Omni-Akuatika, 18 (2): 153 - 164, 2022
ISSN: 1858-3873 print / 2476-9347 online

Research Article

journal homepage: http://ojs.omniakuatika.net

Susceptibility of three indigenous Indonesian fish species: mahseer (*Tor soro*), snakehead (*Channa striata*), and bagrid catfish (*Hemibagrus nemurus*) against parasites infection

Tuti Sumiati[1], Taukhid[2]*, Septyan Andriyanto[3], and Edy Farid Wadjdy[4]

[1]Research Center for Veterinary, National Research and Innovation Agency (BRIN)
[2]Research Center for Fisheries, National Research and Innovation Agency (BRIN)
[3]Faculty of Fisheries and Marine Science, Brawijaya University – Malang
[4]Research Center or Fisheries, National Research and Innovation Agency (BRIN)

**Corresponding author: tauk001@brin.go.id, taukhid_as@yahoo.co.id*

Received 28 July 2022; Accepted 18 November 2022; Available online 22 November 2022

ABSTRACT

Mahseer "dewa" (*Tor soro*), snakehead "gabus" (*Channa striata*), and bagrid catfish "baung" (*Hemibagrus nemurus*) are indigenous fish species that are promising to be developed as freshwater aquaculture commodities in Indonesia. Disease cases/outbreaks in those fish farming have often been reported, however, there is not much information on the epizootiology and disease status of those fish species. The susceptibility of those fish to parasitic infection was evaluated by natural and artificial infection. Natural infection is the presence of parasites found naturally from wild-caught and/or farmed fish populations, and it was conducted by randomly sampling 20 fish at 5-day intervals and lasting for 20 days. In artificial infection, 150 tested fish cohabited with 40 parasite-carrying fish that were known to be definitely infected by the parasite. The observation was carried out by sampling 20 fish at 5-day intervals and lasting for 20 days. The results showed that the three fish species were susceptible to infection with *Trichodina* spp, *Epistylis* spp, *Tetrahymena* spp, *Ichtyophthirius multifiliis*, *Dactylogyrus* spp, and *Gyrodactylus* spp, while the helminth parasite *Pallisentis nagpurensis* (Acanthocephala) was only identified in snakehead. A number of parasites such as *I. multifiliis*, *Dactylogyrus* spp., and *Gyrodactylus* spp. are likely to be potential obstacles in the cultivation of those fish species, especially in hatcheries and nurseries.

Keywords: mahseer, snakehead, bagrid catfish, parasites

ABSTRAK

Ikan "dewa" (*Tor soro*), gabus (*Channa striata*), dan baung (*Hemibagrus nemurus*) merupakan jenis ikan indigenous yang prospektif untuk dikembangkan sebagai komoditas budidaya air tawar di Indonesia. Kasus/wabah penyakit pada ikan-ikan tersebut sudah sering dilaporkan, namun belum banyak informasi mengenai epizootiologi dan status penyakit pada jenis-jenis ikan tersebut. Kerentanan ikan-ikan tersebut terhadap infeksi parasit dievaluasi melalui infeksi alami dan buatan. Infeksi alami adalah adanya parasit yang ditemukan secara alami dari populasi ikan tangkapan liar dan / atau ikan budidaya, dan dilakukan dengan mengambil sampel 20 ikan secara acak dengan interval 5 hari dan berlangsung selama 20 hari. Pada infeksi buatan, 150 ekor ikan uji dipelihara bersama (kohabitasi) 40 ekor ikan yang telah diketahui sedang terinfeksi oleh parasit. Pengamatan dilakukan dengan mengambil sampel 20 ekor ikan dengan interval 5 hari dan berlangsung selama 20 hari. Hasil penelitian menunjukkan bahwa ketiga spesies ikan tersebut rentan terinfeksi *Trichodina* spp, *Epistylis* spp, *Tetrahymena* spp, *Ichtyophthirius multifiliis*, *Dactylogyrus* spp, dan *Gyrodactylus* spp, sedangkan parasit cacing *Pallisentis nagpurensis* (Acanthocephala) hanya teridentifikasi pada ikan gabus. Sejumlah parasit seperti *I. multifiliis*, *Dactylogyrus* spp. dan *Gyrodactylus* spp. berpotensi menjadi kendala potensial dalam budidaya jenis-jenis ikan tersebut, terutama di unit pembenihan dan pendederan.

Kata kunci: ikan dewa, gabus, baung, parasit

http://dx.doi.org/10.20884/1.oa.2022.18.2.1000

1. Introduction

Indonesia is endowed with a diversity of native “indigenous” species of freshwater fish species which have the potential to be cultivated, both as consumption fish and ornamental fish. Mahseer "ikan dewa" (*Tor soro*), bagrid catfish "baung" (*Hemibagrus nemurus*), and snakehead "gabus" (*Channa striata*) are indigenous fish species that are likely to be developed as freshwater aquaculture commodities. The strengths of these three fish species are their "local wisdom", high socio-economic feasibility, and eco-biological suitability to be developed as national aquaculture commodities.

Mahseer (*T. soro*) is a fish of exclusive consumption, especially in Indonesia and Malaysia, with high albumin content, and economic value (Arifin *et al*., 2019). The population of mahseer in the wild has been greatly reduced due to continuous exploitation, however, it has not been widely cultured to meet consumer demands, and restocking to its endangered natural habitat. Under *ex-situ* it’s habitat, mahseer has been successfully spawned in controlled systems and has been able to adapt to artificial feed (Haryono & Subagja, 2007; Subagja *et al*., 2009; Arifin *et al*., 2019).

Snakehead (*C. striata*) is a freshwater predatory fish consisting of two genera, *Channa* spp. which is distributed in Asia, Malaysia, and Indonesia; and *Parachanna* spp. in Africa (Courtenay & Williams, 2004). Snakehead contains a high level of albumin, often used as a health supplement medically (Rahman *et al*., 2018; Alviodinasyari *et al*., 2019). The countless medicinal properties of snakehead extract include accelerating wound healing (Pratiwi, 2021), anti-inflammatory (Abedi *et al*., 2012); and it is often used to treat hypoalbuminemia (Chasanah *et al*., 2015; Pratiwi, 2021). The fulfillment of snakehead supply, both for consumption and medical purposes, still largely relies on catches from nature (Shafri & Manan, 2012). This tendency will certainly continue, and if there is no measurable and sustainable anticipatory action; it is likely that in the near future, the supply of snakeheads will suffer from scarcity.

Bagrid catfish (*H. nemurus*) belongs to the genus *Hemibagrus* which is a member of the bagridae family, inhabiting both fresh and brackish water in Asia and Africa. The cultivation of this species continues to expand, both intensively and extensively (Taukhid *et al*., 2020). Other than being cultivated in backyard ponds, and irrigation; farming this species in floating net cages in lakes/reservoirs and rivers has also been increasingly recognized as a potential and growing people's economic enterprise.

Ex-situ culture technologies for mahseer, bagrid catfish, and snakehead have been widely studied, established, and commercially applied by fish farmers; primarily in Java, Sumatra, and Kalimantan (Arifin *et al*., 2019; Muslim, 2019; Sukendi *et al*., 2019; Taukhid *et al*., 2020; Pratiwi, 2021). In the course of its development; numerous disease occurrences, and resulting in significant mortality in the farming of those fish species have been frequently reported, especially in hatcheries and nurseries caused by parasite infection (Taukhid *et al*., 2020). Furthermore, it could be said that mostly, health management and disease control are less understood aspects of freshwater aquaculture, especially for fish species that are relatively newly developed for aquaculture purposes. Due to limited data and information on the disease etiological agents, and the epizootiology of specific pathogens of these fish species, so controlling technologies cannot be formulated into measurable actions.

Parasites are organisms that live on other organisms for attachment and/or feeding purposes. Parasitic diseases contribute significantly to decreased fish performance, growth, and cause irritation and inflammation to fish organs which in turn trigger secondary infections by other pathogenic agents. It also leads to high production costs, especially for disease control which will ultimately reduce the profit of fish farmers (Pantoja *et al*. 2012). NAAHS (2014) estimated the national economic loss due to parasitic diseases caused by protozoan parasite, *Ichthyophthirius multifiliis* infection in freshwater aquaculture in Indonesia amounted to 2.5 billion rupiah/year. Monir *et al*. (2015) calculated the economic loss due to parasitic diseases in cyprinid fish farming in Bangladesh to reach BDT 35,552.50/ha/year or equivalent to IDR 6 million/ha/year. Furthermore, it was estimated that the overall loss due to parasitic diseases resulted in 11% mortality, and 11% control costs and inhibited fish growth by 65%.

Many parasite species are host-specific to some extent and are capable of infecting one or only a limited number of host species. Host-specificity varies widely among different taxa of parasite. Most parasite species have been recorded from a single species or from very few species of hosts, and only a few parasites have been recorded infecting all of fish species. Some parasites live inside the host's body and some other parasites living outside the host body (Lom & Dykova, 1992).

Based on the experience and problems of parasitic diseases that are widely complained about, and reported by fish farmers of the three fish species, it is necessary to study the status of parasitic diseases that infect the three fish species as an anticipatory step in developing control strategies. This study is aimed to assess the susceptibility to parasitic infections that could potentially be an impediment to the cultivation of those fish species so that control options and strategies could be formulated effectively.

2. Materials and methods

Fish samples

The fish used were mahseer, bagrid catfish, and snakehead which were obtained from different locations with the population size of each species ≈ 750 fish. Mahseer sized 2.0 - 8.0 cm in total length, the population was obtained from controlled hatcheries belong to The Freshwater Germplasm Research Installation - Cijeruk, Bogor; and the hatchery implemented a biosecurity system. Bagrid catfish sized 3.5 - 7.5 cm in total length was obtained from private hatcheries in West Java; and the hatchery only uses water supply from borehole well. Unlike mahseer and bagrid catfish, since there are no hatcheries specifically for snakehead, the population of snakehead in the present study was obtained from wild-caught in Indramayu, and Bogor, West Java. Range total length size of the fish are 4.0 - 10.0 cm.

It was assumed that respective fish species was a single population, each maintained in separate concrete ponds @ 2 x 4 x 0.8 m^3 equipped with an aeration system, and the acclimatization process was set for 3 days in these containers. The feed given was a combination of natural feed (*Tubifex* spp.) and commercial feed with a protein content of ≈ 30%, at 5-10% of body weight/day. No water changes were made during the acclimatization period.

Parasite-carrying fish

The source of parasite-carrying fish used in the artificial infection process were catfish "lele dumbo" (*Clarias* spp.), pangasius "patin" (*Pangasius hypophthalmus*), common carp "mas" (*Cyprinus carpio*), and java-carp "nilem" (*Osteichilus hasselti*). The range size of those fish is 3.0 - 8.5 cm, obtained from live fish markets in Bogor and Sukabumi, West Java. Before being used as a source of infection, a number of 20 fish from each population were taken for parasites examination. The parasites found in the source of the parasite-carrying fish population are presented in Table 1.

Table 1. The parasites were found on parasite-carrying fish (dumbo catfish, pangasius, common carp, and Java carp) before being used as a source of parasite-carrying fish in an artificial infection study on the susceptibility of three indigenous Indonesian fish species to parasite infections.

Fish species	Parasite	Abundance of Infection*
Dumbo catfish (*Clarias spp.*)	*Trichodina* spp.	4.33
	Tetrahymena spp.	-
	Epistylis spp.	1.67
	Ichthyophthirius multifiliis	2.33
	Dactylogyrus spp.	4.00
	Gyrodactylus spp.	5.33
Pangasius *(Pangasius* sp.*)*	*Trichodina* spp.	0.67
	Tetrahymena spp.	1.00
	Epistylis spp.	-
	Ichthyophthirius multifiliis	1.33
	Dactylogyrus spp.	2.00
	Gyrodactylus spp.	2.67
Common carp *(Ciprinus carpio)*	*Trichodina* spp.	0.67
	Tetrahymena spp.	3.33
	Epistylis spp.	-
	Ichthyophthirius multifiliis	-
	Dactylogyrus spp.	0.67
	Gyrodactylus spp.	1.33
Java carp *(Osteichilus hasselti)*	*Trichodina* spp.	0.33
	Tetrahymena spp.	-
	Epistylis spp.	-
	Ichthyophthirius multifiliis	-
	Dactylogyrus spp.	-
	Gyrodactylus spp.	1.67

**) mean number of a particular parasite species per unit area (observation field) at 100X magnification*

Naturally and artificially parasites infection

Susceptibility to parasite infection was assessed by two methods, based on natural and artificial infection. Natural infection is the presence of parasites found in test fish populations obtained from wild-caught and/or farmed fish being used as test fish populations. Natural infection was carried out by separating 200 of each fish species, rearing them in different containers (tarpaulin ponds) equipped with aeration, and without changing new water during the study period. Parasite observation was performed by randomly sampling of 20 fish/population at 5 days intervals and lasting for 20 days.

The artificial infection was undertaken in separate containers, a total of 4 fiber tanks @ 1.0 x 2.0 x 0.5 m^3, were individually equipped with an aeration system; and each group was duplicated 2 times (duplo). Artificial infection was carried out by cohabitation method, in each of the containers, 50 test fish were reared together with 40 parasite-carrying fish that were definitely known to be infected by the parasite. Artificial infection by the cohabitation method was only carried out on mahseer and bagrid catfish, while for snakeheads was not undertaken because in these fish populations has been found almost all species of parasites naturally, where these species of parasites are also found in fish populations are intended to be used as parasite-carrying fish populations.

Observations of behavior, clinical symptoms and mortality that occurred in each container were carried out daily (morning and evening), while sampling for parasite observation purposes was carried out regularly according to a predetermined period. Examination of artificial infection were taken place through regular sampling of 20 test fish for 5 days intervals and lasting for 20 days. The feed given was a combination of natural feed (*Tubifex* spp.) and commercial feed with a protein content of ≈ 30%, at 5-10% of body weight/day. No water changes were made during the acclimatization period. No water changes were made during the observation period.

Analysis

Technical procedures of parasite examination were based on Working Instruction of Fish Parasite Examination–Research Institute for Freshwater Aquaculture and Fisheries Extension (BRPBATPP, 2020). Briefly, all visible external organs-abnormality are examined for clinical symptoms; then external parasites were observed on mucus, skin, fins, and gills. The organs were scraped with a scalpel blade, placed on a glass slide, and then observed using a compound and/or phase-contrast microscope. After the observation of external parasites was completed, then a necropsy is carried out to examine internal parasites on internal organs (liver, stomach, spleen, digestive organs, and muscle/flesh). All visible internal organs are examined for clinical symptoms, removed, and then placed on a petri dish containing phosphate-buffered saline (PBS) solution for further observation.

Parasites found were immediately transferred to a glass slide and covered with a cover-slip for further fixation and/or immediate identification according to standard methods developed by Hoffman (1967), Schell (1970), Kabata (1984), Lom & Dykova (1992), Chinabut & Lim (1993), Williams & Jones (1994), Arthur & Lumanlan-Mayo (1997). Taxonomic identification of the parasite found was carried out up to the genus level. To persuade the prevalence and density of parasite infection in this study, the formula developed by Margolis *et. al*. (1982) was used to fulfill the analysis.

$$\text{Prevalence of infection (\%)} = \frac{\text{Total number of infected sample}}{\text{Total number of the examined sample}} \times 100\%$$

To assess the relative abundance of a parasite species per field of view (100x magnification), each parasite species was counted according to the internal standard method developed by the BRPBATPP (2020), by calculating the average of each parasite species from 10 replicated field of views.

$$\text{Abundance of infection (specimen/view)} = \frac{\text{No. of the parasite in a field of view of obs. (mag. 100x)}}{\text{No. of views of observation}}$$

Parasites and their abundance infecting fish test are visualized on the table, and infection prevalence was presented in graphs; then analyzed descriptively.

3. Results and Discussion

Results

In the fish used as a source of parasite-carrying fish population, 6 parasites species were found, namely *Trichodina* spp., *Tetrahymena* spp., *Epistylis* spp., *Ichthyophthirius multifiliis*, *Dactylogyrus* spp., and *Gyrodactylus* spp. (Table 1). All of the parasites were also found in the snakehead population collected from nature/wild-caught and were used in this study. However, snakehead was not used as a parasite-carrying fish because it has very different bio-ecological characteristics compared to mahseer and bagrid catfish, so it would be problematic if reared together with mahseer or bagrid catfish.

Trichodina spp. is the only parasite infecting the mahseer population obtained from the Freshwater Germplasm Research Installation – Bogor (Table 2); nevertheless, as the result of artificial infection through cohabitation technique, it was known that mahseer has susceptibility to all of the parasites are artificially infected. The results of identified parasites in mahseer during cohabited with parasite-carrying fish are presented in Table 3, and the average prevalence of parasite infection is shown in Figure 1.

The results of artificial infection revealed that mahseer has susceptibility to all parasites exposed. Table 3 and Figure 1 indicate that all of the parasites infecting mahseer population developed progressively over time, both in terms of prevalence and abundance of infection. Fish mortality began to occur since the first sampling, especially in the parasite-carrying fish, and continued persistently until the end of the observation. Meanwhile, mahseer mortality began to occur in the second sampling with the same pattern and tendency. The primary etiological agent of mahseer mortality is strongly

Table 2. Identified and prevalence of naturally found parasites in mahseer (*Tor soro*) and bagrid catfish (*Hemibagrus nemurus*), their development during the observation period without any cohabitation with parasite-carrying fishes

Sampling time	Organs	Parasite species (Fish)	Prevalence (%)
I (0 day)	skin, mucus, fins, gills, and internal organs	*Trichodina* spp. (*mahseer*)	30
		Tetrahymena spp. (bagrid catfis)	10
II (5 days)	skin, mucus, fins, gills, and internal organs	*Trichodina* spp. (*mahseer*)	35
		Tetrahymena spp. (bagrid catfis)	25
III (10 days)	skin, mucus, fins, gills, and internal organs	*Trichodina* spp. (*mahseer*)	50
		Tetrahymena spp. (bagrid catfis)	30
IV (15 days)	skin, mucus, fins, gills, and internal organs	*Trichodina* spp. (*mahseer*)	65
		Tetrahymena spp. (bagrid catfis)	30
V (20 days)	skin, mucus, fins, gills, and internal organs	*Trichodina* spp. (*mahseer*)	70
		Tetrahymena spp. (bagrid catfis)	45

Table 3. Identified parasites in mahseer (*Tor soro*) during cohabited with parasite-carrying fish (catfish, pangasius, common carp, and java carp)

Sampling time	Organs	Parasites	Density of infection*
I (5 days p.i.)	skin, mucus, fins, gills	*Trichodina* spp.	2.00
		Ichthypthirius multifiliis	1.67
		Gyrodactylus spp.	1.67
		Dactylogyrus spp.	2.33
	internal organs	-	-
II (10 days p.i.)	skin, mucus, fins, gills	*Trichodina* spp.	2.67
		I. multifiliis	3.67
		Gyrodactylus spp.	2.33
		Dactylogyrus spp.	3.00
		Tetrahymena spp.	2.67
		Epistylis spp.	1.00
III (15 days p.i.)	skin, mucus, fins, gills	*Trichodina* spp.	3.33
		I. multifiliis	4.33
		Gyrodactylus spp.	3.00
		Dactylogyrus spp.	3.67
		Tetrahymena spp.	3.00
		Epistylis spp.	2.33
	internal organs	-	-
IV (20 days p.i.)	skin, mucus, fins, gills	*Trichodina* spp.	3.33
		I. multifiliis	4.00
		Gyrodactylus spp.	3.67
		Dactylogyrus spp.	3.67
		Tetrahymena spp.	3.33
		Epistylis spp.	3.00
	internal organs	-	-

notes: p.i. (post infection), * abundance (mean number of individuals of a particular parasite species per unit area of observation field at 100X magnification; 10x replicates)

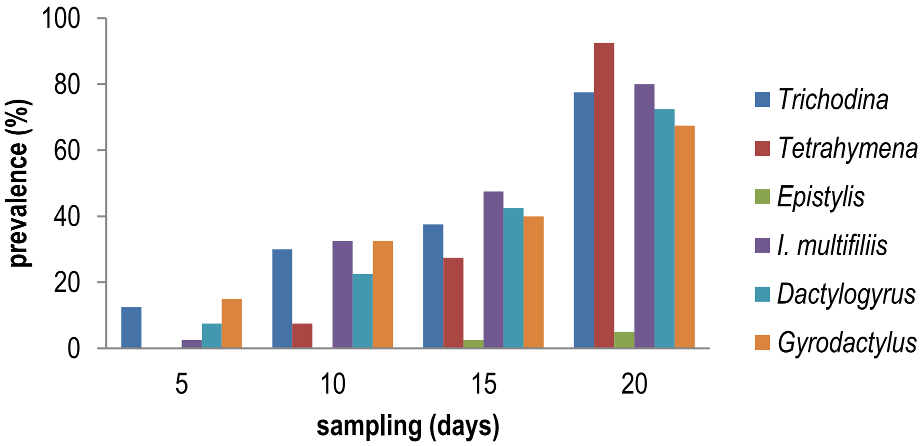

Figure 1. Prevalence of parasitic infection in mahseer fish "ikan dewa" (*Tor soro*) during artificial infection by cohabitation with parasite-carrying fish for 20 days

suspected to be parasitic infection, as all observed moribund and newly dead fish specimens were infected with more than one species of the parasite with high abundance.

The parasite infecting bagrid catfish population originated from the hatchery unit in the West Java area, there is only *Tetrahymena* spp. (Table 2). As happened on mahseer, it turns out that bagrid catfish have susceptibility to all parasites induced. The results of identified parasites in bagrid catfish during cohabited with parasite-carrying fish are presented in Table 4, and the average prevalence of parasite infection is shown in Figure 2.

Bagrid catfish are also susceptible to parasites that are exposed through cohabitation techniques. Table 4 and Figure 2 show that all parasites infecting bagrid catfish were progressively developing over time, both in terms of prevalence and infection abundance. Fish mortality started to appear at the first sampling, and appeared in both groups, the parasite-carrying fish population, and the bagrid catfish. This was an ongoing occurrence, and by the end of the observation, there were no surviving bagrid catfish.

Parasites infecting snakehead when it comes to our wet-laboratory, there are many species of parasites found, and they naturally occurred. The identification results show that the parasites infecting snakeheads are common parasite species as they infect other freshwater farmed fish species. Since the parasite species found in snakehead fish are diverse enough, no artificial infection was conducted in this study. However, the development of parasitic infection was recorded and measured using prevalence and abundance indicators. The observation result for these parameters is presented in Table 5 and Figure 3.

Table 5 and Figure 3, showed that the progression of infection of all parasite species found in wild-caught snakehead populations had the same pattern as that of artificially infected mahseer and bagrid catfish, i.e. it developed progressively as time passed. Mortality of

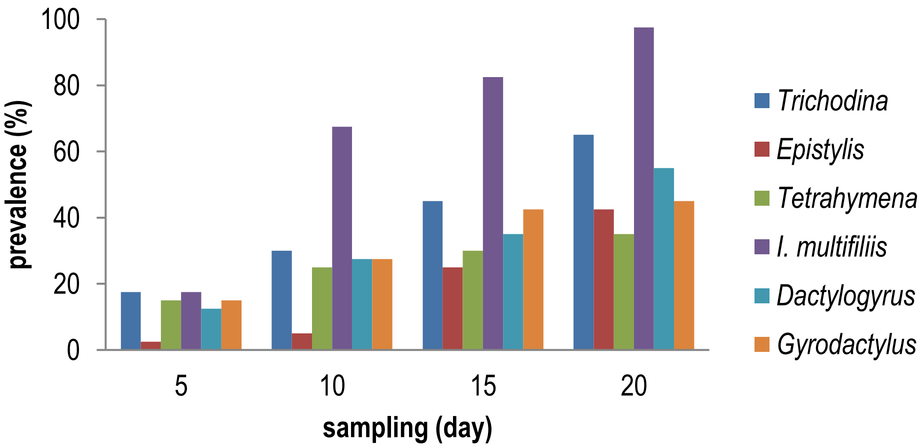

Figure 2. Prevalence of parasitic infection in bagrid catfish "ikan baung" (*Hemibagrus nemurus*) during artificial infection by cohabitation with parasite-carrying fish for 20 days

Table 4. Identified parasites in bagrid catfish (*Hemibagrus nemurus*) during cohabitated with parasite-carrying fish (catfish, pangasius, common carp, and java carp)

Sampling time	Organs	Parasite	Abundance of infection*
I (5 days p.i.)	skin, mucus, fins, gills	*Trichodina* spp.	2.33
		I. multifiliis	2.00
		Gyrodactylus spp.	1.67
		Dactylogyrus spp.	0.67
		Tetrahymena spp.	2.67
		Epistylis spp	1.33
	internal organs	-	-
II (10 days p.i.)	skin, mucus, fins, gills	*Trichodina* spp.	2.00
		I. multifiliis	2.33
		Gyrodactylus spp.	2.67
		Dactylogyrus spp.	1.00
		Tetrahymena spp.	3.00
		Epistylis spp	1.33
	internal organs	-	-
III (15 days p.i.)	skin, mucus, fins, gills	*Trichodina* spp.	2.67
		I. multifiliis	3.67
		Gyrodactylus spp.	2.67
		Dactylogyrus spp.	2.00
		Tetrahymena spp.	3.33
		Epistylis spp	3.67
	internal organs	-	-
IV (20 days p.i.)	skin, mucus, fins, gills	*Trichodina* spp.	4.00
		I. multifiliis	3.33
		Gyrodactylus spp.	3.00
		Dactylogyrus spp.	3.33
		Tetrahymena spp.	2.00
		Epistylis spp	4.00
	internal organs	-	-

Note: p.i. (post infection), * mean number of individuals of a particular parasite species per unit area of observation field at 100X magnification; 10x replicates)

snakehead began to occur during the adaptation process and continued till the end of the observation.

Discussion

The objective of this study was to assess the susceptibility of mahseer "semah", bagrid catfish "baung", and snakehead "gabus" to parasitic infections, both naturally and artificially infections by using cohabitation techniques. Based on the results of the study, it was revealed that the three fish species are susceptible to parasitic infections, which could potentially be an obstacle in the culturing of the three fish species. Experience has shown that a number of parasites such as *I. multifiliis*, *Dactylogyrus* spp. and *Gyrodactylus* spp. infecting cultured fishes

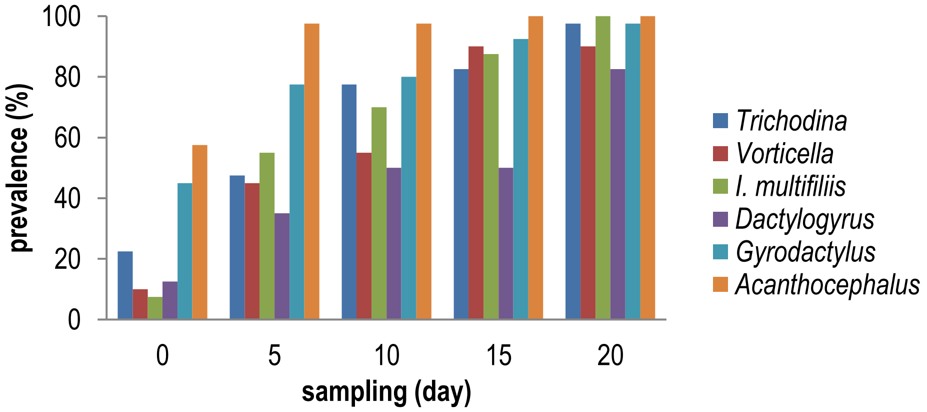

Figure 3. Prevalence of parasitic infection in snakehead "ikan gabus" (*Channa striata*) collected from natural habitat/wild-caught

Table 5. Species of parasites were found in snakehead from wild-caught

Sampling time	Organs	Parasite	Abundance of infection*
I (first day)	skin, mucus, fins, gills	*Trichodina* spp.	0.33
		I. multifiliis	0.67
		Gyrodactylus spp.	0.33
		Dactylogyrus spp.	1.00
		Vorticella spp.	0.33
	internal organs	Acanthocephala	1.67
II (5th day)	skin, mucus, fins, gills	*Trichodina* spp.	1.67
		I. multifiliis	2.00
		Gyrodactylus spp.	1.67
		Dactylogyrus spp.	2.33
		Vorticella spp.	3.33
	internal organs	Acanthocephala	2.00
III (10th day)	skin, mucus, fins, gills	*Trichodina* spp.	1.33
		I. multifiliis	2.33
		Gyrodactylus spp.	3.00
		Dactylogyrus spp.	2.67
		Vorticella spp.	3.00
	internal organs	Acanthocephala	2.67
IV (15th day)	skin, mucus, fins, gills	*Trichodina* spp.	2.00
		I. multifiliis	3.67
		Gyrodactylus spp.	3.00
		Dactylogyrus spp.	3.33
		Vorticella spp.	2.67
	internal organs	Acanthocephala	3.67
	skin, mucus, fins, gills	*Trichodina* spp.	3.33
V (20th day)		*I. multifiliis*	3.67
		Gyrodactylus spp.	3.00
		Dactylogyrus spp.	3.67
		Vorticella spp.	2.67
	internal organs	Acanthocephala	3.00

Note: p.i. (post infection), mean number of a particular parasite species per unit area of observation field at 100X magnification; 10x replicates)

have had serious impacts on aquaculture practices. Although accurate data on economic losses for each parasite species is not available and relatively untraceable; empirically, it is often experienced by practitioners that parasitic diseases contribute significantly to the unsuccessful farming of freshwater fish, especially in hatcheries up to fingerling size.

I. multifiliis, *Dactylogyrus* spp., and *Gyrodactylus* spp. are parasites that are capable of infecting more than one species of fish; and within a single organ, more than one parasite species may be infected (co-infection), resulting in more severe and serious anatomical pathology. In actual practice, disease outbreaks caused by parasitic infections rarely involve only one pathogenic agent, but in many cases collaborate with at least 2 different pathogenic agents, or possibly even more. The involvement of parasites such as *I. multifiliis*, *Dactylogyrus* spp., and *Gyrodactylus* spp. are the most commonly reported parasitic diseases accompanied by mortality in the hatchery of freshwater aquaculture (BRPBATPP, 2019).

White spot disease is a serious challenge to the main commodities of freshwater fish culture in Indonesia, both for consumption and ornamental fish. Accordingly, the MMAF stipulates that white spot is one of the diseases listed in the "List of important fish diseases in Indonesian aquaculture" which must be monitored and controlled (DGA, 2017 and 2018). Outbreaks of white spot disease in mahseer, have not been well documented; though in the West Java Region it is frequently reported. In bagrid catfish, the disease is a serious constraint, especially in the early stages up to fingerling size, which is normally reared in earthen/concrete ponds (Taukhid *et al*., 2020). Whereas in snakehead, *I. multifiliis* has been reported in fish collected from rivers in East Java (Yunus & Wijaya, 2022).

NAAHS (2014) estimated national economic losses due to parasitic diseases caused by *I. multifiliis* (white-spot) infection in freshwater aquaculture in Indonesia at 2.5 billion rupiah/year. In reality, this type of parasite is always accompanied by other parasite infections such as

Dactylogyrus spp. and *Gyrodactylus* spp.. Monir *et al*. (2015) calculated the economic loss due to parasitic diseases in cyprinid fish farming in Bangladesh reached BDT 35,552.50/ha/year or equivalent to IDR 6 million/ha/year. Furthermore, it was estimated that the overall loss due to parasitic diseases resulted in 11% mortality, and 11% increase of production costs and inhibited fish growth by 65%.

Other protozoan parasite species that have been shown to infect these fish species are still likely to be a constraint in their hatcheries. *Trichodina* spp., *Tetrahymena* spp., *Epistylis* spp. and *Vorticella* spp. are considered potential obstacles in hatcheries and nurseries; even though eco-biologically these protozoan parasites are more likely to be facultative parasites and are mostly found in fry to fingerling sizes. Parasites have the ability to multiply rapidly under certain environmental conditions or when fish are stressed by other factors. Once the parasite attaches to the epithelial layer of the fish, it immediately damages the cells around its attachment site, feeding on the destroyed epithelial cells and causing serious irritation (Kabata, 1984; Lom & Dycova, 1992; Noga, 1996; Buchmann *et al*., 2001; Bruno *et al*., 2006).

Infection of *Trichodina* spp. or the other protozoan opportunism parasitic on mahseer has been reported from aquaculture ponds and wild populations (Muchlisin *et al*., 2014), on bagrid catfish (Theerawoot, 2008), and on snakehead (Deb *et al*., 2015; Akther *et al*., 2018; Novita *et al*., 2020; Sembiring *et al*., 2021; Zaiyana *et al*., 2022). Moreover, it was mentioned that massive infections of those parasites can directly result in superficial skin lesions which then allow secondary bacterial and fungal infections to develop at the affected sites. Disease outbreaks involving those parasites are generally triggered by poor fish health management practices such as excessive stocking density, poor water quality especially high organic matter and low oxygen levels, malnutrition, and not applying biosecurity concepts.

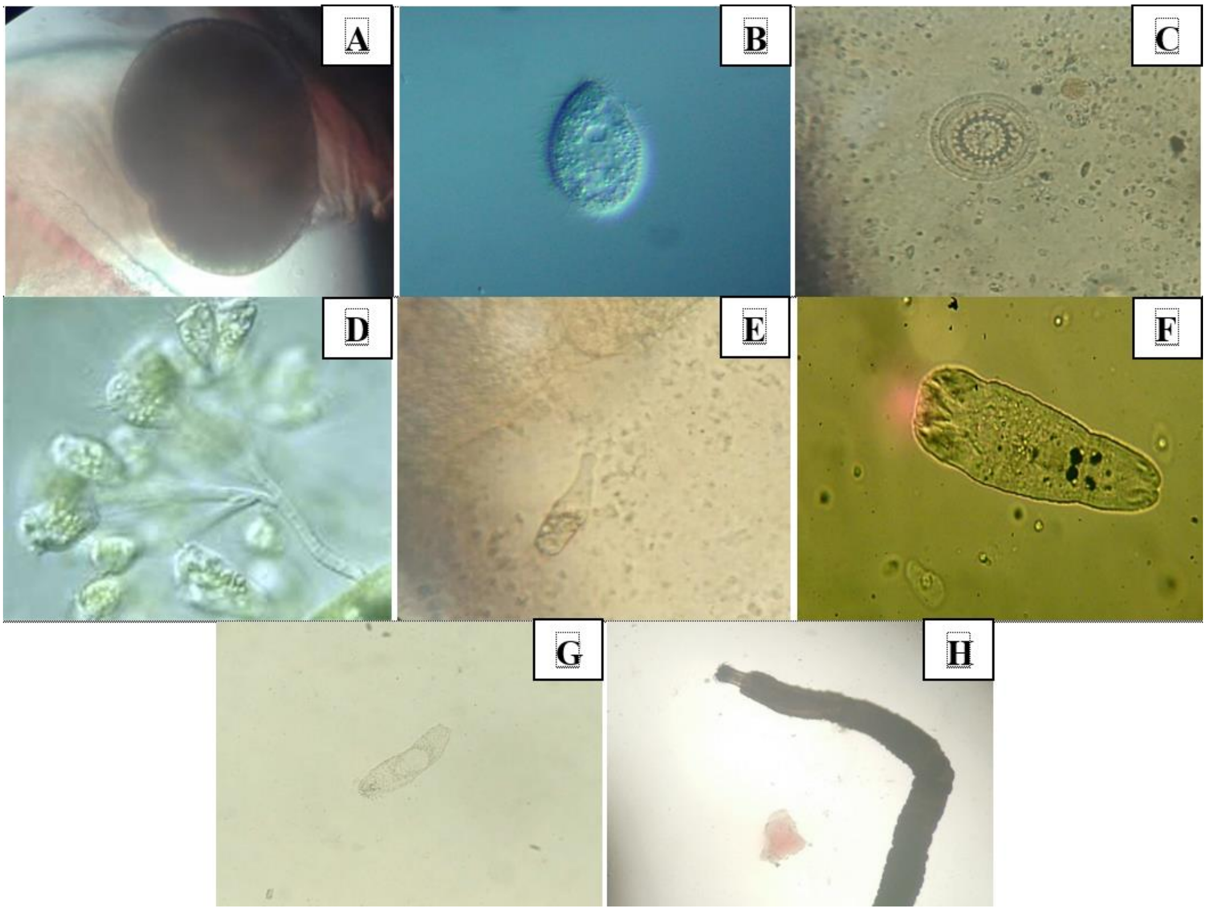

Figure 4. Parasites were observed from mahseer, bagrid catfish, and snakehead in natural habitat and/or artificial infection/cohabitation with parasite-carrying fish (A = *Ichthyophthirius multifiliis*, B = *Tetrahymena* spp., C = *Trichodina* spp., D = *Epistylis* spp., E = *Vorticella* spp., F = *Dactylogyrus* spp., G = *Gyrodactylus* spp., and H = *Acanthocephalus* spp.)

Dactylogyrus spp. and *Gyrodactylus* spp. are ectoparasitic organisms that infect the gills, skin, and fins of fish; in their life cycle only require a single host, and they do generally not host species specific. It has a posterior attachment device equipped with hooks and suction devices. *Dactylogyrus* spp. is named ”gill fluke” because it is the main target organ of infection, and reproduces by laying eggs. Whereas *Gyrodactylus* spp. is more commonly found on the fins and skin of fish, reproducing by breeding. The mucus layer covering the skin, gills, and fins can serve as the first line of defense against these harmful organisms. Infected organs are congested or pale hemorrhagic, with hyper secretion of mucus.

Disease cases by monogenetic trematodes (*Dactylogyrus* spp. and *Gyrodactylus* spp.) on mahseer in Indonesia have not been reported. In bagrid catfish, the disease has been noted (Theerawoot, 2008; Modu *et al*., 2012; Taukhid *et al*., 2020); and the disease is more likely would be a significant constraint on snackhead farming (Akther *et al*., 2018; Novita *et al*., 2020; Sembiring *et al*., 2021), particularly in the early stages up to fingerling size.

Pallisentis nagpurensis (Acanthocephalans) is an endoparasitic worms characterized by a retractable proboscis armed with rows of hooks used to attach to the gut of fish. Young stages live as parasites on crustaceans/insects as intermediate hosts, while adults live in the digestive tract of vertebrates, especially fish as the final hosts. Acanthocephalans are very common in predatory fish such as snakehead (Kennedy, 1981; Umara *et al*., 2014; Chowdhury & Hossain, 2015). Furthermore, it was mentioned that infection of the parasite causies fibrotic nodules on the gut surface. The gut may become inflamed with the destruction of intestinal villi and resulting in necrotic and degenerative changes in the mucosal epithelium. Parasitized fish may be emaciated with an inflamed intestinal tract and tissue necrosis in areas where the worms are attached to the intestinal wall. A mild infection, the pathological-anatomical impact causes the fish to grow very slowly because its nutrients are also utilized by the parasite; however, at the high intensity, it can cause death because it damages the walls of the fish's digestive organs.

4. Conclusion

Mahseer, bagrid catfish, and snakehead are susceptible to several species of parasites that are commonly encountered in freshwater farmed fish species. The parasites that are definitely known to infect the three fish species are *Trichodina* spp., *Epistylis* spp., *Tetrahymena* spp., *Ichtyophthirius multifiliis*, *Dactylogyrus* spp. and *Gyrodactylus* spp. while the helminth parasite *Pallisentis nagpurensis* (Acanthocephalans) was only observed in the digestive organs of snakehead. A number of parasites such as *I. multifiliis*, *Dactylogyrus* spp. and *Gyrodactylus* spp. are potential threats in the cultivation of the three fish species, especially in the hatchery and nursery units.

References

Abedi, S., Ehtesham F, F., Khairi Hus, M., Ahmad, Z., & Manan Mat, A. (2012). Effects of Haruan (*Channa striatus*) Based Cream on Acute Inflammation in Croton Oil Induced Mice Ear Edema Model. *Research Journal of Biological Sciences*, *7*(4), 181–187. https://doi.org/ 10.3923/rjbsci.2012.181.187

Akther, S., Hakkani, E., aman, A., & Mohanta, M. K. (2018). Prevalence of Parasitic Infestations in the Freshwater Fish, *Channa punctatus* (Bloch) from Rajshahi Metropolitan, Bangladesh. *International Journal of Current Microbiology and Applied Sciences*, *7*(04), 3431–3441. https://doi.org/ 10.20546/ijcmas.2018.704.388

Alviodinasyari, R., Pribadi, E. S., & Soejoedono, R. D. (2019). Soluble protein concentration in two species of snakeheads fish albumin from Bogor origin (*Channa striata* and *Channa micropeltes*). *Jurnal Veteriner*, *20*(3), 436. https://doi.org/10.19087/jveteriner.2019.2 0.3.436

Arifin, O. Z., Subagja, J., Asih, S., & Kristanto, A. H. (2019). *Budidaya Ikan Dewa*. IPB Press.

Arthur, J.R. & Lumanlan-Mayo, S. (1997). Checklist of the parasites of fishes of the Philippines. FAO Fisheries Technical Paper. No. 369. Rome, FAO. 1997. 102p.

BRPBATPP. (2019). Kompilasi Laporan Hasil Uji Laboratorium periode 2014 - 2018. Balai Riset Perikanan Budidaya Air Tawar, Pusat Riset Perikanan, Badan Riset dan Sumber Daya Manusia Kelautan dan Perikanan. (Tidak dipublikasikan).

BRPBATPP. (2020). Instruksi Kerja (IK) Ruang Lingkup Pengujian Parasit Ikan. Laboratorium Uji -BRPBATPP, Pusat Riset Perikanan, BRSDMKP.

Bruno, D. W., Nowak, B., & Elliott, D. G. (2006). Guide to the identification of fish protozoan and metazoan parasites in stained tissue sections. *Diseases of Aquatic Organisms*, *70*(1–2), 1–36. https://doi.org/10.3354/dao070001

Buchmann, K., Sigh, J., Nielsen, C. V., & Dalgaard, M. (2001). Host responses against the fish parasitizing ciliate *Ichthyophthirius multifiliis*. *Veterinary Parasitology*, *100*(1–2), 105–116. https://doi.org/10.1016/S0304-4017(01)00487-3

Chasanah, E., Nurilmala, M., Purnamasari, A. R., & Fithriani, D. (2015). Chemical Composition, Albumin Content and Bioactivity of Crude Protein Extract of Native and Cultured *Channa striata*. *JPB Kelautan Dan Perikanan*, *10*(2), 123–132. https://bbp4b.litbang.kkp.go.id/jurnal-jpbkp/ index.php/jpbkp/article/view/364

Chowdhury, S. Z., & Hossain, M. M. M. (2015). Isolation and characterization of internal parasites in snakehead. *International Journal of Fisheries and Aquatic Studies*, *2*(4), 17–22. https://doi.org/ 10.22271/fish.2015.v2.i4a.331

Chinabut, S., Lim, L.H.S. (1993). Seven new species of *Dactylogyrus* Diesing, 1850 (Monogenea) from *Puntius hamilton* (Cyprinidae) of Thailand. *Raffles Bulletin of Zoology.*41(1), 47-59.

Courtenay, W. R., & Williams, J. D. (2004). Snakeheads (Pisces, Channidae) A Biological Synopsis and Risk Assessment. *Geological Survey Circular*, *1251*, 143.

Deb, M., Miah, M. F., Rahman, M., & Khan, Z. K. (2015). Trichodinid Parasites on the Gills of *Channa punctatus* from the Wild and Cultured Environments in Sylhet, Bangladesh . *Advances in Zoology*, *2015*, 1–4. https://doi.org/10.1155/2015/161562

DGA. (2017). Kep. Dirjen Perikanan Budidaya Nomor 16/Kep-DJPB/2017 tentang Daftar Penyakit Ikan Utama dan Target Monitoring Penyakit Ikan Tahun 2017.

DGA. (2018). Kep. Dirjen Perikanan Budidaya Nomor 6/Kep-DJPB/2018 tentang Daftar Penyakit Ikan Utama dan Target Monitoring Penyakit Ikan Tahun 2018.

Dickerson, H. W., & Findly, R. C. (2014). Immunity to *Ichthyophthirius infections* in fish: A synopsis. *Developmental and Comparative Immunology*, *43*(2), 290–299. https://doi.org/ 10.1016/j.dci.2013.06.004

Haryono & Subagja, J. (2007). Pertumbuhan ikan tambra (Tor tambroides) dan kancra (Tor soro) pada proses domestikasi dengan jenis pakan yang berbeda. Jurnal Biologi Indonesia 4 (3): 167–175.

Hoffman, G.L. (*1967)*. Parasites of North American Freshwater *Fishes*. Text Book. University of California Press, Berkeley and Los Angeles.

Kabata, Z. (1984). Parasites and diseases of fish cultured in the tropics. Taylor & Francis. 318 p.

Kennedy, M.J. (1981). *Pallisentis nagpurensis* (Bhalerao, 1931) (Acanthocephala: Quadrigyridae) from the gabus, *Ophiocephalus striatus* from Depok, Indonesia. Can. J. Zool. 59: 1847- 1851.

Lom, J., Dycova, I. (1992). Protozoan parasites of fishes. Developments in Aquaculture and Fisheries Science, 26. Elsevier Amsterdam-London-New York-Tokyo. 315 p.

Margolis, L., Esch, G.W., Holmes, J.C., Kuris, A.M., Schad, G.A. (1982). The use of ecological terms in parasitology (Report of an adhoc committee of the American society of parasitologists). J Parasitol 1982; 68(1):131-133.

Modu, B. M., Saiful, M., Kartini, M., Kassim, Z., & Hassan, M. (2012). Effect of Water Quality and Monogenean Parasite in the Gills of Freshwater Cat Fish, *Hemibagrus nemurus* Valenciennes 1840. Curr. Res. J. Biol. Sci., 4(3): 242-246, January, 1–6.

Monir, M. S., Bagum, N., Rahman, S., Ashaf-Ud-Doulah, M., Bhadra, A., & Chakra Borty, S. (2015). Parasitic diseases and estimation of loss due to infestation of parasites in Indian major carp culture ponds in Bangladesh. *~ 118 ~ International Journal of Fisheries and Aquatic Studies*, *2*(5), 118–122. www.fisheriesjournal.com

Muchlisin, Z. A., Munazir, A. M., Fuady, Z., Winaruddin, W., Sugianto, S., Adlim, M., Fadli, N., & Hendri, A. (2014). Prevalence of ectoparasites on mahseer fish (*Tor tambra* Valenciennes, 1842) from aquaculture ponds and wild population of Nagan Raya District, Indonesia. *Human and Veterinary Medicine*, *6*(3), 148–152.

Muslim, M. (2019). Teknologi pembenihan ikan gabus (*Channa striata*). Jurnal Ruaya : Jurnal Penelitian Dan Kajian Ilmu Perikanan Dan Kelautan, *7*(2), 21–25. https://doi.org/10.29406/jr.v7i2.1312

NAAHS. (2014). The National Aquatic Animal Health Strategy (NAAHS) for the Republic of Indonesia for the period 2015–2020, the outputs of the FAO Project TCP/INS/3402: Development of Preventive Aquatic Animal Health Protection Plan and Enhancing

Emergency Response Capacities to Shrimp Disease Outbreaks in Indonesia. 44p.

Noga, E.J. (1996). Fish disease: diagnosis and treatment. Mosby Year Book, Inc., St. Louis, MO, 166-170.

Novita, H., Andriyanto, S., Sugiani, D., Lusiastuti, A. M., & Caruso, D. (2020). Parasitic and bacterial diseases in aquarium-reared Indonesian snakehead (*Channa micropeltes*). *IOP Conference Series: Earth and Environmental Science*, *521*(1). https://doi.org/10.1088/1755-1315/521/1/012019.

Pantoja, M.F.W, R.L. Neves, R.D.M Diasl. (2012). Protozoan and metazoan parasites of Nile tilapia *Oreochromis niloticus* cultured in Brazil. Revista MVZ Cordova 17 (1): 2812-2819.

Pratiwi, A. T. (2021). The Potensi Ikan Gabus (*Ophiocephalus stratius*) untuk Meningkatkan Kadar Albumin Pada Penderita Hipoalbuminemia. *JIMKI: Jurnal Ilmiah Mahasiswa Kedokteran Indonesia*, *8*(3), 204–210. https://doi.org/10.53366/jimki.v8i3.254

Rahman, M., Molla, M., Sarker, M., Chowdhury, S., & Shaikh, M. (2018). Snakehead Fish (*Channa striata*) and Its Biochemical Properties for Therapeutics and Health Benefits. *SF Journal of Biotechnology and Biomedical Engineering*, *1*(1), 1–5.

Schell, S.C. (1970). The Trematods. Text Book. Wm. C. Brown Co. Dubuque, IA, USA.

Sembiring, I. R., Maryani, M., Monalisa, S. S., & Fransisco, T. (2021). Identification of Ectoparasites in Snakehead Fish (*Channa striata*) in Sebangau River Palangka Raya Central Kalimantan. *Jurnal Akuakultur Sungai Dan Danau*, *6*(2), 63. https://doi.org/10.33087/akuakultur.v6i2.112

Shafri, M. A., & A.M.J. Manan. (2012). Therapeutic potential of the haruan (*Channa striatus*): From food to medicinal uses. *Malaysian Journal of Nutrition*, *18*(1), 125–136.

Subagja, J., Sulhi., M., Asih., S., & Haryono. (2009). Aspek Ekologi Ikan Kancera (*Tor soro*) Kuningan dan Pematangan Gonad Melalui Implantasi Hormon Gonadotropin (HCG). Jurnal Biologi Indonesia, 5(3), 259–267.

Sukendi, S., Putra, R. M., & Heltonika, B. (2019). Application of Technology for Cultivation of Baung Fish (*Mystus murus* CV) in Ponds and Cages. *Unri Conference Series: Community Engagement*, *1*, 569–576.

Taukhid, Sugiani, D., & Sumiati, T. (2020). Penyakit potensial pada pembenihan ikan baung (*Hemibagrus nemurus*) dan pengendaliannya dalam Potensi Budidaya Ikan Lokal Prospektif: BAUNG *Hemibagrus nemurus*. IPB Press.

Theerawoot, L. (2008). Diversity and Distribution of External Parasites from Potentially Cultured Freshwater Fishes in Nakhonsithammarat, Southern Thailand. *Diseases in Asian Aquaculture*, 235–244.

Umara, A., Bakri, M., & Hambal, D. M. (2014). Identification of Parasites in Snakehead Fish (*Channa striata*) in Meunasah Manyang Village Lhoknga Subdistrict Aceh Besar. *Jurnal Medika Veterinaria*, *8*(2).

Williams, H.H. & A. Jones. (1994). Parasitic worms of fish.Taylor and Francis, London, 593 pp.

Yunus, M., & A. Wijaya. (2022). Histopathological Changes in Gills of Wild Snakehead Murrel, *Channa striata* (Bloch, 1793) Infected with *Ichthyophthirius multifiliis* Fouquet, 1876 from Surabaya River . *Proceedings of the 9th International Seminar on Tropical Animal Production (ISTAP 2021)*, *18*(Istap 2021), 269–272. https://doi.org/10.2991/absr.k.220207.056

Zaiyana, N., Sardi, A., Ridwan Harahap, M., Humairani, R., Paujiah, E., Rumondang, R., & Zulfahmi, I. (2022). Alteration in gills, skin, and fins of snakehead fish (*Channa striata*) due to ectoparasite infection: a macropathological and histopathological approach . *E3S Web of Conferences*, *339*(June 2021), 01001. https://doi.org/10.1051/e3sconf/2022339 01001