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Application of different temperatures in the incubation process of Jurung fish eggs (*Tor tambra*)

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ABSTRACT

The habitat of the Jurung fish (*Tor tambra*) is generally inflowing rivers, rocky bottom waters and relatively low water temperatures. This study aimed to determine the hatchability of the Jurung Fish (*Tor tambra*) eggs with different temperature treatments using a tray in the aquarium. The research method used is the laboratory experimental method and the experimental design is a non-factorial completely randomized design (CRD) consisting of 4 treatments and 4 replications: A (control), B (28 °C), C (30 °C) and D (32 °C). The results showed that the application of different temperatures had a significant effect on the hatching of the Jurung Fish (*Tor tambra*) eggs. The results of Duncan's further test analysis showed that the 28 °C temperature treatment was the best compared to other temperatures. This study recommends that further research is needed on larval abnormalities at different water temperatures.

INTRODUCTION

The family *Cyprinidae* is a freshwater fish that is distributed throughout the world, except in Australia, Madagascar, New Zealand and South America which consists of 220 genera and 2420 species (Bell, 2006). The freshwater fish of the *Cyprinidae* tribe that has the potential to be developed is the jurung fish. Jurung fish are fish that belong to the *Tor* genus. In Indonesia, it is known that there are four types of *Tor*, namely *Tor tambroides*, *Tor tambra*, *Tor douronensis* and *Tor soro*. The jurung fish itself is better known as Mahseer or kings of rivers because the body size of the jurung fish can be very large so it is dubbed the king of the river. In the world, there are 20 types of fish from the *Tor* clan scattered in the Asian region (Kiat, 2004). Jurung fish have several local names, namely sapan (Central Kalimantan), semah (Sumatra, West Kalimantan, East Kalimantan), garieng (Padang), kancera (West Java), and Tambra in Central Java (Haryono et al., 2009).

Jurung fish is one type of fish that has a high protein albumin content. Andreeva (2011) stated that serum albumin is a type of protein that is important in the metabolic system of fish. Fish Serum Albumin (FSA) protein has a function to help transport body metabolites (fatty acids, hormones, bilirubin), regulate the blood *colloid osmotic* pressure regulation system and the *osmoregulation* process in the fish body, as well as filter fluids in body tissues. In certain areas fish is used as one of the requirements for traditional ceremonies and is used for medicine by

the people of North Sumatra. In some areas, jurung fish serve as a special attraction to serve as a tourist attraction. One of the endemic species on the island of Sumatra is jurung fish which is consumed by the community and has high economic value. Roesma et al. (2016) reported that in North Sumatra the selling price of the fish weighing 2 kg can reach Rp. 350,000.00.

Hasibuan et al. (2018) states that temperature affects the hatching time of eggs where the higher the temperature, the faster the eggs hatch. Incubation temperature values that are too low or too high can cause improper embryo development, which can cause abnormalities or even death of the embryo (Zarski et al., 2017). This study aims to determine the effect of temperature on hatchability, survival rate, abnormalities, and water quality in the incubation of fish eggs (*Tor tambra*).

MATERIAL AND METHODS

This research was carried out at the Laboratory of the Study Program for Seed and Fish Feed Production Technology, Indonesian Polytechnic Venezuela from June 10–22, 2021. The eggs of the Jurung fish came from the Lawe Bekung Fish Seed Center in Southeast Aceh by going through a shipping process for 15 hours by land transportation. 960 eggs were tested, there were 60 eggs in each research container (aquarium) and they were stocked on a tray. Observations of eggs were only carried out at three stages of egg embryo development, namely the gastrula phase, the blastophore phase until the eggs hatch and run out of food reserves. This is because the mitotic and morula phases have occurred when the eggs are on their way to the research site.

Data collection for hatching eggs is by observing eggs when the eggs are 24 hours, 48 hours, 72 hours, 97 hours and 131 hours until they are in the depleted phase of food reserves. Data on abnormalities and survival of larvae were checked on the last day of the study. While the water quality data collection was checked every morning and evening for 4 days until the eggs hatched entirely. The percentage of egg hatchability was calculated after the total number of hatched eggs was known. Furthermore, to determine the abnormalities and survival of the larvae, counting was carried out after the eggs hatched. Data was collected 15 repetitions for hatching rate, survival rate, abnormalities, and water quality.

Hatching rate. Eggs hatched during incubation, hatching rate (HR) was calculated using the formula, Nurasni (2012).

$$HR = \frac{\text{Number of eggs hatched}}{\text{Number of fertilized eggsi}} \times 100\ \%$$

***Survival rate*.** Larval survival can be calculated using the formula, Yulfiperius (2014).

$$SR = \frac{\text{Final amount fish}}{\text{Number of larvae after hatching eggs}} \times 100\%$$

***Abnormality*.** Calculation of larval abnormalities using the formula, Wirawan (2005).

$$\text{Abnormality} = \frac{\text{Number of abnormal larvael}}{\text{Numberof normal larvae}} \text{x } 100\ \%$$

***Waters quality*.** Water quality measurements were carried out every day, in the morning and evening. Parameters measured include:

Physics Parameters:

1. Temperature
   The measurement of temperature using a mercury thermometer first with the lower end of the thermometer slowly inserted into the surface of the water about 10 cm and left for 2 to 5 minutes until the mercury in the thermometer shows a stable value. Then record the results listed on the thermometer scale. with the condition still submerged on the surface of the water (SNI 06-6989.23-2005).
2. Total Dissolved Solids
   The measurement of dissolved solids is carried out using a TDS meter by inserting the TDS meter into the aquarium, allowing a few moments to show the numbers and then recording the results listed on the TDS meter.

Chemical Parameters:

1. Dissolved Oxygen
   Dissolved Oxygen was measured using a Dissolved Oxygen meter. The Dissolved Oxygen meter is inserted into the aquarium and left for a while until the value contained in the water in the research container appears, then the results are recorded on the Dissolved Oxygen meter.
2. Power of Hydrogen
   The pH of the water was measured using a pH meter. Insert the pH meter into the aquarium, then read the value and record the results that are displayed on the pH meter scale.
3. Ammonia
   Measurement of ammonia (NH3) levels was carried out using an ammonia test kit with a cube stove in the range of 0.5 to 2.5 mg. L^{-1}. Water samples were given liquid ammonia R1 fresh water and Nessler reagent then left for 5 minutes and then the results were recorded on the cube stove.

Data analyzed using SPSS 25.0 software is an analysis of variance ANOVA (Analysis of variance). If it has a significant effect to see the difference between treatments, it will be tested further using Duncan's test with a 95% confidence interval. Meanwhile, water quality data which includes water physic-chemical parameters will be analyzed descriptively.

RESULTS AND DISCUSSION

Based on analysis of variance (ANOVA) the application of different temperatures had a significant effect on the hatching of jurung fish eggs. The results showed that the highest egg hatchability was found in the control treatment (normal water temperature) with a percentage of 68%, while the lowest value was found in the treatment at 32 °C with a percentage of 53%. This is caused by high levels of hemoglobin and hematocrit at temperatures above 30 °C (Muhammad, 2021).

Hatching rate. The results of the observation of the hatchability of jurung fish eggs ranged from 53–68%, the highest value of the hatchability of jurung fish eggs was in the control treatment (normal water temperature). The hatchability rate in the treatment identified that the observed eggs jurung fish were capable of hatching at normal temperatures. The lowest value was found in the treatment of 32 °C, this indicates that the fish eggs are not tolerant to temperatures above 30 °C for hatching eggs.

Table 1. Hatching Rate Percentage

Treatment	Replication				Mean %	Standart Deviation
	1	2	3	4		
Control	78	72	62	58	68	9.2
28 °C	63	70	60	63	64	4.2
30 °C	58	73	62	72	66	7.4
32 °C	57	38	53	62	53	10.0

The best percentage of the hatchability of fish eggs was found in treatments Control (A) with a hatching rate range of 68%, while in treatment D only 53% was obtained. This shows that the results obtained are quite satisfactory because, at the control treatment level (A), the temperature at the time of incubation is close to the natural temperature of the egg habitat, which ranges from 24-25 C (Cahyanti et al., 2020). Hatching eggs can be categorized as very good if the percentage of hatchability is above 70% (Effendie, 2002). The hatching time of eggs depends on the ambient temperature, this study is one level higher than the results of the research by Arifin et al. (2019) which states that the average hatchability of fish eggs is 67%. Meanwhile, Sonaiya and Swan (2004) stated that the standard percentage of normal or satisfactory egg hatchability in natural incubation was 75-80%. The process of hatching fish eggs went through all phases perfectly but the percentage of hatching obtained different results from each treatment and could be categorized as satisfactory.

***Survival rate*.** The application of different temperatures in the incubation process of the fish eggs significantly affects the survival rate of the fish larvae. The results showed that the survival range of the larvae of fish was 24–65%.

Table 2. Survival Rate Percentage

Treatment	Replication				Mean %	Standart Deviation
	1	2	3	4		
Control	75	72	57	55	65	10,2
28°C	63	67	60	63	63	2,7
30°C	53	73	55	68	63	9,9
32°C	22	28	33	12	24	9,4

Based on measurements during the study, it was shown that the highest survival rate of jurung fish larvae was obtained from the control treatment (normal water temperature) with a percentage of 65%, while the lowest survival rate was obtained from the treatment at 32 °C with a percentage of 24%. During the study, the mortality rate of the fish larvae occurred on the 4th day after the eggs hatched and the mortality of the larvae increased dramatically at 32°C, this was due to the adaptive response of the larvae to the treatment and the environment. According to Mulyadi et al. (2014), the factors that influence the level of survival are abiotic and biotic factors, including water quality, competitors, population density, age and the ability of organisms to adapt to the environment. Abiotic factors include the availability of food and the living media environment (Istiqomah & Harwanto, 2018).

The results of research by Yuliyanti et al. (2015) in the rearing of tambra fish (*Tor tambroides*) showed that the rearing temperature of 23-25 °C resulted in a survival rate of 81.9±8.07% while the rearing temperature medium of 20-22 °C produced a survival rate of 81.9±8.07%. the highest percentage with a value of 83.7±4.38%. In the research of Irfandi et al. (2020) in the maintenance of kancra fish, it was shown that the rearing temperature of 22 °C was the best temperature for survival characters (75%). It can be indicated that the fish of the *Tor* genus, including these ling fish, which are kept at low temperatures tend to increase the degree of survival.

Abnormality. The application of different temperatures in the incubation process of jurung fish eggs significantly affected the level of abnormality of the larvae. The results showed that the highest larval abnormality was found in treatment D (temperature 32 °C) with an average percentage of 9%, while the lowest value was found in treatment B (temperature 28 °C) with an average percentage of 0 or no abnormality larvae in treatment B.

Table 3. Abnormality Percentage

Treatment	Replication				Mean %	Standart Deviation
	1	2	3	4		
Control	2	0	0	0	1	1.1
28°C	0	0	0	0	0	0.0
30°C	0	0	3	0	1	1.6
32°C	18	0	0	17	9	10.1

Fish larvae abnormalities can be observed from the shape of the head, body or tail that is bent, the body shrinks or is shorter than normal size, and differences in behavior in fish larvae (Mukti, 2005). According to Ismi (2006), abnormalities in the larval phase can also occur in open gills, defects in the mouth (short upper mouth and/or short lower mouth), and curvature of the spine, including iordosis (upward curving of the body), kyphosis (curved body). downwards), and schiolysis (a shortened appearance of the body due to an upward and downward curvature of the spine). Abnormal larvae are indicated by their smaller body size (premature), and it is possible that the larvae do not live long after 12 hours from hatching (Supriono et al*.,* 2005).

The abnormality was thought to be caused by the diameter of the waring tray in the treatment inhibiting the movement of the embryo at hatching. In addition, the abnormality is also thought to be caused by a temperature that is too high so that the eggs cannot hatch properly and ultimately affect their growth, as well as genetic factors that also affect.

Waters quality. The value of the physicochemical parameters of the water media during the study could still be tolerated by the fish in the process of hatching eggs. According to Subagja et al. (2017), fertilized eggs hatched in an aquarium must have a dissolved oxygen level of at least 5 mg. L^{-1}, pH 7-8, alkalinity <140 mg. L^{-1}, and water temperature between 25-27 °C. Minimum ammonia levels in the aquarium should be less than 1 mg. L^{-1} and nitrite 0.1 mg. L^{-1} (Haryati, 2021). According to Kiat (2004), fish can adapt well to environmental conditions, both physical factors and environmental chemical factors.

Table 4. Water Quality Range During Eggs Hatching

Temperature	Parameters			
	TDS (mg. L^{-1})	DO (ppm)	pH	Ammonia (mg. L^{-1})
Control	150	10	8.1	1.0
28°C	155	10	8.1	<0.5
30°C	165	10	8.1	<0.5
32°C	161	9	8.1	<0.5
Standart Deviation	6.6	0.5	0	0.25

The result of temperature measurement in treatment A (control) is known that the average temperature value obtained is 28.06 °C. This shows that the normal temperature of the water is approximately the same as the temperature of treatment B. Judging from the amount of temperature contained in this study, it is quite different from the temperature of the natural habitat of the fish. This is in contrast to the opinion of Subagja et al. (2017) which states that the process of embryo development in eggs jurung fish requires a temperature of 21-24 °C.

Meanwhile, according to Hutagalung et al. (2016), a good temperature for hatching fish ranges from 27-30 °C.

The results of the measurement of dissolved solids in the study obtained an average value of 158.47 mg. L^{-1}. Total dissolved solids value of 48-395 mg. L^{-1} can result in hatching rate percentage up to 47% but too high total dissolved solids can result in small egg diameter and abnormal (Chapman & Deters, 2009). Total Dissolved Solids (TDS) are dissolved materials (<10-6 mm diameter) and colloids (<10-6 mm – <10-3 mm diameter) in the form of chemical compounds and other materials, which are not filtered on paper. filter with a diameter of 0.45 m (Effendi, 2003).

The results of the measurement of dissolved oxygen in the study obtained an average value of 10.55 mg. L^{-1}. The results obtained indicate that the dissolved oxygen content in the research container is very good, this is in line with the opinion of Subagja et al. (2017) which states that a good range of dissolved oxygen in the rearing of jurung fish >5 mg. L^{-1}. The concentration of dissolved oxygen (DO) in unspoiled waters has a DO value of less than 10 mg. L^{-1}. According to Barus (2020), the value of dissolved oxygen should be in the range of 6-8 mg. L^{-1}, so that it can optimally support the life of aquatic organisms. The optimum dissolved oxygen concentration for the survival of *Tor* fish is above 5 ppm (Siregar et al., 2013).

The results of pH measurements in the study obtained an average value of 8.1. Based on the pH of each station is still classified as good for water and is neutral for the life of the fish. Freshwater fish can still tolerate a water pH of 4.0-10.0. From the measurement of pH parameters carried out in the study, the pH values ranged from 7.8-8.3. The pH value is in the neutral to a low alkaline state. It can be seen that the value of these parameters still meets the water quality in the good category to lightly polluted. This also shows that the media water is still supportive of fish life, one of which is fish from members of the Cyprinidae (Barus, 2020).

The results of the measurement of ammonia during the study obtained an average value of <0.6 mg. L^{-1}. This value is still stated to be good in the incubation pr^{oc}ess of jurung fish eggs. This is in line with the opinion of Haryati (2021) which states that the minimum ammonia level in the aquarium must be less than 1 mg. L^{-1}, the same thing with Sundari's opinion (1983) which also states that ammonia (NH3) is the main product of protein decomposition which is a toxic to fish, therefore the NH3 content of the waters is recommended no more than 1 ppm or 1 mg. L^{-1}. Of all the water quality parameters that affect fish, ammonia is the most important after oxygen, especially in intensive systems. The toxic concentration of ammonia to freshwater fish ranges from 0.7 to 0.4 mg. L^{-1} (Amrial, 2009).

CONCLUSION

Based on the results and discussion of the research that has been carried out, it can be concluded that the application of different temperatures significantly affects egg hatchability, survival and the level of abnormality of fish larvae. Water quality in the control treatment (A), hatchability was influenced by the TDS value. The lowes the TDS value, the higher the percentage of hatching rate and survival rate. water quality at a temperature of 32 °C resulted in a very high percentage of egg abnormalities with a value of 9%, causing the eggs not to hatch.

REFERENCES

Amrial, Y. (2009). *Corydoras corydoras aenus* production at stocking density of 8, 12 and 16 heads/liter in resirculation system [Indonesian]. [Undergraduate thesis, Institut Pertanian Bogor]. https://repository.ipb.ac.id/handle/123456789/19531

Andreeva, A. M. (2011). Mechanisms of the plurality of *Scorpaena porcus L.* serum albumin. *Open Journal of Marine Science*, *1*(2), 31-35. http://dx.doi.org/10.4236/ojms.2011.12003

Arifin, O. Z., Subagja, J., Asih S., & Kristanto, A. H. (2019). *Dewa Fish Cultivation* [Indonesian]. IPB Press. http://ejournal-balitbang.kkp.go.id/index.php/btla/article/viewFile/9556/7034

Barus, T. A. (2020). *Limnologi* [Indonesian]. Nas Media Pustaka. https://books.google.co.id/books?hl=nl&lr=&id=Dsf0DwAAQBAJ&oi=fnd&pg=PA1&dq=related:zwxo_SaXPEgJ:scholar.google.com/&ots=DtGa1ZzCOx&sig=jjpcM9b9PyOR0VQZlKcWZtxQ4q4&redir_esc=y#v=onepage&q&f=false

Bell, M. A. (2006). *Ecology and Evolution*. Stony Brook University. https://doi.org/10.1086/509451

Cahyanti, W., Radona, D., & Kristanto, A. H. (2020). Embryo development and early larval performance of three species of Indonesian Tor fish [Indonesian]. *Jurnal Ilmu-ilmu Hayati*, *19*(3), 239-248. 10.14203/beritabiologi.v19i3A.3832

Chapman, D. C., & Deters, J. E. (2009). Effect of water hardness and dissolved-solid concentration on hatching success and egg size in bighead carp. *Transactions of the American Fisheries Society*, *138*(6), 1226–1231. https://doi.org/10.1577/T09-004.1

Effendie, M. I. (2002). *Fisheries Biology* [Indonesian]. Yayasan Pustaka Nusatama. https://library.unismuh.ac.id/opac/detail-opac?id=67529

Effendi, H. (2003). *Study of water quality for management of aquatic resources* [Indonesian]. Kanisius. https://opac.perpusnas.go.id/DetailOpac.aspx?id=495078

Haryati. (2021). *Nutritional Needs of Parent and Fish Larva* [Indonesian]. Deepublish. https://books.google.com/books?hl=en&lr=&id=LThCEAAAQBAJ&oi=fnd&pg=PP1&dq=nutrisi+ikan&ots=1uEXhkxQK_&sig=gMur82YcKjjNQXlIRQZo2stFRRg

Haryono, A., Tjakrawidjaja, & Wahyudewantoro, G. (2009). *The Domestication and Reproduction Process of the Rare Tambra Fish Towards Its Cultivation* [Indonesian]. LIPI Press.

Hasibuan, R. B., Irawan, H., & Yulianto, T. (2018). The effect of temperature on hatched of seabass egg. *Intek Akuakultur*, *2*(2), 49-57. https://doi.org/10.31629/intek.v2i2.539.

Hutagalung, J., Alawi, H., & Sukendi, S. (2016). Effect of temperature and oxygen on hatching eggs and early survival of pawas (*Osteochilus hasselti* CV) larvae [Indonesian] [Doctoral dissertation, Riau University]. *Jurnal Online Mahasiswa Fakultas Perikanan dan Ilmu Kelautan Universitas Riau*, *4*(1),1-13. http://jom.unri.ac.id/index.php/JOMFAPERIKA/article/view/13196

Irfandi, M, Thaib, A., & Nurhayati, N. (2020). Effect of temperature difference on hatchability of keurling fish (*Tor Soro*) eggs [Indonesian]. *Jurnal Tilapia. 1*(2), 12-18. http://jurnal.abulyatama.ac.id/index.php/tilapia/article/view/1111/686

Ismi, S. (2006). Tiger grouper seed nursery business (*Epinephelus fuscoguttatus*) [Indonesian]. *Jurnal Media Akuakultur*, *1*(3), 97-100. http://ejournal-balitbang.kkp.go.id/index.php/ma/article/view/2781

Istiqomah, D. A., & Harwanto, D. (2018). Effect of water change with different percentages on survival, feed utilization efficiency and growth of monosex tilapia seeds (*Oreochromis niloticus*) [Indonesian]. *Journal of Aquaculture Management and Technology. 7*(1), 46-54. https://ejournal3.undip.ac.id/index.php/jamt/article/view/20368/19200

Kiat, Ng-Chi. (2004). *Kings of the Rivers: Mahseer in Malaysia and the Region. Inter Sea Fishery*. https://books.google.co.id/books/about/Kings_of_the_rivers.html?id=EYr7AAAACAAJ&redir_esc=y

Mukti, A. T. (2005). Differences in the success rate of polyploidization of carp (*Cyprinus carpio*) through heat shock [Indonesian]. *Berkala Penelitian Hayati*, *1*(10), 133-138. https://www.berkalahayati.org/index.php/jurnal/article/view/447/363

Mulyadi, Tang, U., & Yani, E. S. (2014). Recirculation system by using different filters on the growth of tilapia fry (*Oreochromis niloticus*) [Indonesian]. *Jurnal Akuakultur Rawa Indonesia*. *2*(2), 117-124. https://ejournal.unsri.ac.id/index.php/jari/article/view/2079

Nurasni, A. (2012). Effect of temperature and duration of heat shock on the triploidation of sangkuriang catfish (*Clarias gariepinus*) [Indonesian]. *Indonesian Journal of Applied Sciences*, *2*(1): 19-23. http://jurnal.unpad.ac.id/ijas/article/view/2728/2365

Roesma, D.I., Chornelia, A., Mursyid, A., & Kamsi, M. (2016). Fish diversity of the Batang Toru River System, South Tapanuli, North Sumatra. *Biodiversitas*, *17*(2), 628-634. https://doi.org/10.13057/biodiv/d170235

Siregar, B., Barus, T. A., & Ilyas, S. (2013). The relationship between water quality and the food habits of batak fish (*Tor Soro*) in the waters of the Asahan River, North Sumatera [Indonesian]. *Jurnal Biosains Unimed*, *1*(2), 1–11. https://jurnal.unimed.ac.id/2012/index.php/biosains/article/view/12508

Sonaiya, E. B., & Swan, S. E. J. (2004). *Small Scale Poultry Production*. Food And Agriculture Organization of the United Nations. Rome. https://www.fao.org/3/y5169e/y5169e02.htm

Subagja, J., Kristanto, A. H., Sulhi, M. (2013). Domestication of semah fish (*Tor douronensis*) through aquaculture development [Indonesian]. *Prosiding Forum Inovasi Teknologi Akuakultur*. http://ejournal-balitbang.kkp.go.id/index.php/fita/article/view/3619

Sundari, S. (1983). The Effect of Giving Different Amounts of Food to the Growth of Goldfish (*Cyprinus Carpio Linn*) [Indonesian]. [Undergraduate thesis, Institut Pertanian Bogor]. https://repository.ipb.ac.id/handle/123456789/36189

Supriono, E., Lisnawati, L., & Djokosetiyanto D. (2005). Effect of linear alkylbenzene sulfonate on mortality, hatching rate of eggs and abnormality of catfish *(Pangasius hypophthalmus Sauvage*) larvae. *Jurnal Akuakultur Indonesia*, *4*(1), 69-78. https://core.ac.uk/download/pdf/230397129.pdf

Wirawan, I. (2005). Effect of Copper Sulfate ($CuSO_4$) Exposure on Egg Hatchability, Gill Histopathological Changes and Zebra Fish Larvae *(Brachydanio rerio).* [Thesis, Universitas Airlangga] [Indonesian]. https://repository.unair.ac.id/35600/

Yulfiperius. (2014). *Fish Nutrition [Indonesian]*. PT Raja Grafindo Persada. Depok. https://www.rajagrafindo.co.id/produk/nutrisi-ikan/

Yuliyanti, B. E., Diantari R., & Arifin, O. Z. (2015). Effect of Temperature on the Development of Tor Fish (*Tor tambroides*) Eggs and Larvae. [Undergraduate thesis, Universitas Negeri Lampung] [Indonesian].

Żarski, D, Horváth, Á, Bernáth, G, Krejszeff, S, Radóczi, J. (2017). *Controlled reproduction of wild Eurasian Perch: a hatchery manual*. Springer. https://doi.org/10.1007/978-3-319-49376-3