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Best regards,
Arif Ansori

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The Percentage of Milk and Feeds Applied During Copulation Periods in
Mating System Crossed Area
Kismiyati, Arif Ansori, Kismiyati
Department of Animal Husbandry, Faculty of Fisheries and Marine Resources,
Airlangga University,
Department of Biotechnology, Faculty of Veterinary Medicine,
Universitas Airlangga Indonesia

Abstract
Background: One reason of this interest is that people produce milk, milk and cheese
products were found in other fish. This study aims to determine the percentage

 **Kismiyati et al - Fi.**

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

3 **Kismiyati ^{1,*}, Alif Rizky Andika ¹, Kusnoto ²**

4 ¹Department of Aquaculture, Faculty of Fisheries and Marine, Universitas
5 Airlangga, Indonesia.

6 ²Department of Parasitology Veterinary, Faculty of Veterinary Medicine,
7 Universitas Airlangga, Indonesia.

8
9 **Abstract**

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

13 **Methods:** The research was studied using a survey method. The independent variables in
14 this study are carp (*Cyprinus carpio*), goldfish (*Carassius auratus*), comet goldfish
15 (*Carassius auratus auratus*), koi fish (*C. carpio* koi), and the sex of the *Argulus* parasite.
16 The dependent variable of this study was the sex percentage of the *Argulus* parasite. The
17 data analysis was done using analysis of variance (ANOVA) then followed by Duncan's
18 Multiple Range Test to find out the differences between treatments.

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

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

26
27 **INTRODUCTION**

28 Magelang Regency is one of the areas that has undergone aquaculture-based
29 development, prioritizing the principle of efficiency, quality, and sustainability (Wibowo
30 *et al.*, 2015). The area consists of Ngluwar Sub-District, Mungkid Sub-District, and
31 Muntilan Sub-District. Cyprinidae family fish species that are cultivated in Magelang
32 Regency are common carp (*C. carpio*), goldfish (*C. auratus*), comet fish (*C. auratus*
33 *auratus*), and koi fish (*C. carpio* koi) (Badan Pusat Statistik Kab. Magelang, 2014). The
34 main problem in cultivating fish in Indonesia to date revolves around parasites and
35 infectious diseases. The disease causes economic losses because it can result in less
36 optimal fish harvest (Carella and Sirri, 2017; Das and Chandra, 2018). One cause of the
37 disease is the infestation of parasites (Picard-Sánchez *et al.*, 2020). The quality of

38 freshwater ornamental fishes decreased due to attacks from parasites such as *Argulus* sp.
39 (Alifuddin *et al.*, 2002).

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

46 Morphological identification of *Argulus* sp. are mostly based on distinguishing
47 features of an adult male such as carapace and abdominal length or width, dorsal ridges
48 of the carapace, respiratory areas, leg pigments, abdominal lobes and incision, and the
49 presence of a small coxal at the swimming appendages (Sahoo *et al.*, 2012; Soes *et al.*,
50 2010), requiring experienced taxonomists.

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

64

65 **MATERIALS AND METHODS**

66 **Procedures**

67 The research was studied using the survey method. The survey method used in
68 this study was a survey of research locations and *Argulus* parasites in fish samples. The
69 data were collected using the descriptive method. The description of events in this study
70 is the male and female *Argulus* parasite infestations in Cyprinidae of Magelang Regency.

71 This study used a Completely Randomized Factorial Design. The Completely
72 Randomized Factorial Design was applied because the study had two different factors;
73 (1) the *Argulus* sex and (2) the Cyprinidae fish. The independent variables in this study
74 consist of carp (*C. carpio*), goldfish (*C. auratus*), comet goldfish (*C. auratus auratus*),
75 and koi fish (*C. carpio koi*), and the sex of *Argulus*. The dependent variable of this study
76 was the sex percentage of the *Argulus* parasite. The control variables of this study were
77 fish size, location, and environmental conditions in Magelang. The number of samples
78 taken was 10% of the total population. The collected sample amounted to 200 fish.

79 **Data analysis**

80 Analysis of the data used in this study was ANOVA (analysis of variance)
81 using SPSS v16.0. If there are significant differences, further tests would be conducted
82 using Duncan's Multiple Range Test (Santoso, 2008).

83

84 **RESULTS AND DISCUSSION**

85 **Result**

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

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

99



Figure 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*.

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*).

Duncan's Multiple Range Test was done to assess the different types of fish used in the study because they showed significantly different results. The test results show that male *A. japonicus* dominantly infests koi fish (*C. carpio koi*) and goldfish (*C.*

128 *auratus*) but in a number that is not significantly different from carp (*C. carpio*). Male *A.*
129 *japonicus* were least found in comet goldfish (*C. auratus auratus*), but in a number that
130 is not significantly different from carp (*C. carpio*). In contrast, in the female infestation
131 of *A. japonicus*, no differences were found between the four types of fish.

132 **Discussion**

133 It has been identified that the *Argulus* sp. infest in carp (*C. carpio*), goldfish
134 (*C. auratus*), comet goldfish (*C. auratus auratus*), and koi fish (*C. carpio koi*) in
135 Magelang is *A. japonicus*. *A. japonicus* can be distinguished from other *Argulus* sp. by
136 looking at the range of length (3-9 mm) and width of 2-6 mm (Møller, 2009). The
137 respiratory area in the anterior is small, with the posterior being larger, five to nine
138 supporting rods can be found in the Maxilla I, and the Maxilla II is equipped with a total
139 of three hooks. Male *A. japonicus* is equipped with testicles in the abdomen, whereas
140 females have ovaries. The physical difference between the male and female *A. japonicus*
141 can be seen in the abdomen located in the posterior part of the body (Kismiyati et al.,
142 2011). Female *A. japonicus* has spermatheca and ovaries, while males have seminal
143 testicles and vascular (Wardany and Kurniawan, 2014).

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

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

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

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

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

178

179

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180 Acknowledgments are expressed in a brief; all sources of institutional, private
181 and corporate financial support for the work must be fully acknowledged, and any
182 potential conflicts of interest are noted.

183

184 REFERENCES


- 185 Alifuddin, M., Priyono, A., Nurfatimah, A. (2002). Parasites Inventory on Ornamental
186 Fish Transported in Soekarno-Hatta Airport, Cengkareng, Jakarta. *Jurnal Akuakultur*
187 *Indonesia*. 1: 123-128.
- 188 Badan Pusat Statistik Kabupaten Magelang. (2014). Produksi Ikan Air Tawar Menurut
189 Kecamatan. <http://magelangkab.bps.go.id>.

- 190 Bandilla, M. (2007). Transmission and Host and Mate Location in the Fish Louse *Argulus*
191 coregoni and its Link with Bacterial Disease in Fish, Jyvaskyla Studies in Biological and
192 Environmental Science. Jyvaskyla: University of Jyvaskyla Press.
- 193 Carella, F. and Sirri, R. (2017). Fish and Shellfish Pathology. *Frontiers in Marine*
194 *Science*. 4: 375.
- 195 Das, D. R. and Chandra, K. J. (2018). Seasonal Variation Of Gill, Skin, Muscle, Liver
196 And Kidney Pathology Of Mrigal (*Cirrhinus Cirrhosus*) In Cultural Pond Fisheries,
197 Mymensingh, Bangladesh. *Bangladesh Journal of Veterinary Medicine*. 16(1): 121–129.
- 198 Ebrahimi, M., Nematollahi, A., Samiei, A., Golabi, M. (2018). Ectoparasitism on
199 freshwater fish in West Azerbaijan, northwest of Iran. *Comparative Clinical Pathology*.
200 27(2): 353-356.
- 201 Kismiyati, Fatiza, R. N., Kusdarwati, R. (2011). Pengaruh Pemberian Garam (NaCl)
202 terhadap Kerusakan Telur *Argulus japonicus* [Effect of Salt (NaCl) Against Damage of
203 *Argulus japonicus* Egg]. *Jurnal Ilmiah Perikanan dan Kelautan*. 3(1): 113-116.
- 204 Kismiyati, Iskhaq, N. M., Triastuti, J. (2010). Preference of Oviposition Object of
205 Ectoparasite *A. japonicus*. *Jurnal Ilmiah Perikanan dan Kelautan*. 2: 165–169.
- 206 Kumar, S., Sathish, K. T., Vidya, R., Pandey, P. K. (2017). A prospective of
207 epidemiological intervention in investigation and management of argulosis in
208 aquaculture. *Aquaculture International*. 25(1): 303–325.
- 209 Mikheev, V. N., Pasternak, A. F., Valtonen, E. T. (2015). Behavioural adaptations of
210 argulid parasites (Crustacea: Branchiura) to major challenges in their life cycle. *Parasites*
211 *& vectors*. 8(1): p. 394.
- 212 Møller, O. S. (2009). Branchiura (Crustacea)-survey of historical literature and
213 taxonomy. *Arthropod Systematics & Phylogeny*. 67(1): 41–55.
- 214 Picard-Sánchez, A., Estensoro, I., Del Pozo, R., Palenzuela, O. R., Piazzon, M. C., Sitjà-
215 Bobadilla, A. (2020). Water temperature, time of exposure and population density are key
216 parameters in *Enteromyxum leei* fish-to-fish experimental transmission. *Journal of Fish*
217 *Diseases*. 43(4): 491-502.

- 218 Poly, W. J. (2008). Global diversity of fishlice (Crustacea: Branchiura: Argulidae) in
219 freshwater. *Hydrobiologia*. 595(1): 209–212.
- 220 Pramujirini, D. (2016). Predileksi *A. japonicus* Jantan Dan Betina Serta Perubahan
221 Patologi Anatomi Tiga Jenis Ikan Hias Yang Terinfestasi Di Sentra Budidaya Ikan Hias
222 Jawa Timur. Bachelor Thesis. Surabaya: Universitas Airlangga.
- 223 Sahoo, P. K., Mohanty, J., Garnayak, S., Mohanty, B., Kar, B., Prasanth, H., Jena, J.
224 (2013). Estimation of loss due to argulosis in carp culture ponds in India. *Indian Journal*
225 *of Fisheries*. 60(2): 99–102.
- 226 Santoso, S. (2008). Panduan lengkap menguasai SPSS 16. Jakarta: Elex Media
227 Komputindo,.
- 228 Soes, D., Walker, P., Kruijt, D. (2010). The Japanese fish louse *A. japonicus* new for The
229 Netherlands. *Lauterbornia*. 70: 11–17.
- 230 Tandel, R. S., Chanu, K. V., Hussain Bhat, R. A., Dash, P., Shah, T. K., Thakuria, D.
231 (2021). Morphometric and molecular identification of *A. japonicus* (Thiele 1900) in
232 vulnerable Himalayan snow trout, *Schizothorax richardsonii* (Gray 1832). *Aquaculture*
233 *Research*. 52(12): 6770-6778.
- 234 Taylor, N. G. H., Sommerville, C., Wootten, R. (2006). The epidemiology of *Argulus*
235 spp. (Crustacea: Branchiura) infections in Stillwater trout fisheries. *Journal of Fish*
236 *diseases*. 29(4): 193–200.
- 237 Wafer, L. N., Whitney, J. C., Jensen, V. B. (2015). Fish lice (*A. japonicus*) in goldfish (*C.*
238 *auratus*). Comparative medicine. *American Association for Laboratory Animal Science*.
239 65(2): 93–95.
- 240 Walker, P. D., Russon, I. J., Haond, C., Van Der Velde, G., Wendelaar-Bonga, S. E.
241 (2011). Feeding in adult *Argulus japonicus* Thiele, 1900 (Maxillopoda, Branchiura), an
242 ectoparasite on fish. *Crustaceana*. 307-318.
- 243 Wardany, K. H. and Kurniawan, N. (2014). Eksplorasi Ektoparasit Pada Ikan Famili
244 Cyprinidae Di Kolam Rumah Makan Wilayah Malang Raya. *Biotropika: Journal of*
245 *Tropical Biology*. 2(2): 87-91.

- 246 Wibowo, A. B., Anggoro, S., Yulianto, B. (2015). Status keberlanjutan dimensi ekologi
247 dalam pengembangan kawasan minapolitan berkelanjutan berbasis perikanan budidaya
248 air tawar di Kabupaten Magelang. *Saintek Perikanan: Indonesian Journal of Fisheries*
249 *Science and Technology*. 10(2): 107–113.
- 250 Yıldız, K. and Kumantas, A. (2002). *Argulus* foliaceus infection in a goldfish (*C.*
251 *auratus*). *Isr J Vet Med*. 57(3): 118–120

2. First Revision: the Format of the article (February 9, 2022)


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The Percentage of Male and Female Anguilla Sabentia Inferring Cystinidius Fossil Fish in
Mangrove Swamp, Coastal Area
Kismiyati¹, Alm Rully Anikka², Kusnanti³
¹Department of Aquaculture, Faculty of Education and Science, Universitas
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²Department of Parasitology, Universitas, Faculty of Veterinary Medicine,
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Abstract
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48 coldwater fish worldwide (Tandel *et al.*, 2021).

49 Morphological identification of *Argulus* sp. are mostly based on distinguishing
50 features of an adult male such as carapace and abdominal length or width, dorsal ridges
51 of the carapace, respiratory areas, leg pigments, abdominal lobes and incision, and the
52 presence of a small coxal at the swimming appendages (Sahoo *et al.*, 2012; Soes *et al.*,
53 2010), requiring experienced taxonomists.

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

67

68

MATERIALS AND METHODS

69 Procedures

70 The research was studied using the survey method. The survey method used in
71 this study was a survey of research locations and *Argulus* parasites in fish samples. The

72 data were collected using the descriptive method. The description of events in this study
73 is the male and female *Argulus* parasite infestations in Cyprinidae of Magelang Regency.
74 This study used a Completely Randomized Factorial Design. The Completely
75 Randomized Factorial Design was applied because the study had two different factors;
76 (1) the *Argulus* sex and (2) the Cyprinidae fish. The independent variables in this study
77 consist of carp (*C. carpio*), goldfish (*C. auratus*), comet goldfish (*C. auratus auratus*),
78 and koi fish (*C. carpio koi*), and the sex of *Argulus*. The dependent variable of this study
79 was the sex percentage of the *Argulus* parasite. The control variables of this study were
80 fish size, location, and environmental conditions in Magelang. The number of samples
81 taken was 10% of the total population. The collected sample amounted to 200 fish.

82 **Data analysis**

83 Analysis of the data used in this study was ANOVA (analysis of variance)
84 using SPSS v16.0. If there are significant differences, further tests would be conducted
85 using Duncan's Multiple Range Test (Santoso, 2008).

86

87

RESULTS AND DISCUSSION

88 **Result**

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

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

102



Figure 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*.

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*).

Duncan's Multiple Range Test was done to assess the different types of fish used in the study because they showed significantly different results. The test results show that male *A. japonicus* dominantly infests koi fish (*C. carpio koi*) and goldfish (*C.*

131 *auratus*) but in a number that is not significantly different from carp (*C. carpio*). Male *A.*
132 *japonicus* were least found in comet goldfish (*C. auratus auratus*), but in a number that
133 is not significantly different from carp (*C. carpio*). In contrast, in the female infestation
134 of *A. japonicus*, no differences were found between the four types of fish.

135 **Discussion**

136 It has been identified that the *Argulus* sp. infest in carp (*C. carpio*), goldfish
137 (*C. auratus*), comet goldfish (*C. auratus auratus*), and koi fish (*C. carpio koi*) in
138 Magelang is *A. japonicus*. *A. japonicus* can be distinguished from other *Argulus* sp. by
139 looking at the range of length (3-9 mm) and width of 2-6 mm (Møller, 2009). The
140 respiratory area in the anterior is small, with the posterior being larger, five to nine
141 supporting rods can be found in the Maxilla I, and the Maxilla II is equipped with a total
142 of three hooks. Male *A. japonicus* is equipped with testicles in the abdomen, whereas
143 females have ovaries. The physical difference between the male and female *A. japonicus*
144 can be seen in the abdomen located in the posterior part of the body (Kismiyati et al.,
145 2011). Female *A. japonicus* has spermatheca and ovaries, while males have seminal
146 testicles and vascular (Wardany and Kurniawan, 2014).

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

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

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

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

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

181

182

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186

REFERENCES

- 188 Alifuddin, M., Priyono, A., Nurfatimah, A. (2002). Parasites Inventory on Ornamental
189 Fish Transported in Soekarno-Hatta Airport, Cengkareng, Jakarta. *Jurnal Akuakultur*
190 *Indonesia*. 1: 123-128.
- 191 Badan Pusat Statistik Kabupaten Magelang. (2014). Produksi Ikan Air Tawar Menurut
192 Kecamatan. <http://magelangkab.bps.go.id>.

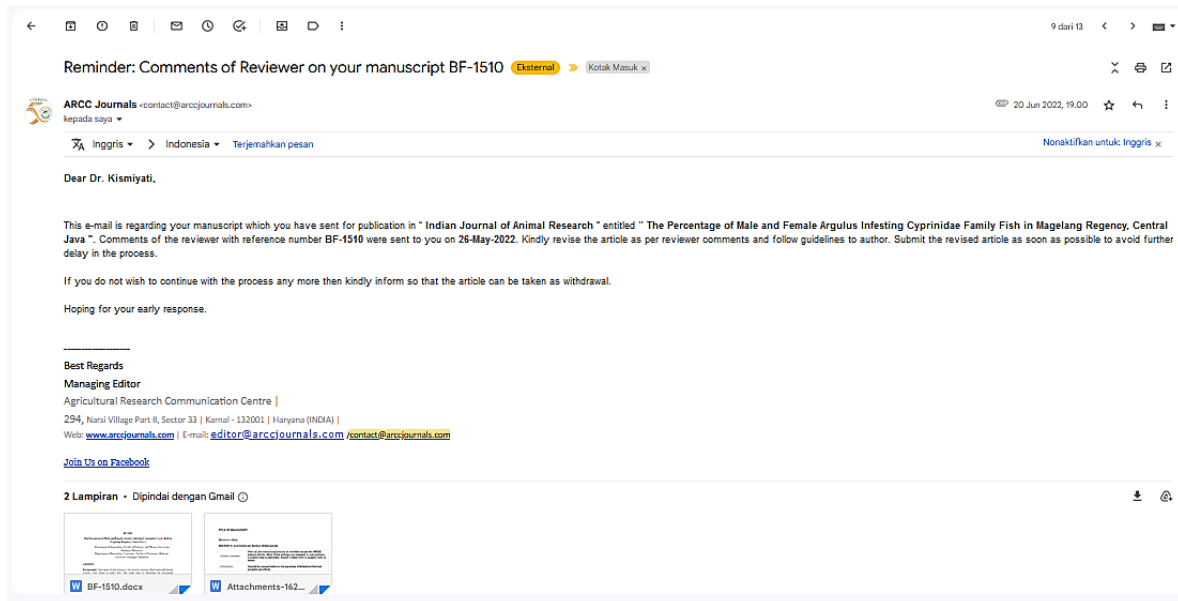
- 193 Bandilla, M. (2007). Transmission and Host and Mate Location in the Fish Louse *Argulus*
194 coregoni and its Link with Bacterial Disease in Fish, Jyvaskyla Studies in Biological and
195 Environmental Science. Jyvaskyla: University of Jyvaskyla Press.
- 196 Carella, F. and Sirri, R. (2017). Fish and Shellfish Pathology. *Frontiers in Marine*
197 *Science*. 4: 375.
- 198 Das, D. R. and Chandra, K. J. (2018). Seasonal Variation Of Gill, Skin, Muscle, Liver
199 And Kidney Pathology Of Mrigal (*Cirrhinus Cirrhosus*) In Cultural Pond Fisheries,
200 Mymensingh, Bangladesh. *Bangladesh Journal of Veterinary Medicine*. 16(1): 121–129.
- 201 Ebrahimi, M., Nematollahi, A., Samiei, A., Golabi, M. (2018). Ectoparasitism on
202 freshwater fish in West Azerbaijan, northwest of Iran. *Comparative Clinical Pathology*.
203 27(2): 353-356.
- 204 Kismiyati, Fatiza, R. N., Kusdarwati, R. (2011). Pengaruh Pemberian Garam (NaCl)
205 terhadap Kerusakan Telur *Argulus japonicus* [Effect of Salt (NaCl) Against Damage of
206 *Argulus japonicus* Egg]. *Jurnal Ilmiah Perikanan dan Kelautan*. 3(1): 113-116.
- 207 Kismiyati, Iskhaq, N. M., Triastuti, J. (2010). Preference of Oviposition Object of
208 Ectoparasite *A. japonicus*. *Jurnal Ilmiah Perikanan dan Kelautan*. 2: 165–169.
- 209 Kumar, S., Sathish, K. T., Vidya, R., Pandey, P. K. (2017). A prospective of
210 epidemiological intervention in investigation and management of argulosis in
211 aquaculture. *Aquaculture International*. 25(1): 303–325.
- 212 Mikheev, V. N., Pasternak, A. F., Valtonen, E. T. (2015). Behavioural adaptations of
213 argulid parasites (Crustacea: Branchiura) to major challenges in their life cycle. *Parasites*
214 *& vectors*. 8(1): p. 394.
- 215 Møller, O. S. (2009). Branchiura (Crustacea)-survey of historical literature and
216 taxonomy. *Arthropod Systematics & Phylogeny*. 67(1): 41–55.
- 217 Picard-Sánchez, A., Estensoro, I., Del Pozo, R., Palenzuela, O. R., Piazzon, M. C., Sitjà-
218 Bobadilla, A. (2020). Water temperature, time of exposure and population density are key
219 parameters in *Enteromyxum leei* fish-to-fish experimental transmission. *Journal of Fish*
220 *Diseases*. 43(4): 491-502.

- 221 Poly, W. J. (2008). Global diversity of fishlice (Crustacea: Branchiura: Argulidae) in
222 freshwater. *Hydrobiologia*. 595(1): 209–212.
- 223 Pramujirini, D. (2016). Predileksi *A. japonicus* Jantan Dan Betina Serta Perubahan
224 Patologi Anatomi Tiga Jenis Ikan Hias Yang Terinfestasi Di Sentra Budidaya Ikan Hias
225 Jawa Timur. Bachelor Thesis. Surabaya: Universitas Airlangga.
- 226 Sahoo, P. K., Mohanty, J., Garnayak, S., Mohanty, B., Kar, B., Prasanth, H., Jena, J.
227 (2013). Estimation of loss due to argulosis in carp culture ponds in India. *Indian Journal*
228 *of Fisheries*. 60(2): 99–102.
- 229 Santoso, S. (2008). Panduan lengkap menguasai SPSS 16. Jakarta: Elex Media
230 Komputindo,.
- 231 Soes, D., Walker, P., Kruijt, D. (2010). The Japanese fish louse *A. japonicus* new for The
232 Netherlands. *Lauterbornia*. 70: 11–17.
- 233 Tandel, R. S., Chanu, K. V., Hussain Bhat, R. A., Dash, P., Shah, T. K., Thakuria, D.
234 (2021). Morphometric and molecular identification of *A. japonicus* (Thiele 1900) in
235 vulnerable Himalayan snow trout, *Schizothorax richardsonii* (Gray 1832). *Aquaculture*
236 *Research*. 52(12): 6770-6778.
- 237 Taylor, N. G. H., Sommerville, C., Wootten, R. (2006). The epidemiology of *Argulus*
238 spp. (Crustacea: Branchiura) infections in Stillwater trout fisheries. *Journal of Fish*
239 *diseases*. 29(4): 193–200.
- 240 Wafer, L. N., Whitney, J. C., Jensen, V. B. (2015). Fish lice (*A. japonicus*) in goldfish (*C.*
241 *auratus*). Comparative medicine. *American Association for Laboratory Animal Science*.
242 65(2): 93–95.
- 243 Walker, P. D., Russon, I. J., Haond, C., Van Der Velde, G., Wendelaar-Bonga, S. E.
244 (2011). Feeding in adult *Argulus japonicus* Thiele, 1900 (Maxillopoda, Branchiura), an
245 ectoparasite on fish. *Crustaceana*. 307-318.
- 246 Wardany, K. H. and Kurniawan, N. (2014). Eksplorasi Ektoparasit Pada Ikan Famili
247 Cyprinidae Di Kolam Rumah Makan Wilayah Malang Raya. *Biotropika: Journal of*
248 *Tropical Biology*. 2(2): 87-91.

- 249 Wibowo, A. B., Anggoro, S., Yulianto, B. (2015). Status keberlanjutan dimensi ekologi
250 dalam pengembangan kawasan minapolitan berkelanjutan berbasis perikanan budidaya
251 air tawar di Kabupaten Magelang. *Saintek Perikanan: Indonesian Journal of Fisheries*
252 *Science and Technology*. 10(2): 107–113.
- 253 Yıldız, K. and Kumantas, A. (2002). *Argulus* foliaceus infection in a goldfish (*C.*
254 *auratus*). *Isr J Vet Med*. 57(3): 118–120

4. Second Revision (June 20, 2022)

Note: Email reply containing articles that have been revised by reviewer on June 20, 2022. The revised sections include: title, abstract, results and discussion.



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Dear Dr. Kismiyati,

This e-mail is regarding your manuscript which you have sent for publication in "Indian Journal of Animal Research" entitled "The Percentage of Male and Female Argulus Infesting Cyprinidae Family Fish in Magelang Regency, Central Java". Comments of the reviewer with reference number BF-1510 were sent to you on 26-May-2022. Kindly revise the article as per reviewer comments and follow guidelines to author. Submit the revised article as soon as possible to avoid further delay in the process.

If you do not wish to continue with the process any more then kindly inform so that the article can be taken as withdrawal.

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General comment:	Over all, the manuscript should be rewritten as per the IMRAD pattern strictly. Most of the writings are repeated in sub-sections. Location map is admirable. Result in table form or graphic form is better.
Introduction:	Should be concentrated on the parasites infested and the host parasite specificity.
Methodology:	Should be written specifically and vividly the pattern followed.
Results:	Methodology repeated in the result is unnecessary
Discussion:	Should be pinned and correlated the results with reasons, why the result so? What is the hypothetical remedy for the same and comment on further study and scope.

SECTION II (Cont.)

Bibliography/References:	It should be written uniformly with comma, semicolon and etc. Cross check all the references in text as well as in list of references. References must be as per format of the journal.
Others:	Grammatical correction is required. Authors should take care of English presentation, as the present depiction is not acceptable. Better to consult some <u>English-speaking native or the person having good hand in English grammar.</u>
Decision:	I suggest, rewrite and accept the MS for publication

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Would you be willing to review a revision of this manuscript? Yes () No (X)

Thank you very much for your contribution !

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

4 ¹Department of Aquaculture, Faculty of Fisheries and Marine, Universitas
5 Airlangga, Indonesia.

6 ²Department of Parasitology Veterinary, Faculty of Veterinary Medicine,
7 Universitas Airlangga, Indonesia.
8

9 **Abstract**

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

13 **Methods:** The research was **studied** using a survey method. The independent variables in
14 this study are carp (*Cyprinus carpio*), goldfish (*Carassius auratus*), comet goldfish
15 (*Carassius auratus auratus*), koi fish (*C. carpio koi*), and the sex of the *Argulus* parasite.
16 The dependent variable of this study was the sex percentage of the *Argulus* parasite. The
17 data analysis was done using analysis of variance (ANOVA) then followed by Duncan's
18 Multiple Range Test to find out the differences between treatments.

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

25 **Key words:** *Argulus*, Cyprinidae, Parasite, Fisheries.
26

27 **INTRODUCTION**

28 Magelang Regency is one of the areas that has undergone aquaculture-based
29 development, prioritizing the principle of efficiency, quality, and sustainability (Wibowo
30 *et al.*, 2015). The area consists of Ngluwar Sub-District, Mungkid Sub-District, and
31 Muntilan Sub-District. Cyprinidae family fish species that are cultivated in Magelang
32 Regency are common carp (*C. carpio*), goldfish (*C. auratus*), comet fish (*C. auratus*
33 *auratus*), and koi fish (*C. carpio koi*) (Badan Pusat Statistik Kab. Magelang, 2014). The
34 main problem in cultivating fish in Indonesia to date revolves around parasites and
35 infectious diseases. The disease causes economic losses because it can result in less

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38 Indonesia.

39 optimal fish harvest (Carella and Sirri, 2017; Das and Chandra, 2018). One cause of the
40 disease is the infestation of parasites (Picard-Sánchez *et al.*, 2020). The quality of
41 freshwater ornamental fishes decreased due to attacks from parasites such as *Argulus* sp.
42 (Alifuddin *et al.*, 2002).

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

49 Morphological identification of *Argulus* sp. are mostly based on distinguishing
50 features of an adult male such as carapace and abdominal length or width, dorsal ridges
51 of the carapace, respiratory areas, leg pigments, abdominal lobes and incision, and the
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81 fish size, location, and environmental conditions in Magelang. **The number of samples**
82 **taken was 10% of the total population.** The collected sample amounted to 200 fish.

83 Data analysis

84 Analysis of the data used in this study was ANOVA (analysis of variance)
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86 using Duncan's Multiple Range Test (Santoso, 2008).

87

88

RESULTS AND DISCUSSION

89 Result

90 Identification results of *Argulus* sp. which infested in carp (*C. carpio*), goldfish
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99 abdomen. *A. japonicus* are found in carp (*C. carpio*), goldfish (*C. auratus*), comet
100 goldfish (*C. auratus auratus*), and koi fish (*C. carpio koi*). *A. japonicus* is one of the

101 ectoparasites that attacks the Cyprinidae family (Wardany and Kurniawan, 2014). *A.*
102 *japonicus* that infest in the Cyprinidae family in Magelang are observed in Figure 1.

103



104

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

108

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

114 Data differences between the infestations of male and female *A. japonicus* in
115 four different species of Cyprinidae were analyzed by analysis of variance (ANOVA).
116 The results of the first ANOVA showed results that were not significantly different ($p >$
117 0.05) between the average numbers of male and female *A. japonicus* that infest carp (*C.*
118 *carpio*), goldfish (*C. auratus*), comet goldfish (*C. auratus auratus*), and koi fish (*C.*
119 *carpio koi*). The second ANOVA showed significantly different results ($p <$ 0.05) between
120 carp (*C. carpio*), goldfish (*C. auratus*), comet goldfish (*C. auratus auratus*), and koi fish
121 (*C. carpio koi*) which have been infected by *A. japonicus*. The infestations analyzed using
122 the third ANOVA were not significantly different ($p >$ 0.05) between the male and female
123 *A. japonicus* females in carp (*C. carpio*), goldfish (*C. auratus*), comet goldfish (*C. auratus*
124 *auratus*), and koi fish (*C. carpio koi*).

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

129 Duncan's Multiple Range Test was done to assess the different types of fish
130 used in the study because they showed significantly different results. The test results show
131 that male *A. japonicus* dominantly infests koi fish (*C. carpio koi*) and goldfish (*C.*
132 *auratus*) but in a number that is not significantly different from carp (*C. carpio*). Male *A.*
133 *japonicus* were least found in comet goldfish (*C. auratus auratus*), but in a number that
134 is not significantly different from carp (*C. carpio*). In contrast, in the female infestation
135 of *A. japonicus*, no differences were found between the four types of fish.

136 **Discussion**

137 It has been identified that the *Argulus* sp. infest in carp (*C. carpio*), goldfish
138 (*C. auratus*), comet goldfish (*C. auratus auratus*), and koi fish (*C. carpio koi*) in
139 Magelang is *A. japonicus*. *A. japonicus* can be distinguished from other *Argulus* sp. by
140 looking at the range of length (3-9 mm) and width of 2-6 mm (Møller, 2009). The
141 respiratory area in the anterior is small, with the posterior being larger, five to nine
142 supporting rods can be found in the Maxilla I, and the Maxilla II is equipped with a total
143 of three hooks. Male *A. japonicus* is equipped with testicles in the abdomen, whereas
144 females have ovaries. The physical difference between the male and female *A. japonicus*
145 can be seen in the abdomen located in the posterior part of the body (Kismiyati et al.,
146 2011). Female *A. japonicus* has spermatheca and ovaries, while males have seminal
147 testicles and vascular (Wardany and Kurniawan, 2014).

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

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

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

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

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

182

183

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186 potential conflicts of interest are noted.

187

188 REFERENCES

189 Alifuddin, M., Priyono, A., Nurfatimah, A. (2002). Parasites Inventory on Ornamental
190 Fish Transported in Soekarno-Hatta Airport, Cengkareng, Jakarta. *Jurnal Akuakultur*
191 *Indonesia*. 1: 123-128.

- 192 Badan Pusat Statistik Kabupaten Magelang. (2014). Produksi Ikan Air Tawar Menurut
193 Kecamatan. <http://magelangkab.bps.go.id>.
- 194 Bandilla, M. (2007). Transmission and Host and Mate Location in the Fish Louse *Argulus*
195 coregoni and its Link with Bacterial Disease in Fish, Jyvaskyla Studies in Biological and
196 Environmental Science. Jyvaskyla: University of Jyvaskyla Press.
- 197 Carella, F. and Sirri, R. (2017). Fish and Shellfish Pathology. *Frontiers in Marine*
198 *Science*. 4: 375.
- 199 Das, D. R. and Chandra, K. J. (2018). Seasonal Variation Of Gill, Skin, Muscle, Liver
200 And Kidney Pathology Of Mrigal (*Cirrhinus Cirrhosus*) In Cultural Pond Fisheries,
201 Mymensingh, Bangladesh. *Bangladesh Journal of Veterinary Medicine*. 16(1): 121–129.
- 202 Ebrahimi, M., Nematollahi, A., Samiei, A., Golabi, M. (2018). Ectoparasitism on
203 freshwater fish in West Azerbaijan, northwest of Iran. *Comparative Clinical Pathology*.
204 27(2): 353-356.
- 205 Kismiyati, Fatiza, R. N., Kusdarwati, R. (2011). Pengaruh Pemberian Garam (NaCl)
206 terhadap Kerusakan Telur *Argulus japonicus* [Effect of Salt (NaCl) Against Damage of
207 *Argulus japonicus* Egg]. *Jurnal Ilmiah Perikanan dan Kelautan*. 3(1): 113-116.
- 208 Kismiyati, Iskhaq, N. M., Triastuti, J. (2010). Preference of Oviposition Object of
209 Ectoparasite *A. japonicus*. *Jurnal Ilmiah Perikanan dan Kelautan*. 2: 165–169.
- 210 Kumar, S., Sathish, K. T., Vidya, R., Pandey, P. K. (2017). A prospective of
211 epidemiological intervention in investigation and management of argulosis in
212 aquaculture. *Aquaculture International*. 25(1): 303–325.
- 213 Mikheev, V. N., Pasternak, A. F., Valtonen, E. T. (2015). Behavioural adaptations of
214 argulid parasites (Crustacea: Branchiura) to major challenges in their life cycle. *Parasites*
215 *& vectors*. 8(1): p. 394.
- 216 Møller, O. S. (2009). Branchiura (Crustacea)-survey of historical literature and
217 taxonomy. *Arthropod Systematics & Phylogeny*. 67(1): 41–55.
- 218 Picard-Sánchez, A., Estensoro, I., Del Pozo, R., Palenzuela, O. R., Piazzon, M. C., Sitjà-
219 Bobadilla, A. (2020). Water temperature, time of exposure and population density are key

220 parameters in *Enteromyxum leei* fish-to-fish experimental transmission. *Journal of Fish*
221 *Diseases*. 43(4): 491-502.

222 Poly, W. J. (2008). Global diversity of fishlice (Crustacea: Branchiura: Argulidae) in
223 freshwater. *Hydrobiologia*. 595(1): 209–212.

224 Pramujirini, D. (2016). Predileksi *A. japonicus* Jantan Dan Betina Serta Perubahan
225 Patologi Anatomi Tiga Jenis Ikan Hias Yang Terinfestasi Di Sentra Budidaya Ikan Hias
226 Jawa Timur. Bachelor Thesis. Surabaya: Universitas Airlangga.

227 Sahoo, P. K., Mohanty, J., Garnayak, S., Mohanty, B., Kar, B., Prasanth, H., Jena, J.
228 (2013). Estimation of loss due to argulosis in carp culture ponds in India. *Indian Journal*
229 *of Fisheries*. 60(2): 99–102.

230 Santoso, S. (2008). Panduan lengkap menguasai SPSS 16. Jakarta: Elex Media
231 Komputindo,.

232 Soes, D., Walker, P., Kruijt, D. (2010). The Japanese fish louse *A. japonicus* new for The
233 Netherlands. *Lauterbornia*. 70: 11–17.

234 Tandel, R. S., Chanu, K. V., Hussain Bhat, R. A., Dash, P., Shah, T. K., Thakuria, D.
235 (2021). Morphometric and molecular identification of *A. japonicus* (Thiele 1900) in
236 vulnerable Himalayan snow trout, *Schizothorax richardsonii* (Gray 1832). *Aquaculture*
237 *Research*. 52(12): 6770-6778.

238 Taylor, N. G. H., Sommerville, C., Wootten, R. (2006). The epidemiology of *Argulus*
239 spp. (Crustacea: Branchiura) infections in Stillwater trout fisheries. *Journal of Fish*
240 *diseases*. 29(4): 193–200.

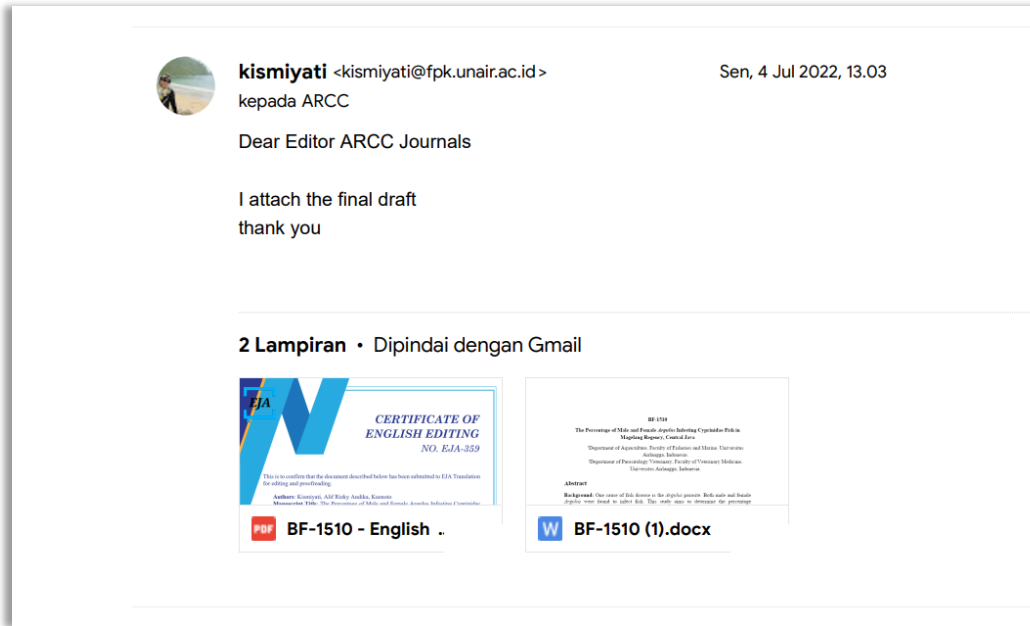
241 Wafer, L. N., Whitney, J. C., Jensen, V. B. (2015). Fish lice (*A. japonicus*) in goldfish (*C.*
242 *auratus*). Comparative medicine. *American Association for Laboratory Animal Science*.
243 65(2): 93–95.

244 Walker, P. D., Russon, I. J., Haond, C., Van Der Velde, G., Wendelaar-Bonga, S. E.
245 (2011). Feeding in adult *Argulus japonicus* Thiele, 1900 (Maxillopoda, Branchiura), an
246 ectoparasite on fish. *Crustaceana*. 307-318.

- 247 Wardany, K. H. and Kurniawan, N. (2014). Eksplorasi Ektoparasit Pada Ikan Famili
248 Cyprinidae Di Kolam Rumah Makan Wilayah Malang Raya. *Biotropika: Journal of*
249 *Tropical Biology*. 2(2): 87-91.
- 250 Wibowo, A. B., Anggoro, S., Yulianto, B. (2015). Status keberlanjutan dimensi ekologi
251 dalam pengembangan kawasan minapolitan berkelanjutan berbasis perikanan budidaya
252 air tawar di Kabupaten Magelang. *Saintek Perikanan: Indonesian Journal of Fisheries*
253 *Science and Technology*. 10(2): 107–113.
- 254 Yıldız, K. and Kumantas, A. (2002). *Argulus foliaceus* infection in a goldfish (*C.*
255 *auratus*). *Isr J Vet Med*. 57(3): 118–120

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

4 ¹Department of Aquaculture, Faculty of Fisheries and Marine, Universitas
5 Airlangga, Indonesia.

6 ²Department of Parasitology Veterinary, Faculty of Veterinary Medicine,
7 Universitas Airlangga, Indonesia.
8

9 **Abstract**

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

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

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

25 **Key words:** *Argulus*, Cyprinidae, Parasite, Fisheries.
26

27 **INTRODUCTION**

28 Magelang Regency is one of the areas that has undergone aquaculture-based
29 development, prioritizing the principle of efficiency, quality, and sustainability (Wibowo
30 *et al.*, 2015). The area consists of Ngluwar Sub-District, Mungkid Sub-District, and
31 Muntilan Sub-District. Cyprinidae family fish species that are cultivated in Magelang
32 Regency are common carp (*C. carpio*), goldfish (*C. auratus*), comet fish (*C. auratus*
33 *auratus*), and koi fish (*C. carpio koi*) (Badan Pusat Statistik Kab. Magelang, 2014). The
34 main problem in cultivating fish in Indonesia to date revolves around parasites and
35 infectious diseases. The disease causes economic losses because it can result in less

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38 Indonesia.

39 optimal fish harvest (Carella and Sirri, 2017; Das and Chandra, 2018). One cause of the
40 disease is the infestation of parasites (Picard-Sánchez *et al.*, 2020). The quality of
41 freshwater ornamental fishes decreased due to attacks from parasites such as *Argulus* sp.
42 (Alifuddin *et al.*, 2002).

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

49 Morphological identification of *Argulus* sp. is mostly based on distinguishing
50 features of an adult male such as carapace and abdominal length or width, dorsal ridges
51 of the carapace, respiratory areas, leg pigments, abdominal lobes and incision, and the
52 presence of a small coxal at the swimming appendages (Sahoo *et al.*, 2012; Soes *et al.*,
53 2010), requiring experienced taxonomists.

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

67

68

69

MATERIALS AND METHODS

70 **Procedures**

71 The research used the survey method. The survey method used in this study
72 was a survey of research locations and *Argulus* parasites in fish samples. The data were
73 collected using the descriptive method. The description of events in this study is the male
74 and female *Argulus* parasite infestations in Cyprinidae of Magelang Regency. This study
75 used a Completely Randomized Factorial Design. The Completely Randomized Factorial
76 Design was applied because the study had two different factors; (1) the *Argulus* sex and
77 (2) the Cyprinidae fish. The independent variables in this study consist of carp (*C. carpio*),
78 goldfish (*C. auratus*), comet goldfish (*C. auratus auratus*), and koi fish (*C. carpio koi*),
79 and the sex of *Argulus*. The dependent variable of this study was the sex percentage of
80 the *Argulus* parasite. The control variables of this study were fish size, location, and
81 environmental conditions in Magelang. The collected sample amounted to 200 fish.

82 **Data analysis**

83 Analysis of the data used in this study was ANOVA (analysis of variance)
84 using SPSS v16.0. If there are significant differences, further tests would be conducted
85 using Duncan's Multiple Range Test (Santoso, 2008).

86

87

RESULTS AND DISCUSSION

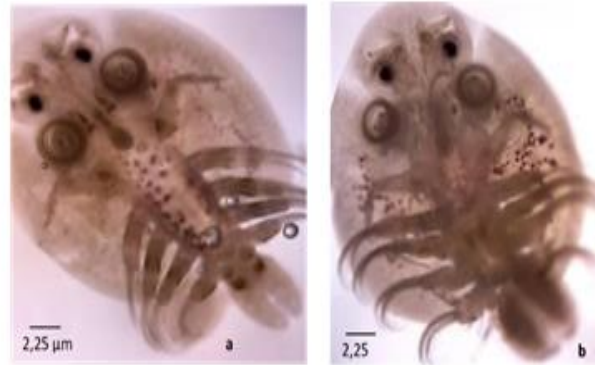
88 **Result**

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

95 The male and female *A. japonicus* can also be distinguished based on their
96 morphology. The males are identified as having an abdominal testis. In comparison, the
97 females are identified by their cephalothorax ovaries and seminal receptacle in the
98 abdomen. *A. japonicus* are found in carp (*C. carpio*), goldfish (*C. auratus*), comet
99 goldfish (*C. auratus auratus*), and koi fish (*C. carpio koi*). *A. japonicus* is one of the

100 ectoparasites that attacks the Cyprinidae family (Wardany and Kurniawan, 2014). *A.*
101 *japonicus* that infest in the Cyprinidae family in Magelang are observed in Figure 1.

102



103

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

107

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

113 Data differences between the infestations of male and female *A. japonicus* in
114 four different species of Cyprinidae were analyzed by analysis of variance (ANOVA).
115 The results of the first ANOVA showed results that were not significantly different ($p >$
116 0.05) between the average numbers of male and female *A. japonicus* that infest carp (*C.*
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118 *carpio koi*). The second ANOVA showed significantly different results ($p < 0.05$) between
119 carp (*C. carpio*), goldfish (*C. auratus*), comet goldfish (*C. auratus auratus*), and koi fish
120 (*C. carpio koi*) which have been infected by *A. japonicus*. The infestations analyzed using
121 the third ANOVA were not significantly different ($p > 0.05$) between the male and female
122 *A. japonicus* females in carp (*C. carpio*), goldfish (*C. auratus*), comet goldfish (*C. auratus*
123 *auratus*), and koi fish (*C. carpio koi*).

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

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130 from carp (*C. carpio*). Male *A. japonicus* were least found in comet goldfish (*C. auratus*
131 *auratus*), but in a number that is not significantly different from carp (*C. carpio*). In
132 contrast, in the female infestation of *A. japonicus*, no differences were found between the
133 four types of fish.

134 **Discussion**

135 It has been identified that the *Argulus* sp. infest in carp (*C. carpio*), goldfish
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139 respiratory area in the anterior is small, with the posterior being larger, five to nine
140 supporting rods can be found in the Maxilla I, and the Maxilla II is equipped with a total
141 of three hooks. Male *A. japonicus* is equipped with testicles in the abdomen, whereas
142 females have ovaries. The physical difference between the male and female *A. japonicus*
143 can be seen in the abdomen located in the posterior part of the body (Kismiyati et al.,
144 2011). Female *A. japonicus* has spermatheca and ovaries, while males have seminal
145 testicles and vascular (Wardany and Kurniawan, 2014).

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

159 There are 60% of male *A. japonicus* infest koi fish (*C. carpio* koi) while the
160 female is 40%. Male *A. japonicus* can be found on the surface of koi fish (*C. carpio* koi).

161 Koi fish (*C. carpio koi*) has a broad body surface that becomes the preferred predilection
162 for male *A. japonicus*. Male *A. japonicus* prefers large areas (Taylor *et al.*, 2006).

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

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

180

181

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183 and corporate financial support for the work must be fully acknowledged, and any
184 potential conflicts of interest are noted.

185

REFERENCES

187 Alifuddin, M., Priyono, A., Nurfatimah, A. (2002). Parasites Inventory on Ornamental
188 Fish Transported in Soekarno-Hatta Airport, Cengkareng, Jakarta. *Jurnal Akuakultur*
189 *Indonesia*. 1: 123-128.

190 Badan Pusat Statistik Kabupaten Magelang. (2014). Produksi Ikan Air Tawar Menurut
191 Kecamatan. <http://magelangkab.bps.go.id>.

- 192 Bandilla, M. (2007). Transmission and Host and Mate Location in the Fish Louse *Argulus*
193 coregoni and its Link with Bacterial Disease in Fish, Jyvaskyla Studies in Biological and
194 Environmental Science. Jyvaskyla: University of Jyvaskyla Press.
- 195 Carella, F. and Sirri, R. (2017). Fish and Shellfish Pathology. *Frontiers in Marine*
196 *Science*. 4: 375.
- 197 Das, D. R. and Chandra, K. J. (2018). Seasonal Variation Of Gill, Skin, Muscle, Liver
198 And Kidney Pathology Of Mrigal (*Cirrhinus Cirrhosus*) In Cultural Pond Fisheries,
199 Mymensingh, Bangladesh. *Bangladesh Journal of Veterinary Medicine*. 16(1): 121–129.
- 200 Ebrahimi, M., Nematollahi, A., Samiei, A., Golabi, M. (2018). Ectoparasitism on
201 freshwater fish in West Azerbaijan, northwest of Iran. *Comparative Clinical Pathology*.
202 27(2): 353-356.
- 203 Kismiyati, Fatiza, R. N., Kusdarwati, R. (2011). Pengaruh Pemberian Garam (NaCl)
204 terhadap Kerusakan Telur *Argulus japonicus* [Effect of Salt (NaCl) Against Damage of
205 *Argulus japonicus* Egg]. *Jurnal Ilmiah Perikanan dan Kelautan*. 3(1): 113-116.
- 206 Kismiyati, Iskhaq, N. M., Triastuti, J. (2010). Preference of Oviposition Object of
207 Ectoparasite *A. japonicus*. *Jurnal Ilmiah Perikanan dan Kelautan*. 2: 165–169.
- 208 Kumar, S., Sathish, K. T., Vidya, R., Pandey, P. K. (2017). A prospective of
209 epidemiological intervention in investigation and management of argulosis in
210 aquaculture. *Aquaculture International*. 25(1): 303–325.
- 211 Mikheev, V. N., Pasternak, A. F., Valtonen, E. T. (2015). Behavioural adaptations of
212 argulid parasites (Crustacea: Branchiura) to major challenges in their life cycle. *Parasites*
213 *& vectors*. 8(1): p. 394.
- 214 Møller, O. S. (2009). Branchiura (Crustacea)-survey of historical literature and
215 taxonomy. *Arthropod Systematics & Phylogeny*. 67(1): 41–55.
- 216 Picard-Sánchez, A., Estensoro, I., Del Pozo, R., Palenzuela, O. R., Piazzon, M. C., Sitjà-
217 Bobadilla, A. (2020). Water temperature, time of exposure and population density are key
218 parameters in *Enteromyxum leei* fish-to-fish experimental transmission. *Journal of Fish*
219 *Diseases*. 43(4): 491-502.

- 220 Poly, W. J. (2008). Global diversity of fishlice (Crustacea: Branchiura: Argulidae) in
221 freshwater. *Hydrobiologia*. 595(1): 209–212.
- 222 Pramujirini, D. (2016). Predileksi *A. japonicus* Jantan Dan Betina Serta Perubahan
223 Patologi Anatomi Tiga Jenis Ikan Hias Yang Terinfestasi Di Sentra Budidaya Ikan Hias
224 Jawa Timur. Bachelor Thesis. Surabaya: Universitas Airlangga.
- 225 Sahoo, P. K., Mohanty, J., Garnayak, S., Mohanty, B., Kar, B., Prasanth, H., Jena, J.
226 (2013). Estimation of loss due to argulosis in carp culture ponds in India. *Indian Journal*
227 *of Fisheries*. 60(2): 99–102.
- 228 Santoso, S. (2008). Panduan lengkap menguasai SPSS 16. Jakarta: Elex Media
229 Komputindo.
- 230 Soes, D., Walker, P., Kruijt, D. (2010). The Japanese fish louse *A. japonicus* new for The
231 Netherlands. *Lauterbornia*. 70: 11–17.
- 232 Tandel, R. S., Chanu, K. V., Hussain Bhat, R. A., Dash, P., Shah, T. K., Thakuria, D.
233 (2021). Morphometric and molecular identification of *A. japonicus* (Thiele 1900) in
234 vulnerable Himalayan snow trout, *Schizothorax richardsonii* (Gray 1832). *Aquaculture*
235 *Research*. 52(12): 6770-6778.
- 236 Taylor, N. G. H., Sommerville, C., Wootten, R. (2006). The epidemiology of *Argulus*
237 spp. (Crustacea: Branchiura) infections in Stillwater trout fisheries. *Journal of Fish*
238 *diseases*. 29(4): 193–200.
- 239 Wafer, L. N., Whitney, J. C., Jensen, V. B. (2015). Fish lice (*A. japonicus*) in goldfish (*C.*
240 *auratus*). Comparative medicine. *American Association for Laboratory Animal Science*.
241 65(2): 93–95.
- 242 Walker, P. D., Russon, I. J., Haond, C., Van Der Velde, G., Wendelaar-Bonga, S. E.
243 (2011). Feeding in adult *Argulus japonicus* Thiele, 1900 (Maxillopoda, Branchiura), an
244 ectoparasite on fish. *Crustaceana*. 307-318.
- 245 Wardany, K. H. and Kurniawan, N. (2014). Eksplorasi Ektoparasit Pada Ikan Famili
246 Cyprinidae Di Kolam Rumah Makan Wilayah Malang Raya. *Biotropika: Journal of*
247 *Tropical Biology*. 2(2): 87-91.

- 248 Wibowo, A. B., Anggoro, S., Yulianto, B. (2015). Status keberlanjutan dimensi ekologi
249 dalam pengembangan kawasan minapolitan berkelanjutan berbasis perikanan budidaya
250 air tawar di Kabupaten Magelang. *Saintek Perikanan: Indonesian Journal of Fisheries*
251 *Science and Technology*. 10(2): 107–113.
- 252 Yıldız, K. and Kumantas, A. (2002). *Argulus* foliaceus infection in a goldfish (*C.*
253 *auratus*). *Isr J Vet Med*. 57(3): 118–120

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Dear Dr. Kismiyati,

Thank you for sending the revised article no. **BF-1510** entitled "**The Percentage of Male and Female Argulus Infesting Cyprinidae Family Fish in Magelang Regency, Central Java**". It has been passed on to the editorial section for final assessment and soon you will be informed further.

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Kismiyati,
Department of Aquaculture, Faculty of Fisheries and Marine,
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Acceptance of manuscript

Dear Dr. Kismiyati,

We are pleased to inform you that your manuscript has been accepted for publication in **Indian Journal of Animal Research**. Your submission is a well-thought out piece of writing and follows many of journal guidelines. The editors agreed that your submission showed great writing skills.

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

Author(s): Kismiyati, Alif Rizky Andika, Kusnoto

Congratulations to you once again on your article acceptance in ARCC Journals, and we look forward to receiving more of your good submissions.

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It is observed that you have quoted a reference- Sahoo et al., (2012) in the text but the year of publication is 2013 given in the List of references. Please inform the corrected year of this reference with complete details.
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9. Final Revision Submitted (August 18, 2022)


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This is my final manuscript BF-1510
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2 The Percentage of Male and Female *Argulus* Infesting Cyprinidae Fish in
3 Magelang Regency, Central Java, Indonesia

4 Kismiyati^{1,*}, Alif Rizky Andika¹, Kusnoto²

5 ¹Department of Aquaculture, Faculty of Fisheries and Marine, Universitas
6 Airlangga, Indonesia.

7 ²Department of Parasitology Veterinary, Faculty of Veterinary Medicine,
8 Universitas Airlangga, Indonesia.

9
10 **Abstract**

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

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

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

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

27
28 **INTRODUCTION**

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

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36 ¹Department of Aquaculture, Faculty of Fisheries and Marine, Universitas Airlangga,
37 Indonesia.

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

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

50 Morphological identification of *Argulus* sp. is mostly based on distinguishing
51 features of an adult male such as carapace and abdominal length or width, dorsal ridges
52 of the carapace, respiratory areas, leg pigments, abdominal lobes and incision, and the
53 presence of a small coxal at the swimming appendages (Sahoo *et al.*, 2013; Soes *et al.*,
54 2010), requiring experienced taxonomists.

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

68

69

MATERIALS AND METHODS

70

71 **Procedures**

72 The research used the survey method. The survey method used in this study
73 was a survey of research locations and *Argulus* parasites in fish samples. The collected
74 specimens were labeled and fixed in 96% alcohol solution (Hasan and Tamam, 2019;
75 Hasan *et al.*, 2021). The data were collected using the descriptive method. The description
76 of events in this study is the male and female *Argulus* parasite infestations in Cyprinidae
77 of Magelang Regency. This study used a Completely Randomized Factorial Design. The
78 Completely Randomized Factorial Design was applied because the study had two
79 different factors; (1) the *Argulus* sex and (2) the Cyprinidae fish. The independent
80 variables in this study consist of carp (*C. carpio*), goldfish (*C. auratus*), comet goldfish
81 (*C. auratus auratus*), and koi fish (*C. carpio koi*), and the sex of *Argulus*. The dependent
82 variable of this study was the sex percentage of the *Argulus* parasite. The control variables
83 of this study were fish size, location, and environmental conditions in Magelang. The
84 collected sample amounted to 200 fish.

85 **Data analysis**

86 Analysis of the data used in this study was ANOVA (analysis of variance)
87 using SPSS v16.0. If there are significant differences, further tests would be conducted
88 using Duncan's Multiple Range Test (Santoso, 2008).

89

90

RESULTS AND DISCUSSION

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

97 The male and female *A. japonicus* can also be distinguished based on their
98 morphology. The males are identified as having an abdominal testis. In comparison, the
99 females are identified by their cephalothorax ovaries and seminal receptacle in the
100 abdomen. *A. japonicus* are found in carp (*C. carpio*), goldfish (*C. auratus*), comet
101 goldfish (*C. auratus auratus*), and koi fish (*C. carpio koi*). *A. japonicus* is one of the

102 ectoparasites that attacks the Cyprinidae family (Wardany and Kurniawan, 2014). *A.*
103 *japonicus* that infest in the Cyprinidae family in Magelang are observed in Figure 1.

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

109 Data differences between the infestations of male and female *A. japonicus* in
110 four different species of Cyprinidae were analyzed by analysis of variance (ANOVA).
111 The results of the first ANOVA showed results that were not significantly different ($p >$
112 0.05) between the average numbers of male and female *A. japonicus* that infest carp (*C.*
113 *carpio*), goldfish (*C. auratus*), comet goldfish (*C. auratus auratus*), and koi fish (*C.*
114 *carpio koi*). The second ANOVA showed significantly different results ($p < 0.05$) between
115 carp (*C. carpio*), goldfish (*C. auratus*), comet goldfish (*C. auratus auratus*), and koi fish
116 (*C. carpio koi*) which have been infected by *A. japonicus*. The infestations analyzed using
117 the third ANOVA were not significantly different ($p > 0.05$) between the male and female
118 *A. japonicus* females in carp (*C. carpio*), goldfish (*C. auratus*), comet goldfish (*C. auratus*
119 *auratus*), and koi fish (*C. carpio koi*).

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

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

130 It has been identified that the *Argulus* sp. infest in carp (*C. carpio*), goldfish
131 (*C. auratus*), comet goldfish (*C. auratus auratus*), and koi fish (*C. carpio koi*) in
132 Magelang is *A. japonicus*. *A. japonicus* can be distinguished from other *Argulus* sp. by
133 looking at the range of length (3-9 mm) and width of 2-6 mm (Møller, 2009). The
134 respiratory area in the anterior is small, with the posterior being larger, five to nine

135 supporting rods can be found in the Maxilla I, and the Maxilla II is equipped with a total
136 of three hooks. Male *A. japonicus* is equipped with testicles in the abdomen, whereas
137 females have ovaries. The physical difference between the male and female *A. japonicus*
138 can be seen in the abdomen located in the posterior part of the body (Kismiyati et al.,
139 2011). Female *A. japonicus* has spermatheca and ovaries, while males have seminal
140 testicles and vascular (Wardany and Kurniawan, 2014).

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

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

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

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

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164 *carpio koi*) and goldfish (*C. auratus*) but in a number that is not significantly different
165 from carp (*C. carpio*). Male *A. japonicus* least infests comet goldfish (*C. auratus*
166 *auratus*), but in a number that is not substantially different from carp (*C. carpio*). That is
167 because all four types of fish have other body surface areas. Male *A. japonicus* favors

168 large areas (Taylor *et al.*, 2006). Duncan's Multiple Range Test results also showed that
169 no differences were found between the four types of fish infested by female *A. japonicus*.
170 Female *A. japonicus* is often found in fish fins (Pramujirini, 2016). The female chooses
171 fins as a place of predilection because the fin movements of carp (*C. carpio*), goldfish (*C.*
172 *auratus*), comet goldfish (*C. auratus auratus*), and koi fish (*C. carpio koi*) are languid.
173 The slow movement of fish fins makes it easy for female *A. japonicus* to break away.
174 Female *A. japonicus* will escape from the host when oviposition (Kismiyati *et al.*, 2010).

175

176

CONCLUSION

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

184

185

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186 Acknowledgments are expressed in a brief; all sources of institutional, private
187 and corporate financial support for the work must be fully acknowledged, and any
188 potential conflicts of interest are noted.

189

REFERENCES

- 191 Alifuddin, M., Priyono, A., Nurfatimah, A. (2002). Parasites Inventory on Ornamental
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193 *Indonesia*. 1: 123-128.
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- 196 Bandilla, M. (2007). Transmission and Host and Mate Location in the Fish Louse Argulus
197 coregoni and its Link with Bacterial Disease in Fish, *Jyvaskyla Studies in Biological and*
198 *Environmental Science*. Jyvaskyla: University of Jyvaskyla Press.

- 199 Carella, F. and Sirri, R. (2017). Fish and Shellfish Pathology. *Frontiers in Marine Science*.
200 4: 375.
- 201 Das, D. R. and Chandra, K. J. (2018). Seasonal Variation Of Gill, Skin, Muscle, Liver
202 And Kidney Pathology Of Mrigal (*Cirrhinus Cirrhosus*) In Cultural Pond Fisheries,
203 Mymensingh, Bangladesh. *Bangladesh Journal of Veterinary Medicine*. 16(1): 121–129.
- 204 Ebrahimi, M., Nematollahi, A., Samiei, A., Golabi, M. (2018). Ectoparasitism on
205 freshwater fish in West Azerbaijan, northwest of Iran. *Comparative Clinical Pathology*.
206 27(2): 353-356.
- 207 Hasan, V., Tamam, M.B. (2019). First record of the invasive Nile Tilapia, *Oreochromis*
208 *niloticus* (Linnaeus, 1758) (Perciformes, Cichlidae), on Bawean Island, Indonesia.
209 *Check List*. 15(1): 225-227.
- 210 Hasan, V., Valen, F.S., Islamy, R.A, Widodo, M.S., Saptadjaja, A.M., Islam, I. (2021).
211 Short Communication: Presence of the vulnerable freshwater goby *Sicyopus auxilimentus*
212 (Gobiidae, Sicydiinae) on Sangihe Island, Indonesia. *Biodiversitas*. 22: 571-579
- 213 Kismiyati, Fatiza, R. N., Kusdarwati, R. (2011). Pengaruh Pemberian Garam (NaCl)
214 terhadap Kerusakan Telur *Argulus japonicus* [Effect of Salt (NaCl) Against Damage of
215 *Argulus japonicus* Egg]. *Jurnal Ilmiah Perikanan dan Kelautan*. 3(1): 113-116.
- 216 Kismiyati, Iskhaq, N. M., Triastuti, J. (2010). Preference of Oviposition Object of
217 Ectoparasite *A. japonicus*. *Jurnal Ilmiah Perikanan dan Kelautan*. 2: 165–169.
- 218 Kumar, S., Sathish, K. T., Vidya, R., Pandey, P. K. (2017). A prospective of
219 epidemiological intervention in investigation and management of argulosis in
220 aquaculture. *Aquaculture International*. 25(1): 303–325.
- 221 Mikheev, V. N., Pasternak, A. F., Valtonen, E. T. (2015). Behavioural adaptations of
222 argulid parasites (Crustacea: Branchiura) to major challenges in their life cycle. *Parasites*
223 *& Vectors*. 8(1): p. 394.
- 224 Møller, O. S. (2009). Branchiura (Crustacea)-survey of historical literature and
225 taxonomy. *Arthropod Systematics & Phylogeny*. 67(1): 41–55.
- 226 Picard-Sánchez, A., Estensoro, I., Del Pozo, R., Palenzuela, O. R., Piazzon, M. C., Sitjà-
227 Bobadilla, A. (2020). Water temperature, time of exposure and population density are key

228 parameters in *Enteromyxum leei* fish-to-fish experimental transmission. *Journal of Fish*
229 *Diseases*. 43(4): 491-502.

230 Poly, W. J. (2008). Global diversity of fishlice (Crustacea: Branchiura: Argulidae) in
231 freshwater. *Hydrobiologia*. 595(1): 209–212.

232 Pramujirini, D. (2016). Predileksi *A. japonicus* Jantan Dan Betina Serta Perubahan
233 Patologi Anatomi Tiga Jenis Ikan Hias Yang Terinfestasi Di Sentra Budidaya Ikan Hias
234 Jawa Timur. Bachelor Thesis. Surabaya: Universitas Airlangga.

235 Sahoo, P. K., Mohanty, J., Garnayak, S., Mohanty, B., Kar, B., Prasanth, H., Jena, J.
236 (2013). Estimation of loss due to argulosis in carp culture ponds in India. *Indian Journal*
237 *of Fisheries*. 60(2): 99–102.

238 Santoso, S. (2008). Panduan lengkap menguasai SPSS 16. Jakarta: Elex Media
239 Komputindo.

240 Soes, D., Walker, P., Kruijt, D. (2010). The Japanese fish louse *A. japonicus* new for The
241 Netherlands. *Lauterbornia*. 70: 11–17.

242 Tandel, R. S., Chanu, K. V., Hussain Bhat, R. A., Dash, P., Shah, T. K., Thakuria, D.
243 (2021). Morphometric and molecular identification of *A. japonicus* (Thiele 1900) in
244 vulnerable Himalayan snow trout, *Schizothorax richardsonii* (Gray 1832). *Aquaculture*
245 *Research*. 52(12): 6770-6778.

246 Taylor, N. G. H., Sommerville, C., Wootten, R. (2006). The epidemiology of *Argulus*
247 spp. (Crustacea: Branchiura) infections in Stillwater trout fisheries. *Journal of Fish*
248 *diseases*. 29(4): 193–200.

249 Wafer, L. N., Whitney, J. C., Jensen, V. B. (2015). Fish lice (*A. japonicus*) in goldfish
250 (*C. auratus*). *Comparative medicine*. American Association for Laboratory Animal
251 *Science*. 65(2): 93–95.

252 Walker, P. D., Russon, I. J., Haond, C., Van Der Velde, G., Wendelaar-Bonga, S. E.
253 (2011). Feeding in adult *Argulus japonicus* Thiele, 1900 (Maxillopoda, Branchiura), an
254 ectoparasite on fish. *Crustaceana*. 307-318.

255 Wardany, K. H. and Kurniawan, N. (2014). Eksplorasi Ektoparasit Pada Ikan Famili
256 Cyprinidae Di Kolam Rumah Makan Wilayah Malang Raya. *Biotropika: Journal of*
257 *Tropical Biology*. 2(2): 87-91.

258 Wibowo, A. B., Anggoro, S., Yulianto, B. (2015). Status keberlanjutan dimensi ekologi
259 dalam pengembangan kawasan minapolitan berkelanjutan berbasis perikanan budidaya
260 air tawar di Kabupaten Magelang. *Saintek Perikanan: Indonesian Journal of Fisheries*
261 *Science and Technology*. 10(2): 107–113.

262 Yıldız, K. and Kumantas, A. (2002). *Argulus foliaceus* infection in a goldfish (*C. auratus*).
263 *Israel Journal of Veterinary Medicine*. 57(3): 118–120

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Figure 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*.

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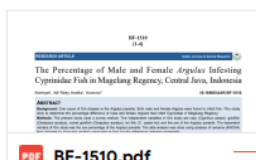
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The Percentage of Male and Female *Argulus* Infesting Cyprinidae Fish in Magelang Regency, Central Java, Indonesia

Kismiyati¹, Alif Rizky Andika¹, Kusnoto²

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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.

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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 japonicus* (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* infests 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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REFERENCES

- Alifuddin, M., Priyono, A., Nurfatimah, A. (2002). Parasites Inventory on Ornamental Fish Transported in Soekarno-Hatta Airport, Cengkareng, Jakarta. *Jurnal Akuakultur Indonesia*. 1: 123-128.
- Badan Pusat Statistik Kabupaten Magelang. (2014). Produksi Ikan Air Tawar Menurut Kecamatan. <http://magelangkab.bps.go.id>.
- Bandilla, M. (2007). Transmission and Host and Mate Location in the Fish Louse *Argulus coregoni* and its Link with Bacterial Disease in Fish, *Jyvaskyla Studies in Biological and Environmental Science*. Jyvaskyla: University of Jyvaskyla Press.
- Carella, F. and Sirri, R. (2017). Fish and shellfish pathology. *Frontiers in Marine Science*. 4: 375.
- Das, D.R. and Chandra, K.J. (2018). Seasonal variation of gill, skin, muscle, liver and kidney pathology of mrigal (*Cirrhinus cirrhosus*) in cultural pond fisheries, mymensingh, Bangladesh. *Bangladesh Journal of Veterinary Medicine*. 16(1): 121-129.
- Ebrahimi, M., Nematollahi, A., Samiei, A., Golabi, M. (2018). Ectoparasitism on freshwater fish in West Azerbaijan, northwest of Iran. *Comparative Clinical Pathology*. 27(2): 353-356.
- Kismiyati, Fatiza, R.N., Kusdarwati, R. (2011). Pengaruh pemberian garam (NaCl) terhadap kerusakan telur *Argulus japonicus* [Effect of salt (NaCl) against damage of *Argulus japonicus* egg]. *Jurnal Ilmiah Perikanan dan Kelautan*. 3(1): 113-116.
- Kismiyati, Iskhaq, N.M., Triastuti, J. (2010). Preference of oviposition object of ectoparasite *A. japonicus*. *Jurnal Ilmiah Perikanan dan Kelautan*. 2: 165-169.
- Kumar, S., Sathish, K.T., Vidya, R., Pandey, P.K. (2017). A prospective of epidemiological intervention in investigation and management of argulosis in aquaculture. *Aquaculture International*. 25(1): 303-325.
- Mikheev, V.N., Pasternak, A.F., Valtonen, E.T. (2015). Behavioural adaptations of argulid parasites (Crustacea: Branchiura) to major challenges in their life cycle. *Parasites and Vectors*. 8(1): p. 394.
- Møller, O.S. (2009). Branchiura (Crustacea)-survey of historical literature and taxonomy. *Arthropod Systematics and Phylogeny*. 67(1): 41-55.

- Picard Sánchez, A., Estensoro, I., Del Pozo, R., Palenzuela, O.R., Piazzon, M.C., Sitjà Bobadilla, A. (2020). Water temperature, time of exposure and population density are key parameters in *Enteromyxum leei* fish to fish experimental transmission. *Journal of Fish Diseases*. 43(4): 491-502.
- Poly, W.J. (2008). Global diversity of fishlice (Crustacea: Branchiura: Argulidae) in freshwater. *Hydrobiologia*. 595(1): 209-212.
- Pramujirini, D. (2016). Predileksi *A. japonicus* Jantan Dan Betina Serta Perubahan Patologi Anatomi Tiga Jenis Ikan Hias Yang Terinfestasi Di Sentra Budidaya Ikan Hias Jawa Timur. Bachelor Thesis. Surabaya: Universitas Airlangga.
- Sahoo, P.K., Mohanty, J., Garnayak, S., Mohanty, B., Kar, B., Prasanth, H., Jena, J. (2013). Estimation of loss due to argulosis in carp culture ponds in India. *Indian Journal of Fisheries*. 60(2): 99-102.
- Santoso, S. (2008). Panduan lengkap menguasai SPSS 16. Jakarta: Elex Media Komputindo.
- Soes, D., Walker, P., Kruijt, D. (2010). The Japanese Fish Louse *A. japonicus* new for The Netherlands. *Lauterbornia*. 70: 11-17.
- Tandel, R.S., Chanu, K.V., Bhat, R.A.H., Dash, P., Shah, T.K., Thakuria, D. (2021). Morphometric and molecular identification of *A. japonicus* (Thiele 1900) in vulnerable Himalayan snow trout, *Schizothorax richardsonii* (Gray 1832). *Aquaculture Research*. 52(12): 6770-6778.
- Taylor, N.G.H., Sommerville, C., Wootten, R. (2006). The epidemiology of *Argulus* spp. (Crustacea: Branchiura) infections in Stillwater trout fisheries. *Journal of Fish diseases*. 29(4): 193-200.
- Wafer, L.N., Whitney, J.C., Jensen, V.B. (2015). Fish lice (*A. japonicus*) in goldfish (*C. auratus*). *Comparative medicine*. American Association for Laboratory Animal Science. 65(2): 93-95.
- Walker, P.D., Russon, I.J., Haond, C., Velde, G.V.D., Wendelaar-Bonga, S.E. (2011). Feeding in adult *Argulus japonicus* Thiele, 1900 (Maxillopoda, Branchiura), an ectoparasite on fish. *Crustaceana*. 307-318.
- Wardany, K.H. and Kurniawan, N. (2014). Eksplorasi ektoparasit pada ikan famili cyprinidae di kolam rumah makan wilayah malang raya. *Biotropika: Journal of Tropical Biology*. 2(2): 87-91.
- Wibowo, A.B., Anggoro, S., Yulianto, B. (2015). Status keberlanjutan dimensi ekologi dalam pengembangan kawasan minapolitan berkelanjutan berbasis perikanan budidaya air tawar di kabupaten magelang. *Saintek Perikanan: Indonesian Journal of Fisheries Science and Technology*. 10(2): 107-113.
- Yıldız, K. and Kumantas, A. (2002). *Argulus foliaceus* infection in a goldfish (*C. auratus*). *Israel Journal of Veterinary Medicine*. 57(3): 118-120.