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Structure Community of Endoparasites in Bullet Tuna *Auxis thazard* Lacepède, 1800 From Amed, Bali

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Abstract: Fish parasites represent a major part of aquatic biodiversity, and consequently affect the environment directly or indirectly through their hosts. The high prevalence of parasitic infections contributes to growth disorders and affects ecosystem dynamics. Parasites can manipulate host behavior, thereby increasing their vulnerability to predation. *A. thazard* samples were obtained directly from Amed fishermen. The size of the tuna used ranged from to 20-30 cm/head, with a total of 30 fish. Samples were preserved in ice, placed in a cool box, and then brought to the Fisheries Science Laboratory, Faculty of Marine and Fisheries for parasitic worm examination. The results of this study, it can be concluded that the types of endoparasites found in this study: *Anisakis* sp., *Rhadinorhynchus* sp., and *Hemiurus* sp., had prevalence values ranging from 18,3-26,6%, intensities ranging from 3.3-23.3 ind/fish, abundance values ranging from 0.61 to 5.8 ind, diversity indices ranging from 0.19 to 0.32 in the low category, and uniformity values ranging from 1,17 to 1.97 in the high category from 30 samples of *Auxis thazard* Lacepède, 1800 obtained from Amed.

Keywords: Ecosystem; Enviroment; Host; Parasitic

Introduction

A. thazard, also known as bullet or frigate tuna, is a small pelagic fish found in tropical and subtropical waters worldwide. Similar to many other marine organisms, *A. thazard* hosts a diverse array of internal endoparasites that infect and reside within its body. Parasitic infections can significantly affect the decline in fish resource stocks, reduce their reproductive ability, and disrupt growth (Lafferty et al., 2008; Sindermann, 1987). In addition, parasites can have negative economic effects on capture fisheries (Gebreegziabher et al., 2020; Jobling et al., 2003).

Research about endoparasites, *A. thazard* is susceptible to infection by a diverse array of endoparasites, including nematodes (Knoff et al., 2017), trematodes (Pantoja et al., 2022), cestodes (Gallagher et al., 1994), and Acanthocephala (Colonne et al., 2023), are particularly prevalent in this species. These parasites can be found in various organ systems of fish, including the gastrointestinal tract, liver, and muscle tissues. Infection rates can be high, with some studies reporting a prevalence of up to 60% in certain populations (Jobling et al., 2003). Koepper et al. (2022) analyzed the endoparasite communities of seven commercial fish species from Java, Indonesia. The authors found that the Frigate Tuna (*A. thazard*) was one of the most heavily infected species, with a parasite prevalence of over 60%.

Fish health is closely linked to the health of humans who consume fish, as fish can act as agents of certain diseases known as zoonoses (Chai et al., 2005). The risk of zoonoses from fish parasites is an important aspect that requires attention because of the interactions among parasites, fish, and humans. Although many zoonoses do not result in the death of their victims, they can significantly disrupt their lives (Boylan, 2016).

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Fish parasites represent a major part of aquatic biodiversity, and consequently affect the environment directly or indirectly through their hosts (Palm et al., 2008). The high prevalence of parasitic infections contributes to growth disorders and affects ecosystem dynamics. Parasites can manipulate host behavior, thereby increasing their vulnerability to predation (Gehman et al., 2017). These behavioral changes can drive shifts in community composition and ecosystem dynamics (Fenton et al., 2006; Hall et al., 2004). Therefore, it is essential to maintain fish quality, particularly when controlling parasites. Therefore, it is crucial to identify the parasites that infect tuna (*A. thazard*).

Method

A. thazard samples were obtained directly from Amed fishermen. The size of the tuna used ranged from to 20-30 cm/head, with a total of 30 fish. Samples were preserved in ice, placed in a cool box, and then brought to the Fisheries Science Laboratory, Faculty of Marine and Fisheries for parasitic worm examination. Using the standard method of Palm (2004) and Palm et al. (2014), the body cavity was opened and endoparasites were collected from the digestive tract using the intestinal washing methodology with 0.9% physiological NaCl, as described by Cribb et al. (2010). Monogenea, Digenea, and Cestoda were fixed in 70% ethanol and were stained with acetic carmine (Palm, 2004), dehydrated in an ethanol series, cleared with a graded series of eugenol, and mounted onto slides in Canada balsam. While Nematoda and Acanthocephala fixed in 70 % ethanol and using KOH (10%) and clove oil for staining were dehydrated in ethanol series (70%, 85%, 90%, and absolute) and transferred into Canada balsam. The parasite identification literature by Gibson et al. (1986) for Digenea, Maurice (1899), Khalil et al. (1994), Palm (2004) for Cestoda, and Morave (1987) for Nematoda.

Prevalence

Prevalence is the percentage of fish infected by parasites in a fish population. The prevalence calculation formula (Williams, 1996).

$$P = \frac{N}{n} x\ 100\ \% \quad (1)$$

Information:
N= Number of infected fish
n = Number of fish examined

Intensity

Intensity describes the number of parasite densities that can infect fish and can be calculated using the formula (William, 1996) and the intensity criteria in Table 2.

$$I = \frac{P}{n} \quad (2)$$

Information:
P = Number of parasites infecting fish
n = Number of fish infected with parasites

Abudance

Abundance is the number of individuals or species found in an area. The formula used to determine abundance values was as follows (Krebs, 1989), as follows:

$$\text{Abundance} = \frac{ni}{N} \quad (3)$$

Information:
ni = Number of parasite individuals found
N = Number of fish examined

Diversity Index (H')

The parasite diversity index was used to calculate the diversity of parasite species found in fish (Odum, 1971).

$$(H') = \sum Pi \ln Pi \quad (4)$$

Information:
H'= Diversity
Pi = Number of parasite individuals found

Evennes Index (E)

The parasite Evenness Index (E) is a formula used to measure the evenness of parasite species in each fish sample (Krebs, 1999).

$$E = \frac{H'}{ln\ S} \quad (5)$$

Information:
H' = Shannon Index of Diversity
S = Total number of parasite species

Result and Discussion

Type of Endoparasite

Endoparasites found in Amed waters consist of three phylum: Nematoda, Acantocephala, and Platyhelminthes, which belong to the genera Anisakis, Rhadinorhynchus, and Hemiurus. These endoparasites infect the intestines, stomach, body cavity, liver, and gonads of the fish (Table 1).

Table 1. Type of Endoparasite and Predilection

Pylum	Class	Order	Species	Predilection
Nematoda	Chromadorea	Rhabditida	*Anisakis* sp.	Intestine, body cavity, liver, gonad
Acanthochepala	Palaeacanthocephala	Echinorhynchida	*Rhadinorhyncus* sp.	Intestine and stomach Intestine and stomach
Platyhelminthes	Trematoda	Plagiorchiida	*Hemiurus* sp.	Intestine

The phylum Nematoda is also called *roundworms* or worms, and is characterized by a *cylindrical body* and *circular in cross-section*. The digestive system consists of three parts: anterior (esophagus), middle (intestine), and posterior (rectum), and ends at the anus (Grabda, 1991). In this study, the Anisakis genus infected the liver, gonads, and intestines, and was found in the body cavity. According to Palm et al. (2008), Anisakis live in tropical or warm waters with dolphins from the Delphinidae, Phocoenidae, and Pontoporidae families as their final hosts. Anisakis is found in the body cavity, stomach, intestines, gonads, and liver of fish. The two *Anisakis* species identified, *A. typica* and *A. pegreffii*, are *zoonotic* (Arizono et al., 2012). If *Anisakis* sp. larvae are ingested by humans due to the consumption of raw or poorly processed fish, they can cause inflammation, bleeding, and swelling of the intestine. *A. simplex* is distributed in temperate *zones* and is found in fish muscle of fish (Strømnes et al., 2003).

The acanthochepala is an elongated cylindrical worm with a contractile proboscis on its head. The proboscis is equipped with hooks. Acanthochephala matures in the host digestive tract. Its body is divided into three parts: proboscis, neck, and trunk (Anshary, 2016). Morphology of Endoparasite show on Figure 1.

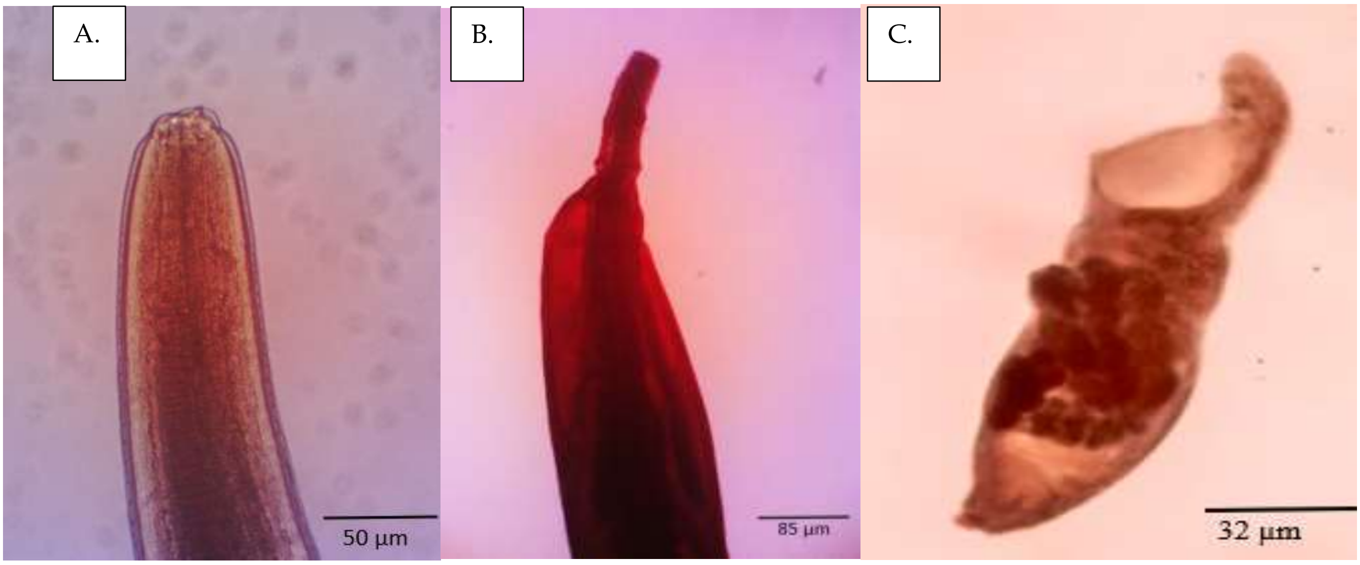

Figure 1. Morphology of Endoparasite (A. *Anisakis* sp. ; B. *Rhadinorhynchus* sp. ; C. *Hemiurus* sp.)

Prevalence

Based on the analysis results, the prevalence in this study ranged from 18.3 to 26.6% with a normal prevalence category. On the research *Rhadinorhyncus* sp. is have high value of prevalence than two genera: *Anisakis* sp. and *Hemiurus* sp. The high prevalence of *Anisakis* sp. and *Rhadinorhynchus* sp. is influenced dietary system of small shrimp/crustaceans, as crustaceans are the first intermediate hosts of *Anisakis* sp. and *Rhadinorhynchus* sp. causing it to develop into the third larval stage in the digestive organs of the fish, resulting in a high infection rate in the digestive tract. According to Santoro et al. (2020), crustaceans are the first intermediate hosts for *Anisakis* sp. and *Rhadinorhynchus* sp, causing high infection rates of *Anisakis* sp. in the digestive organs of skipjack tuna. This is also supported by Navarro-Barranco et al. (2019), who explained that Anisakis develop into stage III larvae in the digestive organs of fish to complete their life cycle. The prevalence values of other endoparasites, such as *Rhadinorhynchus* sp. and *Hemiurus* sp., ranged from 18,3% to 26,6 % with a very frequent prevalence category. This is caused by the migration patterns of pelagic fish, which causes some parasite larvae to attach and develop to complete their life cycle, resulting in a very frequent prevalence. According to Chen et al. (2015), the migration patterns of pelagic fish can cause the prevalence of endoparasites to increase. The prevalence data for each endoparasite species are show on Figure 2.

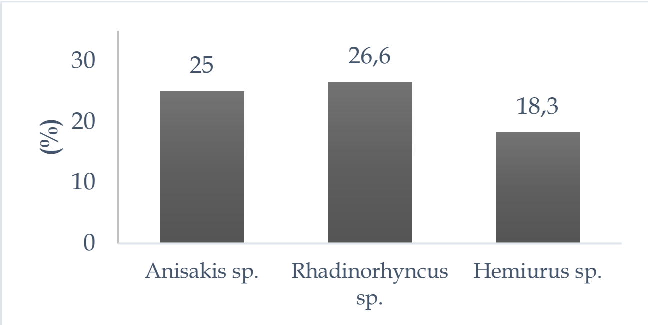

Figure 2. Prevalence of endoparasite

Intensity

The intensity calculation results showed that the value ranges from 3.3 to 23.5 ind/fish with a moderate intensity category. The intensity of endoparasites in this study ranged from 3.3 to 23.5 ind/fish, which is categorized as moderate due to the habitat and depth of pelagic fish. Habitat and depth influence the number of organisms that transmit endoparasites throughout their life cycles. According to Levsen et al. (2018), pelagic fish inhabit the surface of the ocean, allowing plankton and crustaceans to swim and attach their larvae to the water column or other organisms, such as fish, thereby influencing endoparasite intensity values. Pelagic fish are the second intermediate hosts for endoparasites, such as *Anisakis* sp., in completing their life cycle. After developing into stage III larvae, *Anisakis* sp. swims to find marine mammals and develop into stage IV and V larvae. This shows that the presence of Aniakis an be an indicator of the presence of marine mammals in water. According to Santoro et al. (2025), the presence of *Anisakis* spp. in fish can be used as an indicator of the presence of marine mammals in water. These intensities showed notable correlations with host size, feeding habit, and environmental factors: larger fish or those feeding on higher trophic-level prey tended to have higher intensities, likely due to increased opportunities for ingesting intermediate hosts or exposure in more parasite-rich microhabitats (Amin et al., 2019). Intensity data of endoparasite show on Figure 3.

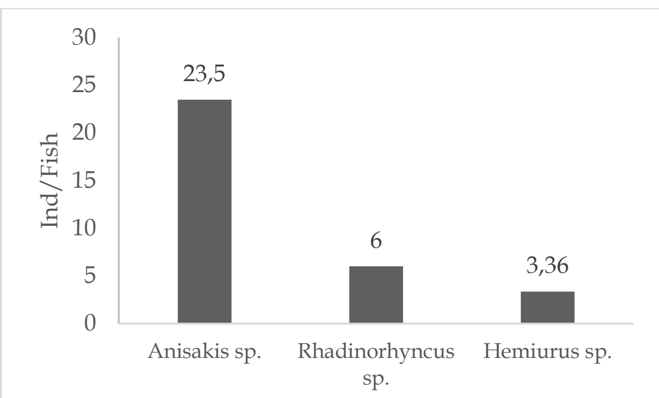

Figure 3. Intensity of endoparasite

Abudance

Based on the results of the study, the abundance value ranged from 0.61 to 5.8 ind, with the highest abundance value being *Anisakis* sp. at 5.8 ind and the lowest abundance value being *Hemiurus* sp. at 0.61 ind are indicates a varying level of infection from low to moderate in the population. According to Aranda et al. (2023), low abundance values ranging from 0.1 to 0.45 indicate limited transmission in the host population, whereas higher values (>1) indicate more intense parasite accumulation in some individuals, which is usually influenced by fish size, age, and more complex feeding patterns. These differences in abundance values are related to the availability of intermediate hosts in the aquatic environment, and spatiotemporal factors such as season and location of capture contribute significantly to variations in abundance (Delgano et al., 2019). In addition, the types of endoparasites found, such as *Anisakis* spp. and *Rhadinorhynchus* sp, have been reported to have low to moderate abundance in scombridae, including the ecologically important tuna. This range of abundance for pelagic fish may reflect the balance between food chain dynamics and parasite life cycle (Pramardika et al., 2025). Abudance data of endoparasite show on Figure 4.

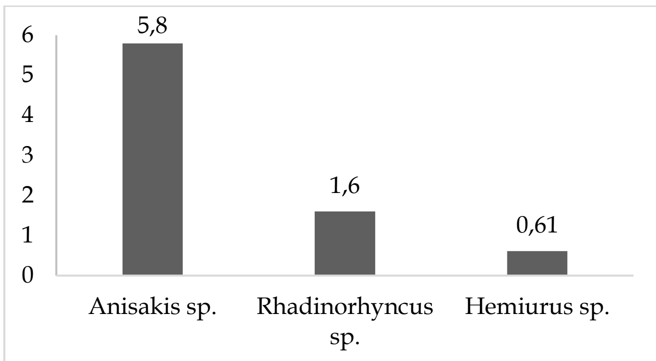

Figure 4. Abudance of Endoparasite

Diversity (D) and Evennes Index (E)

The Diversity Index from this study ranged from 0.19 to 0.32, which is categorized as low, while the Evenness Index from this study ranged from 1,17 to 1.97, which is categorized as high. This indicated that each endoparasite species was evenly distributed among the 60 fish samples. According to Sures et al. (2023), evenness indicates that the species obtained were evenly distributed in each sample studied or at each sampling location, resulting in low diversity and high evenness values. A high uniformity value indicated that the aquatic environment was good, resulting in the endoparasite species being evenly distributed in each sample studied. According to Miranda-Delgano et al. (2019), high uniformity values can indicate a good aquatic environment, which can be related to a good endoparasite life cycle and even availability of intermediate hosts in the water. An evenly distributed intermediate host allows endoparasites to spread to fulfill their life cycle (Johnson et al., 2016). Diversity Index (D) show on Table 2 and Evennes Index (E) Table 3.

Table 2. Diversity Index (D)

Parasite species	Pi ln Pi	H'	Abundance
Anisakis sp.	-0.23	0.23	Low
Rhadinorhyncus sp.	-0.32	0.32	Low
Hemiurus sp.	-0.19	0.19	Low

Table 3. Evennes Index (E)

Parasite species	Evenness Index (E)	Category
Anisakis sp.	1.42	High
Rhadinorhyncus sp.	1.97	High
Hemiurus sp.	1.17	High

Conclusion

Based on the results of this study, it can be concluded that the types of endoparasites found in this study, namely *Anisakis* sp., *Rhadinorhynchus* sp., and *Hemiurus* sp., had prevalence values ranging from 18,3-26,6%, intensities ranging from 3.3-23.3 ind/fish, abundance values ranging from 0.61 to 5.8 ind, diversity indices ranging from 0.19 to 0.32 in the low category, and uniformity values ranging from 1,17 to 1.97 in the high category from 30 samples of *Auxis thazard* Lacepède, 1800 obtained from Amed.

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No conflict interest.

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