Media Konservasi, 30 (1) 141-153

RESEARCH ARTICLE

MEDIA KONSERVASI
SCIENTIFIC JOURNAL IN CONSERVATION OF NATURAL RESOURCES AND ENVIRONMENT

Habitat and Food of Vampire Crabs (*Geosesarma* sp.) in Menoreh Mountain, Yogyakarta, Indonesia

Tito Kurniawan, Waluyo, Andri Nofreeana and Muhammad Tri Aji

Department of Aquaculture, Faculty of Agriculture, Tidar University, Magelang 56116, Indonesia

Article Info:
Received 03 November 2023
Revised 23 October 2024
Accepted 24 October 2024

Corresponding Author:
Tito Kurniawan
Department of Aquaculture, Faculty of Agriculture, Tidar University, Magelang 56116, Indonesia
E-mail: titokur123l@gmail.com

Abstract

Vampire crabs (*Geoseserma* sp.) are freshwater crabs that inhabit humid tropical forest ecosystems, such as the Menoreh Mountain. These crabs play an important role in the ecosystem as detrivores and a food source for other organisms. However, resesearch on their feeding habitat is still limited, leaving gaps in knowledge regarding their dietary preferences and ecological role. Understanding their feeding patterns is essential to support sustainable aquaculture and environmental conservation. The research focused on the feeding habits and food preferences of vampire crabs (*Geosesarma* sp.) in a humid, forested ecosystem. The study was conducted in the Menoreh Mountain region, which provides a unique habitat for these crabs. Understanding their feeding habits in this natural habitat is essential for promoting sustainable aquaculture practices, where environmental conservation is a priority. This research aimed to analyze vampire crabs' food and feeding habits (*Geosesarma* sp.) in their natural habitat to support sustainable aquaculture on the Menoreh mountain slopes. The study employed frequency of occurrence analysis, volumetric analysis, and the Index of Preponderance. Sex ratio analysis and assessments of habitat conditions, including substrate texture and organic content, were conducted. The substrate consisted of sandy clay with an organic content ranging from 8.59% to 37.88%. Vampire crabs were identified as omnivores with a tendency towards herbivory, primarily consuming debris (93.47%), wood (2.75%), worms (1.92%), and leaves (1.86%). Debris was the main food source, supplemented by wood and leaf litter, with worms as an occasional food source. The findings highlighted the crabs' dietary adaptability and provided insights for future sustainable captive breeding efforts.

Keywords: food and feeding analysis, Geosesarma, Index of Preponderance, semi-terrestrial crab

1. Introduction

The vampire crab (*Geosesarma* sp.) is a decorative crab belonging to a large genus of semi-terrestrial and terrestrial crabs that inhabit freshwater environments in Southeast Asia, the Andaman Islands, and the Western Pacific. Currently, there are 64 recorded species, with the majority found in Indonesia [1]. Vampire crabs are frequently found in the Indonesian waters of *Geosesarma dennerle* and *Geosesarma hagen* [2]. In a study conducted on the Slamet Mountain slopes, vampire crabs were only discovered at 787 MASL, inhabiting areas with semi-aquatic habitats or partially submerged water. Therefore, the vampire crabs can be classified as semi-terrestrial freshwater crabs. They were found in small rocks measuring <10 cm and vampire crabs live in colonies [3]. One of the distributions of vampire crabs in Indonesia is found on the Menoreh Mountain slopes in the Kulonprogo Regency, as reported by residents in Kulonprogo, in the Special-Region Yogyakarta in Indonesia.

The *Geosesarma* group is characterized by their relatively square-shaped carapace, the presence of a row of sharp tubercles on the dorsal edge of the dactylus cheliped, and the absence of a flagellum on the third maxilliped [4]. Genus *Geosesarma* is a decorative crab frequently traded, constituting one form of exploitation in Indonesia. The population of vampire crabs on the Menoreh Mountain slopes remains poorly understood. This exploitation threatens the survival of vampire crabs and requires captive breeding and habitat conservation. To succeed in vampire crab breeding, it is essential to understand the factors influencing their populations, food sources, and habitat conditions. Knowledge of feeding habits in natural habitats can support sustainable captive breeding.

2. Materials and Methods

2.1. Research Location and Time

This study was conducted between October 2022 and March 2023. Vampire crab samples were obtained from the slopes of Mount Menoreh, Girimulyo District, Kulonprogo Regency, and Special-Region Yogyakarta in Indonesia, specifically in Jatimulyo Village. The data analyses were conducted at two different locations. Feeding habits and patterns were observed at the Laboratory of the Faculty of Agriculture, Tidar University, Magelang. At the same time, substrate organic matter was analyzed at the Environmental Engineering Laboratory, Diponegoro University, Semarang.

This research involved collecting crab samples at two different stations, focusing on the presence of vampire crabs on the slopes of Mount Menoreh in Jatimulyo Village, and determining the sampling points (Figure 1). Station 1 (110°8'7"E, 7°44'30"S) was in the Sibolong sub-village, Jatimulyo Village, Girimulyo District, and the Kulonprogo Regencies. It is in the snake fruit orchard area, which serves as a habitat for vampire crabs in Jatimulyo Village. Station 2 (110°7'59.09"E, 7°45'26.16"S) was in Sokomoyo Hamlet, Jatimulyo Village, Girimulyo District, and the Kulonprogo Regencies. It is one of the areas that serves as a habitat for vampire crabs in Jatimulyo Village and is in the rocky cliff area of a cave with a flowing water stream.

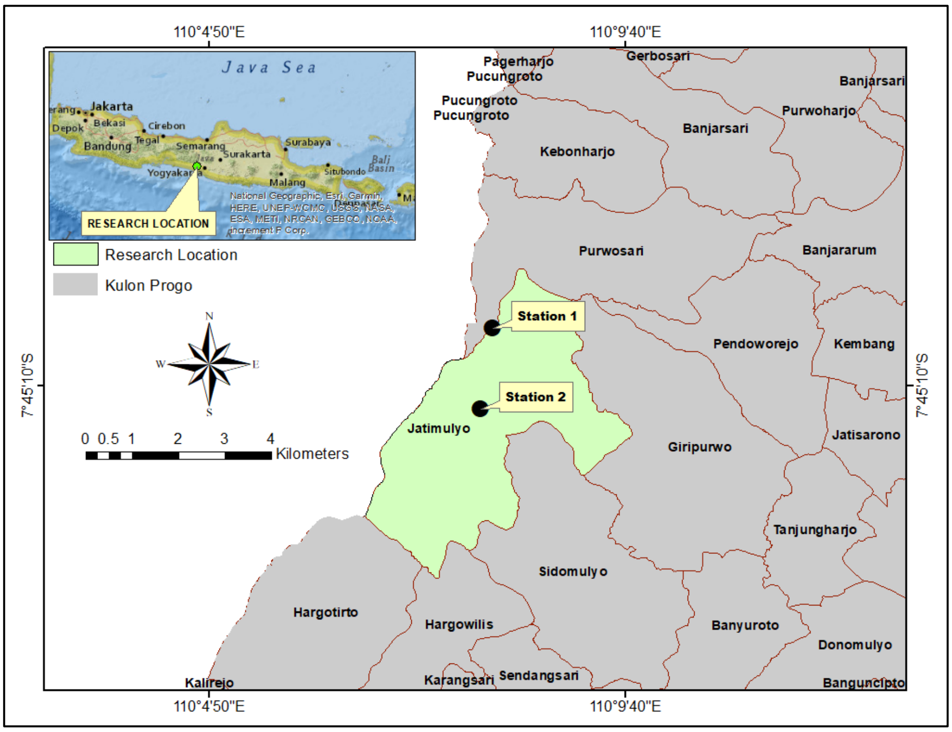

Figure 1. A map of the research location in Jatimulyo Village shows two observation stations.

2.2. Data Collection

The data collection in this research encompassed observations of food habits, feeding habits, and sex ratio of vampire crabs, including substrate texture and organic matter, which were analyzed using a quantitative descriptive method. This study's sampling technique for vampire crabs involved direct sampling at two predetermined stations. Each station consisted of three sub-stations: sub-station one was far from the water source, sub-station two was positioned between the water source and land, and sub-station 3 was in the stream flow area. The approximate distance between substations was only 10 m, so individual coordinates for the substations were not recorded separately. The coordinates provided for the main stations sufficiently represent the overall sampling locations. Vampire crabs were manually collected by hand-picking at each substation.

Crab samples were collected by handpicking; 18 individuals were obtained from Station 1 and 15 from Station 2. Samples were immediately placed in containers filled with 10% formalin [5]. To prevent mortality and stop the food digestion process within their bodies during transportation to the laboratory for stomach content observations.

The primary parameter of this research is the feeding habit of crabs, determined through a combination of the frequency of occurrence method and the volumetric method, which is further evaluated using the Index of Preponderance [6]. To analyze the morphometry of the crabs, we used the relationship between carapace width (Y) and weight (x) using the formula ($Y = be^{ax}$) [7]. The feeding habits of fish and crabs make it better to present results using a combination of frequency of occurrence and volumetric methods [8]

The stomach contents were sampled by first immobilizing the crab and then carefully dissecting the carapace immediately behind the mouth to access the stomach. The carapace was carefully opened using a sterile surgical instrument. Once the carapace was opened, the stomach was carefully extracted to prevent contamination. The stomach contents were then placed on a microscope slide and examined at 40x magnification. This detailed examination allowed for the identification of various food particles and provided comprehensive insights into the diet composition of the vampire crab.

2.2.1. Frequency of occurrence (FO)

Frequency of occurrence (FO) was calculated by recording the number of stomachs containing a specific type of food. The recorded number was then converted into a percentage based on the total number of crab stomachs analyzed. This method provides insight into the dietary preferences of vampire crabs.

$$FO_i = \frac{\sum FO_i}{\sum FO} \times 100\% \quad (1)$$

Where FOi (type of crab food-i), ∑FOi (total stomachs that contain a type of food), and ∑FO (total stomachs that contain food). Differences in the Frequency of Occurrence (FO) of food types were observed based on the following criteria [9]: If FO > 50% (the food type was dominant and characteristic of a predator's diet), if 50% > FO > 10% (the food type was a secondary food component and only consumed when the primary food was not available), and FO < 10% (the food type was consumed incidentally).

2.2.2. Volumetric

Volumetric analysis was carried out to measure the volume of different food types found in the stomachs of the vampire crabs. The volume was determined in percentage units using a combination of gravimetric analyses. This quantitative analysis involved weighing the stomach contents, observing them under a microscope, and then separating and grouping the organisms of the same type. The gravimetric method is essentially like the volumetric method, but instead of measuring the total volume of stomach contents for each organism, it quantifies the weight expressed as a percentage [10]. The volumetric method for measuring fish/crustacean food was based on the percentage of whole food volume in the stomach of crabs [11], and formulated as follows:

$$V = \frac{V_i}{Vt} \times 100\% \quad (2)$$

Where V is the volume of one food type (%), Vi is the volume of one food type (unit gr^{-1}), Vt is the total volume of all food types (unit gr^{-1}).

2.2.3. Index of Preponderance (IP)

The index of preponderance is calculated using this index to evaluate the two methods, the frequency of occurrence method and the volumetric method [12]. This index helps determine the dominance of certain species of the factor in each study. The formula for this model considers each factor's frequency of occurrence and volume, providing a more comprehensive evaluation. Using this index, researchers can better assess the relative importance of each method in their analysis.

$$IP = \frac{V_i \times O_i}{\sum(V_i \times O_i)} \times 100\% \quad (3)$$

Where IP is Index of Preponderance (The Index of Preponderance (IP) values range between > 25% (primary food), 4–25% (supplementary), and < 4% (additional); Vi is the volume percentage of one food type; Oi is percentage of frequent food consumption to 1; ∑Vi x Oi is the sum of Vi x Oi of all food types.

2.2.4. Relationship between carapace width and body weight of the crab

The relationship between carapace width and body weight is the growth pattern of vampire crabs, which can be analyzed using an exponential regression and correlation analysis approach. Correlation analysis aimed to measure the strength or degree of the relationship between independent and dependent variables, specifically the relationship between carapace width and body weight in vampire crabs. The formula for the exponential regression equation is as follows:

$$Y = be^{ax} \quad (4)$$

Where Y is exponential regression “Y” against “x” (Independent variable/carapace width); x is independent variable (crab weight); a, b is constants; e is natural logarithm base (value: 2.71828183).

3. Results

3.1. Habitat Conditions of Vampire Crabs

The habitats of vampire crabs in Indonesia were previously found in Java, Sumatra, and Bali. In this study, the habitat of vampire crabs was discovered on the slope of the Menoreh Mountains, Jatimulyo Village (Girimulyo District, Kulonprogo Regency, in the Special-Region Yogyakarta, Indonesia). The Kulonprogo Regency is one of the five regencies and cities in the Special-Region Yogyakarta, located in the western part. Girimulyo District is situated in the northern part of the Kulonprogo Regency and is characterized by the highlands and hills of Menoreh, with elevations ranging between 500 and 1,000 MASL. Most of this area was designated for cultivation and conservation activities as part of forest protection efforts.

Two stations were used in this study. Station 1 was in the Sibolong sub-village, Jatimulyo Village. It is an area of snake fruit plantation with abundant undergrowth and a substrate structure of sandy clay. At this station, a spring with a relatively gentle flow provided moisture to the surrounding soil, which was filled with sand and small rocks. Station 2 is situated in the Sokomoyo sub-village. It is an area characterized by cliffs covered with dense vegetation, including main plants such as coconut trees and undergrowths such as moss, taro, and grass. According to the local community, this area is prone to landslide. Station 2 also featured a spring surrounded by rocks. An overview of the research locations is shown in (Figure 2).

(a) (b) (c) (d)

Figure 2. Habitat conditions of vampire crabs at station 1 (Sibolong, snake fruit (a), spring water stream (b)) and station 2 (Sokomoyo, vegetation on the slope (c), spring water stream(d)).

3.2. Substrate Parameter of Vampire Crabs

An ecosystem is an ecological system with mutual relationships among species diversity, material cycles, and energy flow through its components. The conditions and composition of the substrate are vital for the survival of many species, including vampire crabs. Substitutes rich in organic matter provide essential nutrients and habitats for crabs to find food, hide, and reproduce. The substrate's texture and organic content can significantly influence an ecosystem's biodiversity and functionality [13]. Table 1 shows the substrate parameters of vampire crab habitats in the research location.

Table 1. Substrate parameter of vampire crab habitats in Menoreh mountains slopes

Station	Substation	Parameters	
		Texture	Organic matter (%)
Sibolong	1.1	Sandy clay	32.02
	1.2	Sandy clay	8.59
	1.3	Dusty clay	22.80
Sokomoyo	2.1	Sandy clay	24.13
	2.2	Sandy clay	13.90
	2.3	Sandy clay	37.88

3.3. Food Habits of Vampire Crabs

Based on the analysis of the frequency of occurrence of the 33 individual crabs, 25 of the individuals had stomach-containing food. In contrast, 8 of individuals had empty stomachs. The frequency of occurrence was determined based on the presence of wood litter, leaves, worms, and debris in the stomachs of vampire crabs that contained food (Table 2) Stomach contents were identified through microscopic observation (Figure 4).

The food habits of vampire crabs are influenced by their natural habitat, which provides abundant organic material and vegetation. *Sphagnum* moss vegetation (Figure 3a) plays a significant role in maintaining the habitat's humidity, while the crabs' activities in this environment (Figure 3b) reflect their adaptation to semi-terrestrial conditions (Figure 3).

The Volumetric analysis of stomach contents (Table 3) revealed that debris dominates the diet of vampire crabs, contributing 76.47% of the total food volume. This is followed by worms (19.67%), wood (2.34%), and leaves (1.52%), which indicates their detritivorous feeding behavior. Additionally, the Index of Preponderance (Table 4) further supports debris as the primary food source, with a contribution of 93.47%, followed by supplementary sources such as wood, worms, and leaves.

Table 2. Stomach contents were identified through microscopic observation (Figure 4).

The food habits of vampire crabs are influenced by their natural habitat, which provides abundant organic material and vegetation. *Sphagnum* moss vegetation (Figure 3a) plays a significant role in maintaining the habitat's humidity, while the crabs' activities in this environment (Figure 3b) reflect their adaptation to semi-terrestrial conditions (Figure 3).

The Volumetric analysis of stomach contents (Table 3) revealed that debris dominates the diet of vampire crabs, contributing 76.47% of the total food volume. This is followed by worms (19.67%), wood (2.34%), and leaves (1.52%), which indicates their detritivorous feeding behavior. Additionally, the Index of Preponderance (Table 4) further supports debris as the primary food source, with a contribution of 93.47%, followed by supplementary sources such as wood, worms, and leaves.

Table 2. Frequency of occurrence (FO) in vampire crabs from Sibolong and Sukomoyo stations (n = 25)

Food type	Type of crab food-i/ FOi	Frequency of Occurrence (%)
Worms	2	8
Wood	24	96
Leaves	25	100
Debris	25	100

The highest frequency of occurrence was observed in leaf litter and debris, which were found in the stomachs of all vampire crabs. This confirms the significance of leaf litter and debris in the stomachs of *Geosesarma* crabs. Wood litter appeared 24 times with a frequency of occurrence of 96%. In contrast, worms had the lowest occurrence, with only two appearances (FO = 8%).

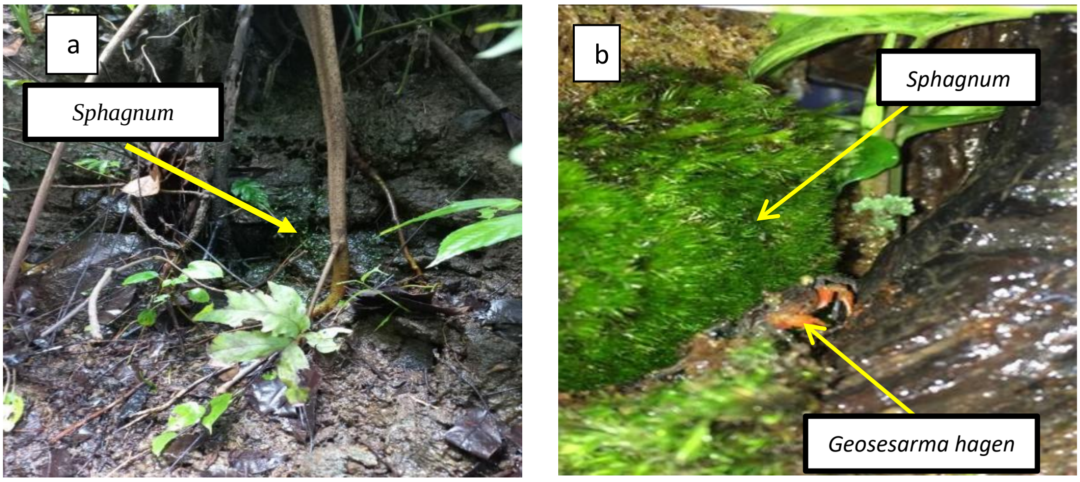

Figure 3. Habitat of *Geosesarma hagen*, showing the presence of *sphagnum* vegetation (a), and the activity of vampire crabs in the surrounding area (b).

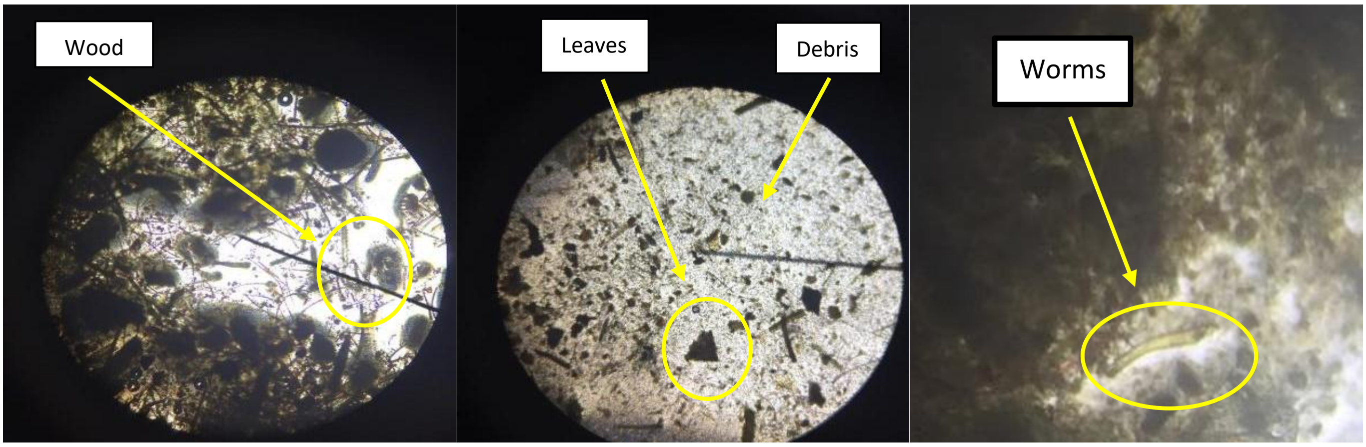

Figure 4. Microscope observations of the stomach contents showed elongated wood fragments, larger and thicker leaves, fine debris particles, and long, transparent worms.

Table 3. Volumetric of food type inside vampire crab's stomach

Food type	Number of stomachs containing food of type i	Volume of food type (unit gr^{-1})	Volume of one food type (%)
Debris	25	0.024301	76.47
Worms	2	0.006250	19.67
Wood	24	0.000744	2.34
Leaves	25	0.000484	1.52
TOTAL		0.031780	100

Table 4. The results of an index of preponderance analysis in the vampire crab's stomach

Food type	∑FOi	Oi (%)	Vi (%)	Oi x Vi	IP (%)
Debris	25	100	76.47	7,646.69	93.47
Wood	24	96	2.34	224.90	2.75
Worms	2	8	19.67	157	1.92
Leaves	25	100	1.52	152.38	1.86
TOTAL				8,181.30	100

3.4. Feeding Habits of Vampire Crabs

Vampire crabs were found on the Menoreh Mountain slopes in Jatimulyo Village. In this village, there are no flowing rivers; instead, they live in snake fruit tree orchards, as shown in (Figure 5c), which have moist and hollow soil structures, living beneath the roots of snake fruit trees. The lifespan of vampire crabs in the Menoreh Mountains is estimated to be 80% terrestrial. The water streams in their habitats have a low intensity and are vegetated. Vampire crabs hide in caves and dig themselves. They are rarely found far from their burrows because they are cautious and shy. They enter burrows if they sense threats or disturbances. (Figure 5d) illustrates the burrows created by vampire crabs, which serve as their homes and hiding places when they feel threatened. These burrows are also used for molting because crabs are vulnerable during molting. Once the molting phase is complete and they regain their strength, they emerge to search for food.

Morphologically, vampire crabs have a smaller mouth size, which affects their feeding behavior and habits. Vampire crabs are omnivorous, meaning that they eat various foods but tend to be more herbivorous. This was based on several considerations, with plant-based food sources being more common than animal-based ones. Owing to the natural behavior of vampire crabs, they consume food from their habitat by using their claws to tear or cut them into pieces that fit into their mouths. Vampire crabs consume food in their habitats if they fit into their mouths. Adult vampire crabs tend to seek food sources in areas above water sources and have even been found on tree branches covered in moss. Younger vampire crabs are more commonly found in areas close to water sources. Adult vampire crabs are rarely found in water and mostly inhabit damp areas, whereas juvenile crabs often remain in or very close to the waterline and are less frequently observed in drier forested areas [14].

Another unique characteristic of vampire crabs is their classification as semi-terrestrial. As long as their bodies remain moist, vampire crabs can survive for an extended period from water sources. This is because they store moisture in their gills to maintain the humidity. If their bodies start to dry out, vampire crabs will release fluid from their bodies, which appears as foam or bubbles, often from their mouths, as shown in (Figure 5b). This adaptation allows vampire crabs to survive far from water sources. They use it to facilitate foraging in higher areas, such as tree branches and rocky slopes on the Menoreh Mountain slopes.

(a) (b) (c) (d)

Figure 5. *Bryophyta* (a), Foam produced by vampire crabs (b), the locality of vampire crabs in Sibolong sub-vellage and Sokomoyo sub-vellage stations (c), *Geosesarma hagen* (d).

3.5. The Relationship between Carapace Width and Weight of Vampire Crabs

All 19 male vampire crabs were sampled, with carapace widths ranging from 9.42–15.68 mm and weights ranging from 0.56–2.94 gr. Regression equations were obtained for the carapace width and weight of vampire crabs using the exponential regression method, with a value of “a” at 0.2339 and “b” at 0.0682, and a correlation value of 0.8556 (85.56%) as presented in (Figure 6a). For female vampire crabs, the regression equation was y = beax with “a” at 0.1679 and “b” at 0.1352, which is $y = 0.1352e^{0.1679x}$, as shown in (Figure 6b).

The relationship between carapace width and the weight of crabs using an exponential regression equation is because the growth of a population is inherently unstable, sometimes experiencing growth and other times experiencing a decrease. Exponential growth occurs under conditions of unlimited environmental resources and carrying capacity, resulting in a growth model graph that takes the shape of a "J" [15].

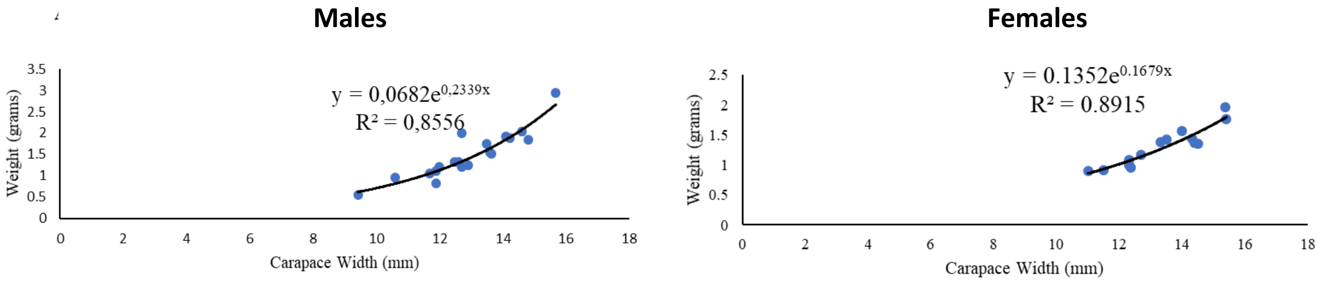

Figure 6. Graphical analysis of the relationship between carapace width and weight of male and female vampire crabs.

Data processing from the exponential regression equation between the carapace width and weight of vampire crabs was performed to understand the growth patterns of these crabs. Based on the exponential regression equation $Y = be^{ax}$, the value of 'b' in this equation determines the growth pattern of vampire crabs. The value of “b” (b = 0.0682) indicates that the growth between the carapace width and weight of male vampire crabs in the Menoreh Slopes exhibits negative allometric growth (b < 3). Meanwhile, for female vampire crabs, the regression equation is y = beax with “a” at 0.1679 and “b” at 0.1352, which is $y = 0.1352e^{0.1679x}$, as shown in (Figure 6b). The results of the exponential regression equation to describe the growth pattern between the carapace width and weight of female vampire crabs suggest that their growth in the Menoreh Slopes region is negatively allometric. Negative allometric growth means that the growth in carapace width occurs more rapidly than the growth in crab weight [16].

3.6. Sex Ratio

In a November study conducted on the slopes of Mount Menoreh, the sex ratio of vampire crabs was observed. The number of male crabs was higher than that of females, with 17 males (61%) and 11 females (39%). This resulted in a male-to-female sex ratio of 1.54:1, suggesting a balanced sex ratio with a higher population of males. Identifying the sex of vampire crabs through the shape of their abdomen, male crab abdomens were narrow and triangular, while female crab abdomens formed a shield-like structure, as shown in Figure 6.

Figure 6. Differences in abdomen morphology between male and female *Geosesarma hagen.* Male crabs have narrow, triangular abdomens, while female crabs have broader, shield-like abdomens.

4. Discussion

4.1. Habitat Adaptations and Environmental Factors Supporting Vampire Crabs

Freshwater crabs inhabit diverse substrates, including rocky, muddy, or mixed sediments, and some species have adapted to semi-terrestrial lifestyles by creating burrows or climbing trees and cliffs. These adaptations are viable if the crab gills remain moist or retain trapped air bubbles [17]. In the case of vampire crabs, an additional mechanism to maintain moisture in their gills includes obtaining water from food or drinking dew that accumulates on rainforest surfaces during the early morning [18].

The findings (Table 1) revealed that most of the substrates in the study area consisted of sandy clays. This substrate type was favorable because of its higher proportion of sand, which increased porosity and water absorption, making it easier for vampire crabs to dig burrows as hiding sites. Morphological adaptations of vampire crabs to substrate conditions also influenced their distribution, with crabs showing a preference for sandy clay because of its suitability for creating burrows and high organic matter content. In contrast, substrates with coarser textures lack organic matter because fine particles, essential for organic material deposition, cannot settle [19,20].

The organic matter content in the substrate ranged from 8.59% to 37.88%. Substrates with 17% and 35% organic matter levels were categorized as high, while levels above 53% were considered very high [21]. This high organic content results from substantial organic carbon input from plant and animal litter, which soil organisms decompose into humus [22]. Such substrate characteristics create an ideal environment for detritivores, such as vampire crabs, which play an important role in breaking down organic matter derived from dead organisms.

As detritivores, vampire crabs derive energy from detritus, including non-living organic materials, such as dead organisms, feces, fallen leaves, and wood [23]. Leaf litter production plays a critical role in nutrient cycling within ecosystems. Nutrients generated from decomposed leaf litter promote the growth of macrofauna, such as sesarmid crabs (*Sesarmidae*), further broken down by various microbes attached to the substrate [24].

The availability of diverse food sources, including insects, worms, and plants, influences the abundance of vampire crabs. However, their populations are also influenced by their interactions with predators and competitors. Predators such as birds and snakes prey on vampire crabs, whereas competition with other crab species for resources and territory could impact their abundance. Intense predator-prey or competitive interactions may lead to declining vampire crab populations [25].

A study by [3] on *Geosesarma* crabs on Mount Slamet, Central Java, supports the significance of environmental factors in shaping crab abundance. Key factors, such as vegetation cover and soil properties, are pivotal in determining suitable habitats for vampire crabs. Understanding these ecological relationships is essential for assessing the distribution and survival of the *Geosesarma* species in this region.

4.2. Feeding Behavior, Growth Patterns, and Population Dynamics of Vampire Crabs

Based on the frequency of occurrence presented in (Table 2), the primary food items for vampire crabs consisted of wood litter, leaves, and debris, with worms serving as a supplementary food source. This dietary preference indicates that vampire crabs are detritus feeders, a classification supported by their stomach content composition. Detritus feeders consume decomposing organic matter, including small particles from plants, fungi, and microorganisms, found in sandy or muddy substrates where they reside [13].

The presence of debris as the most abundant food source in their diet (76.47% of the stomach content volume) aligns with the detritivorous nature of these crabs. Worms in only two sampled stomachs contributed 19.67% to the volume, suggesting they may be a more sporadic but valuable food item. Wood and leaf litter, although present in nearly all stomachs, made up a minor fraction (2.34% and 1.52%, respectively), further highlighting the dominance of debris.

The texture and decomposition state of the food items found in the stomachs of vampire crabs offer insights into their feeding behavior. Wood debris, which appears as fragments from decayed wood and leaf litter and shows signs of decomposition, is easily consumed by crabs. Their red color and transparent bodies characterize worms found in the stomachs of vampire crabs, and their relatively larger size compared to other food items makes them a significant but less common part of the diet. Debris, predominantly composed of decomposed organic material from the substrate, is the most prevalent food type, and its small size allows for easier ingestion compared with the more fibrous wood and leaves. This pattern is consistent with findings from similar studies on detritus feeders, where smaller organic particles were the preferred food [26].

Vampire crabs thrive in habitats where mosses (Bryophyta) are abundant, such as the humid environments of the Menoreh Mountains. While mosses are not a primary food source for crabs, they play an essential ecological role by providing moisture and supporting microhabitats for smaller organisms that may serve as food for crabs. Mosses contribute to the overall ecosystem by maintaining humidity and offering shelter, indirectly supporting crab survival. This finding aligns with the broader ecological understanding of semi-aquatic crabs, typically found in humid, near-water environments where mosses and other plants thrive [17].

As observed in the present study, the growth patterns of vampire crabs are influenced by several factors, including habitat and food availability. Crustacean growth patterns can vary significantly among species and are influenced by external factors such as seasonal changes in microclimate and internal factors such as gender and developmental stage [27]. Research indicates that these growth patterns may be further shaped by the organic content of the substrate, which provides essential nutrients for crabs. Male vampire crabs exhibit more aggressive behaviors than females, leading to higher energy expenditure and potentially influencing their growth rates. This is corroborated by field observations, where female crabs tend to remain near their burrows, which serve as both a refuge and a site for reproduction and molting. This behavioral difference could significantly impact the overall energy dynamics within the population.

The sex ratio of vampire crabs is another important factor influencing their growth and reproductive success. A balanced sex ratio is essential for maintaining a stable population and optimizing the productivity of vampire crabs in farming systems. Male and female crabs exhibit distinct abdominal shapes, which aid in sex determination; males have narrow, triangular abdomens, whereas females have a broader, shield-like abdomen [28]. Understanding these characteristics is crucial for managing populations in wild and controlled breeding environments. Maintaining a proper male-to-female ratio is vital for the reproductive success of vampire crabs, as skewed ratios can affect mating success and population sustainability [28].

In conclusion, the feeding behavior, growth patterns, and population dynamics of vampire crabs in the Menoreh Mountains reflect their adaptation to a humid, semi-aquatic environment rich in organic matter. Their diet, primarily consisting of decomposed plant material supplemented by worms, supports their role as detritus feeders in the ecosystem. Additionally, the influence of sex-specific behaviors and habitat conditions plays a crucial role in their growth and reproductive strategies. Further studies on the sex ratio and population dynamics of vampire crabs are essential to optimize their conservation and potential for sustainable farming practices. By understanding these ecological and biological factors, we can better manage vampire crab populations, ensuring their persistence in natural and cultivated environments.

5. Conclusions

The vampire crab (*Geosesarma* sp.) on the slopes of Mount Menoreh exhibits diverse feeding habits, such as leaves, wood, worms, and debris, as a form of adaptation to the environment and availability of resources in their habitat. Various types of food were identified by analyzing the stomach contents of 25 crabs, including worms, wood, leaves, and debris. Evaluation using the Index of Preponderance (IP) revealed that the primary food source for vampire crabs was debris, with leaf litter and wood serving as supplements and worms as supplementary food. The feeding habits of the vampire crabs were also influenced by their growth stages. Adult crabs tend to actively seek food in areas away from water under humid conditions, whereas juvenile crabs are more commonly found foraging near water sources. It is important to note that the type of food consumed by the vampire crabs had to be suitable for the size of their mouth, and if it was not, the crabs assisted in tearing or cutting the food before digestion. This study provides valuable insights into the feeding behavior of vampire crabs, which could be useful for conservation and cultivation efforts to ensure their survival in the Mount Menoreh region.

Author Contributions

TK: Conceptualization, Methodology, Investigation, Writing - Original Draft, Review and Editing; **W**: Writing - Review and Editing, Supervision, Validation of Results; **AN**: Writing - Review and Editing, Supervision, Validation of Results; **MTA**: Funding, Site Survey, Results Discussion, and Data Processing.

Conflicts of Interest

There are no conflicts to declare.

Acknowledgments

This research was funded by the Faculty of Agriculture, Tidar University, through a lecturer from the aquaculture study program. I want to express my gratitude for the support provided for this research and publication.

References

1. Manuel-Santos, M.R.; Yeo, D.C.J. A New Species of *Geosesarma* from Palawan, Philippines (Crustacea: Decapoda: Brachyura: Sesarmidae). *Zootaxa* **2007**, *1607*, 63–67, 2007.
2. Ng, P.K.L; Wowor, D. A New Genus and New Species of A Semi-terrestrial Freshwater Crab from Montane Tropical Rainforests in Java, Indonesia (Decapoda: Brachyura: Gecarcinucidae). *Journal of Crustacean Biology* **2018**, *38*, 341–348, doi:10.1093/jcbiol/ruy016.
3. Hernawati, R.T. Kepiting Air Tawar (Decapoda: Brachyura) dari Lereng Selatan Gunung Slamet, Kabupaten Banyumas, Provinsi Jawa Tengah. *Zoo Indonesia* **2019**, *28*, 99–100.
4. Ribero, L. Sesarmid Crabs (Brachuyra: Grapsoidea: Sesarmidae) in West Peninsular Malaysia and Brunei Bay Mangroves: Historical Review and Updates on Ecology and Biodiversity at Community and Species Levels. Thesis, University of Malaya, Kuala Lumpur, Malaysia, 2019.
5. Febriani, I.S. Analisis Isi Lambung *Parathelphusa pardus* di Desa Sawah, Kabupaten, Provinsi Riau. Undergraduate Thesis, Riau University, Pekanbaru, Indonesia, 2023.
6. Chen, X.; Liu, B.; Li, Y. Fish prey, food habits, and interspecific relationships. In *Biology of Fishery Resources*; Chen, X., Liu, B.; Springer: New York, USA, 2022; ISBN 9789811669484.
7. Widigdo, B.; Rukisah, Laga, A.; Hakim, A.A.; Wardiatno, Y. Carapace Length-Weight and Width-Weight Relationships of *Scylla serrata* in Bulungan District, North Kalimantan, Indonesia. *Biodiversitas* **2017**, *18*, 1316–1323, doi:10.13057/biodiv/d180405.
8. Widiyanti, S.; Setyohadi, D.; Author, C.; Widiyanti, S.E. Resource Management of Coconut Crab (*Birgus latro*) in Liwo Island, North Maluku of Indonesia. *J. Bio. & Env. Sci* **2015**, *6*, 343–351.
9. Nizar, M. Analisis Isi Lambung Ikang Baung (*Mystus nemurus*) di Bandung Perjaya Martapura Provinsi Sumatera Selatan. *Jurnal Perikanan Perairan Umum* **2023**, *1*, 79–87.
10. Pasaribu, B.N. Makanan dan Kebiasaan Makan Kepiting Bakau (*Syclla serrata* Forskal 1779) di Perairan Kampung Sentosa Barat Kelurahan Belawan Sicanang Kecamatan Medan Belawan. Undergraduate Thesis, Universitas Sumatera Utara, Medan, Indonesia 2017.
11 Fauziyah; Purwiyanto, A.I.S.; Agustriani, F.; Putri, W.A.E.; Ermatita; Putra, A. Assessing the Stock Status of Giant Catfish (*Netuma thalassina*) in Banyuasin Coastal Waters, South Sumatra of Indonesia. *AACL Bioflux* **2020**, *13*, 1858–1864.
12. Jhingran, I.G.A.; Sugunan, V.V. *Conservation and Management of Inland Capture Fishery Resources*; Central Inland Capture Fisheries Risearch Institute (Indian Council of Agricultural Research): Barrackpore, India, 1988.
13. Moore, J.C.; Berlow, E.L.; de Ruiter, P.C.; Dong, Q.; Hastings, A.; Johnson, N.C.; McCann, K.S.; Melville, K.; Morin, P.J.; Nadelhoffer, K.; et al. Detritus, Trophic Dynamics and Biodiversity. *Ecology Letters* **2004**, *7*, 584–600, doi:10.1111/j.1461-0248.2004.00606.x.
14. Ng, P.K.L.; Schubart, C.D.; Lukhaup, C. New Species of ‘Vampire Crabs’ (*Geosesarma* De Man, 1892) from Central Java, Indonesia, and The Identity of *Sesarma* (*Geosesarma*) *nodulifera* De Man, 1892 (Crustacea, Brachyura, Thoracotremata, Sesarmidae). *Raffles Bulletin of Zoology* **2015**, 63, 3–13.
15. Hunaepi, Firdaus, L.; Kurnia, N. Buku Ajar Ekologi Berbasis Kearifan Lokal untuk Mengembangkan Sikap Ilmiah Mahasiswa. *Prisma Sains: Jurnal Pengkajian Ilmu dan Pembelajaran Matematika dan IPA IKIP Mataram* **2016**, 4, 94–101.
16. Sumer, C.; Teksam, I.; Karatas, H.; Beyhan, T.; Aydin, C.M. Beymelek lagün gölündeki (Türkiye’nin güneybatı kıyısı) mavi yengeçlerin, *Callinectes sapidus* Rathbun, 1896, üreme biyolojisi ve büyümesi. *Turk J Fish Aquat Sci* **2013**, *13*, 675–684, doi:10.4194/1303-2712-v13_4_13.
17. Susilo, V.E.; Suratno; Wowor, D.; Abror, M.N. Diversity of Freshwater Crab (Decapoda) in Meru Betiri National Park. *Journal of Physics: Conference Series* **2020**, *1465*, 1–8, doi:10.1088/1742-6596/1465/1/012008.
18. Ng, P.K.L.; Liu, H.; Schubart, C.D. Geosesarma Hednon, A New Species of Terrestrial Crab (Crustacea: Decapoda: Brachyura: Sesarmidae) From Taiwan And The Philippines. *The Raffles Bulletin of Zoology* **2004**, *52*, 239–249.

19. Rahayu, S.M.; Wiryanto; Sunarto. Keanekaragaman Kepiting Biola Di Kawasan Mangrove Kabupaten Purworejo Jawa Tengah. *Bioeksperimen* **2017**, *4*, 53–63.
20. Sanusi, H.S.; Kaswadji, R.F.; Nurjaya, I.W.; Rafni, R. Kajian Kapasitas Asimilasi Beban Pencemaran Organik Dan Anorganik Di Perairan Teluk Jobokuto Kabupaten Jepara Jawa Tengah. *Jurnal Ilmu-Ilmu Perairan dan Perikanan Indonesia* **2005**, *12*, 9–16.
21. Jamaludin, J.; Sedjati, S.; Supriyantini, E. Kandungan Bahan Organik dan Karakteristik Sedimen di Perairan Betahwalang, Demak. *Buletin Oseanografi Marina* **2021**, *10*, 143–150, doi:10.14710/buloma.v10i2.30046.
22. Padfield, R.; Drew, S.; Syayuti, K.; Page, S.; Evers, S.; Campos-Arceiz, A.; Kangayatkarasu, N.; Sayok, A.; Schouten, G.; Maulidia, M.; et al. Landscapes in Transition: An Analysis of Sustainable Policy Initiatives and Emerging Corporate Commitments in the Palm Oil Industry. *Landscapes Research* **2016**, *41*, 744–756, doi:10.1080/01426397.2016.1173660.
23. Reece, J.B.; Urry, L.A.; Cain, M.L.; Wasserman, S.A.; Minorsky, P.V.; Jackson, R.B. *Campbell Biology*, Tenth Edition; Pearson Education: Boston, MA, USA, 2014.
24. Murniati, D.C. Komposisi Jenis Kepiting (Decapoda: Brachyura) dalam Ekosistem Mangrove dan Estuari, Taman Nasional Bali Barat. *Berita Biologi* **2010**, *10*, 259–264.
25. Ng, P.K.L.; Schubart, C.D.; Lukhaup, C. New Species of ‘Vampire Crabs’ (*Geosesarma* De Man, 1892) from Central Java, Indonesia, and The Identity of *Sesarma* (*Geosesarma*) *nodulifera* De Man, 1892 (Crustacea, Brachyura, Thoracotremata, Sesarmidae). *Raffles Bulletin of Zoology* **2015**, 63, 3–13.
26. Alberts-Hubatsch, H.; Lee, S.Y.; Meynecke, J.O.; Diele, K.; Nordhaus, I.; Wolff, M. Life-History, Movement, and Habitat Use of *Scylla serrata* (Decapoda, Portunidae): Current Knowledge and Future Challenges. *Hydrobiologia* **2016**, *763*, 5–21, doi:10.1007/s10750-015-2393-z.
27. Foo, C.H. Growth Models and Analysis of Crustacean Growth Data. Thesis, University of Queensland, Brisbane, Australia, 2017.
28. Hartnoll, R.G.; Clark, P.F. A Mass Recruitment Event in the Land Crab *Gecarcinus ruricola* (Linnaeus, 1758) (Brachyura: Grapsoidea: Gecarcinidae), and A Description of the Megalop. *Zoological Journal of the Linnean Society* **2006**, *146*, 149–164, doi:10.1111/j.1096-3642.2006.00195.x.