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# Mapping the habitat distribution of horseshoe crabs (*Tachypleus gigas*) in Pamekasan, Madura Island, Indonesia

F Ramadhan, P Maulana and D Darmawan\*

Indonesian Blue Swimming Crab Association (Asosiasi Pengelolaan Rajungan Indonesia-APRI), Surabaya, Indonesia

\*Corresponding author: rajunganindonesia@gmail.com

**Abstract.** Horseshoe crabs, often known as Belangkas or Mimi, is one of the ancient marine faunas with protected conservation status. Horseshoe crabs are distributed in coastal waters of Indonesia of the islands of Sumatra, Java, Kalimantan, and Sulawesi, which are often caught as bycatch. Horseshoe crabs's bloods were unique which contain amoebocytes as a test material for the presence of endotoxin bacteria. The purpose of this study was to identify the species of horseshoe crabs and to analyze environmental conditions, as well as the distribution of horseshoe crabs in the coastal waters of Pamekasan, Madura Island. This study was conducted in June 2023 by collecting data from crab fishers. ArcGIS was applied to delineate the distribution of horseshoe crab. The identification results showed that there was one species horseshoe crab of the *Tachypleus gigas* in the waters of Polagan Village, Galis District, Pamekasan Regency. The environmental condition of the waters in Polagan Village, Galis District, and Pamekasan Regency was relatively good. Habitat mapping is one way to protect these animals from the threat of extinction and support conservation efforts.

**Keywords:** distribution; habitat; horseshoe crabs; mapping

## 1. Introduction

Horseshoe crabs, which is often known as Belangkas or Mimi, is one of the marine animals whose existence is rarely known. Due to the fairly intensive fishing by fishers and habitat degradation. The exploitation that occurs is mainly horseshoe crabs, so it must be done to deal with the threat of the extinction of rare animals [1]. There are four species of horseshoe crabs found in the world. The horseshoe crab, *Limulus polyphemus*, is endangered in Atlantic America [2]. Meanwhile, the remaining 3 species of horseshoe crabs in Asia, such as *Tachypleus gigas*, *Tachypleus tridentatus*, and *Carcinoscorpius rotundicauda*, were currently considered "data deficient" by the IUCN [3].

The data deficient category means that there is not enough data available to estimate the risk of extinction for distribution and number of populations, but in the regulation of the Minister of the Environment Number P.92/MENLHK/SETJEN/KUM.1/8/2018, these three species of horseshoe crabs are categorized as protected animals. Indonesia is one of the countries that can still be found in its territorial waters. The distribution area of horseshoe crabs in Indonesia includes the waters of the islands of Sumatra, Java, Kalimantan, and Sulawesi [4]. In the area of Java Island, especially in Pamekasan and Madura, horseshoe crabs was found as a result of discarded catches by fishers in the Pamekasan and



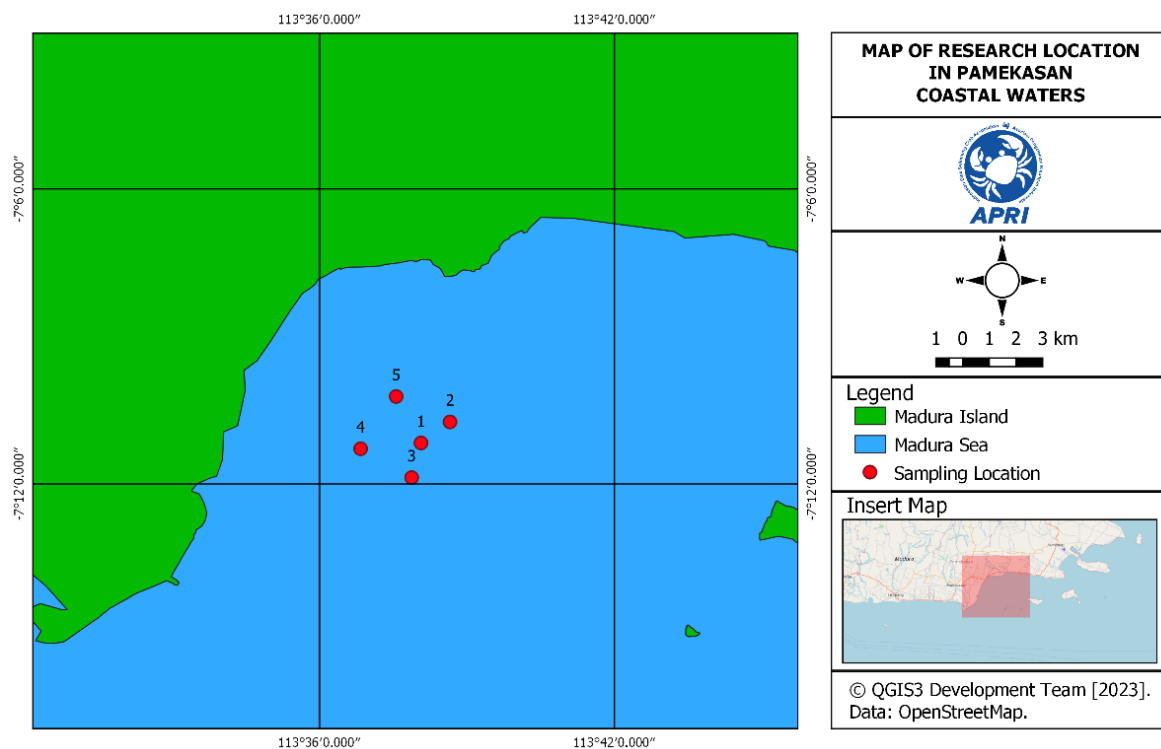
Madura Coastal Waters.

Horseshoe crabs are found in Pamekasan coastal waters, but there is still no information on the distribution and research regarding horseshoe crabs, so horseshoe crabs in Pamekasan coastal waters need to know their environmental conditions and distribution. The purpose of this study was to identify the species of horseshoe crabs, analyze environmental conditions, and the distribution of horseshoe crabs in the coastal waters of Pamekasan, Madura. The results of this study can be used as information and reference material for further research.

## 2. Methods

### 2.1. Study Area

The research was conducted in the coastal waters of Pamekasan, Madura, in June 2023 (Figure 1). Determination of the location of horseshoe crabs using the survey fishing method, which follows the fishing operations of small crab nets (generally these fishers get horseshoe crabs as a result of or bycatches). Location points where horseshoe crabs are found will be used as plots for mapping the horseshoe crab's distribution.



**Figure 1.** Map of research locations in Pamekasan coastal waters.

### 2.2. Data collection

The horseshoe crabs found were identified and their aquatic environmental parameters were measured, including pH and salinity. Horseshoe crabs that have been counted are returned to their original habitat. The tools used to measure environmental parameters are pH meter (for pH) and hand refractometer (for salinity). To create a horseshoe crab distribution map, the coordinates are taken using GPS from a cellphone at each location where horseshoe crabs are found. In addition, cameras, crab net, and fishing boat are also used in data collection.

The data was collected on five observation trips (one day one trip sampling), with total 16 male and female individuals and it was discovered that the only species of horseshoe crab found in Pamekasan coastal waters is *Tachypleus gigas*. On average, 1-4 individuals were identified per trip.

### 2.3. Data Analysis

Identification of horseshoe crabs was carried out morphologically based on sex, telson shape, color, and ophiostoma spines, referring to the book *Biology and Conservation of Horseshoe Crabs* from Sekiguchi in Meilana [5 in 4]. And then, mapping processing of the horseshoe crabs distribution using QGIS3 software with plotting the coordinates where horseshoe crabs was found.

The result of this process is a map of the species and number of horseshoe crabs per location. The data obtained were analyzed descriptively in the form of tables and graphs. Furthermore, comparisons with research that has been done are also carried out to compare and obtain findings.

## 3. Results and Discussion

### 3.1. Species and number of horseshoe crabs

The species and number of horseshoe crabs found was *Tachypleus gigas* (male and female), with as many as 16 as shown in Table 1. The number of females was higher than the males.

**Table 1.** Species and number of horseshoe crabs that found in Pamekasan coastal waters.

Trip	<i>Tachypleus gigas</i>	
	Male	Female
1	0	2
2	2	1
3	1	3
4	0	3
5	0	4
Subtotal	3	13
Total	16	

During the study, the number of horseshoe crabs found was 16 males and females from 5 locations. In general, the average number of horseshoe crabs found is 1-4 (per trip), but sometimes in one trip we don't always get male and female of horseshoe crabs. According to Johnson and Brockmann in Meilana [6 in 4], the difference in male and female composition is due to a period when male horseshoe crabs without partners gather on the beach and act as satellites waiting for their turn to spawn. Another possibility is that the male body size is smaller than the female [5; 7; 8], so males are more agile in avoiding net traps and females are caught in nets.

### 3.2. Environmental parameter conditions

Environmental parameter values are shown in Table 2, where the salinity is around 34 ppt. The pH value of the water is in the range of 8. In general, the environmental parameters in Pamekasan waters are still relatively good for horseshoe crab growth. The natural temperature of tropical waters suitable for the life of organisms ranges from 23–32 °C [9]. Salinity conditions in Pamekasan waters are still suitable for horseshoe crab, as explained by Zaleha *et al.* in Rubiyanto [10 in 8], and the salinity tolerance range for horseshoe crab *T. gigas* is 25–35 ppt.

**Table 2.** The average of environmental parameters of horseshoe crab habitat in Pamekasan coastal waters

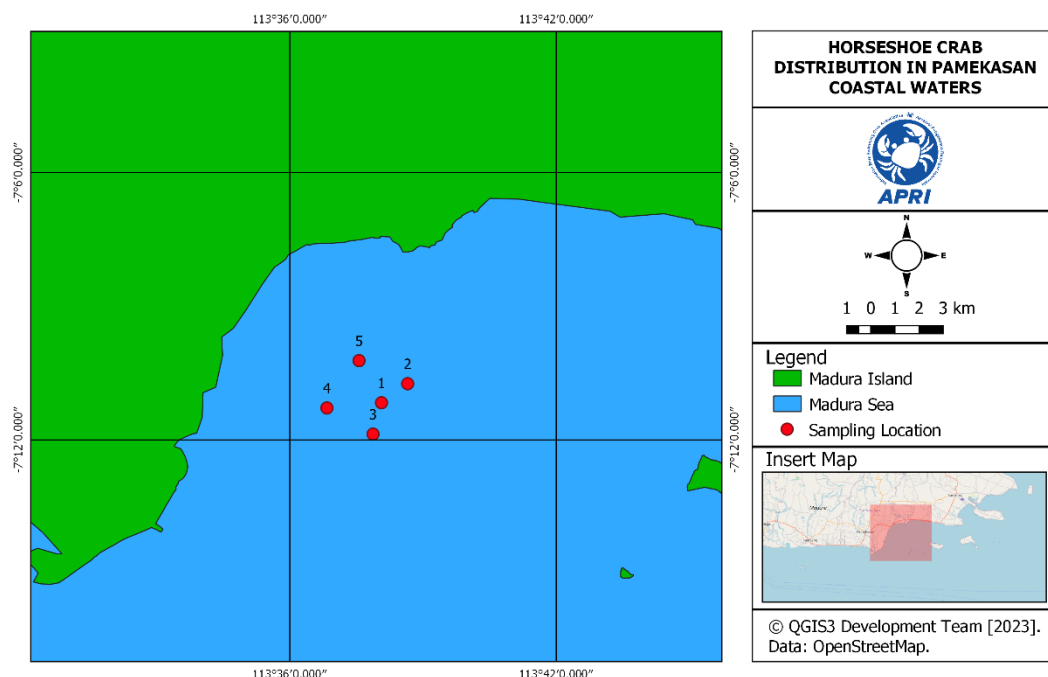
Parameter	Results	Standard
Salinity (ppt)	34	%0*
pH	8	7-8*

Source : \*Standard by [10]

Pamekasan waters are still relatively good because they are still within the threshold set by Ministerial Decree of the Environment [11]. The pH conditions are the same, which is according to Siburian *et al.*, the ideal water pH for aquatic life ranges from 6.5 to 8.5 [9]. According to Pratama *et al.*, the value of variations in salinity is influenced by several factors, including river water input, rain, evaporation, and the circulation of water masses [12]. These waters are still categorized as good for horseshoe crab life or other biota because their value does not exceed the quality standards set by the government for waters. Horseshoe crab usually live in mangrove and highly muddy areas, which provide various types of food to be used as a source of essential nutrients for horseshoe crab lives [13].

### 3.3. Horseshoe crab distribution map

Horseshoe crab in the Pamekasan Coastal Waters are distributed in locations in Polagan Village, Galis District, Pamekasan Regency (Figure 2). The distribution of horseshoe crab that found the most females was on trip 5, and the most males were on trip 2.



**Figure 2.** Horseshoe crabs distribution in Pamekasan coastal waters.

On each trip, different numbers of Belangkas found. Environmental parameters may affect horseshoe crab but are not the only influencing factors [14]. According to Anggraini *et al.* research, horseshoe crab generally spread in coastal areas with mangroves and sandy mud substrates and low salinity [15]. The area is a type of sandy and muddy beach overgrown with mangrove forests that serves as a spawning, nurturing, and foraging area for horseshoe crab. According to Ahmad *et al.*, horseshoe crabs are animals that live on the bottom of sandy and muddy waters [16].

According to Anggraini *et al.*, the mangrove ecosystem is a good feeding ground for the horseshoe crab because it provides a variety of food sources [15]. On each trip that horseshoe crab takes, it is still categorized as good. For horseshoe crabs in the coastal waters of Pamekasan, they have been widely spread, as evidenced by the catching of horseshoe crab on each trip. *T. gigas* that are caught always have females, so that means they are still relatively safe because there are still many horseshoe crabs in that location that can breed. Each trip is not too far from the edge or land because it follows the point where the crab nets are distributed, which is not too far from the center either, so the location is still affected and close to the mangrove area and the mainland. Most of the horseshoe crabs caught are females

compared to males. Generally, horseshoe crabs caught during research are female because their body size is larger, so they are easily caught or caught by nets. Male horseshoe crab populations tend to visit nesting beaches more frequently than females. This indicates that male horseshoe crabs are mostly found in coastal areas. Horseshoe crab *T. gigas* is found mostly in the sea, not on the coast, and prefers high-salt water. This is in line with research Putri *et al*, which found *T. gigas* close to seawater [17]. Types of fine to moderately sandy beaches and open beaches are the habitats of *T. gigas* [18].

#### 4. Conclusion

*Tachypleus gigas* was the only horseshoe crabs that found in Pamekasan coastal waters on average 1-4 individuals during five observation trips. The environmental condition of Pamekasan coastal waters is still considered good in accordance with Minister of Environment Decree No. 51 of 2004. The habitat was identified to be in the area of Polagan Village, Galis District, Pamekasan Regency, where it is found close together. Continuous mapping of the habitat has the potential to reduce the destruction of natural habitats due to human activities such as coastal reclamation or logging of mangrove forests, and provide recommendations for conservation.

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#### **Author Contribution**

**Farhan Ramadhan** : conceptualization, methodology, writing-original draft.

**Pahad Maulana** : review the original draft based on previous research, editing, investigation.

**Dicky Darmawan** : investigation, supervision, writing-review, editing.