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Fecundity and egg diameter of endemic fish (*Telmatherina bonti* Weber and De Beaufort, 1922) from Towuti Lake, South Sulawesi, Indonesia

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Abstract
Lake Towuti are an ancient lake and an oligotrophic lake. The lake is a habitat for endemic fish species such as bonti-boni fish (*Telamatherina bonti*). These fish are of important economic value. The purpose of this study was to analyze fecundity and egg diameter of *T. bonti* in Towuti Lake. The research was conducted at Towuti Lake from January to December 2019. The Samples were collected using seser and it was separated between male and female based on morphological characteristics of the body and gonads. Gonads were preserved in fomaldehyde 4%. The absolute fecundity ranged from 442-1435 eggs. The relationship of fecundity with body weight was greater than the relationship of fecundity with total length. The diameter of the eggs inside the gonads varies. The type of *T. bonti* spawning was categoried of partial spawner.

Keywords: *Telmatherina bonti*, fecundity, egg diameter, partial spawner, Lake Towuti

1. Introduction
Lake Towuti is an oligotrophic lake and ancient lake which has a lot of species endemic. Endemic fish in Lake Towuti were reported 29 species [1], 20 spesies [2], 19 species [3], 15 species [4], and 17 spesies [5]. The endemic fish species from the genus were Telmatherina, Paratherina, Glossogobius, Dermogenys Mugilogobius, Oryzias and Tominanga [6]. Lake Towuti is a biodiversity hotspot that needs attention of sustainability for the Lake Towuti environment and endemic biota species [7].
Telmatherina bonti Weber & de Beaufort, 1922 is one of endemic fish in Lake Towuti, so that it is an economically [8]. *T. bonti* is called Towuti rainbow fish, while the local name is called bonti-bonti [9]. The fishing of *T. bonti* were done more intensively and there has been overfishing [10]. This fish must be protected from extinction because there has been a decline in the population of these fish in Lake Towuti. Currently, these fish were included in the endangered category on the red list of threatened species since 2018 [11].
Knowledge on aspects of fish reproduction are basic requirement to plan conservation, management strategies of fishery resource, life story, domestication and aquaculture [12-18]. Information in the reproduction aspect of *T. bonti* has not been carried out. However, several research on reproduction biology in the genus Telmatherina have been conducted such as on *Telmatherina ladigesi* [19-22], *Telmatherina. celebensis* [23-26], *Telmatherina antoniae* [27, 28], and *Telmatherina sarasinorum* [29].
The information on fecundity and variation eggs diameter of *T. bonti* is very important because it was related to the survival of these fish. Knowledge of fecundity may also be used to assess the spawning stok [12] while information on the spawning season becomes the basis of knowledge for life history [15], and species conservation [30]. Hence, the objective of present study was to evaluate the fecundity and variation eggs diameter of *T. bonti* in Lake Towuti.

2. Materials and Methods
2.1 Description of the study area
The study was conducted in Towuti Lake, East Luwu Regency, South Sulawesi. The location consist of four research stations A: Tanjung Tominanga (02º39'43"LS; 121º32'47"BT); B: Tanjung Bakara (02º40'47"LS; 121º32'46"; C:Sungai Hola-hola (02º47'35,2"LS; 121º24' 21,1"BT); D:Tanjung Kawatang (02º56'0378'' E; 121º23'720"S) (Figure 1).

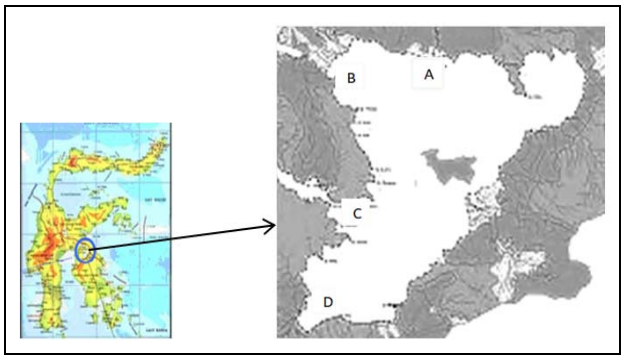

Fig 1: Map of the research location in Towuti Lake, South Sulawesi, Indonesia

2.2 Collection of fish samples

Sampling was carried out every month from January to December 2019. Fishing gear used to catch fish is trapping net (local name of seser). The observation of the sample was performed at Biology Terpadu Laboratory of the Faculty of Fisheries and Marine Sciences, Muslim University of Indonesia. The sex of each specimen was identified by external and internal sexual characteristics to determine of male and female.

The sampled were measured of total length, body weight and gonad weight. Fish samples were performed surgically on the abdomen using a scalpel and scissors to remove the gonad. Furthermore, the gonads were preserved in 4% formalin solution for analysis of fecundity and egg diameter.

2.3 Determination of absolute fecundity (FT)

The number of fish samples used to determine fecundity was 100 fish. Fecundity was calculated using the formula [31] as follows: FT = n (A/a) x (BSC/BG).where: A = volume of gonad samples; a = volume of sub-gonad samples; BSC = weigh of sub-gonad samples; BG = gonad weight, and n = number of observation. The results of fecundity were related to the size of total length and body weight with the equation FT = a + bX; where X = total length (mm) or body weight (mg), a and b = constants.

2.4 Measurement of egg diameter

Measurement of eggs diameter were carried out by taking eggs at maturity levels of III and IV gonads. The number of eggs observed was 150 eggs. Observation of eggs were used a microscope equipped with a micrometer.

3. Results

3.1 Absolute fecundity

The fecundities were ranged from 442-1569 eggs. The relationship of fecundity with total length was: $F = 0.0167PT^{2.5341}$ $R^2 = 0.5848$ (Figure 2) and the relationship of fecundity with body weight was: $F = 397.048BT^{0.5676}$, $R^2 = 0.7003$ (Figure 3). The relationship between fecundity and body weight is stronger than the relationship between fecundity and total length.

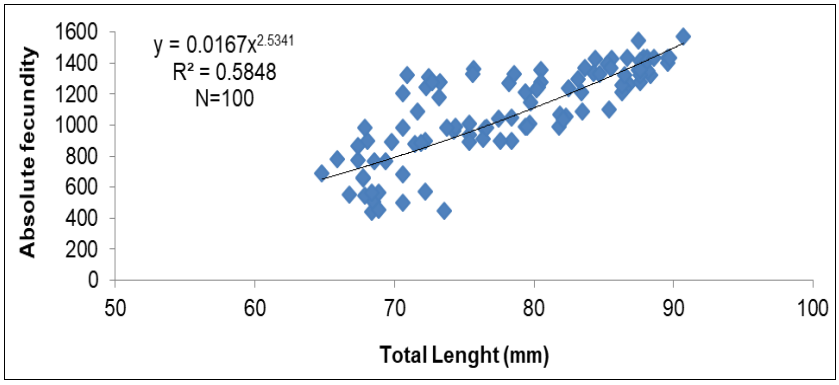

Fig 2: Fecundity-total length relationship of *T. bonti*

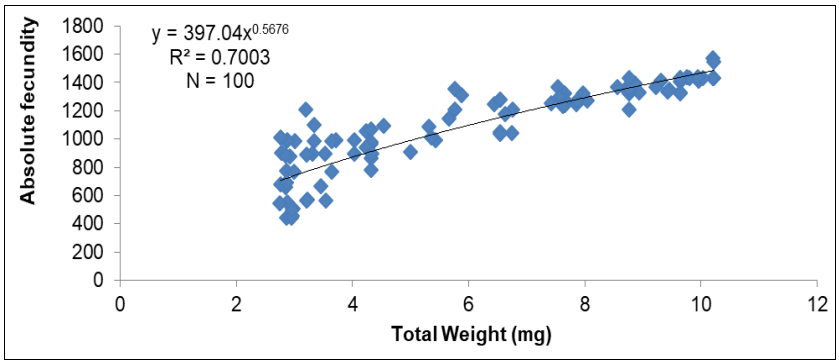

Fig 3: Fecundity-body weight relationship of *T. bonti*

3.2 Egg diameter

The number of sample to measure the egg diameter was 150 fish. The distribution of egg diameter at stage III was 0.29-1.36 mm while in stage IV was 0.33-1.85 mm (Figure 4). The peak distribution of egg diameter in stage III was 0.56-1.04 mm (71%) while the peak distribution of egg diameter at stage IV was 0.98-1.34 mm (64%).

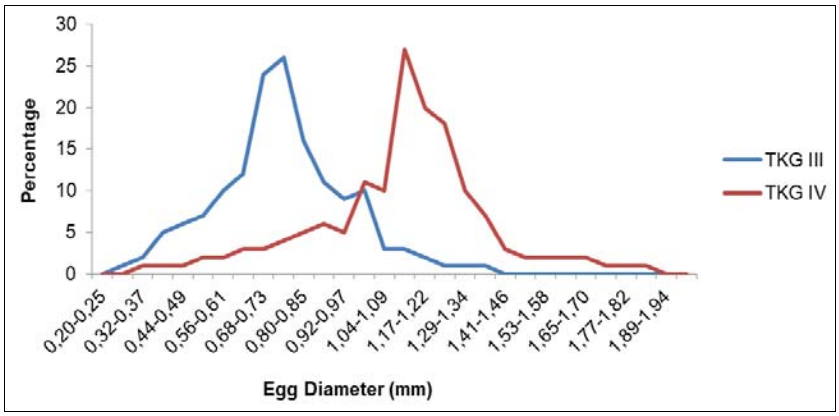

Fig 4: Distribution of egg diameter in maturiry stage III and IV *T. bonti* (n: 150 eggs)

4. Discussion

Fecundity is the number of eggs in female fish before they are released at the time of spawning. The results of this study were the absolute fecundity of *T. bonti* in Lake Towuti were varied between 442-1569 eggs (Total Length: 64.8-89.7 mm and Body Weight: 2.771-10.231 mg) (Figures 2 and 3). Variation in the number of fecundity of endemic genus Telmatherina have been reported such as: *T. celebensis* amounted to 297-1265 eggs [26] (Jayadi *et al*. 2010), *T. celebensis* were 185-1448 eggs [24, 25], *T. ladigesi* amounted to 88-910 eggs [20], *T. ladigesi* amounted to 76-307 eggs [19], *T. ladigesi* ranged from 21-170 eggs [21], *T. ladigesi* amounted to 89-970 eggs [22]. Fecundity was influenced by age, size, species, fish feed, season and environmental conditions [32].

Information on fecundity was used for determining recruitment potential [33], fish stocks and reproductive cycles [34], population dynamics [35], as a biological attribute for evaluating the reproductive capacity of a species [36], a tool for designing sustainable fisheries cultivation and management schemes [37].

This research was showed that the relationship between fecundity and total weight (Fig. 2) was strongly correlated than the relationship of fecundity to total length (Fig. 3). This was also found in *T, celebensis* in Lake Towuti showing a strong correlation between fecundity and total weight [24, 25]. Fecundity variations in fish were influenced by species, age, size, food availability, temperature and season [38].

The distribution of egg diameter was shown in Figure 4. Distribution of egg diameter was used to determine the type of spawning fish. Variations in the distribution of *T. bonti* egg diameter in the adult stage (stage III) and spawning stage (stage IV) were shown in Figure 2 and 3, which indicate that the egg diameter is different at each level of gonad maturity. These is because the ovaries are out of sync. (metacron) [39]. The length of time to spawn was indicated by the number of different egg sizes in the ovary, so it can be said that the diameter of the eggs at each level of gonad maturity will reflect the spawning pattern. The long and continuous spawning time was indicated by the number of different egg sizes in the ovary, so it can be said that the diameter of the eggs at each level of gonad maturity will reflect the spawning pattern. The results of this study was indicated a partial spawner of *T. bonti* in Lake Towuti. Type of spawning was found by *T. ladigesi* [19-22], *T. celebensis* [24, 25], *T. antoniae* [27]. Various egg diameters in the ovary were used to determine reproductive potential [40]. The spawning frequency can be estimated from the egg diameter of the ripe gonads, namely by looking at the mode of distribution, while the spawning time can be estimated from the frequency of the egg diameter [41]. The information regarding fecundity and egg diameter can be used for domestication [42].

5. Conclusion

The absolute fecundity of *T. bonti* was varied between 442-1569 eggs. The relationship between fecundity and weight is positively. The diameter of the eggs inside the gonads varies. The type of *T. bonti* spawning was categoried of partial spawner.

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