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Length-weight relationship and condition factor of male and female Japanese weather loach (*Misgurnus anguillicaudatus*) grown in ponds in Bauko, Mountain province, Philippines

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Abstract
This study was conducted to determine the equation parameters of length-weight and condition factor of male and female Japanese weather (*Misgurnus anguillicaudatus*) loach collected from Bauko, Mountain Province, Philippines. From the 78 pieces of collected loach, 47 were males and 31 were females. Female loach (total length = 10.012 cm, weight = 4.161) were longer and heavier than male loach (total length = 10.152 cm, weight = 4.687). Size 9 to 10 cm was the most common size for male loach and 11 to 12 cm for the female. The growth of male and female loach was described as positive allometric because computed b was greater than 3 with length-weight relationship equation of $W = 0.0623\ L^{3.335}$ for male and $W = 0.057\ L^{3.433}$ for female. Condition factor of male loach (K = 0.171) was slightly higher than female loach (K = 0.140).

Keywords: Japanese weather loach, length-weight relationship, condition factor, growth

Introduction
The Japanese weather loach (*Misgurnus anguillicaudatus*), belonging to the family Cobitidae, is widely distributed on the Eurasia continent, including Japan, South Korea and most areas of China [1]. The fish typically inhabits sub-tropical climates with a temperature range of 5 to 25 °C and a latitudinal range of 53° N to 27° S. However, it has been found to tolerate temperatures as low as 2 °C and as high as 30 °C. Its natural environment includes streams, ditches and rice paddy fields, preferably with a soft muddy bottom [2].

The loach fish is instantly recognizable creature, due to the barbs found around its mouth, a short dorsal fin and a long body shape. It has a worm-like body and grows to about 3 to 4 inches long. They often feed on insect larvae, snails, worms, ostracods, cladocerans, fish eggs, algae and detritus. They tend to mature very rapidly, possessing an omnivorous digestive system and can live closely packed together [3].

The Japanese weather loach was introduced in the Philippines before the World War II along with the so-called Japanese snails as food staple of Japanese soldiers. The fish is locally known as 'Yuyu'. The fish was accepted as a fish species in the Cordilleras because it is cold tolerant and can survive a long periods in very shallow water or even out of water. Today, the fish is very popular in Japan and Korea where its price is high as P 6,000.00 per kilo [4]

Length-weight relationship is important in studying fisheries biology [5]. The population size of a stock for exploitation can be inferred from length-weight relationship[6]. On the other hand, the degree of well-being of a fish in their respective habitat can be assessed through the computation of condition factor or coefficient of condition. Condition factor is a measure of various ecological and biological factors such as degree of fitness, gonad development and the suitability of the environment with regard to the feeding condition [7]. This factor is affected by stress, sex, season, availability of feeds, and other water quality parameters [8].

This study was conducted to determine the equation parameters of length-weight and condition factor of male and female Japanese weather loach collected from Bauko, Mountain Province, Philippines

2. Materials and Methods

Seventy eight pieces of Japanese Weather loach were hand collected from two fish ponds located in Bauko, Mountain Province, Philippines. The collected samples were sorted according to their sex. Male loach has long and pointed pectoral fin while female has round and shorter pectoral fin and fuller abdomen (Figure 1).

The individual length (cm) and weight (g) of the fish were determined using electronic weighing scale and ruler, respectively. The association degree between length and weight was calculated by the correlation coefficient (r) using trendline analysis in MS Excel. The length-weight relationship of the fish was estimated using the formula: $W = e^a (L^b)$.

Where

W = weight of fish in gram
L = length of fish in cm
a = intercept
b = slope

The condition factor of the fish was determined with the equation, $K = W*100/L^3$

Where

K = condition factor
W = weight of fish in gram
L = total length of the fish in centimeter

Fig 1: Male (A) and female (B) loach

3. Results and Discussion

From the 78 pieces of collected loach, 47 were males and 31 were females. Female loach (total length = 10.012 cm, weight = 4.161) was longer and heavier than male loach (total length = 10.152 cm, weight = 4.687) but statistical analysis showed no significant difference in average total length and weight. According to Urquhart (2013), sex showed significant effects on total length and body weight with female fish being longer and heavier than males [9]. Both males and females reached length at maturity (10 cm total length) within the first year, and fish showed continued growth throughout their lifespan [10, 11]. Length-frequency distribution of the present study revealed that size 9 to 10 cm was the most common size for male loach and 11 to 12 cm for the female. In Yamaguchi prefecture in Japan, 3,928 collected loach from 1946, 1947, 1948, and 1954 had mean body lengths ranged from 6.6 to 7.4 cm, with body weight means of 2.30 to 3.35 g [12]. The male fish can reach a maximum standard length of 28 cm [13].

Based upon computed r, very strong association existed between length and weight of male (r = 0.955) and female (r = 0.905) loach. 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 [14]. The growth of male and female loach was described as positive allometric because computed b was greater than 3 (male = 3.335; female = 3.433). Positive allometric growth implies the fish becomes relatively stouter or deeper-bodied as it increases in length. The length-weight relationship equation of male and female loach was $W = 0.0623\ L^{3.335}$ and $W = 0.057\ L^{3.433}$, respectively. The Bayesian length-weight of the fish was a = 0.006 and b = 3.04 [15]. Condition factor of male loach (K = 0.171) was slightly higher than female loach (K = 0.140) but not statistically significant when compared to one another (Table 1; Figure 2).

Table 1: Average total length and weight, and equation parameters of length-weight and condition factor of male and female Japanese weather loach collected from Bauko, Mountain Province, Philippines

Sex	Average Total Length (cm)	Average Weight (g)	r^2	r	a	b	K
Male	10.012±1.798[a]	4.161±2.413[a]	0.955	0.977	-2.770	3.335	0.171±0.022[a]
Female	10.152±1.978[a]	4.687±3.431[a]	0.905	0.951	-2.863	3.433	0.140±0.029[a]

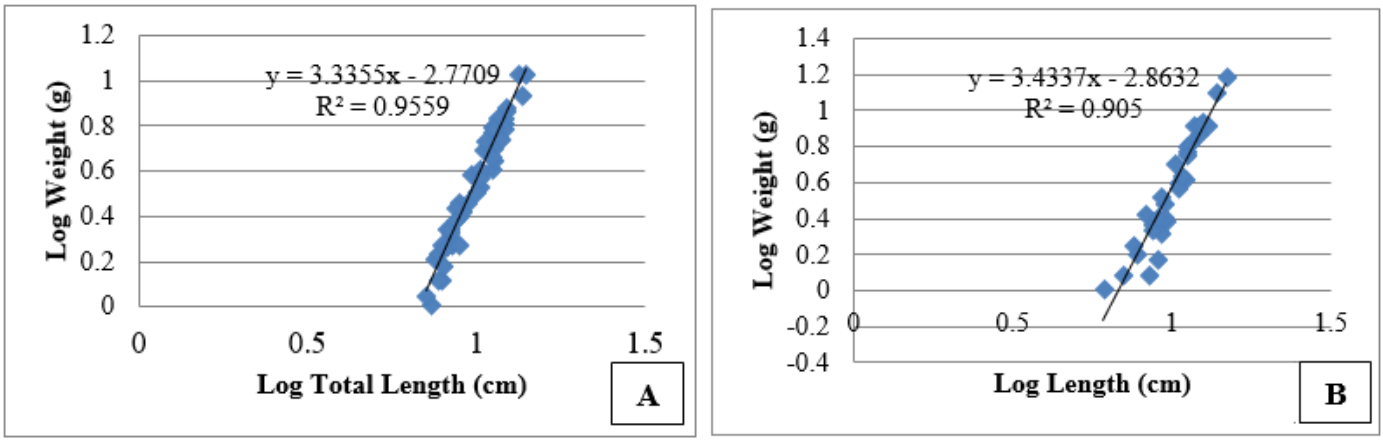

Fig 2: Length-weight relationship of male (A) and female (B) Japanese weather loach collected from Bauko, Mountain Province, Philippines

4. Conclusion

Equation parameters of length-weight and condition factor of male and female Japanese weather loach collected from Bauko, Mountain Province, Philippines was comparable to one another. The females were slightly longer and heavier than males while the latter had higher condition factor.

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