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RESEARCH ARTICLE

Feeding Habits of *Faunus ater* in Krueng Bale and Reuleung, Aceh Besar - Indonesia

Rahmi Agustina[1,*], Ervina Dewi[1], Ilyas Daud[2], Junaidi[3], M Ali Sarong[4], Fredinan Yulianda[5] and Suhendrayatna[6]

[1]Department of Biology, Faculty of Teacher Training and Education, Jabal Ghafur University, Sigli, Indonesia
[2]Department of Physics, Faculty of Teacher Training and Education, Jabal Ghafur University, Sigli, Indonesia
[3]Department of Mathematics, Faculty of Teacher Training and Education, Jabal Ghafur University, Sigli, Indonesia
[4]Departement of Biology, Faculty of Teacher Training and Education, Universitas Syiah Kuala, Banda Aceh, Indonesia
[5]Departement of Water Resources Management, Faculty of Fisheries and Marine Sciences, Bogor Agricultural University, Bogor, Indonesia
[6]Department of Chemical Engineering, Faculty of Engineering, Universitas Syiah Kuala, Banda Aceh, Indonesia

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***Corresponding Author:**
ami.binti.asyar@gmail.com

ABSTRACT

This study was aimed to determine the eating habits of *Faunus* (*F.*) *ater* based on gastric contents analysis to determine the type of food that *F. ater* likes and to determine the eating habits of *F. ater* based on the length class, carried out in the Bale and Reuleung rivers. Sampling was carried out once and 150 samples of F. ater were examined. The data obtained were analyzed for variance followed by Duncan's double-spaced test at 5% level to determine the eating habits of *F. ater*. The types of food found in the digestive tract were identified by matching the picture with the book. The results of the analysis of gastric contents from 150 samples of *F. ater* found 3 types of food, namely *Amphisolenia sp.*, *Parafavella sp.* and *Nannochloropsis sp.* The frequencies of *Parafavella sp.* and *Nannochloropsis sp.* recorded in the *F. ater* hull of the two rivers showed no significant difference, namely 12.9% for Krueng Bale:13.1% for Krueng Reuleung and 87.1% for Krueng Bale and 86.86% for Krueng Reuleung. Analysis of the *F. ater* length class on the food occurrence frequency index showed that there were 8 *F. ater* length classes for the two rivers observed. In general, at each length of food class *F. ater* was dominated by *Nannochloropsis* sp. and *Paravafella* sp. The results of the analysis of gastric contents in 300 samples of *F. ater* in Krueng Bale and Reuleung found three types of food, namely *Amphisolenia* sp., *Parafavella* sp. and *Nannochloropsis* sp. The percentage value of the frequency of eating occurrences of *F. ater* showed *Nannochloropsis* sp. the highest compared to other types of food, while the lowest frequency of eating was *Amphisolenia* sp. There are eight length classes of *F. ater* class for the two rivers observed. In conclusion, at each length of food class *F. ater* was dominated by *Nannochloropsis sp.* and *Paravafella sp.*

INTRODUCTION

Aceh Besar is one of the districts in Aceh Province that has the potential for large inland public waters (PUD), including rivers such as Krueng Leupung, Krueng Raba, Krueng Aceh, Krueng Reuleung and Krueng Bale. According to Sarong et al. (2015), several macrozobenthic species were identified in Krueng Reuleung Leupung District, Aceh Besar Regency. Among the identified species, *Faunus ater*, often consumed by people in Aceh Besar. In another study, about 17% of the macrozobenthos in Krueng Reuleung is *F. ater* (Afkar et al., 2014). *F. ater* is a group of snails that have shell-protected soft body containing high protein with cysteine as the dominant amino acid (Diarra, 2015; Haryatfrehni et al., 2015; Ab Lah et al., 2017).

F. ater is widely utilized as a food source and accessories (its shell) by the local communities (Sahin and Sumnu, 2006). Its high economic value encourages locals to collect *F. ater* excessively causing a depletion of its population. Moreover, the situation is worsened by the presence of Pb and Zn contamination (Prosi, 1989; Santoro et al., 2009; Gupta et al., 2009). The threat also comes from the reclamation project carried out by the local government causing a decrease on *F. ater* habitat. It is suggested that *F. ater* could have a crucial role in a food chain that contributes to the ecosystem balance (Rosnawati et al., 2018). Therefore, *F. ater* cultivation should be to avoid its extinction. Analysis of the feeding habits of *F. ater* could provide an overview of its role in aquatic ecosystems and its natural food resources (Putra, 2017). Previously, studies on eating habit of gastropods were only conducted for *Amusium Pleuronectes* (Taufani et al., 2016), *Batissa violacea* (Bahtiar, 2014), and *Placuna placenta* (Gallardo et al., 1992). This is the first study reporting the eating habits of *F. ater*, in which, as suggested by previous studies, will be determined by analyzing its stomach (gastric) (Eze et al., 2010; Pasaribu, 2017; Capinera, 2017).

MATERIALS AND METHODS

Location and time of research

This research was conducted in October 2019. Samples of *F. ater* were collected from Krueng Bale and Krueng Reuleung Rivers, Aceh Besar Regency with coordinates of 5° 23´ 1´´ N, 95° 15´ 36´´ E and 5° 27´ 6´´ N, 95 ° 14´ 38´´ E, respectively. Samples were then transported to the Biology Laboratory of the Teaching and Education Faculty, Jabal Ghafur University, Sigli for the identification of stomach contents.

Tools and Materials

The tools and materials used in this study were digital scales ION Ipso5 weighing equipment; A4 matrix paper (210x297 mm^2); ruler (30-cm length); microscope Olympus CX 21; truscolup; formalin 10%; sampling bottles; medium-sized hammer; scissors; and blades.

Sampling protocol

F. ater samples were collected once with a total number of samples of 150 considered to be representative of its population. The sample was collected by hand from each predetermined plot (1x1 m^2). Upon collection, the sample was put into a container containing formalin 10% solution before transported to the laboratory.

Gastric contents analysis

Observation of *F. ater* eating habits was carried out by analyzing the stomach contents. After removal from its shell, the body of the *F. ater* was dissected and the digestive tract was separated and measured for its length and weight. Thereafter, the digestive tract was dissected for microscopic examination. The type of food present was observed and matched with the identification books, entitled: Ecology of Phytoplankton (Reynolds, 2006); Plankton of Inland Waters (Likens, 2010); and Identifying Marine Phytoplankton (Tomas, 1997).

Food habits were determined by the frequency of occurrence method with reference to (Rao et al., 2016) using the following Equation (1):

$$Oi = ni / \Sigma ni \times 100 \quad (1)$$

Where Oi, ni, and Σni represent occurrence of a specific food (%); number of foods I-i; and total amount of food in the stomach.

Eating habits were also investigated by the relative intestinal length index *(*relative gut index), which is the percentage of the length of the digestive tract compared to the length of the body of the *F. ater*. The formula (Equation 2) refers to (Sivan, 2011):

$$RGi = LG / TL \times 100 \quad (2)$$

Where, RGi = relative gut index; TL = total length (mm) and LG = length of gut (mm).

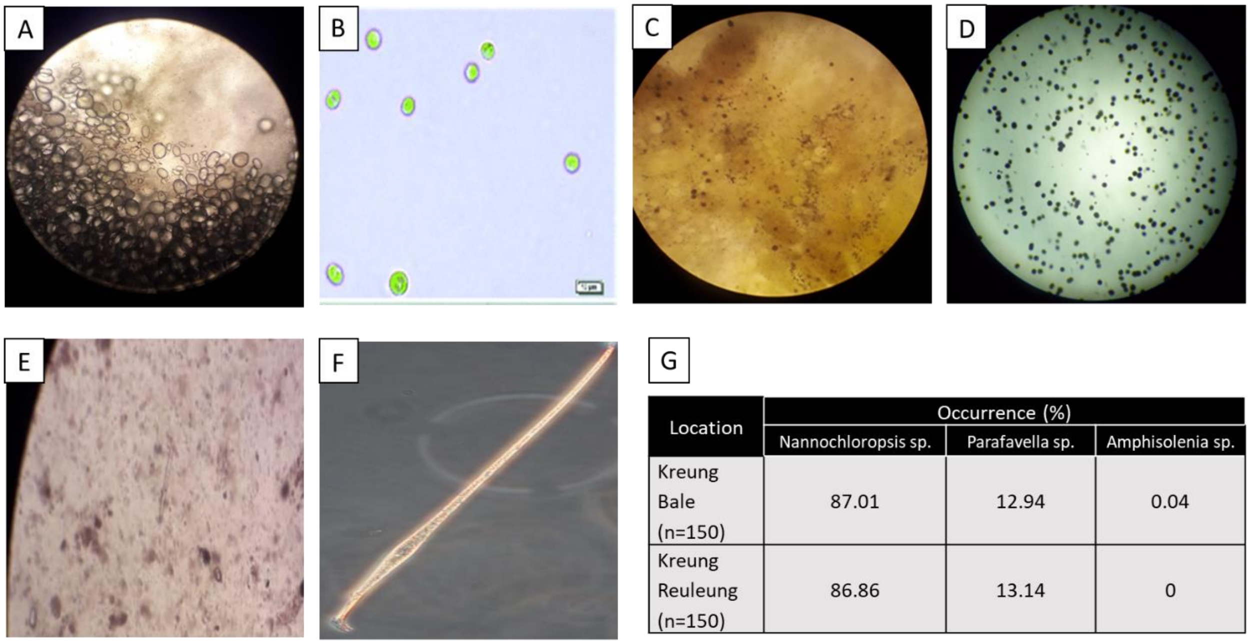
Data analysis

The data obtained were statistically analyzed using ANOVA with post hoc Duncan's multiple spacing test at α=5% level, performed on IBM SPSS 21.0 (NY, USA).

RESULTS

Feeding frequency

Images of phytoplankton found in the digestive tract of *F. ater* observed under the microscope along with their references from the book are presented in Figure 1. There were three types of food, namely *Amphisolenia* sp., *Parafavella* sp. and *Nannochloropsis* sp. founded in the digestive tract. From the calculation of the feeding frequency for each type of phytoplankton the data have been obtained and presented in Table 1. The most consumed phytoplankton was observed to be *Nannochloropsis* sp. with occurrence percentages reaching 87.1 and 86.8% in a sample collected from Krueng Bale and Krueng Reuleung, respectively. The second most consumed phytoplankton was *Parafavella* sp. shown by samples from both Krueng Bale and Krueng Reuleung (12.9 and 13.1%, respectively). As for the *Amphisolenia* sp., the occurrence only reached 0.04% observed in the digestive tract of *F. ater* from Kreung Bale, while no occurrence was found in samples from Kreung Reuleung.



Location	Occurrence (%)		
	Nannochloropsis sp.	Parafavella sp.	Amphisolenia sp.
Kreung Bale (n=150)	87.01	12.94	0.04
Kreung Reuleung (n=150)	86.86	13.14	0

Figure 1: Phytoplankton *Nannochloropsis* sp. found in the digestive tract of *F. ater* as seen under the microscope (A) and its image from the reference book (B). Phytoplankton *Parafavella* sp. found in the digestive tract of *F. ater* as seen under the microscope (C) and its image from the reference book (D). Phytoplankton *Amphisolenia* sp. found in the digestive tract of *F. ater* as seen under the microscope (R) and its image from the reference book (F). Table depicting the feeding frequency of *F. ater* for each type of phytoplankton (G).

Table 1: Occurrence frequency index for type of food based on the length classification of the body of *F. ater* collected from Kreung Bale

Class ranges (mm)	n	Occurrence frequency index (%)		
		Amphisolenia sp.	*Parafavella* sp.	*Nannochloropsis* sp.
27-32	2	0	8.51	91.49
33-38	24	0	8.78	91.21
39-44	32	0.16	10.77	89.07
45-50	39	0	12.16	87.84
51-56	33	0.03	13.94	86.03
57-62	17	0	27.91	72.09
63-68	1	0	10.63	89.47
69-75	2	0	0	100
Mean		0.02	11.59	88.4

Table 2: Occurrence frequency index for each type of food based on the length classification of the body of *F. ater* collected from Kreung Reuleung.

Class ranges (mm)	n	Occurrence frequency index (%)	
		Parafavella sp.	*Nannochloropsis* sp.
23-28	3	35.53	64.47
29-34	24	11.08	88.92
35-40	19	17.02	82.97
41-46	50	13.22	86.78
47-52	32	12.07	87.93
53-58	12	11.37	88.63
59-64	8	15.17	84.83
65- 70	2	6.93	93.07
Mean		15.29	84.7

Table 3: Results from Duncan's multiple range test on occurrence frequency of the type of food observed in *F. ater* collected from Kreung Bale and Kreung Reuleung.

Location	*Amphisolenia* sp.	*Parafavella* sp.	*Nannochloropsis* sp.
Krueng Bale	0.02±0.06	11.59±7.79	88.40±7.79
Krueng Reuleung	0.0±0.00	15.29±8.70	84.7± 8.70

Length classification and relative gut index (RGI)

The analysis results on the length classification of the *F. ater* and the occurrence frequency index for each type of food as observed in samples collected from Kreung Bale have been presented in Table 1. In general, *F. ater* fell under the range of 27-32 mm (n=2) and 33-38 mm (n=24) had the highest occurrence frequency of eating *Nannochloropsis* sp. (91.4 and 91.2%, respectively). The highest occurrence frequency of *Parafavella* sp. was found in a group with 57-62 mm range of length (n=17). As for the *Amphisolenia* sp., the highest occurrence with a percentage of 0.16% was observed in 39-44 mm group (n=32).

Classification based on the range of body length of the *F. ater* collected from Krueng reuleung, along with the occurrence frequency for each type of food is presented in Table 2. *F. ater* in the longest range of body length (65-70 mm; n=2) had the highest occurrence of *Nannochloropsis* sp. Followed by

Nannochloropsis sp. observed in 29-34 mm (n=24) and 53-58 mm (n=12) with percentages reaching 88.92 and 88.63%, respectively. In case of *Parafavella* sp., the highest occurrence was found in 23-28 mm group (35.53%; n=3), followed by 35-40 mm group (17.02%; n=19). The results of Duncan's multiple range test on occurrence frequency of the type of food observed in *F. ater* collected from Kreung Bale and Kreung Reuleung are presented in Table 3.

DISCUSSION

This research aimed to determine the eating habits of *F. ater* based on gastric contents analysis and determination of the type of food that *F. ater* likes, and to determine the eating habits of *F. ater* in the Bale and Reuleung rivers. The data showed that *F. ater* mainly consumes phytoplankton, hence categorized as herbivore or phytoplankton feeder to be more specific. The most preferred phytoplankton for consumption was *Nannochloropsis* sp., which could be associated for its abundance in the sampling location. In line with reported studies, *Nannochloropsis* sp. was found as a food source for zooplankton (rotifer, copepod, artemia), which are consumed by fish larvae (Hasmalasari et al., 2017). Observed microalgae herein was reported capable of living in heavy metal-contaminated environment (Upadhyay et al., 2016; Chan, 2019; Khan et al., 2017). Moreover, previous studies that suggested the use of *Nannochloropsis* sp. for bioremidation of polluted waters owint to its ability to absorb heavy metal Pb (Masithah et al., 2013; Bassler, 2017). However, at Pb concentration of more than 50 mg/L, the toxicity could reduce the population of *Nannochloropsis salina* (Masithah et al., 2013). Therefore, uncontrolled heavy metal pollution could risk the availability of the food source for *F. ater*.

Nannochloropsis sp. is a cosmopolitan microalgae group, especially in waters with various pressures (Lestari *et al*., 2019; Wang *et al*., 2019; Wijayati, 2019). The greater number of *Nannochloropsis* sp. found in the digestive tract of *F. ater* allegedly by its very slow mobility allowing it to be easily captured. Rahman et al. (2018) explained that *Nannochloropsissp* has slow mobility, is very reproductive, and easy to breed with simple nutritional requirements. In addition, *Nannochloropsis* sp. has been reported to be high tolerant against environmental pressures including salinity and nitrogen contents by producing excessive transcellular proteins and lipids (Pal et al., 2011; Caporgno et al., 2015; Boli et al., 2021).

Conclusion

Nannochloropsis sp. is the main food source of *F. ater* regardless its habitat locations (Krueng Bale or Kreung Reueleung) and body length. It is suggested that care must be taken while unregulated heavy metal pollution that has already existed because it could impact the availability of *Nannochloropsis* sp.

Authors' Contribution

All authors contributed equally to this manuscript.

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