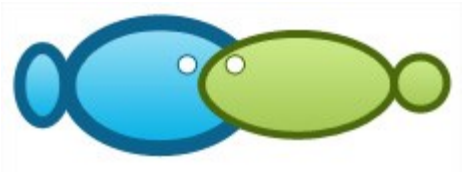

Cannibalistic behavior and way of predation among the fry of Asian redtail catfish *Hemibagrus nemurus* at different stocking densities

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Abstract. Cannibalistic behavior of Asian redtail catfish is a quite significant obstacle in cultivation, especially in the hatchery phase. The purpose of this study was to evaluate intracohort cannibalism of Asian redtail catfish fry and the way of predation among them at high stocking densities. The rearing method used a completely randomized design with 4 treatments, namely stocking densities of 3 (A), 4 (B), 5 (C), and 6 (D) fish L^{-1}, with 5 replications each. The experimental fish were fed commercial formulated feed with 40% crude protein, 4 times a day until satiation. The results showed that the stocking density affected cannibal indexes (CI) and survival of the fish. The CI values for stocking densities of 3, 4, 5, and 6 fish L^{-1} were 40, 44.5, 50.40 and 54.83%, and the survival rates were 57.67, 54.00, 46.20 and 43.83%, respectively, with significant differences observed ($p<0.05$). The highest survival rate was found in fry from treatment A, but there was no difference regarding the cannibalism type and growth performances (weight and length) among treatments. There were 3 ways of preying based on the observations conducted on the victims, namely preying on the tail, preying on the stomach and preying on the head. The conclusions of this study are that there is a relationship between the incidence of cannibalism and stocking density in Asian redtail catfish fry, and that there are 3 ways of preying.

Key Words: cannibalism index, density, preying way.

Introduction. In the Malay community, one of fishes with high-economic value is the Asian redtail catfish, *Hemibagrus nemurus*, especially in Sumatra. To meet market demand, Asian redtail catfish is mainly obtained from natural catches, even though aquaculture businesses do exist. Riau Province has been conducting Asian redtail catfish cultivation since 2006. Fry are obtained from hatcheries. However, Asian redtail catfish fry amount is constrained due to the high mortality risk at this stage. The survival rate of the fry of Asian redtail catfish is diverse, many authors obtaining different results. Thus, the survival rate can range from 40-49% (Ali & Junianto 2014), 20-28% (Aysah 2014), 44-48% (Heltonika & Karsih 2017), 2-18.7% (Kusmini et al 2018) and 50.17-64.75% (Farida et al 2015). Cannibalism is often associated with the death of Asian redtail catfish fry (Akbar & Hanafie 2013; Baras et al 2013; Rahmah et al 2014a; Rahmah et al 2014b; Aysah 2014; Ali & Junianto 2014; Cahyanti et al 2015; Sugihartono et al 2016; Heltonika & Karsih 2017; Kusmini et al 2018).

Based on the study of Heltonika et al (2021), the increase in stocking density increases cannibalistic behaviour in Asian redtail catfish fry. It is necessary to carry out further studies on the incidence of cannibalism in Asian redtail catfish juveniles reared at high stocking densities. There are two types of cannibalism in Asian redtail catfish fry, i.e. cannibalism type I and cannibalism type II. In cannibalism type I, the most common observation is the dead victim with bite marks or missing parts of the body. However, the cannibalism type II is the condition of the fish being eaten completely or missing. Based

on the results reported by Naumowicz et al (2017), the stocking density could decrease or increase the cannibalism incidence in fish. It is important to evaluate the stocking density effects on the incidence of cannibalism. In addition, it is important to evaluate the preying ways of Asian redtail catfish fry. Therefore, this study aims to determine some aspects of cannibalism and preying types in the juveniles of Asian redtail catfish at high stocking densities.

Material and Method

Description of the study. This research was conducted from January to February 2020, at the Fish Breeding and Hatchery Laboratory, Faculty of Fisheries and Marine Science, Riau University, Indonesia. The study employed a completely randomized design consisting of 3 (A), 4 (B), 5 (C), and 6 (D) fish L^{-1} stocking densities and replicated 5 times. Determination of stocking density was conducted based on the results reported by Heltonika et al (2021), who determined that the optimum stocking density for Asian redtail catfish is 2 fish L^{-1}. Therefore, in this study, the optimum stocking density used was considered 2 fish L^{-1}. The density used to stimulate cannibal behavior were stocking densities above the optimum stocking density found in the previous study.

This study used Asian redtail catfish juveniles of 3.5±0.19 cm, which were ordered from a hatchery and from the same pair of parents. The experimental juveniles were reared in 20 L of water. The experiment was conducted for 30 days. Feeding was done with 40% crude protein feed with a frequency of 4 times a day until satiation. Fry rearing was carried out in a controlled room using air conditioner as a temperature stabilizer, and the media temperature conditioned at 28^{o}C.

The parameters of cannibalism include the number of dead fish observed every six hours, the number of cannibalism incidences based on types I and II, and the cannibalism index. Type I cannibalism is a condition where dead fish present damage to the tail, with stomach or head marks. Type II is the condition where the fish was eaten completely or missing (Król et al 2014). The cannibalistic category was determined according to Król & Zakęś (2016):

Cannibalism type I (%) = (number of dead wounded fish/number of initial fish) x 100

Cannibalism type II (%) = (number of missing fish/number of initial fish) x 100

The cannibalistic rate was measured according to Obirikorang et al (2014):

Cannibalism index (%) = (number of missing and dead wounded fish/number of initial fish) x 100

Mortality is the number of individuals that died normally, not due to cannibalistic behaviour during the rearing period. Mortality was calculated using the following formula:

Normal Mortality (%) = (number of normal dead fish/number of initial fish) x 100

The survival rate is represented by the number of living fish at the end of the study. Survival rate was calculated using the following formula:

Survival rate (%) = (number of fish at the end of the study/number of initial fish) x 100.

Parameters observed included growth performance, index of cannibalism, survival rate, observation of predation methods, and water quality. The parameters for the production performance of juveniles consisted of weight and length growth. Total weight growth was calculated to determine the weight gain of experimental fish during cultivation with the formula of Effendie (1997):

Wm = Wt – Wo

Where: Wm is the absolute weight growth (g), Wt is the average weight at the end of the study (g), and Wo is average weight at the start of the study (g). The daily-weight growth rate (SGR) was calculated by the formula:

SGR (%/day) = (lnWt - lnWo)/t x 100

Where: Wt is the average weight of fish at time t (g), Wo is the average weight of fish at the beginning of rearing (g), and t is the length of the trial (days).

The total length growth was calculated using the Effendie (1997) formula:

Lm = Lt – Lo

Where: Lm is the absolute length growth (cm), Lt is the final average length of the fish in the study (cm), and Lo is the average initial length of juveniles (cm). The daily-length growth rate (SLR) rate was calculated by the formula:

SLR (%/day) = (lnLt - lnLo)/t x 100

Where: Lt is average length of fish at time t (cm), Lo is the average length of fish at the beginning of rearing (cm), and t is the length or duration of the experiment (day).

The way of predation was observed based on the victim fish that died due to cannibalistic behavior among the reared fish. The body parts with wounds were observed.

Measurement of water quality was carried out. Temperature was determined using a thermometer daily. The pH was determined using a pH meter and dissolved oxygen using a DO meter, every 7 days.

Statistical analysis. The data were tabulated by using Microsoft Office Excel 2016. All data were tested for normality and homoscedasticity. Variations between data were compared using one-way ANOVA, followed by Duncan post hoc test. Significance of differences was defined at $p<0.05$. Statistical analyses were performed using SPSS 22 software. Water quality parameters were explained descriptively.

Results. The results of cannibalism type, index of cannibalism, normal death and survival rate are presented in Table 1.

Table 1

Cannibalism type, index of cannibalism, normal death, and survival rate (%)

Treatment	*Cannibalism type I*	*Cannibalism type II*	*Index of cannibalism*	*Normal death*	*Survival rate*
A	35.33±6.5^{a}	4.67±3.61^{a}	40^{a}±8.58^{a}	2.33±5.22^{a}	57.67±6.52^{b}
B	38±6.77^{a}	6.5±3.24^{a}	44.5±5.9^{ab}	1.5±1.37^{a}	54±1.37^{ab}
C	36±6.53^{a}	14.4±9.76^{a}	50.4±5.03^{bc}	3.4±4.34^{a}	46.2±4.34^{a}
D	43.33±4.21^{a}	11.5±6.55^{a}	54.83±8.89^{c}	1.33±0.46^{a}	43.83±8.77^{a}

Note: different superscripts in the same column indicate significant differences ($p<0.05$); A - stocking density of 3 fish L^{-1}; B - stocking density of 4 fish L^{-1}; C - stocking density of 5 fish L^{-1}; D - stocking density of 6 fish L^{-1}.

There was an increase in the incidence of cannibalism of Asian redtail catfish (Table 1). There were significant differences between among treatments regarding cannibalism index ($p<0.05$), with the highest cannibalism incidence at a stocking density of 6 fish L^{-1}, 54.83±8.89%. Although statistically the mortalities of type I and II cannibalism were not significantly different ($p<0.05$), there was a pattern of increasing incidence of mortality with the increasing stocking density. For normal death, namely death without any bodily injury, there was no significant difference among treatments ($p<0.05$). Meanwhile, the lowest survival rate was found in the high stocking density (6 fish L^{-1}), and the highest survival rate was found in the lowest stocking density 3 fish L^{-1} ($p<0.05$).

Based on the analysis of cannibalism type I and mortality-based data on days 7, 14, 21, and 30 (Figure 1), the incidence of cannibalism type I mostly occurred in the first 7 days. Furthermore, on days 14, 21, and 30, the incidence of death due to cannibalism continued to decrease, this condition occurring in all treatments. The high incidence of cannibalism at the beginning of rearing was probably influenced by the stocking density, because on days 14, 21 and 30, the incidence continued to decrease with reducing density.

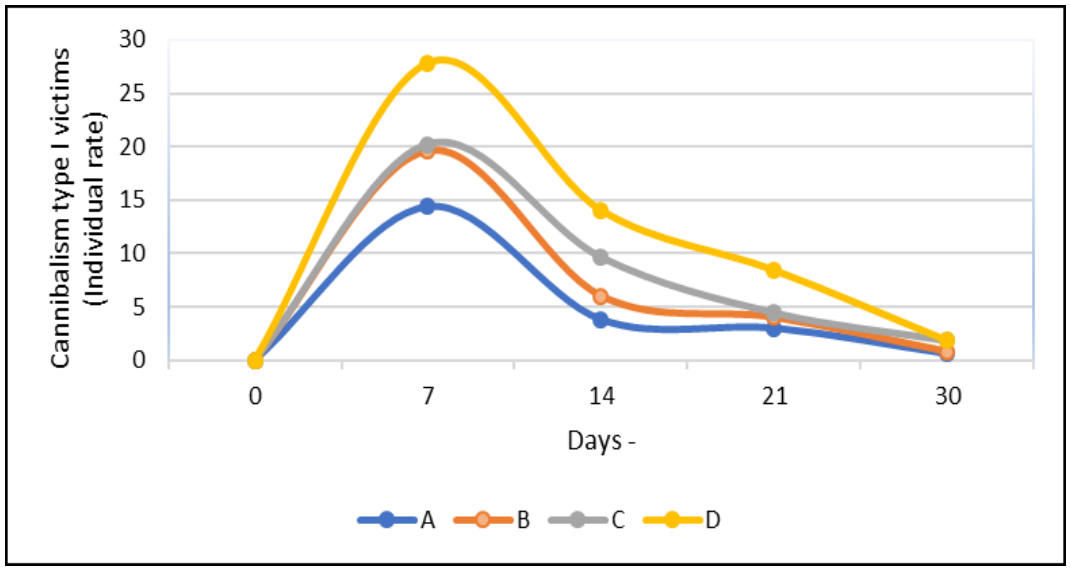

Figure 1. Daily mortality rate caused by cannibalism type I on Asian redtail catfish fry reared for 30 days.

According to the table of fry production performance (Table 2), there was no difference in growth performance among treatments.

Table 2

Fry production performance

Treatment	*Weight growth (g)*	*Length growth (mm)*	*Daily weight growth rate (%)*	*Daily length growth rate (%)*
A	2.1356±0.38^a	31.09±2.73^a	6.1548±0.53^a	2.1099±0.14^a
B	1.942±0.43^a	29.77±2.52^a	5.881±0.57^a	2.0431±0.13^a
C	1.8747±0.23^a	28.55±3.27^a	5.8105±0.35^a	1.9783±0.17^a
D	2.3591±0.64^a	32.81±5.98^a	6.3994±0.76^a	2.1874±0.29^a

Note: different superscripts in the same column indicate significant differences ($p<0.05$); A - stocking density of 3 fish L^{-1}); B - stocking density of 4 fish L^{-1}; C - stocking density of 5 fish L^{-1}; D - stocking density of 6 fish L^{-1}.

Cannibalistic behavior. Based on the observations during this research, there are three ways of cannibalizing in the Asian redtail catfish:

1. Biting from the tail

This behavior is the most frequently found, predation starting with preyed fish bitten by one of the predators, then released. The bitten fish will be bitten alternately by the other fish, as if the bite wound made the other fish to be aggressive. The victim will be injured and, not infrequently, a wound will form to reveal the victim's vertebrae, and eventually the fish die (Figure 2).

2. Biting the stomach

This behavior is very rare, but it exists. Wounds are made in the abdomen by predators, so that the victim loses part of the stomach (Figure 3). However, from the observations on the other body parts, there were no bite marks on other parts of body.

Figure 2. Cannibalism victim that was bitten from the tail; the victim died with the back of the body consumed.

Figure 3. Asian redtail catfish fry bitten in the stomach.

3. Biting from the head

This behavior is also very rare. From several incidents, usually both the victim and the predator will die, because when the victim is preyed on, they will defend themselves by expanding their pectoral fin, so that it is caught in the digestive tract. This is what causes the predator to eventually die (Figure 4).

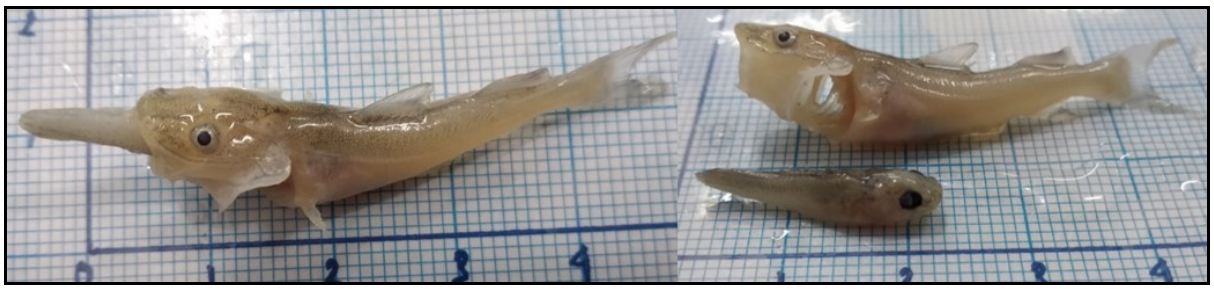

Figure 4. Fish that was preyed on the head; both fish died; a - the condition of the fish when it was found; b - condition when prey was released with the victim's pectoral fins expanded.

During the study, water quality was within the normal range for the maintenance of Asian redtail catfish fry (Table 3). Water temperature conditions were maintained approximately near the planned value of 28^{o}C. The pH conditions were easily tolerated by Asian redtail catfish. Dissolved oxygen was in normal conditions.

Table 3

Water quality

Treatment	*Temperature (°C)*	*pH*	*Dissolved oxygen (ppm)*
A	28–29	6–6.5	6.3–7.5
B	28–29	6–6.5	6.5–7.3
C	28–29	6–6.5	6.2–7.3
D	28–29	6–6.5	6.3–7.2
Yudha et al (2018)	27–30	5–7	5–7

Discussion. Cannibalism is a basic habit of fish preying on other fish of the same species, either on all or on part of the body. Cannibalism in fish is regulated by morphology, habits and physiological factors (Mukai et al 2013). One of the exogenous intraspecific factors that influences cannibalism is stocking density (Smith & Reay 1991; Hecht & Pienaar 1993). According to Naumowicz et al (2017), excessive stocking density could increase or decrease the incidence of cannibalism in fish. The results of this study showed that the increase in stocking density of Asian redtail catfish fry causes an increase in the incidence of cannibalism, confirmed from the value of the cannibalism index. According to Hecht & Pienaar (1993), the stocking density increases, the territoriality of fish also increases, which causes aggressiveness closely related to cannibalism.

At the end of research, there were no Asian redtail catfish in the potential cannibal category. The potential cannibals are fish 3 times larger than the average size. In our study, the fish had relatively uniform sizes. This condition contradicts the opinion of other authors (Hecht & Pienaar 1993; Baras et al 2000; Xi et al 2017; Pereira et al 2017), that cannibalism only occurred in groups of fry with non-uniform sizes. From observations during the study, the dominant Asian redtail catfish attack the target fish on the tail, after which the injured fish will be attacked continuously. This condition is in accordance with the results of Loadman et al (1986), where *Stizostedion vitaeum* (walleye) attacks on the tail are dominant in cannibalism events. There was an interesting phenomenon observed: if one fish was bitten by another fish, then the bitten fish will be continuously attacked also by other fish, until major body damage and ultimately death, most likely due to the bite wound releasing certain compounds causing aggressiveness of other fish. Mukai et al (2013) stated that chemical substances are generated from the injured skin surface, these chemical stimuli triggering cannibalistic behavior in other nearby fish.

Based on some of the studies reviewed, it is possible that this behavior is stimulated by hormonal action, thereby increasing aggressiveness. Aggressiveness that causes death in a group is regulated by hormones in other pathways, and is the basis for cannibal behavior (Naumowicz et al 2017). Testosterone is one of the hormones responsible for aggressive behavior. Increased aggressiveness is associated with the high testosterone concentrations in the male African cichlid *Astatotilapia burtoni* (Alcazar et al 2016). The concentration of testosterone hormone in *Clarias batrachus* begins to increase in line with the increase in the process of vitellogenesis and gonad maturity, then accumulates in the eggs carried by the larvae; this could be the aggressive behavior trigger in cannibalistic behavior (Zairin et al 2002).

Conclusions. The increase in density in the maintenance of Asian redtail catfish causes an increase in the cannibalism index, thereby reducing the survival rate. There is an effect of high stocking density on the cannibalism index. There is an increase in cannibalism type with increasing stocking density of Asian redtail catfish fry. The highest incidence of cannibalism occurred at 6 fish L^{-1} stocking density, while there was no difference among treatments for growth performance. Regarding predatory behavior, there are 3 ways of preying, namely from the tail, stomach, and head. Hormones have been know to control cannibalism in fish, so further research is recommended to explore whether there is an effect of hormone treatment on cannibal behavior in Asian redtail catfish to control cannibalism.

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Conflict of Interest. The authors declare that there is no conflict of interest.

References

Akbar J., Hanafie A., 2013 [Effect of different doses of acriflavin and immersion time on male sex formation ratio of Asian redtail catfish (*Hemibagrus nemurus*)]. Depik 2:1-5. [In Indonesian].

Alcazar R. M., Becker L., Hilliard A. T., Kent K. R., Fernald R. D., 2016 Two types of dominant male cichlid fish: behavioral and hormonal characteristics. Biology Open 5(8):1061-1071.

Ali M., Junianto R. S., 2014 [Further effect of temperature on hatching eggs on growth and survival of Asian redtail catfish (*Hemibagrus nemurus*) fry]. Prosiding Seminar Nasional Lahan Suboptimal, pp. 301-308. [In Indonesian].

Aysah S., 2014 [Effect of time of transfer of natural feed to artificial feed with enzymes on survival, growth in the rearing of Asian redtail catfish (*Mystus nemurus*) larvae]. Fish Scienctiae 4:42-58. [In Indonesian].

Baras E., Hafsaridewi R., Slembrouck J., Priyadi A., Moreau Y., Pouyaud L., 2013 Do cannibalistic fish possess an intrinsic higher growth capacity than others? A case study in the Asian redtail catfish *Hemibagrus nemurus* (Valenciennes, 1840). Aquaculture Research 45(1):68-79.

Baras E., Ndao M., Maxi M. Y. J., Jeandrain D., Thomé J. P., Vandewalle P., Mélard C., 2000 Sibling cannibalism in dorada under experimental conditions. I. Ontogeny, dynamics, bioenergetics of cannibalism and prey size selectivity. Journal of Fish Biology 57(4):1001-1020.

Cahyanti W., Prakoso V. A., Subagja J., Kristanto A. H., 2015 [Effects of feeding and compensatory growth on the fry of Asian redtail catfish (*Hemibagrus nemurus*)]. Media Akuakultur 10:17-21. [In Indonesian].

Effendie M. I., 1997 [Fisheries biology methods]. Yayasan Agromedia, Bogor, Indonesia, 162 p. [In Indonesian].

Farida, Susanto D., Rachimi, 2015 [Effect of different water depths on growth and survival of Asian redtail catfish (*Hemibagrus nemurus*) larvae]. Jurnal Ruaya 6:33–36. [In Indonesian].

Hecht T., Pienaar A. G., 1993 A review of cannibalism and its implications in fish larviculture. Journal of the World Aquaculture Society 24(2):246-261.

Heltonika B., Karsih O., 2017 [Maintenance of Asian redtail catfish (*Hemibagrus nemurus*) fry with photoperiod technology]. Jurnal Berkala Perikanan Terubuk 45:125-137. [In Indonesian].

Heltonika B., Zairin M. J., Widanarni, Suprayudi M. A., Manalu W., Hadiroseyani Y., 2021 Green catfish (*Hemibagrus nemurus*) seeds cannibali at different stocking densities. IOP Conference Series: Earth and Environmental Science 695:012028, 5 p.

Król J., Flisiak W., Urbanowicz P., Ulikowski D., 2014 Growth, cannibalism, and survival relations in larvae of European catfish, *Silurus glanis* (Actinopterygii: Siluriformes: Siluridae) - attempts to mitigate sibling cannibalism. Acta Ichthyologica et Piscatoria 44(3):191-199.

Król J., Zakęś Z., 2016 Effect of dietary L-tryptophan on cannibalism, survival and growth in pikeperch *Sander lucioperca* (L.) post-larvae. Aquaculture International 24:441-451.

Kusmini I. I., Kristanto A. H., Subagja J., Prakoso V. A., Putri F. P., 2018 [Response and growth pattern of Asian redtail catfish (*Hemibagrus nemurus*) from three generations reared in different culture containers]. Jurnal Riset Akuakultur 13:201-211. [In Indonesian].

Loadman N., Moodie G. E. E., Mathias J. A., 1986 Significance of cannibalism in larval walleye (*Stizostedion vitreum*). Canadian Journal of Fisheries and Aquatic Sciences 1:613-618.
Mukai Y., Sanudin N., Firdaus R., Saad S., 2013 Reduced cannibalistic behavior of African catfish, *Clarias gariepinus*, larvae under dark and dim conditions. Zoological Science 30(6):421-424.
Naumowicz K., Pajdak J., Terech-Majewska E., Szarek J., 2017 Intracohort cannibalism and methods for its mitigation in cultured freshwater fish. Reviews in Fish Biology and Fisheries 27:193-208.
Obirikorang K., Madkar H. A., Boeateng A., 2014 A study of intra-cohort cannibalism in juveniles of the African catfish, (*Clarias gariepinus*) under controlled conditions. International Journal of Science and Technology 3:23-26.
Pereira L. S., Agostinho A. A., Winemille K., 2017 Revisiting cannibalism in fishes. Reviews in Fish Biology and Fisheries 27:499–513.
Rahmah S., Kato K., Yamamoto S., Takii K., Murata O., Senoo S., 2014a Improved survival and growth performances with photoperiod and feeding schedule manipulation in bagrid catfish *Mystus nemurus* (Cuvier & Valenciennes 1840) larvae. Aquaculture Research 45(3):501-508.
Rahmah S., Kato K., Yamamoto S., Takii K., Murata O., Senoo S., 2014b Improved survival and growth performances with stocking density manipulation and shelter availability in bagrid catfish (*Mystus nemurus* Cuvier & Valenciennes 1840) larvae. Aquaculture Research 45(12):2000-2009.
Smith C., Reay P., 1991 Cannibalism in teleost fish. Reviews in Fish Biology and Fisheries 1:41-64.
Sugihartono M., Ghofur M., Satrio, 2016 [Effect of different stocking densities on the survival and growth of Asian redtail catfish (*Mystus nemurus*) larvae]. Jurnal Akuakultur Sungai dan Danau 1:12-21. [In Indonesian].
Xi D., Zhang X., Lü H., Zhang Z., 2017 Cannibalism in juvenile black rockfish, *Sebastes schlegelii* (Hilgendorf, 1880), reared under controlled conditions. Aquaculture 479:682-689.
Yudha R. A., Putri B., Diantari R., 2018 [Suitability of waters for the cultivation of Asian redtail catfish (*Mystus nemurus*) in the Way Kiri River, Panaragan Village, Tulang Bawang Barat Regency]. Jurnal Sains Teknologi Akuakultur 2(2):48-57. [In Indonesian].
Zairin M., Furukawa K., Aida K., 2002 Reproductive endocrinology of the tropical walking catfish, *Clarias batrachus*. Fisheries Science 68:690-693.

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