Journal of Tropical Biodiversity and Biotechnology
Volume 10, Issue 02 (2025): jtbb15180
DOI: 10.22146/jtbb.15180

Short Communication

Characteristics of Habitat and Diet of the Southern River Terrapin (*Batagur borneoensis*) in the Conservation Area on the Coast of Aceh, Indonesia

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Keywords:
Batagur borneoensis
Coastal
Conservation
Diet
Habitat
Submitted:
26 July 2024
Accepted:
23 December 2024
Published:
02 May 2025
Editors:
Ardaning Nuriliani
Annisaa Widyasari

ABSTRACT
The Southern River Terrapin (*Batagur borneoensis*) is an endangered aquatic species with a critically low population, found only in specific habitats. Surveys revealed that it forages, basks, and mates in freshwater to brackish rivers, while nesting occurs in sandy coastal areas. Its diet consists of crustaceans (41 %), vegetation (41 %), and gastropods (18 %), indicating a primarily carnivorous diet that includes fruits, flowers, leaves, shoots, and aquatic vegetation. Various crustaceans and gastropods were also observed as food sources. Conservation efforts are essential to preserving its habitat and food supply, ensuring the survival of this endemic species.

How to cite:
Mawardi, A.L., Atmaja, T.H.W. & Khalil, M., 2025. Characteristics of Habitat and Diet of the Southern River Terrapin (*Batagur borneoensis*) in the Conservation Area on the Coast of Aceh, Indonesia. *Journal of Tropical Biodiversity and Biotechnology*, 10(2), jtbb15180. doi: 10.22146/jtbb.15180

The eastern coastal region of Aceh Province is home to one of the largest mangrove ecosystems in Southeast Asia, covering an area of 8,000 hectares (Safuridar et al. 2022). This mangrove area plays a crucial ecological role for various aquatic animals, including fish, shrimp, and the Southern River Terrapin (*Batagur borneoensis*). The mangrove vegetation and root structures, such as stilt roots, pneumatophores, and buttress roots, are highly beneficial as breeding grounds, nurseries, shelters, and foraging areas for various aquatic animals (Mawardi et al. 2023). The high nutrient composition in this mangrove ecosystem, derived from the decomposition of leaves and organic matter, makes this coastal area a potential habitat with a complex food chain (Mawardi et al. 2024).

The Southern River Terrapin (*Batagur borneoensis*) is an endemic aquatic species belonging to the class Reptilia and family Geoemydidae. According to The Red List of Threatened Species (IUCN), *B. borneoensis* is categorised as an endangered endemic aquatic species (Shepherd et al. 2021). Its population in its natural habitat is currently declining due to ecological pressures, illegal hunting by collectors, and threats from climate change and predators (Saputra et al. 2023; Suriadi et al. 2024). Currently, studies reported that the population of this species is only found in the aquatic regions of Asia, including Indonesia, Malaysia, and Bangladesh (Saputra et al. 2020; Bristy et al. 2021). The unique habitat characteristics and the abundance of available food in specific areas are the main reasons this aquatic species can only live and reproduce sustainably in suitable coastal regions (Guntoro et al. 2020).

The coastal region of Aceh Province plays a crucial role as a natural habitat for *B. borneoensis*. The suitable environmental characteristics of this coastal area are key factors in supporting the population of this endemic species. The extensive mangrove ecosystem provides abundant food, while the calm river flows and the wide sandy beaches create an ideal habitat for *B. borneoensis* (Saputra et al. 2023). To ensure the survival of this endemic coastal species in its habitat, conservation efforts are essential (Serdiati et al. 2023). The Yayasan Satucita Lestari Indonesia (YSLI) is one of the leading organisations in the conservation of *B. borneoensis* in the coastal region of Aceh Province. Routine patrols are conducted to prevent the hunting of *B. borneoensis* eggs and adults and to educate the community about preserving the coastal environment as a habitat for various species, including endangered endemic animals (Mawardi et al. 2022).

This research aims: 1) to identify the habitat characteristics of *B. borneoensis*, including its foraging areas, basking spots, nesting sites, and nursery zones; 2) to identify the types of food consumed by *B. borneoensis* in its natural habitat in the coastal waters of Aceh, and; 3) to maintain a stable food supply during conservation efforts. The abundance of food and suitable habitats are crucial components for the survival of this endemic species in its natural environment.

The research was conducted in the coastal area of Seruway, Aceh Province, from April to July 2024. Activities involved tracing the river currents and coastal edges for *B. borneoensis* to determine habitat characteristics and identify the types of food consumed by this endemic species. Habitat characteristics and food types were identified at four locations within the survey was conducted daily, once a week, using a boat from 7:00 AM to 6:00 PM. The identification of habitat characteristics was carried out by observing the activities of *B. borneoensis* at four designated locations, including basking, feeding, mating, nesting, and nursery areas. All observed data were then recorded accordingly. Similarly, the types of food were identified based on field observations of what *B. borneoensis* consumed in its habitat, and all kinds of food eaten were comprehensively recorded. The four research locations along the coastal area of Seruway, Aceh Province, can be specifically seen in Figure 1. Parame-

ters measured included water pH using a pH meter (Extech PH100), water salinity using a Hand Refractometer (RHS-10ATC), and water temperature using a Mercury Thermometer (-10 °C to 110 °C). All data on food types and physicochemical parameters of the aquatic environment were analysed descriptively in percentage form using Microsoft Excel.

The results of the observations in the research area showed that *B. borneoensis* was predominantly found in freshwater river streams and mangrove water areas, accounting for 84.62 %, while only 15.38 % were found in coastal areas. This endemic species predominantly lives in water, only coming ashore or onto trees at specific times to bask (Hernawan et al. 2019). The abundance of aquatic vegetation and mangrove plants provides an ideal habitat for the terrapin, serving not only as a food source but also as a basking sites and shelter from predators and other threats. Observations show that terrapin are seen predominantly basking on the branches of *Sonneratia caseolaris* and *Rhizophora mangle*. These plants are favoured by the terrapin, as they provide both basking spots and food resources. The specific habitat characteristics of *B. borneoensis* are detailed in Table 1.

According to Table 1, the main habitat of *B. borneoensis* includes river flows and mangrove ecosystem areas. The habitat characteristics of this species are dominated by *Sonneratia caseolaris* and various aquatic plants such as *Eichhornia crassipes*. The terrapin predominantly inhabits mangrove ecosystems in coastal regions, which are also occupied by species like *Rhizophora mangle*, *Casuarina equisetifolia*, and other aquatic species (Mallick et al. 2021; Mim et al. 2022). In addition to providing food, the plant vegetation in this habitat also serves as a basking site and shelter for the terrapin (Bristy et al. 2021). *B. borneoensis* exhibits unique behaviour when nesting; it migrates to

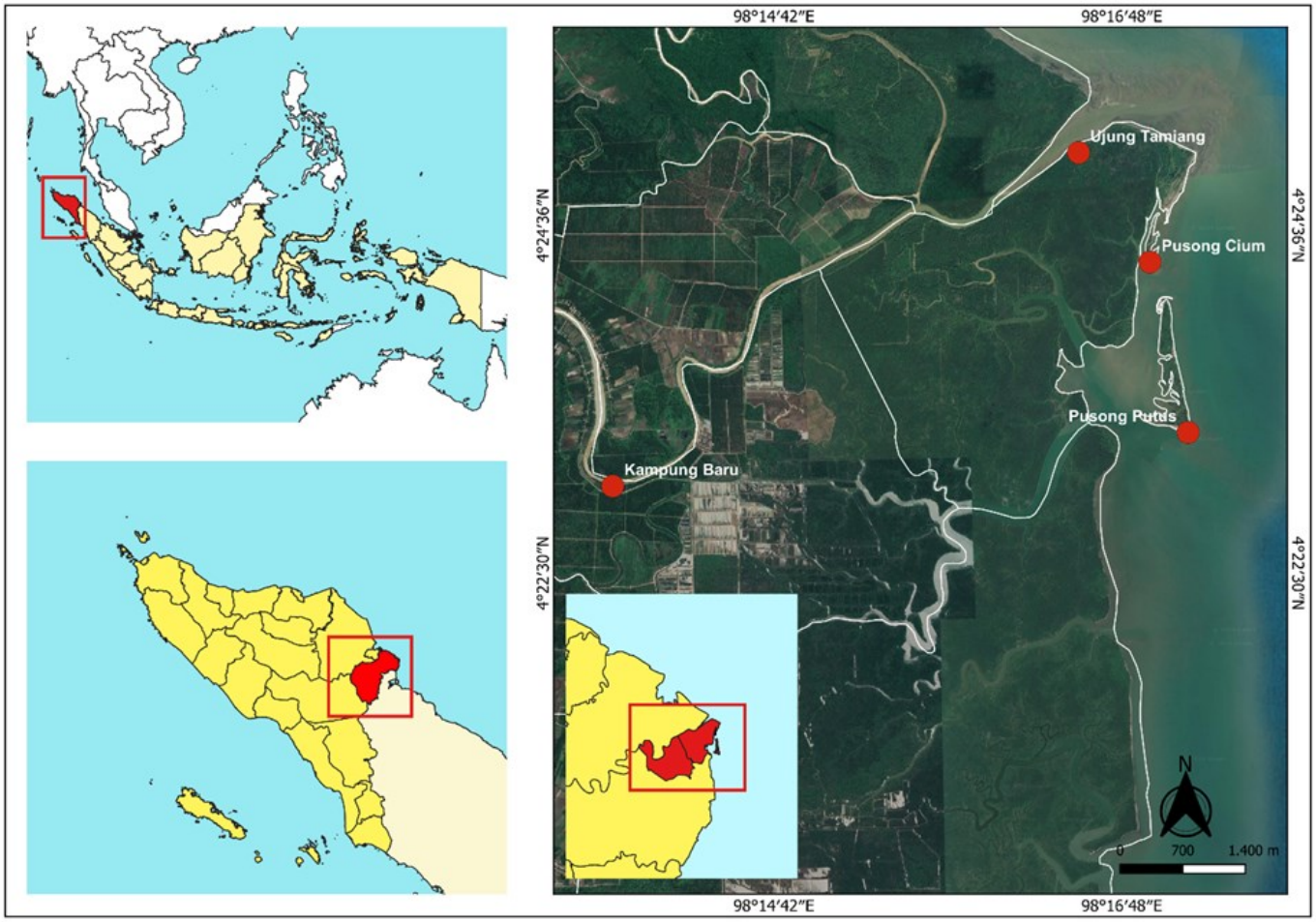

Figure 1. Research locations for habitat characteristics and diet of *B. borneoensis* in the coastal area of Aceh Province.

Table 1. Habitat characteristics of *B. borneoensis* in the coastal area of Aceh Province.

Location	Water Salinity (°C)	Water pH	Water Temperature (‰)	Plant Vegetation	Habitat Type
Kampung Baru	0.00-5.00	6.3	28	*Sonneratia caseolaris*, *Eichornia crassipes*, *Rhizophora mangle*.	Foraging, basking, mating, and nursery areas
Ujung Tamiang	15-21	6.5	28.5	*Avecennia germinans*, *Ipomoea imperati*, *Casuarina equisetifocia*.	Nesting & spawning
Pusung Cium	32-35	6.8	29	*Scaevola taccada*, *Casuarina equisetifocia*, *Avecennia germinans*.	Nesting & spawning
Pusung Putus	25-32	6.7	29	*Ageratina adenophora*, *Canavalia rosea*, *Casuarina equisetifocia*.	Nesting & spawning

sandy coastal areas to select suitable and safe locations for laying eggs (Figure 2). During nesting, the terrapin digs a hole in the sandy beach and, after laying eggs, covers it with sand to protect it from predation and human exploitation (Spitzweg et al. 2018; Guntoro et al. 2020).

Figure 2. (a) Habitat of *B. borneoensis* in mangrove ecosystem, Ujung Tamiang; (b) Nesting site on the beach, Pusung Cium.

B. borneoensis is a carnivorous species that consumes a variety of aquatic and mangrove vegetation. Fruits and flowers are the most dominant plant organs eaten by the terrapin, coming from various mangrove plant species and aquatic animals. Aquatic plants, such as leaves, shoots, and roots, are also part of its diet. The observations and surveys conducted in its natural habitat along the coastal areas of Aceh Province successfully recorded and collected data on various species of gastropods and crustaceans living in both aquatic and coastal areas, which form the regular diet of this endemic species. Observations collected various aquatic animal species as food for *B. borneoensis* (Table 2).

Table 2 shows that the most dominant food sources for *B. borneoensis* in its habitat are plant vegetation and species of crustaceans. Based on observations, various species of gastropods also serve as a potential and nutrient-rich food source, with most of the gastropods consumed by the terrapin belonging to the Family Neritidae. Fruits and flowers of plants are the most dominant plant organs consumed by *B. borneoensis*, followed by leaves and shoots. When the terrapin is in freshwater river areas, roots and tubers of aquatic plants are the most dominant food sources (Saputra et al. 2023). It is crucial to protect various plant species that serve as both habitat and food sources for the terra-

Table 2. Types of Food Consumed by *B. borneoensis* in Its Habitat at the Research Location.

Family	Species Names	Organs			Organs & meat
		Leaves/shoots	Fruits/flowers	Tuber/root	
Plants					
Lythraceae	*Sonneratia caseolaris*	-	+	-	-
Convolvulaceae	*Ipomoea aquatica*	+	+	+	-
	Ipomoea imperati	+	+	+	-
Ontederiaceae	*Pontederia crassipes*	-	-	+	-
Vitaceae	*Cayratia trifolia*	-	+	-	-
Fabaceae	*Cercis siliquastrum*	+	+	-	-
Rhizophoraceae	*Rhizophora mangle*	+	+	+	-
Acathaceae	*Avecennia germinans*	+	+	-	-
Pandanaceae	*Pandanus odorifer*	-	+	-	-
Crustacea					
Penaeidae	*Penaeus marguensis*	-	-	-	+
	Penaeus monodon	-	-	-	+
	Penaeus setiferus	-	-	-	+
		-	-	-	+
Sergestidae		-	-	-	+
Mysidae		-	-	-	+
Palaemonidae		-	-	-	+
Ocypodidae		-	-	-	+
		-	-	-	+
Gastropoda					
Neritidae		-	-	-	+
		-	-	-	+
		-	-	-	+
Naticidae		-	-	-	+

pin, as this vegetation plays a vital role in the sustainable survival of this endemic species (Tshewang et al. 2021).

In general, the regular diet of *B. borneoensis* in its natural habitat consists of various plant vegetation, different species of crustaceans, and gastropods found in freshwater, brackish, and coastal areas. Plant organs and crustacean species are the most dominant foods consumed by this terrapin, each constituting 41 % of the diet, while gastropod species contribute the least at 18 % (Figure 3). Adequate food sources and suitable environmental conditions are key factors for the survival of various animal species, including *B. borneoensis*. Environments with abundant food sources positively impact the high biodiversity of the area (Talukdar et al. 2021; Mawardi et al. 2024).

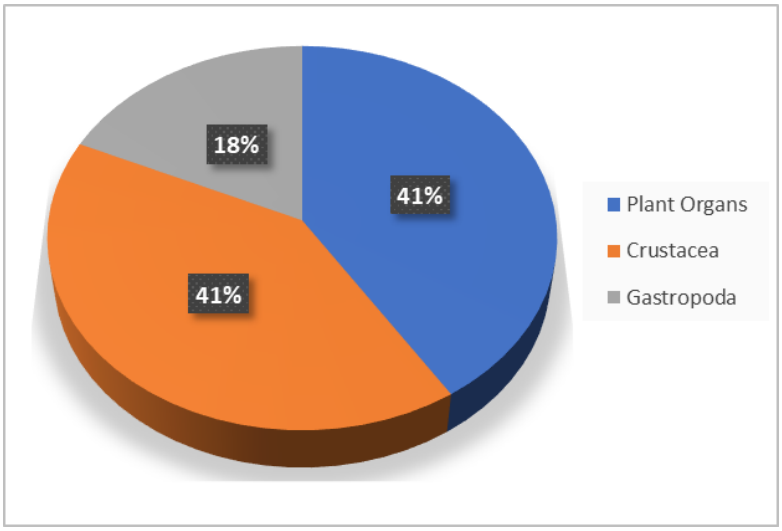

Figure 3. Diet composition of *B. borneoensis* in its habitat at the research location.

The research results aimed at identifying the types of food based on animals closely related to *B. borneoensis* (Karyadi et al. 2023) reported that the diet of the turtle (*Heosemys spinosa*) in the conservation area at Bengkulu University includes various types of plants, vegetables, gastropods, annelids, and various insect species. The dietary data for *Heosemys spinosa* can be seen in Table 3.

Table 3. The diet of the turtle (*Heosemys spinosa*) in the conservation area at Bengkulu University.

Food Groups	Type of Food (Organism)
Plants	Taro leaves
	Banana fruit
	Papaya fruit
	Vegetables
	Other herbal plants
Gastropods	Various species of snails
Insects	Various species of insects
Annelids	Various species of earthworms

Morphologically, *B. borneoensis* has two pairs of legs with webbed feet that function as propulsion and swimming tools in strong current areas, such as river flows and coastal regions. When it is time to lay eggs, *B. borneoensis* migrates from freshwater or brackish water to the coastline (Figures 4a & 4b). The nesting behaviour of this endemic species is similar to that of sea turtles; it seeks a suitable location to create a nest, then digs a hole on the beach to lay its eggs. After laying the eggs, the terrapin covers them with sand to protect them from predation and human exploitation (Spitzweg et al. 2018; Saputra et al. 2020).

Figure 4. (a) *B. borneoensis* species (b) Nest and eggs of *B. borneoensis* on the beach.

Research conducted in various countries shows that the population of *B. borneoensis* in the wild is now endangered due to habitat degradation and, the exploitation of eggs and adults for commercial purposes, and as collectibles by collectors (Rahayu et al. 2021). The exploitation of eggs by local communities harms the regeneration of this endemic species, leading to a decline in the population of *Batagur borneoensis* in its natural habitat, as well as predation by natural predators in the surrounding area (Suriadi et al. 2024). The situation facing the population of *Batagur borneoensis* must be addressed collectively by the government, academics, and the public to ensure the conservation of this species (Hernawan et al. 2019; Guntoro et al. 2020).

Environmental degradation in the coastal areas of Aceh Province, which serve as the primary habitat for *B. borneoensis*, represents a serious threat to

the conservation of this species (Stanford et al. 2020). Increasing coastal community activities, such as fishermen using river flows as transportation for fishing, and the clearing of new lands for agriculture and plantations, have significantly disrupted the habitat of *B. borneoensis* (Saputra et al. 2021). Serious efforts from various parties and stakeholders are required for sustainable coastal management to protect the habitat of aquatic biota and endangered endemic species.

AUTHORS CONTRIBUTION

A.L.M. designed the research activities, coordinated the research, and wrote reports and scientific articles. T.H.W.A. conducted field observations on the habitat characteristics and diet of *B. borneoensis*. M.K. assisted with data collection and analysis of the habitat and diet of *B. borneoensis*.

ACKNOWLEDGMENTS

The authors would like to thank the Research and Community Service Institute of Samudra University for funding this research under contract No. 364/UN54.6/PG/2024. Special thanks are also extended to the team from the Yayasan Satucita Lestari Indonesia (YSLI) for their assistance with this research.

CONFLICT OF INTEREST

The authors declare no conflicts of interest regarding this research.

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