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HABITAT CHARACTERISTICS OF SEAHORSES AT JAMBULA WATERS, TERNATE ISLAND, NORTH MALUKU

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ABSTRACT

Seahorses are used as traditional medicine and ornamental fish, resulting in high demand and a decline in their population in natural habitats. In Ternate waters, information on seahorses is very limited. One of the habitats is Jambula waters. This study aimed to assess the characteristics of seahorse habitat including type and density of seagrass, several parameters of water quality, and the association of seahorses and seagrass species. Observations were conducted along the Jambula coast using visual census method. The results found four seagrass species in the habitat, namely *Enhalus acoroides, Cymodocea rotundata, Halophila minor,* and *Halophila decipiens,* with densities of 172, 280, 164, and 116 ind/m^2, respectively. Water quality parameters measured in such as depth, temperature, salinity, pH, and dissolved oxygen showed suitable values for seahorse life. The results also showed the association of seahorses with certain seagrass species, namely *E. acoroides* and *H. minor*. This information is needed for seahorse management, so it is important to pay attention so that the sustainability of this resource can be ensured.

INTRODUCTION

Indonesia is a maritime country that has great potential for ornamental fish. One type of seawater ornamental fish is seahorse because of its high value. Seahorses are not only marketed domestically, but also exported internationally, causing the need for seahorses to increase, which results in exploitation that threatens their sustainability. This phenomenon does not only occur in Indonesia, but also in other countries (Koning & Hoeksema, 2021; Putri et al., 2019; Sy & Melgar, 2022). This large-scale exploitation has led to habitat degradation and even the extinction of some high economical and ecological value species (Syafiuddin, 2010).

In Indonesia, seahorses are also known as "tangkur kuda" fish and are genetically closely related to "tangkur buaya" fish (pipefish). They are very unique because they have a different morphology compared to other fish. In addition to its head shape resembling a horse's head, the male fish has an egg pouch that other fish do not have. The pouch serves to protect and incubate fertilized eggs until they hatch into larvae, and continue to protect the eggs in the pouch until they are ready to be released into the wild as young seahorses (Rahardjo, 2022).

Seahorses are used as traditional medicinal ingredients, as well as ornamental fish (Mulalinda, 2017), resulting in high demand for them, and a decline in their natural population. Threats to seahorses have resulted in their categorization as Appendix II CITES (Convention on International Trade in Endangered Species) resulting in restrictions on the capture and trade of seahorses internationally (Mulyawan & Saokani, 2015; Putri et al., 2019).

In general, seahorse research in Indonesia provides a lot of information from various perspectives such as bioecology and biotechnology, but only a few studies have investigated bioecological aspects in eastern Indonesia such as in Ternate waters, North Maluku (Dody et al., 2021; Syazili et al., 2023). One of the bioecological aspects that has a strong influence on the life of aquatic organisms is habitat (Findra et al., 2016, 2024; Pratama et al., 2023; Taula et al., 2022). Previous studies in several waters in Indonesia have shown that habitat differences are an important factor in the presence of seahorses (Putri et al., 2019; Syafiuddin, 2010). Appropriate habitat use is crucial to determine the distribution and primary habitat for low-mobility animals such as seahorses (Zhang & Vincent, 2018). In Ternate waters, information on the presence of seahorses is still very limited, one of the waters that become their habitat is Jambula waters. Jambula waters are coastal waters covered by seagrass vegetation and seahorses are commonly associated with them. Therefore, this study aimed to assess seahorse habitat characteristics including species and density of seagras, several water quality parameters, and association of seahorses with seagrass species at Jambula waters, Ternate Island.

LITERATURE REVIEW

Classification and Morphology

Seahorses are true bony fish that have gills, swim bubbles and fins. Seahorses belong to the genus *Hippocampus* of the family Syngnathidae which is included in the seahorse and seadragon groups. Their classification according to Froese & Pauly (2024) is Animalia (Kingdom), Chordata (Phylum), Vertebrata (Subphylum), Gnathostomata (Infraphylum), Osteichthyes (Parvphylum), Actinopterygii (Gigaclass), Actinopteri (Superclass), Teleostei (Class), Syngnathiformes (Order), Syngnathidae (Family), Hippocampinae (Subfamily), and Hippocampus (Genus).

Seahorses have a slightly flattened and curved body shape, have a rough abdominal surface, have a snout like a horse's head, and a tail longer than the head.

Seahorses are also unisexual animals, consisting of male and female fish. The males have a burrowing sac located in the abdomen, while the females do not have (Hanifaturahmah et al., 2020; Lourie et al., 2004).

Seahorses' body is not covered with scales, but with shield-like pieces of bone. Seahorses do not have ribs, although their shape is different from ordinary fish, they can still find the same organs as fish, such as gills for breathing, dorsal fins for movement, and vertebrae that support the body. They have medium-sized eyes and no teeth (Lourie et al., 2016; Mulalinda, 2017; Putri et al., 2019).

Habitat and Distribution

Seahorses are found in almost all waters of the world in tropical and subtropical waters, with the highest diversity in Indo-pacific waters, generally living in shallow waters. Currently, there are 48 accepted species of Hippocampus (Reviewed by Koning & Hoeksema, 2021). Species found in Indonesian waters include *H. barbouri, H. bargibanti, H. comes, H. denise, H. histrix, H. kelloggi, H. kuda, H. spinosissimus,* and *H. trimaculatus* (Lourie et al., 2004). Some locations of seahorse distribution in Indonesia can be seen in Table 1.

Table 1. Distribution of seahorse species in various Indonesian waters.

Location	Species	Source
Bintan Island	*H. comes, H. spinossisimus, H. hystrix, H. kuda*	Putri et al. (2019)
Lampung Bay	*H. comes, H. kuda*	Putri et al. (2019)
Tanakeke Islands	*H. barbouri*	Mulyawan & Saokani (2015); Putri et al. (2019)
Selayar Island	*H. barbouri, H. kuda*	Ambo-Rappe et al. (2021)
Padang Bai Karangasem, Bali	*H. comes*	Saraswati & Pebriani (2016)
Ternate Island	*H. kuda*	Dody et al. (2021)
Morotai Island	*H. kuda, H. kelloggi, H. spinosissimus*	Koroy et al. (2023)

METHOD

Time and Location

The research was conducted from June to July 2024. This research took place at the waters of Jambula, Ternate Island, North Maluku (Figure 1).

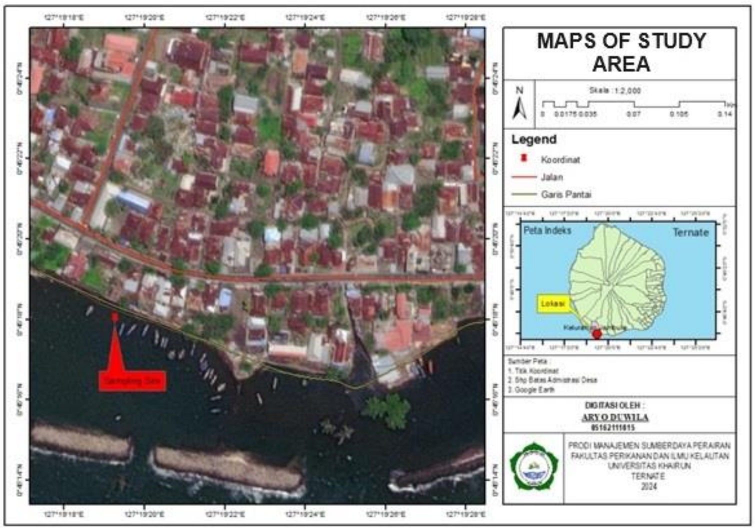


Figure 1. Map of the study area at Jambula waters, Ternate Island.

Tools and Materials

The tools used in this research were basic diving gear (masks, snorkels, and fins), underwater camera, quadrant transect, thermometer, scale stick, pH meter, handrefractometer, and DO meter. The materials used were aquadest and research object of seahorses.

Data Collection Procedures

The visual census method was used to observe the presence of seahorses. Observations were conducted along Jambula beach, which is a seahorses habitat on Ternate Island. Observations of seagrass species and density analysis were conducted at points where seahorses were found. Identification of seagrass species used seagrass identification guidelines based on Rahmawati et al. (2014) and Hernawan et al. (2017). Seagrass density was calculated using a 50 × 50 cm2 quadrant transect with three replicates. In line with seahorses and seagrass observations, several water quality parameters were also measured in situ. The parameters measured consisted of depth, temperature, salinity, pH, and dissolved oxygen (DO).

Data Analysis

Seagrass species densities were calculated using a formula recommended by Mulyawan & Saokani (2015) as follows:

$$D = \frac{\sum Ni}{A}$$

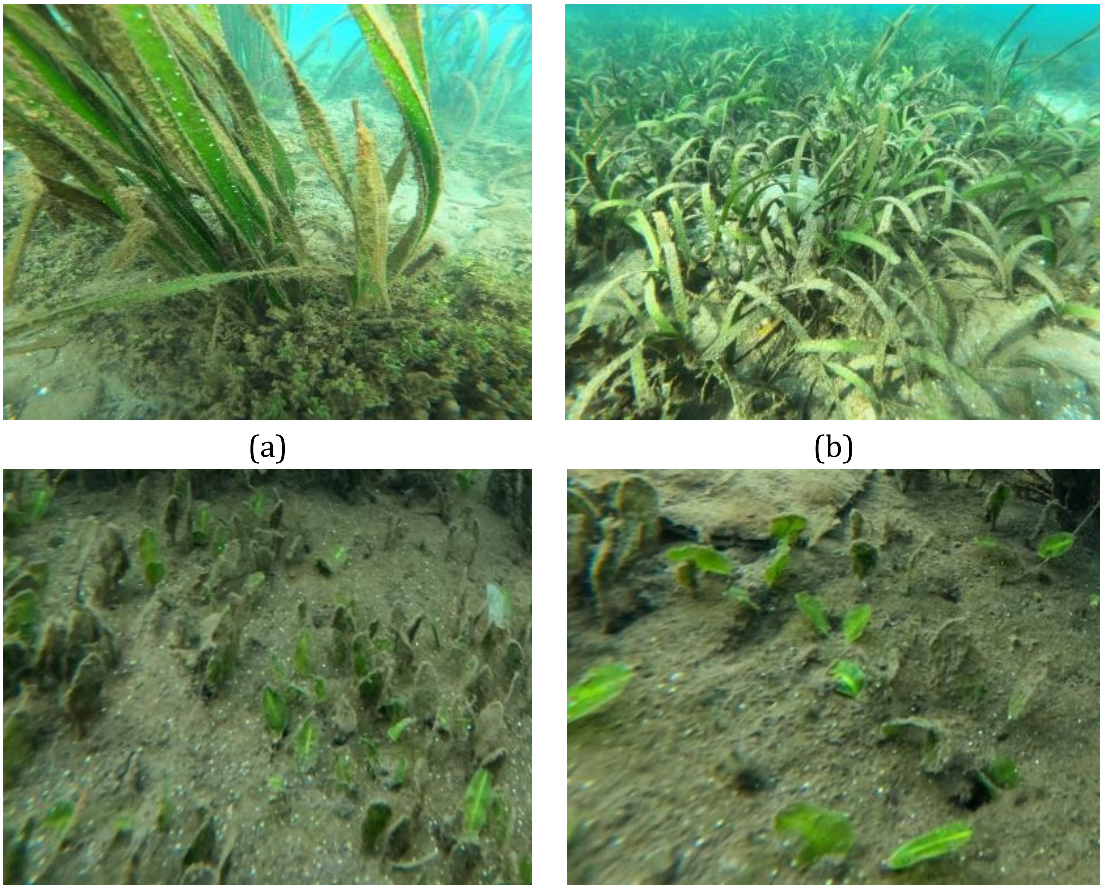
where D = species density (ind/m^2), Ni = number of stands of species i (ind), and A = area of observation (m^2).

Furthermore, data on seagrasses species and density, and water quality parameters were analyzed descriptively in the form of tables and figures. The association of seahorses and seagrass species was also analyzed descriptively.

RESULT AND DISCUSSION

Species and Density of Seagrass

The results found four types of seagrass in seahorses habitat at Jambula waters, namely *Enhalus acoroides, Cymodocea rotundata, Halophila minor,* and *Halophila decipiens* (Figure 2). The density of each seagrass species can be seen in Table 2.



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

Figure 2. Seagrass species in seahorse habitat at Jambula waters (a = *E. acoroides,* b = *C. rotundata, c* = *H. minor,* dan d = *H. decipiens*)

The first seagrass species found was *E. acoroides*. It was found with the characteristics of having straight and long leaves like ribbons, leaves emerging from thick and rough rhizomes, creeping and hairy rhizomes. According to Hernawan et al. (2017), the special feature of *E. acoroides* has hair on the rhizome and is the largest seagrass species. The classification of this species is Plantae (Kingdom), Viridiplantae (Subkingdom), Streptophyta (Infrakingdom) Tracheophyta (Phylum), Spermatophytina (Subphylum), Magnoliopsida (Class), Lilianae (Superorder), Alismatales (Order), Hydrocharitaceae (Family), *Enhalus* (Genus), *Enhalus acoroides* (Species) (Guiry & Guiry, 2024a).

The second seagrass species found was *C. rotundata*, which has rhizomes that grow creeping and elongated. The general characteristics of this species have straight, long leaves and have one central leaf bone that does not protrude and the leaf blade is completely closed. The tip of the leaf is in the shape of the letter "m", the edge of the leaf is smooth and not serrated (Hernawan et al., 2017; Rawung et al., 2018). The classification of this species is Plantae (Kingdom), Viridiplantae (Subkingdom), Streptophyta (Infrakingdom) Tracheophyta (Phylum), Spermatophytina (Subphylum), Magnoliopsida (Class), Lilianae (Superorder), Alismatales (Order), Cymodoceaceae (Family), *Cymodocea* (Genus), *Cymodocea rotundata* (Species) (Guiry & Guiry, 2024b).

The third seagrass species found was *H. minor* which has an oval leaf shape like an egg, small in size with paired petioles at each node. The fourth species was *H. decipiens*, which has paired leaves with hairy, translucent and thin leaflets. The classification of these two seagrass species are Plantae (Kingdom), Viridiplantae (Subkingdom), Streptophyta (Infrakingdom), Tracheophyta (Phylum), Spermatophytina (Subphylum), Magnoliopsida (Class), Lilianae (Superorder), Alismatales (Order), Hydrocharitaceae (Family), *Halophila* (Genus), *Halophila decipiens* and *Halophila decipiens* (Species) (Guiry & Guiry, 2024c, 2024d).

Table 2. Density of seagrass species in Jambula waters.

Species	Density (ind/m^2)
Enhalus acoroides	172
Cymodocea rotundata	280
Halophila minor	164
Halophila decipiens	116

The four seagrass species found have different densities, of which *C. rotundata* has the highest density (280 ind/m^2), followed by *E. acoroides*, *H. minor*, and *H. decipiens*. *C. rotundata* has the highest density among the four species, indicating that it is more dominant at the area compared to other seagrass species. This high density could be due to the suitable environmental conditions for its growth. *E. acoroides* is in the second position in density. It is known to have a larger structure, so although its density is not as high as *C. rotundata*, it still contributes significantly in providing habitat and supporting seagrass ecosystems. *H. minor* and *H. decipiens* are lower than the others, suggesting that their distribution is not very extensive in these waters. It is also suspected that these species may have limitations in adaptation to environmental conditions in Jambula waters, or competition with other more dominant seagrass species. The same phenomenon was reported by Wahab et al. (2017) in Panggang Island waters (Jakarta), where *C.*

rotundata has the highest density, followed by *E. acoroides* and other species. The difference is caused by several factors, namely topography, physical conditions, coastal community activities around seagrass beds and seagrass adaptation.

Water Quality Parameters

The water quality parameters measured in this study included both physical and chemical parameters. The physical parameters included water depth and temperature, while the chemical parameters included pH, salinity, and DO. The measurement results are presented in Table 3.

Table 3. Measurement results of water quality parameters in the seahorse habitat at Jambula waters.

Parameters	Measurement result
Depth (cm)	90 - 112
Temperature (°C)	29,4 – 30,0
Salinity (ppt)	29 - 30
pH	6,7 - 6,8
DO (mg/L)	6,1-7,0

The waters depth in the seahorse habitat was recorded ranging from 90 to 112 cm, indicating that the seahorse habitat in Jambula is located in relatively shallow waters. This is consistent with the seahorse's preference for living near the seagrass bed in shallow depths, where they can forage for food and seek shelter among seagrass. On Sebong Pareh Island (Bintan), seahorses were found at depths ranging from 152.3 to 163 cm (Maulidina et al., 2024). These waters are also categorized as shallow, allowing seahorses to thrive.

The waters temperature in this habitat ranged from 29.4 to 30.0°C. This temperature falls within a normal range that generally supports the life of seahorses as well as seagrass vegetation. Maintaining stable temperatures within this range is crucial for the health of the seagrass ecosystem and the survival of seahorses. Other studies had reported similar ranges; for example, on the northern coast of Bintan Island, the water temperature in seahorse habitats ranged from 25.5 to 26.3°C (Hasikin et al., 2024), while the waters around Sebong Pareh Island had a temperature of 29.9°C (Maulidina et al., 2024). Based on these data, it can be concluded that seahorses can thrive in temperatures ranging from 25 to 30.0°C.

The salinity in the seahorse habitat in Jambula waters ranged from 29 to 30 ppt, indicating that the water in this habitat is seawater with stable salinity levels (with little fluctuation). In several studies, seahorses have been found in varying salinity conditions. For example, in the waters around Bintan Island, salinity was reported ranging from 30 to 35.4 ppt (Hasikin et al., 2024; Maulidina et al., 2024).

The pH levels in the Jambula waters ranged from 6.7 to 6.8, indicating slightly acidic conditions. Although this is slightly below neutral (pH 7), these pH levels are still within the tolerable range for seahorses. However, conditions closer to neutral pH are generally more optimal for the survival of various marine organisms. In other studies, seahorses had been found to thrive in higher pH ranges, from 7.15 to 8.1

(Hasikin et al., 2024; Maulidina et al., 2024). Despite the lower pH in Jambula, other water quality parameters, such as temperature, salinity, and dissolved oxygen, are at levels that support seahorse life. Additionally, other environmental factors, such as food availability, seagrass vegetation, and the low presence of predators, may provide sufficient support for seahorses to survive.

The dissolved oxygen content in the Jambula waters ranged from 6.1 to 7.0 mg/L. This DO level is adequate and supports the life of aquatic organisms. Sufficient DO is crucial for the respiration of organisms like seahorses and maintaining the ecosystem balance in seagrass habitats. In the northern coastal waters of Bintan Island, DO levels ranged from 6.08 to 7.18 mg/L (Hasikin et al., 2024), while in the coastal waters of Padang Bai (Bali), the range was 7 to 7.75 mg/L (Saraswati & Pebriani, 2016). These values also indicate that the oxygen needs of seahorses in each location are met within these ranges. Furthermore, Saraswati & Pebriani (2016) noted that seahorses, particularly male seahorses carrying eggs, require adequate oxygen despite their low activity levels.

Association of Seahorses with Seagrass Species

Observations of seahorse presence in the Jambula waters revealed an association with specific seagrass species. Seahorses were found to be associated with two types of seagrass, namely *Enhalus acoroides* and *Halophila minor* (Figure 3).

(a) (b)

Figure 3. Association of seahorses with seagrass species *E. acoroides* (a) and *H. minor* (b) in Jambula waters

Seahorses in Jambula waters show an association with seagrasses *E. acoroides* and *H. minor*. Seagrasses not only provide physical habitat and protection for seahorses but also support a rich ecosystem with abundant food resources. The variety of seagrass species found in Jambula creates a complex and diverse environment, allowing seahorses to choose habitats that meet their ecological needs. Some studies had also reported specific associations between seahorses and certain seagrass species. For example, Putri et al. (2019) reported that *H. barbouri* seahorses in Tanakeke waters are commonly found in *E. acoroides* seagrass ecosystems, while *H. comes* seahorses in Bintan waters are associated with brown algae and scattered seagrass in the study area. Mulyawan & Saokani (2015) also reported that seahorse habitats in Tanakeke Island included three seagrass species: *E. acoroides*, *Thalassia hemprichii*, and *Syringodium isoetifolium*. Hasikin et al. (2024) reported that *H. kuda* seahorses have a close relationship with *E. acoroides*, while *H. comes* seahorses are closely associated with *T. hemprichii*. This association indicates that seahorses tend to prefer larger and more robust seagrass species as their habitat.

In addition to their association with seagrasses, some studies had found that seahorses are also associated with various types of algae. Maulidina et al. (2024) reported that seahorses are commonly associated with brown algae (*Sargassum* sp.). Young seahorses often position themselves at the base of *Sargassum* sp., a behavior related to their camouflage strategy when threatened. As they mature, they move to the middle and eventually to the top of the algae. Another study reported that *H. kuda* seahorses are associated with the *Halimeda* sp. macroalgae. However, in this study, seahorses were not found associated with macroalgae, including *Sargassum* sp. and *Halimeda* sp., despite the presence of both algae in Jambula waters.

CONCLUSSION

The seahorse habitat in Jambula waters is characterized by the presence of four seagrass species: *Enhalus acoroides*, *Cymodocea rotundata*, *Halophila minor*, and *Halophila decipiens*, with *C. rotundata* exhibiting the highest density. Both physical and chemical water quality parameters fall within tolerable ranges for seahorse life. Seahorses in this habitat are associated with two seagrass species, namely *E. acoroides* and *H. minor*. Understanding these habitat characteristics is crucial for the management of seahorse resources, making it essential to monitor and maintain the sustainability of these resources.

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