Size distribution, length–weight relationship and condition factor of three species male fiddler crab from jaboy mangrove wetland, Sabang, Indonesia

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Abstract. The size distribution, length–weight relationship and factor condition of three species male fiddler crab (Tubuca dussumieri, Gelasimus vocans and Austruca perplexa) from jaboy mangrove wetland, Sabang, Indonesia were examined. 50 samples from each species was collected from three station using digging method and cast net. Samplings were carried out during May 2019. The carapace length (CL) and total weight (TW) was measured using a digital caliper (standard error: 0.01 mm) and digital scale (standard error: 0.01 g). Result showed that Tubuca dussumieri, Gelasimus vocans and Austruca perplexa were found in the size range of 12.37–17.19 mm, 12.03–16.46 mm, 7.79–10.39 and mm carapace length, respectively. Besides, the total weight varied from 2.09–8.20 g, 2.85–5.07 g and 1.15–2.26 g, respectively. All species of male fiddler crab showed negative allometric growth (b < 3). The highest value of b was founded in Tubuca dussumieri, while the lowest was founded in Gelasimus vocans were 2.659 and 1.299, respectively. Nevertheless, Austruca perplexa has a higher value of factor condition than Tubuca dussumieri and Gelasimus vocans.

1. Introduction
Fiddler crabs (Decapoda; Ocypodidae) are widely distributed in Indo-Pacific coastal region [1]. It’s spatial distributions across the mangrove ecosystem are influenced by physiological stressors independent of any sympatric interactions [2]. Fiddler crab exists as a deposit feeder especially in the intertidal area around the mangrove ecosystem [3]. Morphologically, fiddler crabs are characterized by small size with a brightly carapace color pattern. The males have on propodus much larger than the other one [4]. According to Weiss and Weiss, there are 19 types of fiddler crabs in Indonesia and distributed
in almost all regions including Sumatra, Java, Madura, Bali, Lombok, Timor, Ternate and Papua [5]. Fiddler crabs commonly inhabit muddy or sandy substrates, inactive and spent most of the time feeding in place [5]. In addition to, type of substrate plays an important role in determining spawning ground, feeding ground, and nursery ground of fiddler crabs [4]. Fiddler crabs are abundant in the intertidal area with warm climate and also able to growth over temperature of 25ºC to 30ºC, salinity of 23 to 26 ppt and organic matter content of 12.08% to 12.34% [6].

Ecologically, fiddler crabs are vital to support intertidal and mangrove ecosystem [7]. It can excavate a burrow to the middle layer of sediment, therefore the oxygen can reach the sediment layer. This results provide the air circulation and avoid mineral accumulation in the bottom of the sediment, therefore the nutrient contents tend to stable and able to support the plant growth [8]. Jabot mangrove area of Weh Island is a natural habitat for male fiddler crabs. Based on the preliminary observations, there are three dominant species of fiddler crab observed in this area namely *Austruca perplexa* (Milne-Edwards 1852), *Gelasimus vocans* (Linnaeus 1758) and *Tubuca dussumieri* (Milne-Edwards 1852). However, to best our knowledge, there are lack of information related to distribution and length–weight relationship and condition factors of the fiddler crab in Weh Island. Thus, this present study aimed to examine the size distribution, length–weight relationship and factor condition of three species male fiddler crab from jaboy mangrove wetland, Sabang, Indonesia.

2. Methods

2.1. Sampling area and specimen collection

This research was carried out in Jaboi mangrove area of Weh Island, Province of Aceh (50°51 '20 'N- 95°15 '50' S) during May 2019 (Figure 1). The sampling was conducted at low tide using the digging and direct sampling method. The digging method was carried out through excavation to fiddler crab nests into the 30 cm depth, while the direct sampling was conducted on fiddler crab that emerged above the ground. Every collected fiddler crab was photographed using a digital camera. The samples collected were separated by species and placed in a labeled bottle that was added by 70% alcohol. 50 individual fiddler crab from each species were collected in this study.

![Figure 1. Map of sampling location.](image)

2.2. Data analysis

The number of size groups of fiddler crab was determined using formula as follows [9]:

\[ n = 1 + 3.32 \log N \]  \hspace{1cm} (1)

Note: \( n \) was the number of size group; \( N \) was the number of observational data. The class width of each size group of fiddler crab was calculated using the following formula [9]:

\[ \text{Class Width} = \frac{N}{n} \]
\[ c = \frac{a - b}{n} \]  
(2)

Note: \( c \) was the class width, \( a \) was the maximum length of the fiddler crab carapace, \( b \) is the minimum length of carapace of fiddler crab and \( n \) was the number of size groups. Length–weight relationship of each species of fiddler crab was determined using the following formula [10]:

\[ W = aL^b \]  
(3)

Note: \( W \) was the total weight of fiddler crab (g), \( L \) was the length of carapace fiddler crab (mm), \( a \) was intercept, and \( b \) was regression coefficient. The fiddler crab condition factor was measured using the formula from the following equation [10]:

\[ K = \frac{W}{L^3} \times 100 \]  
(4)

Note: \( K \) was the fulton condition factor, \( W \) was the total weight of fiddler crab (g), and \( L \) was the carapace length of fiddler crab (mm).

3. Results and discussion

3.1. Carapace length and total weights distribution

The length of the *Tubuca dussumieri* carapace ranged from 12.73 mm-17.57 mm. The highest frequency of carapace length of *Tubuca dussumieri* observed in the range of 14.53 mm -15.03 mm with 11 individuals, while the lowest frequency observed in the range of 14.02 mm-14.52 mm with 1 individual. The highest frequency of carapace length of Gelasimus vocans obtained in the range of 11.98 mm-12.48 mm (14 individuals), while the lowest frequency obtained in the ranges of 14.02 mm -14.52 mm, 15.04 mm-15.54 mm and 16.06 mm -16.56 mm with 1 individual. The length of the *Austruca perplexa* carapace was in the range of 7.39 mm-10.61 mm. The highest frequency of carapace length obtained in the range of 8.41 mm-9.91 mm (19 individuals), while the lowest frequency of carapace length obtained in the range of 7.90 mm -8.40 mm (2 individuals) (Figure 2).

![Figure 2](image-url)

*Figure 2.* Carapace length distribution of Tubuca dussumieri, Gelasimus vocans and Austruca perplexa.

Based on total weight, *Tubuca dussumieri* collected in this study ranged from 2.09-8.20 g. The highest frequency of carapace of *Tubuca dussumieri* was obtained in the range of 5.66-6.16 g and 7.19-7.69 g
with 2 individuals respectively). The total weight of *Gelasimus vocans* ranged from 2.85-5.07 g. The highest total weight frequency obtained in the range of 3.62-4.12 g (23 individuals), while the lowest frequency obtained in the range of 2.60-3.11 g and 4.64-5.14 g (2 individuals respectively). The total weight of *Austruca perplexa* ranged from 1.15-2.26 g. The highest total weight frequency obtained in the range of 1.07-1.57 g (27 individuals), while the lowest frequency obtained in the range of 2.09-2.59 mm (1 individual) (Figure 3).

![Figure 3. Total weight distribution of Tubuca dussumieri, Gelasimus vocans and Austruca perplexa.](image)

Fiddler crabs occur globally in all tropical and subtropical coastal habitats including mangrove swamps, which are declining worldwide [11]. The result of this study showed that *Tubuca dussumieri* and *Gelasimus vocans* tend to inhabit areas with a higher percentage of muddy substrate compared to *Austruca perplexa*. Previous researches with similar result have been reported on fiddler crab collected from Beano mangrove wetland, Bali and Bai mangrove wetland, Bengkulu [12,13]. The results revealed that *Tubuca dussumieri* and *Gelasimus vocans* tend to be distributed on fine muddy substrates, whereas *Austruca perplexa* tends to be distributed on sandy substrates around the intertidal area. Intertidal area supported with mangrove ecosystem provide a suitable area fiddler crabs [14]. In this area, fiddler crabs can excavate burrows in the substrate to protect themselves from predators and harsh environmental conditions, and for physiological needs [15].

### 3.2. Length–weight relationship and condition factor

All species of fiddler crab examined in this study had negative allometric growth patterns (*b*<3). *Tubuca dussumieri* had a higher coefficient of *b* than *Austruca perplexa* and *Gelasimus vocans* were 2.659, 2.107 and 1.299 respectively (Figure 4). In contrast, *Austruca perplexa* had a higher value of condition factor (K) than *Gelasimus vocans* and *Tubuca dussumieri* were 1.009, 1.006 and 0.993 respectively (Table 1). The value of coefficient *b* of fiddler crab collected from Jaboi mangrove area was still higher than that of *Uca Tangeri* (1.164) collected from the mangrove wetland of Lagos, Nigeria [16]. This indicates that the growth rate of carapace of fiddler crab in Jaboi mangrove area were still lower compared fiddler crab in the Lagos mangrove area, Nigeria.

The condition factor (K) values fiddler crabs ranged from 0.993 to 1.009. K value close to 1 indicates stable habitat conditions with sufficient food availability [16]. However, *Tubuca dussumieri*, *Austruca perplexa* had a lower value of the condition factor compared to other. This low value might cause due to the existence of competition to obtain food and living space with *Gelasimus vocans*, which tend to distributed in the same habitat [3].
Figure 4. Length–weight relationship of Tubuca dussumieri, Gelasimus vocans and Austruca perplexa.

Table 1. Length–weight relationship coefficient, condition factor and Growth Pattern of Tubuca dussumieri, Gelasimus vocans and Austruca perplexa.

| Fiddler Crab        | a   | b   | R²  | K   | Growth Pattern       |
|---------------------|-----|-----|-----|-----|----------------------|
| Tubuca dussumieri   | 0.003 | 2.659 | 0.853 | 0.993 | Negative Allometrics |
| Gelasimus vocans    | 0.127 | 1.299 | 0.372 | 1.006 | Negative Allometrics |
| Austruca perplexa   | 0.015 | 2.107 | 0.607 | 1.009 | Negative Allometrics |

4. Conclusion
In conclusion, this study showed that carapace length of Tubuca dussumieri, Gelasimus vocans and Austruca perplexa ranged from 12.37–17.19 mm, 12.03–16.46 mm, and 7.79–10.39 mm, respectively. Besides, the total weight varied from 2.09–8.20 g, 2.85–5.07 g and 1.15–2.26 g, respectively. All species of male fiddler crab showed negative allometric growth (b < 3). The highest value of b was founded in Tubuca dussumieri, while the lowest was founded in Gelasimus vocans were 2.659 and 1.299, respectively. Nevertheless, Austruca perplexa has a higher value of factor condition than Tubuca dussumieri and Gelasimus vocans.

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