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# Record of Acanthocephala on Shortfin Scad (*Decapterus macrosoma* Bleeker, 1851) from the Southern Coast of the Special Region of Yogyakarta, Indonesia

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## *ABSTRACT*

Acanthocephala is a parasite commonly found in the digestive tract of fish. This study aimed to determine the prevalence and mean intensity of Acanthocephala infecting the shortfin scad (*Decapterus macrosoma*) caught from the southern coast of Yogyakarta and to identify those parasites by morphological approach. A total of 221 samples of fish were obtained from local fishermen operating in fishing grounds along the southern coast of the Indian Ocean in the Special Region of Yogyakarta. The fish samples were measured for total length (TL) and weight and dissected to examine for the presence of Acanthocephala. Parasite samples were collected from the digestive tract of shortfin scad and preserved in absolute ethanol for further identification. Data analysis focused on calculating prevalence and mean intensity of infection. The results showed that the prevalence of Acanthocephala infection was 16.3%, with a mean intensity of 1.9 larvae/host. Both the prevalence and the mean intensity tended to increase with increasing fish length. Most of the shortfin scad (75%) was infected with Acanthocephala at a relatively low intensity (1-2 larvae/host). The highest intensity of Acanthocephala infection was 13 larvae/host and was only found in one fish. Morphological identification indicated that the genus infecting shortfin scad was *Acanthocephalus (*Koelreuther, 1771).

**Keywords:** *Acanthocephalus*, biological tag, morphology, parasite, prevalence

## *ABSTRAK*

Acanthocephala adalah parasit yang biasa ditemukan di saluran pencernaan ikan. Penelitian ini bertujuan untuk mengetahui prevalensi dan rata-rata intensitas Acanthocephala pada ikan layang deles (*Decapterus macrosoma*) dan potensi penanda biologisnya. Sebanyak 221 sampel ikan diambil dari nelayan lokal yang menangkap ikan tersebut di daerah penangkapan ikan di sepanjang pantai selatan Samudra Hindia di Daerah Istimewa Yogyakarta. Sampel ikan diukur panjang total (TL) dan beratnya, kemudian dibedah untuk pemeriksaan Acanthocephala. Sampel Acanthocephala diambil dari saluran pencernaan ikan layang deles dan diawetkan dengan menggunakan etanol absolut untuk identifikasi lebih lanjut. Analisis data meliputi prevalensi dan rata-rata intensitas infeksi. Hasil penelitian menunjukkan bahwa prevalensi Acanthocephala pada ikan layang deles sebesar 16,3%, dengan intensitas rata-rata sebesar 1,9 larva/individu. Baik prevalensi maupun intensitas rata-rata cenderung meningkat seiring dengan bertambahnya panjang ikan. Sebagian besar ikan layang deles (75%) terinfeksi Acanthocephala dengan intensitas yang relatif rendah (1-2 larva/individu). Intensitas infeksi Acanthocephala tertinggi adalah 13 larva/individu dan hanya ditemukan pada satu sampel. Identifikasi morfologi menunjukkan bahwa Genus Acanthocephala yang menginfeksi ikan layang deles adalah *Acanthocephalus* (Koelreuther, 1771).

**Kata kunci:** *Acanthocephalus*, morfologi, parasit, penanda biologi, prevalensi

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## 1. Introduction

Acanthocephalans are endoparasitic worms that are frequently found in the digestive tracts of both freshwater and marine fishes. Acanthocephala's life cycle involves an arthropod as an intermediate host and a vertebrate as a definitive host (Kennedy, 2006). Some acanthocephalans use paratenic hosts (often teleosts, reptiles, or small mammals) to bridge the trophic gap between intermediate and definitive hosts (Schmidt, 1985). Acanthocephala is known as a thorn-headed worm, marked by the occurrence of a proboscis, which functions to penetrate and hold the intestinal wall of a definitive host (Shih et al., 2010). Acanthocephalan eggs are in the intestinal lumen of the definitive host and excreted through feces. The first larvae (acanthor) hatch from an egg after being swallowed by a suitable invertebrate host acting as an intermediate host. Isopods, ostracods, and amphipods were recognized as the important intermediate hosts for aquatic species. In the intestinal host of invertebrates, acanthor molts into a second-stage larvae called acanthella. Second-stage larvae (acanthella or cystacanth) in the paratenic host will not develop into adulthood until the definitive or final host ingests them. Infection occurs when a definitive host consumes a paratenic host that has an infective cystacanth stage.

In addition, the most recent information shows that, in some cases, the transfer of adults after the cycle between fish can occur by predation. Worm recruitment to fish populations generally occurs in the spring; however, maturation, egg production, and transmission to intermediate hosts occur in the summer and early autumn. Acanthocephalan infection occurs globally in most fishes and is not considered to cause significant economic losses. Epizootics of these parasites are known in fish from hatcheries (Bullock, 1963), and they have been associated with the local extinction of natural populations (Schmidt et al., 1974). The knowledge of the parasite's effects on the host populations is still limited, but significant mortality might occur when the host is in a stress condition (Jilek, 1979; Connors & Nickol, 1991). Acanthocephala have been reported found in the digestive tract of various marine fish, e.g., *Siganus luridus* (Rüppell, 1829) and *Rastrelliger kanagurta* (Cuvier, 1816) caught from the Red Sea (Hassanine, 2006); *Mugil cephalus* (Linnaeus, 1758), *Scomber australasicus* (Cuvier, 1832), and *Siganus fuscescens* (Houttuyn, 1782) in Taiwanese waters (Shih et al., 2010); *Nibea albiflora* (Richardson, 1846), *Johnius carouna* (Cuvier, 1830), *Cypselurus hexazona* (Bleeker, 1853), and *Scatophagus argus* (Linnaeus, 1766) in the Pacific Ocean waters of Vietnam (Amin et al., 2014); *Decapterus punctatus* (Cuvier, 1829) caught from the coastal waters of Brazil (Braicovich et al., 2014); *Lepturacanthus savala* (Cuvier, 1829), *Johnius coitor* (Hamilton, 1822), and *Gempylus serpens* (Cuvier, 1829) from Java, Indonesia (Verweyen et al., 2011); and *Decapterus maruadsi* (Temminck & Schlegel, 1843), *Triacanthus biaculeatus* (Bloch, 1786), *Auxis thazard* (Lacepède, 1800), and *Auxis rochei* (Risso, 1810) on the Pacific Coast of Vietnam (Amin et al., 2019).

Over the past several decades, parasites have been developed as biological tags for the identification and qualitative description of fish populations (Mattiucci et al., 2005; Santos et al., 2009; Luque et al., 2010; Hermida et al., 2013; Mackenzie & Hemmingsen, 2015). As part of the overall fish stock concept (Begg & Waldman, 1999), parasites have been used as biological tags to determine migratory behaviour and host feeding habits. Although not as advanced as the uses of *Anisakis* as a biological indicator (Mattiucci et al., 2007; Setyobudi et al., 2013), Acanthocephala has also been used as a biological tag in some ecological studies. Cribb et al. (2000) used Acanthocephala to describe the movement between fish populations in a region of less than one kilometer in a coral reef environment. Moreover, Smith et al. (2005) demonstrated Acanthocephala, *Rhadinorhynchus* sp., as a biological tag to show short-term movement in two groups of blue mackerel (*Scomber australasicus*) in New Zealand. Mackenzie et al. (2008) interpreted the presence of the Acanthocephala *R. cadenati* in *Trichiurus trachurus* captured off the south coast of Portugal as an indication of migration from farther south off the coast of Africa.

Shortfin scad has a wide distribution area, covering tropical and subtropical waters. Scad (*Decapterus* spp.) is a commercially important small pelagic fish species widely caught around the world. FAO (2021) noted the total catch of scad in 2019 was 1.29 million tons. Among the world's major fishing areas, the Eastern Indian Ocean shows a steady yield increase. The schooling of *D. macrosoma* spreads over the Indian Ocean and the West and East Pacific Oceans at a depth of 30-70 m above water level (Kimura et al., 2013). Shortfin scad (*D. macrosoma*) is one of the catches of fishermen in the Southern Coast of Yogyakarta Special Region (Lubis et al., 2019; Kusumaningrum et al., 2021). Besides being consumed directly, this fish is also used as the raw material for the fish processing industry. Research on Acanthocephala in marine fish is still limited, even though there are thousands of fish species in Indonesia. Therefore, it is essential to gather comprehensive information on Acanthocephala infection throughout Indonesian waters. *Acanthocephalus* sp. have been reported

**Figure 1.** Shortfin scad (*D. macrosoma*) caught from the southern coast of the Special Region of Yogyakarta.

infecting *Rastrelliger* sp. landed in Sibolga Fishing Port (Rumondang et al., 2023). Furthermore, Pramardika et al. (2024) reported two genera of Acanthocephala, i.e., *Echinorhynchus* and *Rhadinorhynchus*, were found to infect the marine fish *Aprion virescens* and *Katsuwonus pelamis* in the maritime border region of Indonesia and the Philippines. This study aimed to determine the prevalence and mean intensity and identify Acanthocephala infecting the shortfin scad (*Decapterus macrosoma*) caught from the southern coast of Yogyakarta.

## 2. Materials, methods and data analysis

A total of 221 shortfin scad were collected between April and July 2019 from the local fishermen who operating along the southern coast of Yogyakarta, Indonesia. Shortfin scad (D. macrosoma) caught from the southern coast of the Special Region of Yogyakarta was shown in **Figure 1**. Each fish was measured for total length before dissection. The digestive tracts were examined for Acanthocephala parasites. The recovered Acanthocephala were rinsed with physiological saline solution (0.9% NaCl) and preserved in absolute ethanol for further identification. Parasitological parameters were calculated following Bush et al. (1997): prevalence (the number of hosts infected with parasites divided by the total number of hosts examined, expressed as a percentage) and mean intensity (the average of parasite infection among the infected fish expressed as larvae/host). To determine the relationship between fish length (which reflects age) and the risk of infection, samples were grouped into several length classes, and the prevalence and average intensity of infection were determined.

The identification of Acanthocephala was conducted using a morphological approach. Morphological identification of Acanthocephala was conducted using light microscopy and scanning electron microscopy (SEM). For light microscopy, samples were stained with acetocarmine for 24 hours, dehydrated through a graded ethanol series (50-100%) each for 5 minutes, soaked in xylene for 1 minute, mounted in Canada balsam, and observed under a light microscope. For SEM, specimens were washed in cacodylate buffer at 4°C for 6 hours, prefixed in 2.5% glutaraldehyde for 12 hours, and post-fixed in 2% tannic acid for 6 hours. Dehydration was done in a graded ethanol series (30%, 50%, 70%, 85%, 90%, and 99,6%). Samples were mounted on stubs, coated with gold using an Ion Coater SPT-20, and examined using a Hitachi SU3500 SEM.

## 3. Results and Discussion

### 3.1. Prevalence and mean intensity of Acanthocephala

*Decapterus macrosoma* caught at the southern coast of the Special Region of Yogyakarta was susceptible to acanthocephalan infection with its low prevalence (16.3%) and low mean intensity (1.9 larvae/host) (**Table 1**). Most of the shortfin scad (*D. macrosoma*) were 75% infected with Acanthocephala with an intensity of 1-2 larvae/ host. The highest intensity of Acanthocephala larvae found in one fish was 13 as shown on **Figure 2**. A previous study reported the differences in prevalence and mean intensity of Acanthocephala infection among various fish species coming from different regions. The high prevalence was found in *Strongylura strongylura* (van Hasselt, 1823) (100%) and *Megalops cyprinoides* (Broussonet, 1782) (100%) from the East Coast of Vietnam (Amin et al., 2011), and *Platichthys flesus* (Linnaeus, 1758) from the Baltic Sea (96.6%) (Kennedy, 1984), while the moderate prevalence was found in *Pleuronectes platessa* (Linnaeus, 1758) from the Baltic Sea (42.8%) and *Scomber australasicus* from New Zealand (50%). As a comparison, the low prevalence of Acanthochephala infection (<10%) was observed on *Johnius carouna*, *Pennahia argentata* (Houttuyn, 1782), and *Clupanodon thrissa* (Linnaeus, 1758) (Amin et al., 2011). As for the mean intensity, a high value was observed on *Mugil cephalus* caught from Tamil Nadu, which is 26-68 larvae/infected host (Jithendran & Kannappan, 2010). In the case of *Strongylura strongylura* and *Megalops cyprinoids*, even though they have high prevalence but only low mean intensity, i.e., 6 and 1 larvae/host, respectively (Amin et al., 2011).

**Table 1**. Prevalence and mean intensity of Acanthocephala in *D. macrosoma* at southern coast of the Special Region of Yogyakarta.

| Fish Length (cm) | The number of fish (ind.) | The number of infected fish (ind.) | Prevalence (%) | Mean Intensity (larvae/host) |
|---|---|---|---|---|
| ≤20.5 | 8 | 1 | 12.5 | 1.0 |
| 20.6-23.1 | 68 | 5 | 7.4 | 3.4 |
| 23.2-25.7 | 78 | 15 | 19.2 | 1.5 |
| 25.8-28.3 | 62 | 13 | 20.9 | 1.7 |
| ≤30.9 | 5 | 2 | 40.0 | 3.5 |
| | | | 16.3 | 1.9 |

Differences in the prevalence and mean intensity of parasite infections in fish were influenced by host species, types of prey, and the abundance of intermediate hosts (Sharif & Negm-eldin, 2013). Moreover, Marcogliese (2002) states that the prevalence and intensity of parasites with complex life cycles are directly related to the abundance of their hosts, particularly free-living fauna. Therefore, the variation in prevalence and intensity of parasites may reflect the density of organisms that act as intermediate or definitive hosts or changes in habitat conditions affecting the food webs (Hemmingsen & MacKenzie, 2001). The higher nutrient availability in ecosystems increases parasite prevalence (Sanchez-Thirion et al., 2019).

The prevalence and intensity of Acanthocephala infection in shortfin scad (*D. macrosoma*) from the southern coast of the Special Region of Yogyakarta increase with increasing fish body length (Table 1). Several studies reported similar results, such as on *Mugil cephalus* (Jithendran & Kannappan, 2010), *Neogobius melanostomu*s (Pallas, 1814) (Emde et al., 2012), and several fish species from Arkansas (McAllister et al., 2015). The increased prevalence and intensity of infection indicated that larger fish are more susceptible than smaller fish (Hassan et al., 2013). Larger fish tend to live longer and consume more prey, potentially leading to a higher accumulation of parasites (Hassan et al., 2013). Changes in the host's immune response or age-related feeding behavior may influence the positive correlation between parasite accumulation and fish body size (Cruz et al., 2007). Repeated transmission of larvae through predator-prey interactions among fish species can also contribute to infection accumulation (Mattiucci et al., 2017).

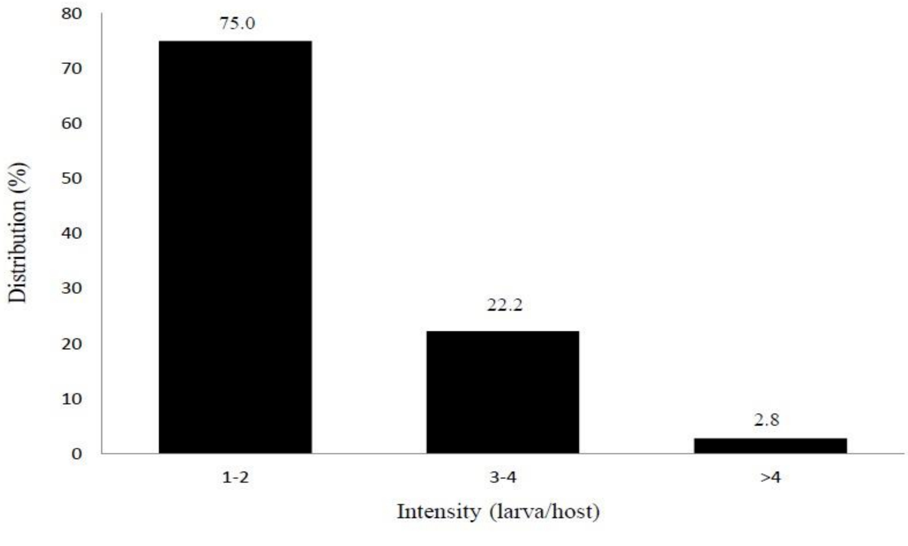


**Figure 2.** Intensity distribution of Acanthocephala infection in *D. macrosoma* at southern coast of the Special Region of Yogyakarta.

Infection of Acanthocephala on the shortfin scad indicates that the fish was act as a definitive host in the acanthocephalan life cycle. Shortfin scad might have preyed on copepods, which are known as an intermediate host for Acanthocephala. The presence of particular parasitic species in a host indicates that all host species needed for that parasite life cycle exist in the environmental community; or at least the essential host for those parasitic transmission needs is in the same environment (Culurgioni et al., 2015).

### 3.2. Acanthocephala identification

Acanthocephala observations using a light microscope are shown in **Figure 3**. Observations of the proboscis section as the main morphological character using a light microscope made it difficult to identify those samples at the genus level. Selected samples were then observed using a Scanning Electron Microscope (SEM). In this study, Acanthocephala were characterized by 10-12 hook lines, with 5-6 hooks in each row. Based on the morphological characteristics described by Kabata (1985), the observed samples were included in the Genus *Acanthocephalus*. The morphology of Genus *Acanthocephalus* is shown in **Figure 4**. The Genus *Acanthocephalus* is characterized by a proboscis that is quite long and has an ovoid or claviform shape, with 6-28 lines extending along its length and 4-15 hooks in each row (Kabata, 1985).

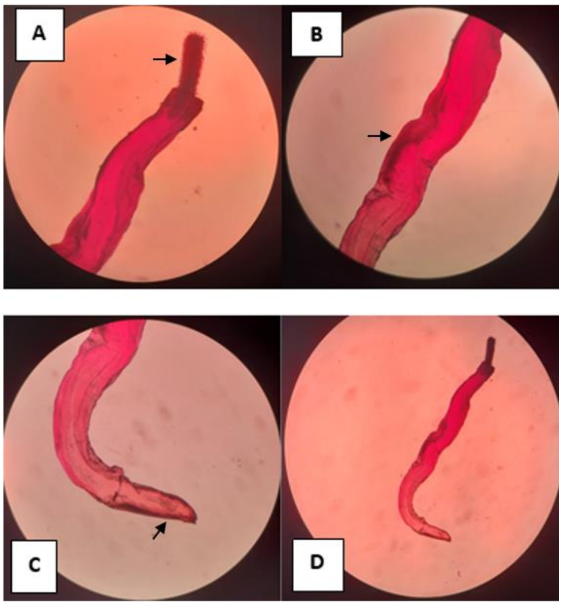


**Figure 3.** The results of observing the Acanthocephala sample using a microscope (A) the proboscis section (B) the middle/trunk (C) posterior/trunk (D) part of the whole sample.

Morphological identification showed two members of Acanthocephala infecting shortfin scads, namely Genus *Acanthocephalus*. Genus *Acanthocephalus* has been found in several fish species, some of which are the intestine of *Clarias macrocephalus* (Günther, 1864) in Thailand (Kabata, 1985); rainbow trout and Atlantic and Pacific salmon in the United States and Europe (Bruno & Ellis, 1996); *Anguilla anguilla* (Linnaeus, 1758) in France (Fazio et al., 2008); and *Decapterus kurroides* (Bleeker, 1855) in Vietnam (Amin & Van Ha, 2011). Infection of *Acanthosentis* has been reported in *Puntius gonionotus* (Bleeker, 1849) and *Puntius* sp. in Thailand (Kabata, 1985).

The presence of Acanthocephala on *D. macrosoma* at the southern coast of Yogyakarta in the present study might be developed as a biological indicator for various fish stocks and ecological studies. However, MacKenzie & Abaunza's (1998) criteria should guide the determination of the potential use of parasites as a biological indicator. Adult acanthocephalans are short-lived parasites compared to cestodes, nematodes, and larvae, and their life span in definitive hosts is generally less than one year (Brattey, 1988). Parasites with a short lifespan (less than one year) were more precisely used for short-term migration, especially for seasonal fish populations, and might not be suitable for fish stock identification, recruitment, and long-term migration (MacKenzie & Abaunza, 1998). Shih et al. (2010) state that the use of Acanthocephala as a biological tag is limited to studying the dynamics of short-term migration in fish (in season) compared to long-term differences between fish populations. Acanthocephala as a biological tag for short-term migration has been used in two blue mackerel populations (*Scomber australasicus*) in New Zealand (Smith et al., 2005).

The parasites with a single life cycle are easier to use as biological tags than those with complex life cycles. The development of parasites as biological tags requires various additional pieces of information, including other biotic and abiotic factors related to parasitic transmission. The life cycle of the Acanthocephala, which involves various organisms as its host, will help understand the distribution of parasites, the host migration area, and the food web structure in the aquatic ecosystem.

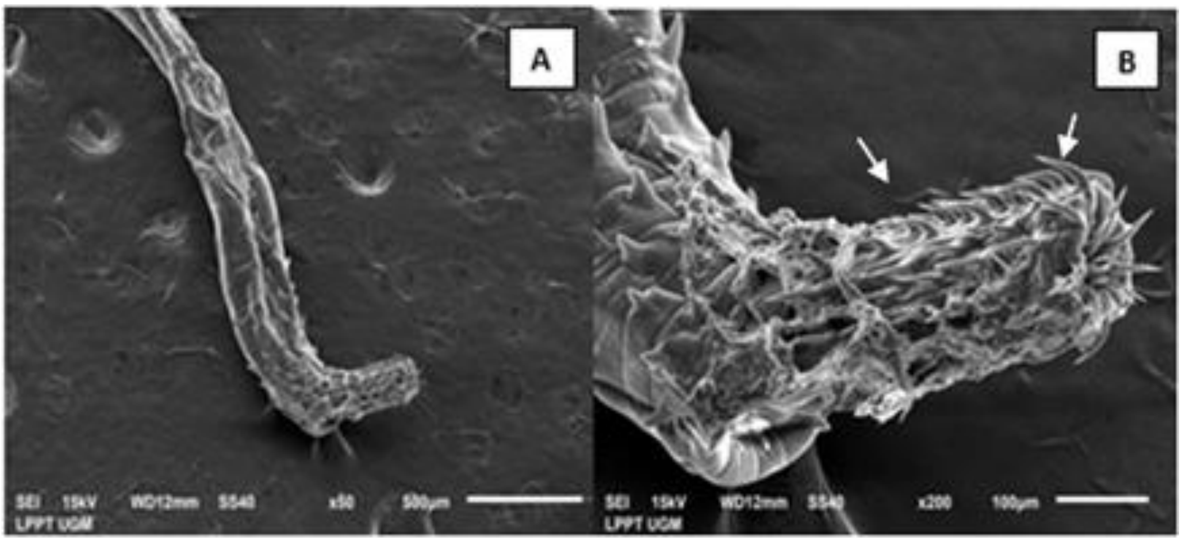


**Figure 4.** Morphology of Acanthocephala Genus *Acanthocephalus* results from SEM (A) anterior part (B) proboscis

Acanthocephalan parasites can be easily identified based on morphological and molecular characterization with the help of appropriate keys. Acanthocephalans are a diverse group of parasitic worms, with an estimated 1,100 species described within the phylum Acanthocephala (Mathison et al., 2021). Acanthocephala is rarely reported to cause severe illness or high mortality in fish because the intensity of the infection is much lower compared to other worm parasites (Shih et al., 2010). In this study, Acanthocephala might not cause acute pathogenicity due to its low infection rate (prevalence = 16.3%; mean intensity = 1.9 larvae/infected host). Furthermore, the larvae found were only attached to the mucosa of the digestive tract walls in shortfin scad (*D. macrosoma*).

## 4. Conclusion

This study confirm that Acanthocephala can infect shortfin scad, a finding that has been rarely reported before. The prevalence and mean intensity of Acanthocephala in shortfin scad caught from the southern coast of Yogyakarta were relatively low (prevalence =16.3%; mean intensity=1.9 larvae/host). Morphological identification revealed that the genus *Acanthocephalus* infects shortfin scad. Both prevalence and mean intensity tended to increase with increasing fish length. Further research is needed to investigate the abundance and distribution of Acanthocephala in other fish hosts as well as the application of molecular approaches for parasite identification.

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