The Percentage of Male and Female Argulus Infesting Cyprinidae Fish in Magelang Regency, Central Java, Indonesia

by Kismiyati Kismiyati

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The Percentage of Male and Female *Argulus* Infesting Cyprinidae Fish in Magelang Regency, Central Java, Indonesia

Kismiyati[1], Alif Rizky Andika[1], Kusnoto[2]

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ABSTRACT

Background: One cause of fish disease is the *Argulus* parasite. Both male and female *Argulus* were found to infect fish. This study aims to determine the percentage difference of male and female *Argulus* that infect Cyprinidae in Magelang Regency.

Methods: The present study used a survey method. The independent variables in this study are carp (*Cyprinus carpio*), goldfish (*Carassius auratus*), comet goldfish (*Carassius auratus*), koi fish (*C. carpio* koi) and the sex of the *Argulus* parasite. The dependent variable of this study was the sex percentage of the *Argulus* parasite. The data analysis was done using analysis of variance (ANOVA) then followed by Duncan's multiple range test to find out the differences between treatments.

Result: The first ANOVA result showed no significant difference ($p>0.05$), the second ANOVA showed significantly different results ($p<0.05$) and the third ANOVA reveals no significantly different percentage ($p>0.05$). The highest infestation rate of male *Argulus japonicus* is found in koi fish (*C. carpio* koi) is 60% and the lowest is in comet goldfish, which is 38.46%. Whereas infestation of female *A. japonicus* in carp, goldfish, comet goldfish and koi fish also obtained a similar result.

Key words: *Argulus,* Cyprinidae, Fisheries, Parasite.

INTRODUCTION

Magelang Regency is one of the areas that has undergone aquaculture-based development, prioritizing the principle of efficiency, quality and sustainability (Wibowo *et al.,* 2015). The area consists of Ngluwar Sub-District, Mungkid Sub-District and Muntilan Sub-District. Cyprinidae family fish species that are cultivated in Magelang Regency are common carp (C. *carpio*), goldfish (C. *auratus*), comet fish (C. *auratus auratus*) and koi fish (C. *carpio* koi) (Badan Pusat Statistik Kab. Magelang, 2014).

The main problem in cultivating fish in Indonesia to date revolves around parasites and infectious diseases. The disease causes economic losses because it can result in less optimal fish harvest (Carella and Sirri, 2017; Das and Chandra, 2018). One cause of the disease is the infestation of parasites (Picard Sánchez *et al.,* 2020). The quality of freshwater ornamental fishes decreased due to attacks from parasites such as *Argulus* sp. (Alifuddin *et al.,* 2002).

Argulus is a crustacean branchiuran parasite that causes severe problems in aquaculture throughout the world. Around 129 species of *Argulus* (family: Argulidae) are distributed worldwide and 12 species have been described in various freshwater, brackish water, marine and ornamental fish in India (Kumar *et al.,* 2017). Among them, *A. japonicus* are considered as emerging pathogens of freshwater, brackish water and coldwater fish worldwide (Tandel *et al.,* 2021).

Morphological identification of *Argulus* sp. is mostly based on distinguishing features of an adult male such as carapace and abdominal length or width, dorsal ridges of the carapace, respiratory areas, leg pigments, abdominal lobes and incision and the presence of a small coxal at the swimming appendages (Sahoo *et al.,* 2013; Soes *et al.,* 2010), requiring experienced taxonomists.

[1]Department of Aquaculture, Faculty of Fisheries and Marine, Universitas Airlangga, Indonesia.
[2]Department of Parasitology Veterinary, Faculty of Veterinary Medicine, Universitas Airlangga, Indonesia.

Corresponding Author: Kismiyati, Department of Aquaculture, Faculty of Fisheries and Marine, Universitas Airlangga, Indonesia. Email: kismiyati@fpk.unair.ac.id

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Argulus is one of the ectoparasites that attacks the Cyprinidae (Wardany and Kurniawan, 2014). *Argulus* attacks the fins, skin, gill and the entire surface of the host body (Pramujirini, 2016). Fish that has been infested by *Argulus* looks thin, with red spots appearing on its body, causing it often to rub its body on the edge of the pool. This parasitic attack is more often deadly in young fish because the body's defense system has not yet developed (Bandilla, 2007). Male and female *Argulus* usually attack carp (*C. carpio*) (Ebrahimi *et al.,* 2018). Male and female *Argulus* is also found to attack the goldfish (*C. auratus*). Male and female *Argulus* have the same properties as goldfish (*C. auratus*) (Yıldız and Kumantas, 2002). Based on these descriptions, this study aims to determine the percentage difference of *Argulus* male and *Argulus* females infesting carp (*C. carpio*), goldfish (*C. auratus*), comet goldfish (*C. auratus auratus*) and koi fish (*C. carpio* koi), as well as to find the amount of male and female *Argulus* infestation on the Cyprinidae family.

MATERIALS AND METHODS

Procedures

The research used the survey method. The survey method used in this study was a survey of research locations and *Argulus* parasites in fish samples. The data were collected using the descriptive method. The description of events in this study is the male and female *Argulus* parasite infestations in Cyprinidae of Magelang Regency. This study used a completely randomized factorial design. The completely randomized factorial design was applied because the study had two different factors; (1) the *Argulus* sex and (2) the Cyprinidae fish. The independent variables in this study consist of carp (C. *carpio*), goldfish (C. *auratus*), comet goldfish (C. *auratus auratus*) and koi fish (C. *carpio* koi) and the sex of *Argulus*. The dependent variable of this study was the sex percentage of the *Argulus* parasite. The control variables of this study were fish size, location and environmental conditions in Magelang. The collected sample amounted to 200 fish.

Data analysis

Analysis of the data used in this study was ANOVA (analysis of variance) using SPSS v16.0. If there are significant differences, further tests would be conducted using Duncan's multiple range test (Santoso, 2008).

RESULTS AND DISCUSSION

Identification results of *Argulus* sp. which infested in carp (*C. carpio*), goldfish (*C. auratus*), comet goldfish (*C. auratus auratus*) and koi fish (*C.* carpio koi) in Magelang Regency is *A. japonicus*. *A. japonicus* can be distinguished from other *Argulus* sp. by looking at the morphology. *A. japonicus* is identified as having a length of 3-5 mm and a width of 2-4 mm. In the Maxilla I, there is a supporting rod totaling five to nine pieces and the Maxilla II is equipped with three hooks.

The male and female *A. japonicus* can also be distinguished based on their morphology. The males are identified as having an abdominal testis. In comparison, the females are identified by their cephalothorax ovaries and seminal receptacle in the abdomen. *A. japonicus* are found in carp (*C. carpio*), goldfish (*C. auratus*), comet goldfish (*C. auratus auratus*) and koi fish (*C. carpio* koi). *A. japonicus* is one of the ectoparasites that attacks the Cyprinidae family (Wardany and Kurniawan, 2014). *A. japonicus* that infest in the Cyprinidae family in Magelang are observed in Fig 1.

The percentage of male *A. japonicus* infests carp (*C. carpio*) is 51.51%, while female *A. japonicus* is 48.49%. Male *A. japonicus* infest goldfish (*C. auratus*) is 50%, with the female having the same percentage. 38.46% of male *A. japonicus* infest comet goldfish (*C. auratus auratus*), with the female infestation percentage of 61.54%. 60% of male *A. japonicus* infests koi fish (*C. carpio koi*), while the female is 40%.

Data differences between the infestations of male and female *A. japonicus* in four different species of Cyprinidae were analyzed by analysis of variance (ANOVA). The results of the first ANOVA showed results that were not significantly different ($p>0.05$) between the average numbers of male and female *A. japonicus* that infest carp (*C. carpio*), goldfish (*C. auratus*), comet goldfish (*C. auratus auratus*) and koi fish (*C. carpio* koi). The second ANOVA showed significantly different results ($p<0.05$) between carp (*C. carpio*), goldfish (*C. auratus*), comet goldfish (*C. auratus auratus*) and koi fish (*C. carpio* koi) which have been infected by *A. japonicus*. The infestations analyzed using the third ANOVA were not significantly different ($p>0.05$) between the male and female *A. japonicus* females in carp (*C. carpio*), goldfish (*C. auratus*), comet goldfish (*C. auratus auratus*) and koi fish (*C. carpio* koi).

Based on the data from the analysis, the two treatments did not show any interaction. Thus, the data was included in the simple treatment. The simple treatment in question involves the male and female *A. japonicus* that infest carp (*C. carpio*), goldfish (*C. auratus*), comet goldfish (*C. auratus auratus*) and koi fish (*C. carpio* koi).

The test results show that male *A. japonicus* dominantly infests koi fish (*C. carpio* koi) and goldfish (*C. auratus*) but in a number that is not significantly different from carp (*C. carpio*). Male *A. japonicus* were least found in comet goldfish (*C. auratus auratus*), but in a number that is not significantly different from carp (*C. carpio*). In contrast, in the female infestation of *A. japonicus*, no differences were found between the four types of fish.

It has been identified that the *Argulus* sp. infest in carp (*C. carpio*), goldfish (*C. auratus*), comet goldfish (*C. auratus auratus*) and koi fish (*C. carpio* koi) in Magelang is *A. japonicus*. *A. japonicus* can be distinguished from other *Argulus* sp. by looking at the range of length (3-9 mm) and width of 2-6 mm (Møller, 2009). The respiratory area in the anterior is small, with the posterior being larger, five to nine supporting rods can be found in the Maxilla I and the Maxilla II is equipped with a total of three hooks. Male *A. japonicus* is equipped with testicles in the abdomen, whereas females have ovaries. The physical difference between the male and female *A. japonicus* can be seen in the abdomen located in the posterior part of the body (Kismiyati *et al*., 2011). Female

Fig 1: *Argulus japonicus* infested common carp (*C. Carpio*), goldfish (*C. auratus*), comet fish (*C. auratus auratus*) and koi fish (*C. carpio* koi). a. Female *Argulus japonicus*; b. Male *Argulus japonicus*.

A. japonicus has spermatheca and ovaries, while males have seminal testicles and vascular (Wardany and Kurniawan, 2014).

The percentage of male *A. japonicus* infests carp (*C. carpio*) is 51.51%, while female *A. japonicus* is 48.49%. Both male and female *A. japonicus* are known to infect fish (Walker *et al*., 2011). The percentage of male and female *A. japonicus* found to infest carp (*C. carpio*) is almost the same. That is because carp (*C. carpio*) is one of the preferred hosts of both male and female *Argulus japonicas* (Poly, 2008).

The male and female *A. japonicus* that infest goldfish (*C. auratus*) have the same percentage of 50%. Both male and female *A. japonicus* were found to infest goldfish (*C. auratus*) (Wafer *et al.,* 2015). That is because of their same parasitic properties (Mikheev *et al.,* 2015). 38.46% of male *A. japonicus* infects comet goldfish (*C. auratus auratus*), with the female infestation percentage of 61.54%. Female *A. japonicus* is found in comet goldfish fins (*C. auratus auratus*). This is due to the wide surface and slow movement of the fins (Pramujirini, 2016). The slow-motion of fish fins makes it easy for female *A. japonicus* to break away when oviposition (Kismiyati *et al.,* 2011).

There are 60% of male *A. japonicus* infest koi fish (*C. carpio* koi) while the female is 40%. Male *A. japonicus* can be found on the surface of koi fish (*C. carpio* koi). Koi fish (*C. carpio* koi) has a broad body surface that becomes the preferred predilection for male *A. japonicus*. Male *A. japonicus* prefers large areas (Taylor *et al.,* 2006).

The average number of male and female *A. japonicus* that infest carp (*C. carpio*), goldfish (*C. auratus*), comet goldfish (*C. auratus auratus*) and koi fish (*C. carpio* koi) is not significantly different ($p > 0.05$). That is because of their same parasitic properties (Mikheev *et al.,* 2015). Male and female *A. japonicus* are found to attack the Cyprinidae family (Wardany and Kurniawan, 2014).

The test results show that male *A. japonicus* dominantly infests koi fish (*C. carpio* koi) and goldfish (*C. auratus*) but in a number that is not significantly different from carp (*C. carpio*). Male *A. japonicus* least infests comet goldfish (*C. auratus auratus*), but in a number that is not substantially different from carp (*C. carpio*). That is because all four types of fish have other body surface areas. Male *A. japonicus* favors large areas (Taylor *et al.,* 2006). Duncan's Multiple Range Test results also showed that no differences were found between the four types of fish infested by female *A. japonicus*. Female *A. japonicus* is often found in fish fins (Pramujirini, 2016). The female chooses fins as a place of predilection because the fin movements of carp (*C. carpio*), goldfish (*C. auratus*), comet goldfish (*C. auratus auratus*) and koi fish (*C. carpio* koi) are languid. The slow movement of fish fins makes it easy for female *A. japonicus* to break away. Female *A. japonicus* will escape from the host when oviposition (Kismiyati *et al.,* 2010).

CONCLUSION

Argulus is capable of infecting cyprinid fish with different percentages for each host genus. In carp (*C. carpio*), the percentage of male *A. japonicus* infects more than female *A. japonicus*. In goldfish (*C. auratus*), male and female *A. japonicus* have the same percentage, while in comet goldfish (*C. auratus auratus*), the percentage of female *A. japonicus* is higher than female *A. japonicus*. Although there is a difference in the percentage of male and female *A. japonicus* in a host, both have the same detrimental effect on the host fish.

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Conflict of interest: None.

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GENERAL COMMENTS

Instructor

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RUBRIC: 6TH-8TH SCIENCE ARGUMENT (CER)

CLAIM

Take an arguable position on the scientific topic and develop the essay around that stance.

ADVANCED	The essay introduces a precise, qualitative and/or quantitative claim based on the scientific topic or text(s), regarding the relationship between dependent and independent variables. The essay develops the claim and counterclaim fairly, distinguishing the claim from alternate or opposing claims.
PROFICIENT	The essay introduces a clear, qualitative and/or quantitative claim based on the scientific topic or text(s), regarding the relationship between dependent and independent variables. The essay effectively acknowledges and distinguishes the claim from alternate or opposing claims.
DEVELOPING	The essay attempts to introduce a qualitative and/or quantitative claim, based on the scientific topic or text(s), but it may be somewhat unclear or not maintained throughout the essay. The essay may not clearly acknowledge or distinguish the claim from alternate or opposing claims.
EMERGING	The essay does not clearly make a claim based on the scientific topic or text(s), or the claim is overly simplistic or vague. The essay does not acknowledge or distinguish counterclaims.

EVIDENCE

Include relevant facts, definitions, and examples to back up the claim.

ADVANCED	The essay supplies sufficient relevant, accurate qualitative and/or quantitative data and evidence related to the scientific topic or text(s) to support its claim and counterclaim.
PROFICIENT	The essay supplies relevant, accurate qualitative and/or quantitative data and evidence related to the scientific topic or text(s) to support its claim and counterclaim.
DEVELOPING	The essay supplies some qualitative and/or quantitative data and evidence, but it may not be closely related to the scientific topic or text(s), or the support that is offered relies mostly on summary of the source(s), thereby not effectively supporting the essay's claim and counterclaim.
EMERGING	The essay supplies very little or no data and evidence to support its claim and counterclaim, or the evidence that is provided is not clear or relevant.

REASONING

Explain how or why each piece of evidence supports the claim.

ADVANCED	The essay effectively applies scientific ideas and principles in order to explain how or why the cited evidence supports the claim. The essay demonstrates consistently logical reasoning and understanding of the scientific topic and/or text(s). The essay's explanations anticipate the audience's knowledge level and concerns about this scientific topic.

PROFICIENT	The essay applies scientific reasoning in order to explain how or why the cited evidence supports the claim. The essay demonstrates logical reasoning and understanding of the scientific topic and/or text(s). The essay's explanations attempt to anticipate the audience's knowledge level and concerns about this scientific topic.
DEVELOPING	The essay includes some reasoning and understanding of the scientific topic and/or text(s), but it does not effectively apply scientific ideas or principles to explain how or why the evidence supports the claim.
EMERGING	The essay does not demonstrate clear or relevant reasoning to support the claim or to demonstrate an understanding of the scientific topic and/or text(s).

FOCUS

Focus your writing on the prompt and task.

ADVANCED	The essay maintains strong focus on the purpose and task, using the whole essay to support and develop the claim and counterclaims evenly while thoroughly addressing the demands of the prompt.
PROFICIENT	The essay addresses the demands of the prompt and is mostly focused on the purpose and task. The essay may not acknowledge the claim and counterclaims evenly throughout.
DEVELOPING	The essay may not fully address the demands of the prompt or stay focused on the purpose and task. The writing may stray significantly off topic at times, and introduce the writer's bias occasionally, making it difficult to follow the central claim at times.
EMERGING	The essay does not maintain focus on purpose or task.

ORGANIZATION

Organize your writing in a logical sequence.

ADVANCED	The essay incorporates an organizational structure throughout that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. Effective transitional words and phrases are included to clarify the relationships between and among ideas (i.e. claim and reasons, reasons and evidence, claim and counterclaim) in a way that strengthens the argument. The essay includes an introduction and conclusion that effectively follows from and supports the argument presented.
PROFICIENT	The essay incorporates an organizational structure with clear transitional words and phrases that show the relationship between and among ideas. The essay includes a progression of ideas from beginning to end, including an introduction and concluding statement or section that follows from and supports the argument presented.
DEVELOPING	The essay uses a basic organizational structure and minimal transitional words and phrases, though relationships between and among ideas are not consistently

	clear. The essay moves from beginning to end; however, an introduction and/or conclusion may not be clearly evident.
EMERGING	The essay does not have an organizational structure and may simply offer a series of ideas without any clear transitions or connections. An introduction and conclusion are not evident.

LANGUAGE

Pay close attention to your tone, style, word choice, and sentence structure when writing.

ADVANCED	The essay effectively establishes and maintains a formal style and objective tone and incorporates language that anticipates the reader's knowledge level and concerns. The essay consistently demonstrates a clear command of conventions, while also employing discipline-specific word choices and varied sentence structure.
PROFICIENT	The essay generally establishes and maintains a formal style with few possible exceptions and incorporates language that anticipates the reader's knowledge level and concerns. The essay demonstrates a general command of conventions, while also employing discipline-specific word choices and some variety in sentence structure.
DEVELOPING	The essay does not maintain a formal style consistently and incorporates language that may not show an awareness of the reader's knowledge or concerns. The essay may contain errors in conventions that interfere with meaning. Some attempts at discipline-specific word choices are made, and sentence structure may not vary often.
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