences Journal 2011;14:207-209.
19. Carlander KD. Handbook of freshwater fishery biology. The Iowa State University Press, Ames, IA 1977;2:431.
20. Hossain MY. Morphometric Relationships of Length Weight and Length-Length of Four Cyprinid Small Indigenous Fish Species from the Padma River (NW Bangladesh). Turk J Fish Aquat Sci 2010;10:131-134.
21. Carlander KD. Handbook of Freshwater Fishey Biology. William C. Brown Company, Dubuque, Iowa 1950, 281.
22. Savaş Yılmaz, Yazıcıoğlu O, Erbaşaran M, Esen S, Zengin M, Polat N. Length-weight relationship and relative condition factor of white bream, *Blicca bjoerkna* (L., 1758), from Lake Ladik, Turkey. Journal of the Black Sea / Mediterranean Environment 2012;18:380-387.
23. De Giosa M, Czerniejewski P, Rybczyk A. Seasonal Changes in Condition Factor and Weight-Length Relationship of Invasive *Carassius gibelio* (Bloch, 1782) from Leszczynskie Lakeland, Poland. Advances in Zoology 2014;2014:678763.
24. Bister TJ, Willis DW, Brown ML, Jordan SM, Neumann RM, Quist MC, *et al.* Proposed Standard Weight (Ws) Equations and Standard Length Categories for 18 Warmwater Nongame and Riverine Fish Species. N Am J Fish Manag 2000;20:570-574.
25. Richter TJ. Development and Evaluation of Standard Weight Equations for Bridgelip Suckers and Largescale Suckers. N Am J Fish Manage 2007;27:936-939.
26. Rypel AL, Richter TJ. Empirical percentile standard weight equation for the blacktail redhorse. N Am J Fish Manage 2008;28:1843-1846.