Domestication of Celebes rainbow fish (*Marosatherina ladigesi*)

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Abstract. In this research, domestication of Celebes rainbow fish (*Marosatherina ladigesi*) was started from the broodstock rearing, spawning and larval rearing. The purpose of this study was to determine the survival rate, fecundity rate, and gonad maturity levels of the broodstock that was fed live feed; *Daphnia* sp., *Chironomus* sp., and *Culex* sp., whereas during the spawning period, the total number of eggs; the number of eggs hatching; egg incubation time; the number of unhatched eggs; and hatching rate were evaluated. The aim of study in the larval rearing is to determine the survival rate of the larva. Broodstocks of *M. ladigesi* were collected from Bantimurung river and Patunung Asue River of Maros regency; Jennae River and Gowalorong River of Pangkajenne Kepulauan regency; Asanae River of Bone regency. The result of research demonstrated that survival rates of broodstocks fed *Dapnia* sp., *Chironomus* sp., and *Culex* sp. were 91%, 86%, 81%, respectively. Broodstocks of *M. ladigesi* that were fed *Daphnia* sp. produced the highest number of eggs (849), with the hatching rate of 70.77%, whereas the broodstocks that were fed *Chironomus* sp. produced 595 eggs, with the hatching rate of 67.11%, and the broodstocks that were fed larvae of *Culex* sp. obtained 565 eggs with the hatching rate of 65.14%. The incubation period was 8-9 days. The larvae were given nauplius of *Daphnia* sp. can achieve the survival rate of larvae was 38.31-39.02% until age 5 days, 62.44-71.67% at 10 days, 20-30 days after hatching, the survival rates ranged from 73.06-99.84%.

Key Words: *Marosatherina ladigesi*, broodstock rearing, spawning, larval rearing, hatching rate, survival rate.

Introduction. In South Sulawesi province of Indonesia, several species of native freshwater fish and endemic fish of the family Telmatherinidae are found such as *Marosatherina ladigesi, Telmatherina antoniae, T. albolabiosus, T. bonti, T. celebensis, T. obscura, T. prognatha, T. wahjui, T. sarasinorum, T. opudi,* and *T. abendanoni* (Parenti 2011). One species that has been listed in the International Union for Conservation of Nature (IUNC) since 1990 due to the threat of extinction is *M. ladigesi* (Kottelat 1996; IUNC 1996). Based on the BLAST-N gene analysis with the 99% similarity index (Jayadi et al 2015), *M. ladigesi* is the new valid synonime name for former *Telmatherina ladigesi* (Kottelat et al 1993; Parenti 2011). The fish is locally knowns as "beseng-beseng" while the trade name is Celebes rainbow fish. This fish has been categorized as endangered fish in their natural habitats (Anonim 2012). In the recent years, the fish is only found in Bantimurung river at Maros regency, Sawae river at Bone regency, Jenae river at Pangkajenne and Kepulauan regency, Asanae river at Soppeng regency (Jayadi et al 2016), Pattunung Asue River at Maros regency (Karyanti et al 2014). The fish scarcity in nature due to the continuous use of pesticides in the paddy fields, overfishing, and destruction of their natural habitats (Said & Haryani 2011). *M. ladigesi* that still survive in the wild have extremely low levels of genetic diversity (Jayadi et al 2015). Thus this condition may further exacerbate its existence in nature.

M. ladigesi is known as freshwater ornamental fish that has important economic value (Kottellat et al 1993; Andriani 2000; Said et al 2005; Nasution et al 2006; Said & Mayasari 2007; Parenti 2011; Jayadi et al 2013, 2015), because its highly attractive appearance, especially the males. Hence, *M. ladigesi* is still sought via online trade (Hardiaty 2007). This fish is also still demanded from businessmen of ornamental fish from the interview with fishermen in Maros (Jayadi et al 2013). However, they cannot meet the demand due to declined population of the wild-caught fish from its habitat (Said & Haryani 2011; Kariyanti et al 2014; Jayadi et al 2013). The exploitation rates (E) of *M. ladigesi* have exceeded the optimum limit of 0.0919 in Bantimurung river (Bahrul 2014), and in Jennae river and Gowa Lorong river of 0.935 (Jayadi et al 2016).

M. ladigesi is an endemic fish that may be extinct in the wild because the spread of the fish is very limited and only found in several rivers in South Sulawesi, Indonesia (Kottelat et al 1993; Kottelat 1996; Said et al 2005; Said & Haryani 2011; Jayadi et al 2013). To ensure the sustainability of fish stocks in nature and to meet the supply for ornamental fish, domestication of *M. ladigesi* is required to produce seeds (larvae and juvenile), which in turn can prevent the extinction of this fish in the wild.

Studies have been done on *M. ladigesi* such as bio-ecology, morphology, and karyotype (Andriani 2000); fish reproduction (Nasution et al 2006); reproduction test on ex-situ (Said et al 2005); feeding habits (Jayadi et al 2013); infestations of ectoparasites (Amrullah et al 2013); analysis of fecundity and egg diameter (Kariyanti et al 2014); and gonadal maturation with live feed (Jayadi et al 2015). However, limited information is available concerning the domestication of the fish. The success of domestication of *M. ladigesi* is generally dependent on the maintenance of broodstock, spawning or breeding and rearing of larvae and juvenile (seed) in captivity. The study aimed to determine fecundity, hatching rate of the broodstock and survival rate of the larvae and juvenile of *M. ladigesi* fed with different live feed.

Material and Method. The study was conducted at the freshwater ornamental fish hatchery at Manggala village, municipality of Makassar, south Sulawesi, Indonesia on January to July 2016.

Broodstock. Broodstocks of *M. ladigesi* were collected from Bantimurung river and Patunung Asue River of Maros regency; Jennae River and Gowa Lorong River of Pangkajenne Kepulauan regency; Asanae River of Bone regency. The broodstock was collected using a landing net with a mesh size of 1 mm, and transported to the hatchery of freshwater ornamental fish in Manggala, Makassar. Upon the arrival, the broodstock was acclimatized and immersed in 2 mg L^{-1} potassium permanganate ($KMnO_4$) solution for 10 minutes.

Preparation of water. Water sources were obtained from the ground water, which pumped into 2 tanks. Before used, the water was precipitated overnight, filtered, and circulated to broodstock rearing, spawning, and larval rearing tanks by gravity.

Broodstock rearing. The broodstocks were maintained in a fiberglass tank (L x W x H; 200 x 150 x 75 cm), equipped with an aeration and filtration system. The water volume in the fiberglass tank was kept at 350 liters. Before stocking, the broodstocks were soaked in 1 mg L^{-1} potassium permanganate (KMnO4) for 10 min. During the rearing periods, the broodstocks were fed three types of live food; *Daphnia* sp., *Chironomus* sp., and *Culex* sp. In the first group, the broodstocks that were fed *Daphnia* sp., the total length of the female and male broodstock were from 4.5 to 5.4 cm and from 5.1 to 6.3 cm respectively. In the second group, the broodstocks that were fed *Chironomus* sp., the total length of female and male broodstock were from 4.8 to 5.6 cm, and from 5.0 to 6.4 cm, respectively, while in the third group, that were fed *Culex* sp., the total length of the female and male broodstock were from 4.9 to 5.5 cm and 4.9 to 6.3 cm, respectively. Feed was given twice daily *ad libitum*. Fifty percent (50%) of water exchange was done weekly. Parameters measured were survival rate, fecundity, and gonad maturity level. The water quality parameters observed weekly were dissolved oxygen (DO), pH, temperature, and ammonia. After 5 months of the rearing period, 20 broodstocks were used for sampling to determine fecundity and gonad maturity level of the broodstock.

***Spawning**.* The broodstocks were kept at a fiberglass tank (L x W x H; 130 x 80 x 60 cm), equipped with the aeration system. The volume of the water in the spawning tank was 100 liters. The ratio of males to females was 1:2 (Said & Mayasari 2007). The number female that used was 50 females and 25 males. The feed was given as previously described in the broodstock rearing. The attachment substrate of the fish eggs was made of the ropes that stretched out to resemble the plant roots. The substrate was placed in the middle of the tank. After 24 h, the attached eggs were collected and numbered. Incubation tank was a plastic bucket filled with 10 liters of water. The attachment substrate of the eggs was incubated in a plastic bucket. Parameters measured were the total number of eggs; the number of eggs hatching; egg incubation time; the number of unhatched eggs; and hatching rate. After the eggs hatched into larvae, then the larvae were transferred to larval tanks.

***Larval rearing**.* The larvae were maintained in a fiberglass tank (L x W x H; 60 x 40 x 35 cm), equipped with the aeration system. The volume of the water in the tank was 20 liters. Rearing of fish larvae was divided into three groups: the first group was the larvae obtained from the broodstock that fed *Daphnia* sp., the second group was the larvae generated from broodstock that fed *Culex* sp., and the third group was the larvae obtained from broodstock that fed *Chironomus* sp. The number of larva used in each group was 200 individuals that were randomly distributed to 4 tanks, and each tank consisted of 50 larvae. Larval rearing was carried out by spawning time at the each group. The feed used in each group was similar; nauplii of *Daphnia* sp. The larvae were reared for 30 days. Feeding frequency was twice daily. Parameter measured was survival rate. Number of dead larvae was calculated daily. Water quality measured every week such as dissolved oxygen, pH, temperature, and ammonia.

Results and Discussion

***Broodstock rearing**.* The survival rates, fecundity and gonad maturity level of the broodstocks that were fed three types of live fish: *Daphnia* sp., larvae of *Culex* sp. and *Chironomus* sp. are shown in Table 1. The survival rate of the broodstock fed *Daphnia* sp. was the highest, whereas the lowest was observed in the broodstock feed larva *Culex* sp. These results were different with the previous study of Jayadi & Husma (2015) that survival of the broodstocks that were fed *Daphnia* sp. was 83.33%, while *Chironomus* sp. and *Culex* sp. were 63.33% and 65.00%, respectively.

Table 1

Survival rates, fecundity and gonadal maturity level (GML) of *M. ladigesi* fed *Dapnia* sp., larvae of *Culex* sp. and *Chironomus* sp. for 5 months

Treatment of feeding	*Survival rate (%)*	*Fecundity (ind.)*	*Number (ind.)*	
			GML III	*GML IV*
Dapnia sp.	91	65–281	4	16
Chironomus sp.	86	49–172	9	11
Larva *Culex* sp.	81	37–154	8	12

Similar trend was also observed in fecundity, in which the broodstocks that were fed with *Daphnia* sp. induced higher fecundity compared with other live feed. Fecundity of *M. ladigesi* that were obtained from this study showed lower levels compared with those in their natural habitat as reported by several researchers (Andriani 2000; Nasution et al 2006; Karyanti et al 2014; Jayadi et al 2013). The fecundity of fish is affected by the length, weight, age, genetic factors, environmental factors, food, species of fish (Effendie 1979; Mondal & Kaviraj 2010; Bindu & Padmakumar 2014). Likewise, the number of broodstock that achieved the highest gonadal maturity level (GML) was 16 in the broodstock fed *Daphnia* sp., while the broodstock fed *Chironomus* sp. and *Culex* sp. was only 11 and 12 respectively. The use of *Dapnia* sp., *Chironomus* sp. and larvae of *Culex* sp. as live feed for *M. ladigesi* can improve gonadal development into the GML III and IV, because the nutritional value of feed given throughout the rearing period (Table 2) met the demand of the broodstock. The feed given to the broodstock had similar proximate analysis results with *M. ladigesi*, in which the protein content was 52.65%, fat was 10.93%, and carbohydrate was 5.62%. Nutritional value of the feed given to the broodstock affected gonad development and fecundity (Fernandez-Palacios et al 1995). During the study, the number of broodstock that were used in each treatment was 100 individuals and reared for 5 months.

Table 2

The proximate analysis of the live feed

Treatment of feeding	*Water (%)*	*Ash (%)*	*Protein (%)*	*Fat (%)*	*Carbohydrate (%)*
Chironomus sp.	8.4	10.00	44.22	8.69	28.69
Dapnia sp.	4.9	6.26	53.12	20.13	15.59
Larva *Culex* sp.	13.3	8.47	49.07	13.17	15.99

The range of water quality during the the broodstock rearing of *M. ladigesi* is presented in Table 3. The range of water quality parameters were within the limits that can be tolerated by *M. ladigesi*. The results were similar with the previous study of Jayadi et al (2013) that investigated the water quality parameters of *M. ladigesi* in their natural habitats. The water quality parameters in their natural habitats are as follows: temperatures ranged from 28-30^oC; DO was 5.8 to 8.2 mg L^{-1}; pH ranged from 6.2 to 8.2; NH_3 was < 0.008 mg L^{-1}; and nitrite was < 0.0003 mg L^{-1}

Table 3

The range of water quality during the rearing of *M. ladigesi* broodstock

Treatment of feeding	*Temperature (^oC)*	*pH*	*DO (mg L^{-1})*	*NH_3 (mg L^{-1})*	*Nitrite (mg L^{-1})*
Chironomus sp.	27.5–28.9	6.8–7.9	7.43–7.76	0.002–0.007	0.001–0.003
Dapnia sp.	27.8–28.7	6.7–8.0	7.43–7.75	0.003–0.006	0.001–0.002
Larva *Culex* sp.	27.6–28.7	6.7–8.0	7.43–7.75	0.002–0.006	0.001–0.002

Spawning. The results of *M. ladigesi* spawning obtained on the total number of eggs; number of hatched eggs; number of unhatched eggs; hatching rate and hatching period are depicted in Tables 4, 5, and 6.

Table 4

Total number of eggs; number of hatched eggs; number of unhatched eggs; hatching rate and hatching period of *M. ladigesi* that were fed *Daphnia* sp.

Spawning date	*Number of eggs (ind.)*	*Hatched larvae (ind.)*	*Number of unhatched eggs (ind.)*	*Hatching rate (%)*	*Hatching period (days)*
17 May 2016	121	92	29	76.03	9
19 May 2016	84	58	26	69.05	9
20 May 2016	96	73	23	76.04	8
21 May 2016	129	98	31	75.97	9
23 May 2016	86	61	25	70.93	8
24 May 2016	107	89	18	83.18	8
25 May 2016	83	56	27	67.47	8
27 May 2016	75	49	26	65.33	8
29 May 2016	68	36	32	52.94	9
Total	849	612	237	-	-
Average	94.33	68	26.33	70.77	8.4

Table 5
Total number of eggs; number of hatched eggs; number of unhatched eggs; hatching rate and hatching period of *M. ladigesi* that were fed larva *Culex* sp.

Spawning date	*Number of eggs (ind.)*	*Hatched larvae (ind.)*	*Number of unhatched eggs (ind.)*	*Hatching rate (%)*	*Hatching period (days)*
19 May 2016	112	75	37	66.94	9
20 May 2016	76	51	25	67.10	9
22 May 2016	106	79	27	74.53	9
24 May 2016	83	57	26	68.67	8
26 May 2016	73	46	27	63.01	9
28 May 2016	62	39	23	62.90	9
30 May 2016	53	28	25	52.83	8
Total	565	375	190	-	-
Average	80.71	53.57	27.14	65.14	8.7

Table 6
Total number of eggs; number of hatched eggs; number of unhatched eggs; hatching rate and hatching period of *M. ladigesi* that were fed *Chironomus* sp.

Spawning date	*Number of eggs (ind.)*	*Hatched larvae (ind.)*	*Number of unhatched eggs (ind.)*	*Hatching rate (%)*	*Hatching period (days)*
18 May 2016	102	74	28	72.55	8
19 May 2016	92	62	30	67.39	8
21 May 2016	114	69	45	60.52	9
23 May 2016	98	71	27	72.45	9
25 May 2016	61	46	15	75.40	9
26 May 2016	78	54	24	69.23	8
28 May 2016	42	28	14	66.67	9
30 May 2016	38	20	18	52.63	9
Total	625	424	201	-	-
Average	78.13	53	25.13	67.10	8.6

M. ladigesi was fed *Dapnia* sp. produced 849 eggs, with the hatching rate of 70.77%, while the number of eggs produced by the broodstock fed *Chironomus* sp. was 625 eggs, with the hatching rate of 67.10%. *M. ladigesi* were fed larvae *Culex* sp. produced 565 eggs with the hatching rate of 65.14%. The use of the three types of feed on *M. ladigesi* caused different effects on the broodstock (Tables 4, 5 and 6). The use of *Daphnia* sp. resulted in better results than larva of *Cules* sp. and *Chironomus* sp. *Daphnia* sp. have high nutritional values such as protein (53.12%) and fat (20:13%) (Table 2) which are equal with the body composition of *M. ladigesi* (52.65% protein, and 10.93% fat) (Jayadi & Husma 2015). The quality of *Pagrus major* eggs was strongly influenced by the content of protein, fat, phosphorous, pigments and essential fatty acids of the feed (Watanabe et al 1984). *M. ladigesi* eggs hatched after 8-9 days at temperatures of 27-28^{o}C (Tables 4, 5 and 6). According to Depeche & Billard (1994) the length of the incubation time of fish eggs depends on the fish species and environmental factors such as temperature, light and oxygen. Based on the results of gonad maturity index of *M. ladigesi*, we can conclude this fish may spawn throughout the year (Jayadi et al 2016). Spawning models of some fish species of the genus *Telmatherina* have been reported in several studies such as *T. antoniae* (Sumasetiadi 2003); *T. celebensis* (Nasution 2004); *T. bonti* (Jayadi et al 2006). Factors that affect spawning in fish have been reported by Scott (1979). *M. ladigesi* maintained in captivity can spawn after the availability of spawning aggregation sites. *M. ladigesi* is a kind of fish that attach their eggs to the substrate, such as Clupeiformes (Ohta 1984); Cypriniformes (Long & Ballard 1976); Siluriformes (Kobayakawa 1985).

Larval rearing. Water quality parameters during larval rearing are shown in Table 7. The water quality conditions were similar to the fish natural habitat in the wild (Jayadi et al 2013). Broodstock of *M. ladigesi* that were fed *Dapnia* sp. spawned 9 times and produced 612 total number of larvae (Table 8), while the broodstocks that were fed *Culex* sp. spawned 7 times and generated 375 total number of larvae (Table 9), and the broodstocks fed *Chironomus* sp. spawned 8 times and produced 424 larvae (Table 10).

Table 7

The range of water quality during the larval rearing of *M. ladigesi*

Group	*Temperature (°C)*	*pH*	*DO (mg L^{-1})*	*NH_3 (mg L^{-1})*
Daphnia sp.	27.9–29.0	6.8–8.1	7.64–7.78	0.002–0.005
Larvae *Culex* sp.	27.8–29.0	6.8–8.0	7.63–7.77	0.003–0.004
Chironomus sp.	27.9–29.1	6.8–8.0	7.63–7.78	0.002–0.005

Survival rate of larvae obtained from the broodstock that were fed *Daphnia* sp. was 39.02 % at age 5 day, 71.67% at age 10 days. The survival rate of larvae at age 20 days was 78.18%, the survival rate at age 30 days was 99.84 % (Table 8).

Table 8

Survival rate of *M. ladigesi* larvae obtained from the broodstock that were fed *Dapnia* sp.

Date of spawning	*Number of larvae (ind.)*	*Survival rate at 5 days (%)*	*Survival rate at 10 days (%)*	*Survival rate at 20 days (%)*	*Survival rate at 30 days (%)*
17 May 2016	92	33.37	72.83	81.56	100
19 May 2016	58	29.78	72.41	75.26	100
20 May 2016	73	34.76	75.34	75.05	100
21 May 2016	98	39.78	68.37	78.57	100
23 May 2016	61	40.32	75.41	75.45	100
24 May 2016	89	38.06	73.89	80.81	98.59
25 May 2016	56	42.78	66.07	76.21	100
27 May 2016	49	49.52	67.35	77.35	100
29 May 2016	36	42.79	73.33	83.33	100
Total	612				
Average	68	39.02	71.67	78.18	99.84

Survival rate of larvae from the broodstocks that were fed larva of *Culex* sp. was 38.53% at age 5 days, 70.76% at age 10 days. The survival rate of larvae at age 20 days was 73.06%, the survival rate at age 30 days reached 96.92% (Table 9).

Table 9

Survival rate of *M. ladigesi* larvae obtained from the broodstocks that were fed larvae *Culex* sp.

Date of spawning	*Number of larvae (ind.)*	*Survival rate at 5 days (%)*	*Survival rate at 10 days (%)*	*Survival rate at 20 days (%)*	*Survival rate at 30 days (%)*
19 May 2016	75	30.67	68.00	70.23	89.47
20 May 2016	51	39.71	74.51	74.51	100
22 May 2016	79	32.67	62.03	69.38	93.23
24 May 2016	57	42.69	75.43	77.27	100
26 May 2016	46	40.78	69.57	70.57	100
28 May 2016	39	35.79	74.36	75.07	95.78
30 May 2016	28	47.42	71.42	74.42	100
Total	375				
Average	53.57	38.53	70.76	73.06	96.92

Survival rate of larvae from the broodstocks that were fed *Chironomus* sp. was 38.31% at age 5 days, 62.44% at age 10 days, the survival rate of larvae at age 20 days was 87.89%, the survival rate of larvae at the age of 30 days reached 96.14% (Table 10).

Table 10

Survival rate of *M. ladigesi* larvae obtained from the broodstocks that were fed *Chironomus* sp.

Date of spawning	*Number of larvae (ind.)*	*Survival rate at 5 days (%)*	*Survival rate at 10 days (%)*	*Survival rate at 20 days (%)*	*Survival rate at 30 days (%)*
18 May 2016	74	35.24	59.62	81.54	92.35
19 May 2016	62	31.21	60.74	79.23	97.32
21 May 2016	69	45.23	55.21	82.12	89.23
23 May 2016	71	44.38	56.23	79.63	98.74
25 May 2016	46	31.34	65.22	81.51	91.45
26 May 2016	54	42.56	69.37	100	100
38 May 2016	28	29.43	62.57	100	100
30 May 2016	20	47.07	70.55	99.12	100
Total	424				
Average	53	38.31	62.44	87.89	96.14

The fish larvae abilities to take food from outside determine the survival and subsequent development of the fish. Fish larvae started to consume food after the larvae can open its mouth (Hunter 1981; Bagarinao 1986; Blaxter 1988). The results of this study showed that the larvae of *M. ladigesi* started to open the mouth at 70-72 hours after hatching and taking food from the outside before the endogenous were absorbed. Several types of fish took food before the egg yolk run out as shown in *Oxyeleotris marmorata* (Wahyuningrum 1991); *Mystus nemurus* (Amornsakun & Hasan 1997); *Lates calcarifer* (Kohno et al 1986); and several species of grouper such as *Epinephelus fuscoguttatus* (Kohno et al 1990); *E. malabaricus* (Ruangpanit et al 1993); *E. tauvina* (Husain & Higuchi 1980) and *E. microdon* (Jayadi & Ardiansyah 2012). Fish larvae took food from the outside, which depended on the type and amount of food available (Hunter 1980). Food selected by the larvae was influenced by the abundance, size, agility, and the feasibility or easy invisible of the food by the larvae (Noakes & Gordin 1988). The fish larvae can take the food that they can see in the water (Hunter 1981).

As shown in Tables 8, 9 and 10, the high mortality of larvae occurred at ages 1 to 10 days after hatching, the feeding period from endogenous to exogenous. This period is a critical period of fish larvae (Iwai 1972; Bagarino 1986; Fukuhara 1988). With the availability of suitable food in the transition, the larval mortality could be reduced (Noakes & Gordin 1988). *M. ladigesi* larvae is able to eat live food such as nauplius of *Daphnia* sp. (size < 0.08 mm). Some studies reported that almost all types of fish larvae utilize plankton for early feeding because the plankton fulfill the size, composition, movement and digestion capacity of larvae (Watanabe et al 1983; Ahlgren et al 1990; Holt 1992; Arief et al 2009). Selection of the type of live feed for fish larvae is recommended by some researchers for several reasons. Live food is easily digested by the larvae because the live food contains digestive enzymes. This can be seen from the increased activity of protease enzymes in the digestive tract of whitefish were fed natural rotifer (Stroband & Dabrowski 1979). The use of live feed in roach fish resulted in a higher activity of the enzyme trypsin (Hofer 1985). The second reason, because the nutritional value of natural feed is almost similar with the fish's body (Stroband & Dabrowski 1979), so the nutritional needs of the fish can be fulfilled from of live feed. The third reason is live feed does not quickly decompose, so it does not pollute the environment. Thus water quality parameters were still kept in a good condition.

Conclusions. The use of live feed affected the successfulness of rearing and spawning of the broodstock, and the larval rearing of *M. ladigesi*. Live feed such as *Daphnia* sp., *Culex* sp. and *Chironomus* sp. are suitable for the broodstock. The incubation period was 8-9 days, whereas the hatching rate was 65.14-70.77%. Larvae of *M. ladigesi* started to open the mouth at 70-72 hours after hatching and took food from the outside before the endogenous were exhausted. The size of the nauplius of *Daphnia* sp. given to the larvae was < 0.08 mm. The survival rate of larvae was 38.31-39.02% until age 5 days, 62.44-

71.67% at 10 days, 20-30 days after hatching the survival rate reached ranged from 73.06-99.84%.

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