Journal of Aquaculture and Fish Health Vol. 13(1) - February 2024
P-ISSN: 2301-7309 / E-ISSN: 2528-0864
doi : 10.20473/jafh.v13i1.54102

The Prevalence, Intensity and Degree of Infestation Profile *Argulus japonicus* Ectoparasite in Common Carp (*Cyprinus carpio*) at Ngawi and Tambakrejo, Sidoarjo, East Java, Indonesia

Sadida Anindya Bahtiar[1], Kismiyati[2*] and Nirattisai Petchsupa[3]
[1]Biotechnology of Fisheries and Marine Study Program, Faculty of Fisheries and Marine, Universitas Airlangga, Jl. Mulyorejo, Mulyorejo, Surabaya, East Java 60115, Indonesia
[2]Department of Aquaculture, Faculty of Fisheries and Marine, Universitas Airlangga, Jl. Mulyorejo, Mulyorejo, Surabaya, East Java 60115, Indonesia
[3]Department of Fishery, Faculty of Science and Technology, Prince of Songkhla University, Pattani Campus 94000, Thailand

*Correspondence :
kismiyati@fpk.unair.ac.id

Received : 2024-01-17
Accepted : 2024-02-01

Keywords :
Argulus japonicus, Cyprinus carpio, Prevalence, Intensity, Degree of infestation

Abstract

The demand for common carp in Indonesia is high, and the success of seed production relies on the quality of the broodstock. However, freshwater aquaculture faces challenges from diseases, particularly parasites like *Argulus japonicus*. This study aimed to determine the prevalence, intensity, and degree of infestation of *A. japonicus* on common carp. The research method was a survey. The research was conducted in October 2019 at Ngawi Fish Hatchery Center and in November 2023 at Tambakrejo Village, Waru, Sidoarjo, East Java, Indonesia. There were 26 broodstock of common carp as samples. *A. japonicus* were ectoparasites found to infest 10 common carp (*Cyprinus carpio*) broodstock that was ready to spawn at Fish Hatchery Center in Ngawi, East Java, and 16 common carp (*C. carpio*) that were raised from Tambakrejo Village farmer in Waru, Sidoarjo, East Java. The prevalence of the fish infested with *A. japonicus* was the same in 100% of both regions. However, there is a difference in the intensity of *A. japonicus* at Ngawi Fish Hatchery Center (29 individuals/head) and Tambakrejo Village, Waru, Sidoarjo (42,5 individuals/head). However, the degree of infestation in both locations was classified as severe. Attachment sites of *A. japonicus* were in the fish body surface, fins, and mouth. During the research, water quality is within normal limits that can be observed by 28°C temperature, 7.1 pH, and 2.6 mg/L DO. In conclusion, common carp in Ngawi Fish Hatchery Center and Tambakrejo Village, Waru, Sidoarjo, East Java, were infested with the heavy category of *A. japonicus*.

INTRODUCTION

In 2001, Indonesia's aquaculture industry produced 418,910 tons of common carp, accounting for 63.5% of the national production (Ariyanto, 2022). This popularity is due to its economic value, widespread availability, and demand for seeds. Common carp also contributes to the fisheries sector, with a production of

Cite this document as Bahtiar, S.A., Kismiyati and Petchsupa, N., 2024. The Prevalence, Intensity and Degree of Infestation Profile *Argulus japonicus* Ectoparasite in Common Carp (*Cyprinus carpio*) at Ngawi and Tambakrejo, Sidoarjo, East Java, Indonesia. *Journal of Aquaculture and Fish Health*, *13*(1), pp.134-143.

13,248 tons in 2021 (Ariyanto, 2022; Rahimi *et al*., 2021; SEAFDEC, 2004). However, it faces challenges such as diseases caused by parasites, leading to a decline in production. Nonetheless, common carp remains important in Indonesia's aquaculture and fisheries industries.

The future production of common carp in Indonesia is at risk due to poor broodstock quality. Most hatcheries in the country are small-scale and rely on a limited number of broodstock, increasing the risk of inbreeding (Ariyanto, 2022). Obtaining high-quality broodstock remains a challenge for carp fish farmers (Wijaya *et al*., 2021). The National Seed Agency has established criteria for quality and production techniques, but there has been a decline in both the quality and volume of carp seed production (Bondad-Reantaso, 2007). This decline can negatively impact the growth performance of fish seeds used in the industry. Prioritizing superior-quality carp broodstock is crucial for income security in rural areas of Indonesia (Wijaya *et al*., 2021).

According to the Central Bureau of Statistics of East Java, the production and value of cultured goldfish in Sidoarjo Regency, East Java reached 24 tons with a total value of Rp. 501,900,000. Meanwhile, in Ngawi Regency, the production of goldfish reached 38 tons with a total value of Rp. 751,000,000. This indicates that the production and value of cultured goldfish in both regencies are striving to meet the high demand for carp (BPS, 2021). The most commonly found ectoparasite in carp farming in Indonesia is *A. japonicus*, which causes infestation among the carp population (Rustikawati *et al*., 2004). The prevalence of *A. japonicus* in carp in Indonesia ranges from 26.7% to 65.0%. Infested carp may experience weight loss, weakness, hemorrhage, and secondary infections. Synthetic insecticides are used to control the infestation, but their use can disrupt the aquatic environment. The presence of *A. japonicus* can have significant implications for aquaculture, impacting fish health and growth and leading to economic losses. Careful consideration should be given to the use of insecticides due to potential environmental disturbances (Farizqi and Nugroho, 2021). This study's objective is to investigate the prevalence, intensity, and level of infestation of the ectoparasite *A. japonicus* on carp broodstock in Ngawi and Tambakrejo, Sidoarjo, East Java.

METHODOLOGY

Ethical Approval

This study follows international standards for the use and care of lab animals, as outlined by the American Fisheries Society and Canadian Council on Animal Care, which serve as an alternative to Ethical Approval. It is important to note that no treatments are being given to the fish in this research, only the parasites are being removed.

Place and Time

The research was conducted in October 2019 at Ngawi Fish Hatchery Center and in November 2023 at Tambakrejo Village, Waru, Sidoarjo, East Java, Indonesia.

Research Materials

The equipment used in this study is magnifying glass (Joyko MFR-9), object glass (One Lab 7101 Ground Edges), cover glass (One Lab), binocular (Nikon Eclipse E-1000), ruler, section set (DES-KIT-110), and vial bottle sample (Mutiara Labsains, IDN). The materials used in this study are common carp broodstock samples, tissue, aquades, absolute alcohol, and glycerin.

Research Design

The research design used in this study is the observational method. The way of determination and sampling using a purposive sampling method.

Cite this document as Bahtiar, S.A., Kismiyati and Petchsupa, N., 2024. The Prevalence, Intensity and Degree of Infestation Profile *Argulus japonicus* Ectoparasite in Common Carp (*Cyprinus carpio*) at Ngawi and Tambakrejo, Sidoarjo, East Java, Indonesia. *Journal of Aquaculture and Fish Health*, *13*(1), pp.134-143.

doi : 10.20473/jafh.v13i1.54102

Work Procedure
Test Fish Preparation

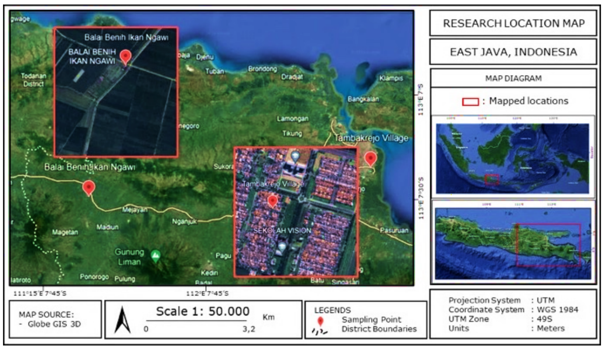

Figure 1. The collection site for research samples located at the Ngawi Fish Hatchery Center and Tambakrejo Village in Waru, Sidoarjo, East Java, Indonesia.

The research started by collecting common carp samples from Ngawi Fish Hatchery Center in October 2019. Another collection from Tambakrejo Village, Sidoarjo is planned for November 2024. Common carp samples collected from Ngawi Fish Hatchery Center (7°29'25" S 111°26'33" E) and Tambakrejo Village (7°21'12" S 112°47'17" E) can be seen in Figure 1. The purposive sampling technique was used to select a sample of 10 common carp broodstock in the size of 29 cm from Ngawi Fish Hatchery Center in East Java. In addition, 16 common carp broodstock in the size of 28 cm were collected from Tambakrejo Village, Waru, Sidoarjo, also located in East Java. Direct observation of samples and measurement of water quality are conducted on-site during the sampling process.

Parasite Identification

The research conducted involved the identification of Argulus specimens, which was carried out after the collection of samples. This was done to ensure that the *Argulus* specimens remained in optimal condition throughout the study. The identification process primarily relied on observing the shape of the respiratory area and the presence of a spur on the 4th leg. In the case of *A. japonicus*, the respiratory area is divided into two parts, namely large and small. The identification of this species is based on various characteristics of its body, including the carapace, maxilla, abdomen, respiratory area, and legs (Cesare, 1986). To identify the parasite *A. japonicus*, we compared the observed characteristics under a binocular microscope with the key identification provided by Nagasawa (2021).

Determination of Prevalence

Prevalence is the percentage of fish infected by parasites within a fish population. The determination of the prevalence rate refers to Dyer's (1998) study as presented in Table 1.

Cite this document as Bahtiar, S.A., Kismiyati and Petchsupa, N., 2024. The Prevalence, Intensity and Degree of Infestation Profile *Argulus japonicus* Ectoparasite in Common Carp (*Cyprinus carpio*) at Ngawi and Tambakrejo, Sidoarjo, East Java, Indonesia. *Journal of Aquaculture and Fish Health*, *13*(1), pp.134-143.

Table 1. The prevalence infestation parasite category refers to Dyer (1998).

No.	Infestation Category	Explanation	Prevalence
1	Always	Very severe infestation	100-99%
2	Almost always	Severe infestation	98-90%
3	Usually	Moderate infestation	89-70%
4	Very often	Very often infestation	69-50%
5	Generally	Common infestation	49-30%
6	Frequent	Frequent infestation	29-10
7	Sometimes	Sometimes infestation	9-1%
8	Rare	Rare infestation	1-0.1%
9	Vary rare	Very rare infestation	0.1-0.01%
10	Almost never	Never infestation	<0.01%

The calculation formula for prevalence (Kabata, 1985) is as follows:

$$\text{Prevalence(\%)} = \frac{\sum \text{Fish infested with parasites}}{\sum \text{Examined fish}} \text{x}100\%$$

The intensity is defined as the number of parasites found living on the infected fish host. The intensity level, as presented in Table 2.

Determination of Intensity

Table 2. Level of infestation parasite category refers to Dyer (1998).

No.	Level of Infestation	Intensity (individual/head)
1	Very low	<1
2	Low	1-5
3	Medium	6-55
4	Severe	51-100
5	Very severe	>100
6	Super infestation	>1000

The calculation of intensity is performed using the Kabata formula (1985) based on the data obtained from the examined samples as follows:

Intensity

$$\left(\text{individual}/\text{head}\right) = \frac{\sum \text{Parasites discovered}}{\sum \text{Infested fish}}$$

Determination Degree of Infestation

Samples of carp fish obtained from the Ngawi Fish Hatchery Center, East Java, and Tambakrejo Village, Waru, Sidoarjo, East Java, were separated into positive and negative samples infested with *A. japonicus*. The positive samples were counted for the number of parasites on each fish to determine the degree of infestation. The infested fish samples were then grouped based on the degree of infestation. According to Kismiyati (2009), infestation is classified as mild if 1-5 parasites are found, moderate if 6-10 parasites are found, and severe if more than 10 parasites are found. Fish without any *A. japonicus* can be considered normal and healthy.

Data Analysis

It was carried out by descriptive in the form of tables, graphs, and descriptions, and the results of data analysis are adjusted with water quality standards and analysis regression.

Cite this document as Bahtiar, S.A., Kismiyati and Petchsupa, N., 2024. The Prevalence, Intensity and Degree of Infestation Profile *Argulus japonicus* Ectoparasite in Common Carp (*Cyprinus carpio*) at Ngawi and Tambakrejo, Sidoarjo, East Java, Indonesia. *Journal of Aquaculture and Fish Health*, *13*(1), pp.134-143.

RESULTS AND DISCUSSION

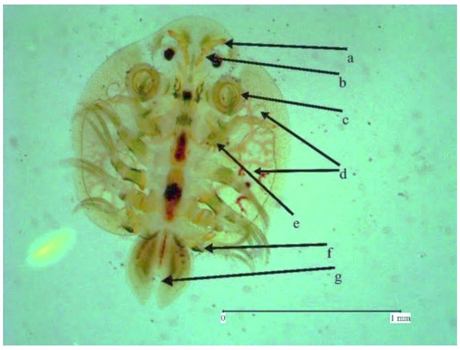

Figure 2. The result of microscopic anatomy observation of A. japonicus on carp body (40x microscopy magnification).

Description: (a) antennule, (b) antenna, (c) maxilla I, (d) respiratory area, (e) maxilla II, (f) fourth leg, (g) abdomen.

The documentation findings indicate that the Argulus specimen being studied has two respiratory areas, located at levels of maxilla sucker and second maxillae to first legs, and the abdominal region contains a divided lobe that is split in half. The maxilla sucker is surrounded by seven supporting rods, and the presence of three spines on maxilla II suggests that the species is *A. japonicus*. According to Nagasawa (2021), *A. japonicus* has paired respiratory areas consisting of a small oval anterior area and a large reniform posterior area. These areas are found at the levels of the first maxillae, second maxillae, and first legs. The first maxillae have cup-like suckers with two membranes containing 50 and 52 supporting rods respectively. Each rod is composed of six to seven sclerites.

The first segment of maxilla II has three blunt projections on the posterior margin. The abdomen is divided into two lobes and has an anal indentation that measures 46.2% of its length (Nagasawa, 2021). Different from *A. indicus* has a wide, acorn-shaped abdomen with rounded and short posterior lobes that have a slight split. The respiratory area is divided into a small, round anterior part and an extensive, elongated, rounded posterior section. The maxilla sucker of *A. indicus* has 67-76 supporting rods, each consisting of three elongated sclerites (Amriana *et al*., 2021).

A total of 26 common carp samples were collected from two different locations for the study. Among these samples, all 26 common carp were found to be infested with *A. japonicus*. The infested common carp were then divided into three groups based on the severity of infestation: mild, moderate, and severe. The results showed that all common carp from the Fish Hatchery Center in Ngawi, Jawa Timur, and Karangrejo Village in Waru, Sidoarjo, Jawa Timur were heavily infested with *A. japonicus*. This finding aligns with a previous study by Iriansyah *et al*. (2020), which found a 100% prevalence rate of ectoparasites in freshwater fish in Sukoharjo District, Indonesia. The intensity of *A. japonicus* infestation was 29 individuals per head at the Ngawi Fish Hatchery Center and 42.5 individuals per head at Tambakrejo Village, Waru, Sidoarjo. In cases of severe infestation, more than 10 *A. japonicus* were found on each common carp, as reported by Kismiyati (2009). The prevalence, intensity, and severity of infestation in common carp infested with *A. japonicus* from the two locations can be seen in Table 3.

Cite this document as Bahtiar, S.A., Kismiyati and Petchsupa, N., 2024. The Prevalence, Intensity and Degree of Infestation Profile *Argulus japonicus* Ectoparasite in Common Carp (*Cyprinus carpio*) at Ngawi and Tambakrejo, Sidoarjo, East Java, Indonesia. *Journal of Aquaculture and Fish Health*, *13*(1), pp.134-143.

Table 3. The prevalence, intensity, and severity of infestation in common carp infested with *A. japonicus* from the two locations.

Location	Examined Fish	Infested Fish	Parasite Collected	Prevalence	Mean Intensity (Individual/head)	Degree of Infestation
Ngawi	10	10	290	100%	29	Severe
Sidoarjo	16	16	680	100%	42.5	Severe

Multiple factors contribute to the high prevalence and severity in the degree of *A. japonicus* infestation in common carp. *A. japonicus* can infest a wide range of hosts, including common carp, which explains why it is so prevalent and intense in various aquatic environments. In aquaculture farms, both traditional and intensive, Argulosis caused by *A. japonicus* is commonly encountered. The proximity of fish in these settings allows for the rapid spread of infestations, leading to a higher prevalence and intensity of infestation. *A. japonicus* infestation causes fin rots, scale loss, anemic gills, and swollen inner organs. Histopathological analysis revealed severe alterations in the gills, liver, heart, and gut morphology, which can be attributed to the direct and indirect effects of this highly invasive species, *A. japonicus* (Mamun *et al*., 2021). The occurrence of *A. japonicus* infestation can be influenced by environmental factors such as water quality, temperature, and seasonal changes. Monthly variations in the prevalence, abundance, and intensity of infestation have been observed, with certain months having higher levels. This indicates that environmental factors play a significant role in shaping the dynamics of infestation (Khan *et al*., 2017; Alom *et al*., 2019).

Environmental factors such as changes in temperature or poor water quality can weaken the immune system of fish and increase their vulnerability to *A. japonicus* infestation (Riantono *et al*., 2016). Water quality parameters such as temperature and dissolved oxygen can affect the level of parasite infestation in fish. Extreme temperature changes and dissolved oxygen levels can increase the vulnerability of fish to *A. japonicus* infestation (Mahanani *et al*., 2016). The availability of suitable habitats for the development and reproduction of parasites can also influence the level of infestation. An environment that supports the development of parasites can cause an increase in infestation in fish (Sari, 2014). Additionally, the high population density of fish in aquaculture systems can affect the level of infestation of *A. japonicus*. The stocking density of carp in Fish Hatchery Center Ngawi was 10 fish/m^2, while in Tambakrejo, Sidoarjo, it reached 4 fish/m^2. This indicates that the stocking density of fish in both locations has exceeded the operational standards for carp production. According to BSN (1999), the standard stocking density for carp broodstock production is 2 fish/m^2. A high population density of fish tends to increase the risk of *A. japonicus* infestation (Juniarsih *et al*., 2017).

Numerous studies have focused on the infestation of *A. japonicus* in common carp, scientifically known as *C. carpio*. The presence of *A. japonicus* in common carp has been extensively documented in different geographical areas, highlighting its significance in terms of fish health and management. The infestation of *A. japonicus* can cause stress in fish, which can lead to the development of stress-related diseases and reduced overall health. *A. japonicus* infestation can have detrimental effects on the host fish, such as stunted growth, abnormal swimming patterns, and physical damage to the skin and fins. In cultured common carp, the high prevalence and intensity of infestation can lead to reduced feed efficiency and the development of anatomical abnormalities in the affected fish (Rahmawati *et al*., 2022). High prevalence and intensity of infestation can result in reduced feed efficiency

Cite this document as Bahtiar, S.A., Kismiyati and Petchsupa, N., 2024. The Prevalence, Intensity and Degree of Infestation Profile *Argulus japonicus* Ectoparasite in Common Carp (*Cyprinus carpio*) at Ngawi and Tambakrejo, Sidoarjo, East Java, Indonesia. *Journal of Aquaculture and Fish Health*, *13*(1), pp.134-143.

and increased economic losses for fish farmers, as they need to invest more resources in treating and controlling the infestation (Pratiwi, 2014). The prevalence and intensity values of different parasite species indicate the presence of influencing factors, such as host size. This is supported by Putri and Fauziyah (2021), who state that host size is an important and influential factor in determining the differences in prevalence and intensity values for each parasite species.

During the research, water quality was at normal limits with 28°C temperature, 7.1 pH, and 2.6 mg/L dissolved oxygen level. The water quality measurement results from the samples taken in the cultivation pond indicate that the water quality is normal and suitable for common carp. According to Fadlilah (2023), the ideal dissolved oxygen (DO) content for common carp cultivation is > 4 mg/l, the pH level should be between 6.5 and 8.5, and the temperature should be between 25-30°C. However, *A. japonicus* has a wide temperature tolerance of up to 29°C. The tested water temperature of 28°C falls within the normal range but can affect the reproductive ability of *A. japonicus*. Changes in water pH can also impact the parasite's availability and reproductive ability. The level of dissolved oxygen in the water can create suboptimal conditions for common carp growth and health (Wafer *et al*., 2015). This can lead to a higher infestation rate of *A. japonicus*, resulting in a severe infestation. Imbalances in the environment, fish, and pathogens can lead to diseases in the water body. Poor cultivation practices can cause stress in fish, weakening their immune system and making them more susceptible to diseases (Kriswijayanti *et al*., 2013).

CONCLUSION

The parasite found in common carp at Karangrejo Village, Waru, Sidoarjo, East Java, and at Ngawi Fish Hatchery Center, East Java, is *A. japonicus*. The prevalence of *A. japonicus* in common carp at both locations is 100%, with an intensity of 29 individuals per head at Ngawi Fish Hatchery Center, East Java, and 42.5 individuals per head in the Karangrejo Village, Waru, Sidoarjo, East Java. The infestation level of *A. japonicus* in common carp at these two locations in East Java is classified as severe.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest within the authorship.

AUTHOR CONTRIBUTION

Each author has contributed as follows; Bahtiar principle investigator, Kismiyati corrected and revised the manuscript so that it was suitable for scientific writing, and Nirattisai Petchsupa assisted with the proofreading.

ACKNOWLEDGMENT

Writers would like to acknowledge the valuable support provided by the Freshwater Hatchery Center in Ngawi and the common carp farmer in Karangrejo Village, Waru, Sidoarjo, East Java, Indonesia during our research efforts. Additionally, we are grateful to the Faculty of Fisheries and Marine at Universitas Airlangga for granting us access to the Cultivation and Anatomy Laboratory. We would also like to extend our thanks to all those who have contributed to the successful completion of this study.

REFERENCES

Alom, M.Z., Yasmin, M.S., Rahman, M.A. and Khan, S., 2019. Status, occurrence, intensity and impact of Argulosis in different brood stock ponds. *MOJ Ecology & Environmental Sciences,* *4*(5), pp.225–229. http://dx.doi.org/10.15406/mojes.2019.04.00158

Amriana, Sari, K.D., Sriwulan and Anshary, H., 2021. Morphological and molecular description of *Argulus indicus* Weber, 1892 (Crustacea: Branchiura) found from striped snakehead fish (*Channa striata*) in Lake Towuti, Indonesia. *AACL Bioflux, 14*(3), pp.1373-1382. http://www.bioflux.com.ro/docs/2021.1373-1382.pdf

Ariyanto, D., 2022. The use of superior common carp for a better aquaculture. *IOP Conference Series: Earth and Environmental Science, 1119*, 012061. http://dx.doi.org/10.1088/1755-1315/1119/1/012061

Bondad-Reantaso, M.G., 2007. *Assessment of freshwater fish seed resources for sustainable aquaculture: Fisheries Technical Paper*. FAO, Rome. pp.329-341. http://dx.doi.org/10.13140/RG.2.1.2133.4482

BPS [Badan Pusat Statistik], 2021. Produksi dan Nilai Produksi Perikanan Budidaya Ikan Mas dan Kakap Menurut Kabupaten/Kota dan Komoditas Utama di Provinsi Jawa Timur. https://jatim.bps.go.id/statictable/2023/03/28/2629/produksi-dan-nilai-produksi-perikanan-budidaya-ikan-mas-dan-kakap-menurut-kabupaten-kota-dan-komoditas-utama-di-provinsi-jawa-timur-2021.html

BSN [Badan Standarisasi Nasional], 1999. Produksi Induk Ikan Mas (*Cyprinus carpio Linneaus*) strain Majalaya Kelas Induk Pokok (Parent Stock). SNI:01-6131-1999. https://kkp.go.id/an-component/media/upload-gambar-pendukung/DIT%20PERBENIHAN/SNI%20Perbenihan/SNI%20Mas%20Majalaya/31_01-6131-1999.pdf

Cesare, L.C., 1986. Taksonomie Ekologie en Morfologie Van Die *Argulus muller*, 1785 (Crustacea: Branchiura) in Afrika. University of Randae Afrikaanse, pp.26-70.

Fadlilah, S., 2023. Analisis Kualitas Air sebagai Sumber Air untuk Budidaya Ikan Mas (*Cyprinus carpio*) di Sungai Gandekan, Kecamatan Magelang Selatan, Kota Magelang. Bachelor Thesis. Fakultas Pertanian. Universitas Tidar. Magelang. pp.10-13.

Farizqi, A.N. and Nugroho, W., 2021. Review: Epidemiologi dan Pengendalian Argulosis pada Ikan Mas (*Cyprinus carpio* L.) di Indonesia. *Journal of Berdaya Jurnal Pengabdian Masyarakat. 1*(2), pp.53-61. http://dx.doi.org/10.24198/job.v1i2.35897

Iriansyah, A.H., Budihardjo, A. and Sugiyarto, 2020. Parasites prevalence which infecting freshwater fishes in Mulur Reservoir of Sukoharjo District, Indonesia. *International Journal of Bonorowo Wetlands, 10*(2), pp.92-97. http://dx.doi.org/10.13057/bonorowo/w100203

Juniarsih, A., Mahasri, G. and Kismiyati, 2017. Infestations Argulus In Carp (*Cyprinus carpio*, L.) At The Pond Land Base And Concrete Base, Muntilan And Mungkid Sub-Districts, Magelang District. *Journal of Aquaculture and Fish Health, 6*(2), pp.74-80. http://dx.doi.org/10.20473/jafh.v6i2.11282

Kabata, Z., 1985. Parasites and Disease of Fish Culture in The Tropics. Taylor and Francis, London and Philadelphia. London, UK: Taylor & Francis.

Khan, S., Ali, W., Javid, M., Ullah, I., Hussain, G., Shahnaz, Z., Ullah, I. and Ullah, I., 2017. Prevalence of *Argulus* in Common Carp (*Cyprinus carpio*) From D.I. Khan (Khyber Pakhtunkhwa) Pakistan. *Journal of Entomology and Zoology Studies, 5*(1), pp.203-205. https://www.entomoljournal.com/archives/2017/vol5issue1/PartC/4-3-39-472.pdf

Kismiyati, 2009. Ektoparasit *Argulus japonicus* (Crustacea: Argulidae) pada

Ikan Maskoki *Carassius auratus* (Cypriniformes: Cyprinidae) dan Upaya Pengendalian dengan ikan Sumatera *Puntius tetrazone* (Cypriniformes: Cyprinidae). Dissertation. Universitas Airlangga. pp.20.

Kriswijayanti, B.D., Kismiyati and Kusnoto, 2013. Identifikasi dan Derajat Infestasi *Lernaea* pada Ikan Maskoki (*Carassius auratus*) di Kabupaten Tulungagung, Jawa Timur. *Journal of Aquaculture and Fish Health, 3*(1), pp.1-7. http://dx.doi.org/10.20473/jafh.v3i1.12983

Mamun, M.A.A., Nasren, S., Rathore, S.S. and Ramesh, K.S., 2021. Histopathological Studies of Pond Reared Indian Major Carp, Catla catla Infested with *Argulus japonicus* and Trial for Argulosis Treatment. *Punjab University Journal of Zoology, 36*(2), pp.131-139. https://dx.doi.org/10.17582/journal.pujz/2021.36.2.131.139

Mahanani, S.O., Kismiyati, and Sulmartiwi, L., 2016. Patologi Anatomi Ikan Komet (*Carassius auratus auratus*) Akibat Infestasi *Argulus japonicus* Jantan dan Betina Pada Derajat Infestasi yang Berbeda. *Jurnal Ilmiah Perikanan dan Kelautan, 8*(2), pp.84-93. http://dx.doi.org/10.20473/jipk.v8i2.11181

Nagasawa, K., 2021. *Argulus japonicus* (Branchiura: Argulidae) parasitic on largemouth bass *Micropterus salmoides* in Japan, with the morphology of the adult female of the argulid. *Crustacean Research*, *50*, pp.119-129. http://dx.doi.org/10.18353/crustacea.50.0_119

Pratiwi, D.A., 2014. Pengaruh Perendaman Insektisida Permetrin Terhadap Daya Tetas Telur *Argulus japonicus*. Bachelor Thesis. Faculty of Fisheries and Marine. Universitas Airlangga. p.1.

Putri, M. and Fauziyah, N.A., 2021. Prevalensi dan Intensitas Parasit *Oreochromis niloticus* pada Kolam Budidaya di PBIAT Janti dan *Barbonymus gonionotus* di BBIAT Muntilan, Jawa Tengah. *Jurnal Enggano, 6*(1), pp.138-146. https://doi.org/10.31186/jenggano.6.1.%25p

Rahimi, S.A.E., Razeky, M.M., Perdana, A.W. and Putra, D.F., 2021. The growth performance of common carp (*Cyprinus carpio*) co-cultured with different vegetable plants in aquaponics system. *DEPIK Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan. 10*(1), pp.30-34. http://dx.doi.org/10.13170/depik.10.1.19467

Rahmawati, Y., Kismiyati and Lamid, M., 2022. Efek Enzim Bromelin dari Bonggol Nanas Terhadap Efesiensi Pakan dan Patologi Anatomi pada Ikan Mas (*Cyprinus carpio*) yang Diinfestasi *Argulus japonicus*. *Proceedings Series on Physical & Formal Sciences, 4*, pp.467-474. http://dx.doi.org/10.30595/pspfs.v4i.541

Riantono, F., Kismiyati and Sulmartiwi, L., 2016. Perubahan Hematologi Ikan Mas Komet (*Carassius auratus auratus*) Akibat Infestasi *Argulus japonicus* Jantan dan *Argulus japonicus* Betina. *Journal of Aquaculture and Fish Health, 5*(2), pp.28-35. http://dx.doi.org/10.20473/jafh.v5i2.11325

Rustikawati, I., Rostika, R., Iriana, D. and Herlina, E., 2004. Intensity and Prevalence of Ectoparasites in Common Carp (*Cyprinus carpio* L.) fry from Traditional Pond and “Longyam” at Sukamulya Villages, Singaparna, Tasikmalaya. *Jurnal Akuakultur Indonesia, 3*(3), pp.33-39. http://dx.doi.org/10.19027/jai.3.33-39

Sari, N.D.K., 2014. Pengendalian Telur *Argulus japonicus* dengan Cara

Cite this document as Bahtiar, S.A., Kismiyati and Petchsupa, N., 2024. The Prevalence, Intensity and Degree of Infestation Profile *Argulus japonicus* Ectoparasite in Common Carp (*Cyprinus carpio*) at Ngawi and Tambakrejo, Sidoarjo, East Java, Indonesia. *Journal of Aquaculture and Fish Health*, *13*(1), pp.134-143.

Pengeringan. Bachelor Thesis. Fakultas Perikanan dan Kelautan. Universitas Airlangga. p.29.

SEAFDEC [Southeast Asian Fisheries Development Center], 2024. Fisheries Country Profile: Indonesia. http://www.seafdec.org/fisheries-country-profile-indonesia/

Wafer, L.N., Whitney, J.C. and Jensen, V.B., 2015. Fish Lice (*Argulus japonicus*) in Goldfish (*Carassius auratus*). *Comparative Medicine, 65*(2), pp.93–95. https://www.ingentaconnect.com/content/aalas/cm/2015/00000065/00000002/art00001

Wijaya, R.A., Zamroni, A., Hafsaridewi, R. and Hikmah, 2021. Carp hatchery business development in Subang Regency. *IOP Conference Series: Earth and Environmental Science 860*, 012055. http://dx.doi.org/10.1088/1755-1315/860/1/012055

Dyer, W.G., 1998. Parasites of Off shore, big game fishes of Puerto Rico and the Western Atlantic. *Journal of Aquatic Animal Health, 10*(3), pp.309-310. https://doi.org/10.1577/1548-8667(1998)010%3C0309:POOSBG%3E2.0.CO;2

Cite this document as Bahtiar, S.A., Kismiyati and Petchsupa, N., 2024. The Prevalence, Intensity and Degree of Infestation Profile *Argulus japonicus* Ectoparasite in Common Carp (*Cyprinus carpio*) at Ngawi and Tambakrejo, Sidoarjo, East Java, Indonesia. *Journal of Aquaculture and Fish Health*, *13*(1), pp.134-143.