

Research Article

Length-Weight Relationship and Sex Determination of Half-Smooth Tongue Sole *Cynoglossus semilaevis* in Northern China

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Keywords

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- Length-weight
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- Morphological differences

Abstract

Length-Weight Relationships (LWR) is presented for females of the half-smooth tongue sole *Cynoglossus semilaevis*, a fish species in Shandong peninsula, China. A simple method for distinguishing males from females was introduced.

INTRODUCTION

The half-smooth tongue sole *Cynoglossus semilaevis* a rare large marine flatfish species widely distributed throughout coastal areas of China. In 2005, the artificial reproduction and production of half-smooth tongue sole *Cynoglossus semilaevis* succeeded, thus beginning the farming history of the half-smooth tongue sole *Cynoglossus semilaevis* in China [1,2]. Due to its delicious taste and high economic value, the fish has been selected as a newly exploited and promising species for aquaculture in coastal areas of northern China, especially in Shandong peninsula. Currently, the species has become an important commercial marine fish species in China and it has much potential for further expansion in fish farming.

In nature, the half-smooth tongue sole *Cynoglossus semilaevis* lives in sandy or muddy seabed areas and often feeds at night. The species can tolerate a wide range in salinity and temperature (from 16‰ to 35‰, and 4°C to 30°C, respectively). The difference in size and growth rate for females and males are significant. Mature females have a Total Length (TL) that is twice that of males, and the Body Weight (BW) of females may be six times that of males. For aquaculture, it is important to screen out males as early as possible, to obtain the maximum economic benefit. In this paper, the weight-length relationship of half-smooth tongue sole *Cynoglossus semilaevis* was estimated, and a simple method introduced to distinguish males from females.

MATERIALS AND METHODS

This study was carried out at the Changyi Haifeng Aquaculture Limited Liability Company of Shandong province, China from October 2011 to January 2013. Half-smooth tongue

sole *Cynoglossus semilaevis* was cultured in tanks (6 m × 6 m × 1.5 m) with a 0.4 m water depth. The stocking density was 138 fish/m² before the fish had a TL of 15 cm. Because of their slow growth rate, male fish were screened out when they reached about 15 cm and removed from the farm. Female fish were cultured at a density of 27 fish/m² from TLs of 15 cm to 40 cm. After reaching a TL of 40 cm, the stocking density was adjusted to 14 fish/m².

TL was measured with a slide caliper to the nearest 0.1 cm; BW was determined with a digital balance to the nearest 0.1 g. Estimation of the Length-Weight Relationship (LWR) was made by an exponential curve ($W=aL^b$); where W is BW in g, and L is TL in cm [3,4]. The function can be converted into the logarithmic equivalent: $\log W = \log a + b \log L$; where a is the intercept, and b is the slope. For the relationship with statistical significance (P), the coefficient of determination (r^2) and the confidence intervals of the parameters were obtained using SPSS software (Version 11.5, SPSS Inc., Chicago, IL).

RESULTS AND DISCUSSION

Length-Weight Relationship (LWR)

The values of a and b , and the associated statistical information, are provided in Table 1. The value of b for half-smooth tongue sole *Cynoglossus semilaevis* was 2.9987 (Table 1), and the value of a was 0.006036. The r^2 value for this regression was 0.771, the level of significance was highly significant (<0.001, Table 2).

Method of distinguishing males and females

When the TL reaches 15 cm, male and female half-smooth tongue sole *Cynoglossus semilaevis* can be distinguished by their



Figure 1 The morphology difference between male and female of *Cynoglossus semilaevis*.

Table 1: Descriptive statistics and estimated parameters of LWR for female *Cynoglossus semilaevis* cultured in north China.

Species	N	Total length (cm)		Body weight (g)		Regression Parameters				
		Min.	Max.	Min.	Max.	a	95%CI of a	b	95%CI of b	r ²
<i>Cynoglossus semilaevis</i>	156	36.3	54.6	256.0	933.0	0.006036	0.005934-0.006139	2.9987	2.9942-3.0031	0.771

$W=aL^b$; a = coefficient for LWR; 95% CI of a= confidence limits for a, b = exponent for RLW; 95%CI of b=confidence limits for b; and r²= coefficient of determination for LWR; n = sample size; min = minimal total length or weight observed (cm or g); max = maximal total length or weight observed (cm or g).

Table 2: The coefficients of regression analysis.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-852.687	60.377		-14.123	.000
	X	31.204	1.369	.878	22.788	.000

morphological differences. When a light source is placed under the fish, the different gonadal development can be seen for males and females (black arrow in Figure 1). The gonads of the male fish are seen as a dark cone (Figure 1B), which is not apparent in the female fish (Figure 1A). This method of observation allows male and female fish to be easily discerned.

CONCLUSION

For half-smooth tongue sole *Cynoglossus semilaevis*, the data represents the first reference to the length-weight relationship for the species. Values of *b* are acceptable when between 2.5 and 3.5 [5]. In this study, the value of *b* for half-smooth tongue sole *Cynoglossus semilaevis* was 2.9987 (Table 1), and the value of *a* was derived by setting *b* at 3.0 and estimating the geometric mean for *a*. The r² value for this regression was low (0.771, Table 1), but the level of significance was highly significant (<0.001, Table 2), which suggests that the LWR should be believed. Although this study provides data for only one fish species, the results provide valuable biological data for use in future studies of half-smooth tongue sole *Cynoglossus semilaevis* that use length-weight relationships. The data can also help researchers evaluate the effect of farming, and environmental and ecological change, etc.

Sex determination by morphological characters has been widely used in aquatic animals, especially in Crustaceans, and adult fish, etc. It is difficult to distinguish male and female of young fishes. The difference in size and growth rate for females and males are significant in several fishes, particularly significant in half-smooth tongue sole *Cynoglossus semilaevis*, which mature females have twice TL and six times BW those of males. For

aquaculture, it is important to screen out males as early as possible, to obtain the maximum economic benefit. In this study, a method was found through the degree of gonadal development.

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