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Research Article

Microscopic Evaluation of Balloon Variety Jack Dempsey (*Rocio octofasciata* Regan, 1903) Larval Ontogeny

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Abstract

In this study, it was aimed to determine the larval ontogeny of the balloon Jack Dempsey (*Rocio octofasciata* Regan, 1903) on the Atlantic slopes from Southern Mexico (Papaloapán River) to Honduras (Ulua River). In addition, embryonic and larval developmental stages were evaluated microscopically. Experiments were performed with 25 broodstock fishes (20 females-5 males) and their reproduction was carried out after the appropriate adaptation period. The ellipsoidal and transparent eggs were found to be short axis with an average of 973.2±21.7 µm and long axis with an average of 2159±84.5 µm (n:60). Eggs have started to hatch at 27.30±0.41°C approximately 52 hours after spawning. It was determined that the total length of the newly hatched larvae was around 3220±20 µm (n:30), they started to feed exogenously 6 days after hatching and they started to take particulate and powder feeds at the end of 21 days after hatching. The early-stage growth formula calculated with Jack Dempsey's exponential relationship model is $y = 4.097e^{0.052x}$ ($R^2 = 0.8669$, n=30).

Keywords: Fish Evaluation, Fish Larvae Ontogeny, *Rocio octofasciata*, Jack Dempsey Fish.

Balon Jack Dempsey'in (*Rocio octofasciata* Regan, 1903) Larval Ontogenisinin Mikroskobik Değerlendirilmesi

Öz

Bu çalışmada, Atlantik'te Güney Meksika'dan (Papaloapán Nehri) Honduras'a (Ulua Nehri) kadar yayılış gösteren balon Jack Dempsey (*Rocio octofasciata* Regan, 1903) balığının larval ontogenisinin belirlenmesi amaçlanmıştır. Bununla beraber, embriyonik ve larval gelişim aşamaları mikroskobik olarak değerlendirilmiştir. Denemeler 25 adet anaç balık kullanılarak (20 dişi-5 erkek) gerçekleştirilmiş ve uygun adaptasyon süresinden sonra üremeleri gerçekleştirilmiştir. Elips şeklinde ve şeffaf yapıda olan yumurtaların çapları kısa eksende ortalama 973.2±21.7 µm, uzun eksende ortalama 2159±84.5 µm (n:60) olarak bulunmuştur. Yumurtlamadan yaklaşık 52 saat sonra 27.30±0.41°C'de yumurtalar açılmaya başlamıştır. Yumurtadan yeni çıkan larvaların total boylarının 3220±20 µm (n:30) civarında olduğu, kuluçkadan 6 gün sonra eksojen beslenmeye başladıkları, 21 gün sonra partikül ve toz yemler almaya başladıkları belirlenmiştir. Jack Dempsey'nin üstel ilişki modeliyle hesaplanan erken evre büyüme formülü $y = 4.097e^{0.052x}$'tir ($R^2 = 0.8669$, n=30).
Anahtar Kelimeler: Balık Değerlendirme, Balık Larvası Ontogenisi, *Rocio octofasciata*, Jack Dempsey Balığı.

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1. Introduction

In the taxonomic hierarchy, *Rocio octofasciata* is in the genus Rocio, in the family Cichlidae, in the suborder Labroidei, in the order Perciformes, in the suborder Acantopterygii, in the class Teleostei, in the superclass Actinopterygii (Anonymous, 2022a). *Rocio octofasciata* was named Jack Dempsey in the world, Silmlaik-juveelahven in Estonia, Helmikirjoahven in Finland, Achtbindenbuntbarsch in Germany, Mojarra castarrica and Riquiraqui in Mexico, Pielegnica niebieskoluska in Poland (Anonymous, 2022b). *R. octofasciata*, which lives in freshwater and benthopelagic, is distributed tropically (21°N - 14°N) in North and Central America. It is one of the neotropical cichlids (Mendoza-Palmero et al., 2019). The quality of the waters where *R. octofasciata* lives is between 22°C-30°C, pH 7.0-8.0, and dH 9-20 (Anonymous 2022c).

Body size data for Jack Dempsey cichlids are a maximum length of 250 mm TL, average length of 7.5 cm TL, and log10 body size of 2.398 (Page and Burr, 1991; Hugg, 1996; Steele, 2018). The number of dorsal spine rays, dorsal soft rays, anal spine rays and anal soft rays is 17-19, 8-10, 8-9 and 7-9, respectively. This species has about 15 aligned spots on sides that are smaller than scales. In the species, the abdomen is predominantly whitish or greyish (Anonymous 2022c).

In spite of the fact that aquaculture is ordinarily seen as a hobby, it has become an important sector concerning aquaculture, which arouses the interest of millions of people in various parts of the earth and has a very high profit. Thus, in recent years, important large-scale producers have started to emerge in many countries of the world (Hekimoğlu, 2006). Parallel to the increase in the diversity of species in the aquarium sector, the materials used in the aquarium setup and maintenance, equipment such as filtration, lighting and water regulating chemicals have created a new commercial field brought by the sector. This situation has further expanded the trade volume of the sector on a global scale (Alpbaz, 1993; Hunt and Koca, 2014).

In ornamental fish culture, losses happen most frequently in the early larval stages. For this reason, it is very important to know the larval development stages well. Fish larvae are generally transparent in their developmental processes up to the postlarval stage. During this period, microscopes should be used in ontogeny studies. It is important to use microscopic methods to determine the early stage feeding procedures of larvae, monitor metamorphosis, to determine the stages such as mouth opening, swim bladder formation, differentiation of the digestive tract and formation of the functional stomach.

For the sustainability of aquarium fish that have already been caught, the production methods of the fish should be fully revealed. Thus, it should be ensured that no more fishing is done. For this reason, egg and embryological development of *R. octofasciata*, which has a relevant place in aquarium fish trading, have been revealed. To shed light on those who will work on this subject in the future, allometric growth curves and microscopic monitoring, which have not been included in recent studies, are presented in this article. In the present study, embryonic and early life stage larval development, and allometric growth measurements of Jack Dempsey fishes were examined microscopically.

2. Material and Method

2.1. Fish Material

The broodstock fishes that have reached sexual maturity and have a total length of 7.03±0.6 cm in females and 10.09±1.1 cm in males were used (Figure 1.). In total, 5 glass aquariums with a volume of 250 litres, each with 4 females and 1 male, were used for breeding trials. Lots of rocks and stones have been placed on the floor and suitable breeding areas have been created due to the territorial behaviour of cichlids. Commercial flake and granulated feeds were used at certain rates (80% Tetra discus granulate and 20% Tetra pro-energy flakes) in feeding approximately 4% of body weight twice a day (Ghosh et al., 2008). Freeze-dried bloodworms were also fed to adapt the fishes to granular and flake baits. Water temperature in breeding aquariums was 28.13±1.10 °C, pH 7.87±0.27, EC 1716±24 µS/cm, salinity 0.11±0.01 mg/L and DO 6.87±0.15 mg/L during the acclimation process. Eggs and larvae of fishes, which were reproduced after a certain adaptation period, were examined microscopically and also some allometric growth parameters were measured.

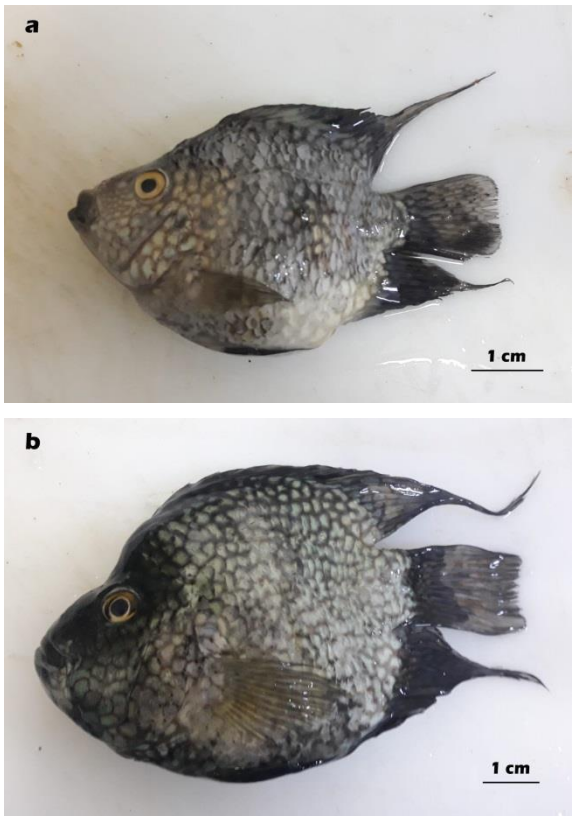

Figure 1. Broodstock fishes used for breeding trials (a: female, b: male).

2.1.1. Spawning of Broodstock Fishes

Breeding was carried out in 250 L glass aquariums with a water temperature of 27.30±0.41 °C, EC 21.1±1.2 µS/cm and pH 6.10±0.21 and DO 7.17±0.11 mg/L after 3 months of conditioning. After the eggs were observed on the aquarium bottom, the broodstocks were taken from the breeding tank and sampling was carried out here.

2.1.2. Egg and larva sampling

The first day of egg hatching was accepted as the first day of the larvae. Eggs taken from the same broodstock fishes in a

single batch were sampled at 6, 12, 30, 47 and 52th hours and just before egg hatching. And also larvae were sampled every day in the first 10 days, from the 10th day until the 21st day, once every 2 days (n:60). Randomly selected eggs and larvae were examined under a light microscope to determine embryonic and larval developmental stages according to Önal et al., (2008), Santos et al., (2016) and Aminaghie and Esmaeili (2017).

Morphometric measurements were performed using ToupView and ImageJ 1.46 software. The first egg diameter, the pigmentation pattern is seen in the egg and larva, the egg hatching period and developmental stages, the first larva size, the absorption time of the yolk sac, the opening of the mouth and anus and the length of the first mouth opening were revealed. Mouth gap sizes were examined in fish larvae when the first exogenous feeding begins, the perpendicular distance between the jaws and the distance between the horizontal hinges were measured at the position where the mouth was wide open, as noted in Cunha and Planas, (1999), Ramezani-Fard et al., (2011) and Riar et al., (2018). In addition, allometric growth parameters (total length (TL), eye diameter (ED), Pre-anal myomere length, (PrAM) Post-anal myomere length (PoAM) and Body Back Height (BH) changes were determined for the sampling days (Figure 2).

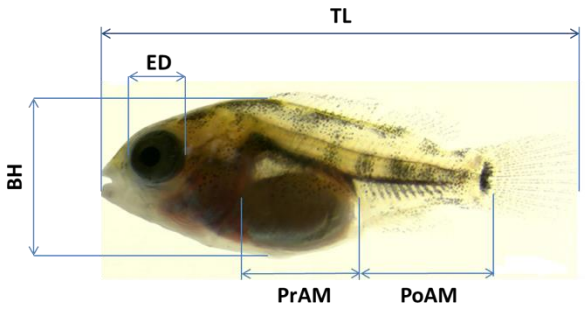

Figure 2. Symbols for Certain Metrical Growth Characters on Fish Larvae (TL: total length, PoAM: Post-anal myomere length, PrAM: Pre-anal myomere length, ED: eye diameter, BH: Back height).

BH parameters were measured as the increase in back height and massing of the body as in the balloon variety is an important distinction.

Allometric growth models were described by linear regression formulas which were stated by correlating related body regions with total length (TL) (Fuiman, 1983; Gisbert et al., 2002; Çelik et al., 2011). Morphometric growth characters considering total length proportions were scored utilising the allometric equation $Y = aX^b$. (Y= Measured character, X= Independent variable (TL), a= Intersection point and b= Growth coefficient).

3. Results and Discussion

3.1. Egg structure and reproductive characteristics

Totally 9 times spawning was carried out at different times for each of the groups during the trial. It has been observed that egg-laying was completed in 6-7 hours and also it was determined that the eggs were elliptical in shape, sticky and transparent. It has been reported that the egg-laying takes 1 hour in green terror cichlids (*Aequidens rivulatus*) (Güngör, 2012), 1.5 hours in jaguar cichlids (*Parachromis managuensis*) (Arık, 2013), and 1-1.5 hours in discus fishes (*Symphsodon aequifasciatus*) (Erik, 2012). Compared to the studies, it was determined that the egg-laying period was longer in this study.

In the samples examined within the first 1-3 hours from the eggs and it was determined that the egg diameter average was 973.2±21.7 µm and also long axis average was 2159±84.5 µm (n:60). The short and long axes were 1.47±0.03 mm and 1.92±0.05 mm in the Jaguar cichlid (Arık, 2013); 1.22±0.08 mm and 1.61±0.09 mm in zebra cichlids (Bayraklı et al. 2001); 1.25±0.05 mm and 1.65±0.05 mm in Cichlasoma dimerus (Meijide and Guerrero 2000); 0.80-1.00 mm and 1.00-1.20 mm in discus (Çelik 2008); 1.19±0.02 mm and 1.77±0.02 mm in discus (Erik 2012); 1.17 mm and 1.43 mm in angelfish (Korzelecka-Orkisz et al. 2012); 0.93-1.20 mm and 1.25-1.54 mm in angelfish (Dalgıç 2002); 1.45±0.05 mm and 1.86±0.04 mm in green terror cichlid (Güngör 2012), respectively. The egg form in this study was determined to be more elliptical when compared to other studies.

In addition, the eggs contain 4 round shape oil drops, one larger than the other droplets (Figure 3). Fecundity was found as an average of 495±153.1 eggs with a minimum of 285 and a maximum of 690 all of the reproduction trials (n:9). Although the amount of eggs was low in the first laying, fecundity increased in later reproductions.

In the study, embryonic and larval development was investigated in 495±153.1 eggs obtained from these fish. Arık (2013) in 1236±187.40 eggs of jaguar cichlids (*Parachromis managuensis*), Güngör (2012) in 527±70 eggs of green terror cichlids (*Aequidens rivulatus*), Dalgıç (2002) in 185 eggs of angelfish (*Pterophyllum scalare*), Erik (2012) in 182 eggs of discus (*Symphsodon aequifasciatus*), and Bayraklı (2001) in 136 eggs of zebra cichlids (*Cichlasoma nigrofasciatum*) investigated stages of embryonic and larval development. The number of eggs used in the study was found to be sufficient when compared with other researchers.

It has been detected the water temperature values directly affect the egg hatching time in the decapsulation of eggs. Eggs hatched in 52 hours at 28.7 °C, and 59 hours at 26.9 °C in trials.

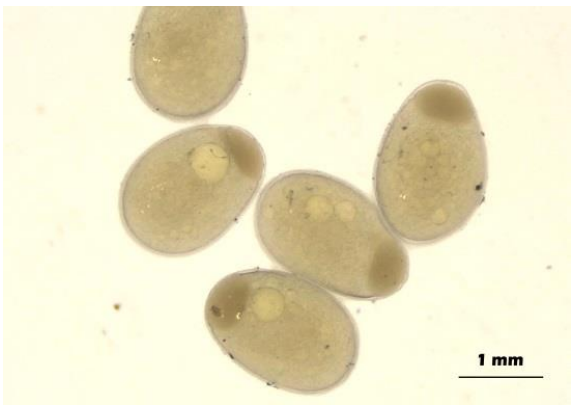

Figure 3. Egg shape and oil droplets.

3.2. Microscopy of embryonic development

Microscopic images of the embryological development stages of eggs are given in Figure 4 and details about the stage of the eggs are in Table 1. In this research, each egg was gathered from a single batch of eggs.

In the study, the pre-hatching took place between 47-52 hours (Table 1). In some studies prehatching took place between 49 hours 30 minutes and 70 hours (Arık, 2013) , at 57 hours (Erik, 2012), at 75 hours 30 minutes (Güngör, 2012), at 48 hours, (Bindu and Padmakumar, 2012), at 56 hours (Bayraklı et al., 2001), at 59 hours (Dalgıç, 2002), at 53 hours (Meijide and Guerrero, 2000), at 23 hours (Fijimura and Okada, 2007), and at 21 hours 20 minutes Korzelecka-Orkisz et al. (2012).

Table 1. Explanations of the embryonic development stages

Figures	Descriptions/Measurements
a	12th hour, Sphere stage the blastodisc gradually flattens, VD_{Avg}: LA:1985±21 µm, SA: 1289±34 µm, multi-cell (>64) formation-early morula stage, CD_{Avg}: LA: 2279±14 µm, SA: 1759±26 µm, PS 85.2±4.2 µm
b	28-30th hour, 2 somite formation, %90 epiboly shape, VD_{Avg}: LA: 1709±44 µm, SA: 1280±62 µm, CD_{Avg}: LA: 2052±24 µm, SA: 1440±70 µm
c	47th hour, embryo formation, 16 somite stage, CD: LA: 2072 µm, SA: 1566 µm
d	47-52th hour, embryo formation, Pre-hatching, 24 somite stage ED_{Avg}: LA: 1296±52 µm, SA: 873±14 µm

*VD: Vitellus diameter, CD: Chorion diameter, ED: Egg diameter, LA: Long axis, SA: Short axis, Avg: average.
** Eggs given embryonic development stages were incubated at 28.3 °C and hatched in 52 hours.

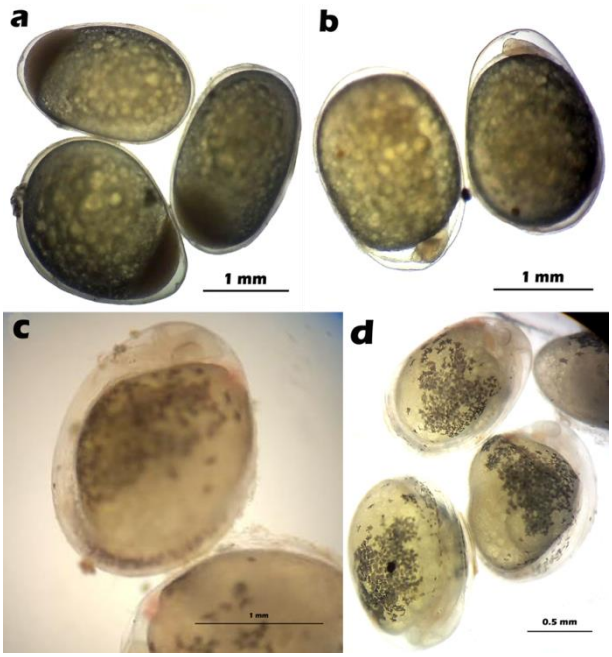

Figure 4. Eggs developmental stages from newly laid eggs to the 52nd hour.

(a: 12th hour (sphere stage), b: 28-30th hour, c: 45-47th hour, d: 47-52th hour).

3.3. Microscopy of larval development

Microscopic images of the sampled larvae are given in Figures 5 and 6. Morphometric growth parameter values such as the first total length of the pre-larvae, the diameter of the yolk sac and the first mouth gap size were measured throughout the development from the first hatching to the post-larval stage (Table 2).

In some studies the first total lengths of the pre-larvae were measured as 4.02±0.53 mm (Arık, 2013), 5.10±0.07 mm (Sezen, 2011), 2.60±0.09 mm (Korzelecka-Orkisz et al., 2012), 3.00±0.01 mm (Sarma et al., 2012), 3.00±0.02 mm (Adebiyi et al., 2013), 3.90 mm (Bindu and Padmakumar, 2012), 3.32±0.10 mm (Meijidei and Guerrero, 2000), 4.26±0.10 mm (Güngör, 2012), 3.03±0.04 mm (Erik, 2012), and 3.46±0.07 mm (Bayraklı et al., 2001).

Some of the water quality values during both egg hatching and larval development stages were measured as pH 8.53±0.4, EC 1846±17 µS/cm, salinity 0.14±0.01 mg/L, DO 7.04±0.12 mg/L and 28.30±1.60 °C. It was determined that the larvae completely absorbed the yolk sac at the end of the 5 DAH (the day after hatching) and mouth opening occurred at the beginning of the 6 DAH. At the opening of the mouth and anus, the yolk was entirely or just about used up. A newly opened mouth gap size is not suitable for feeding with newly hatched Artemia at this stage, so egg yolk was given as the first food. Since egg yolk was seen in the stomach and digestive tract of all larvae, it was decided that the larvae started exogenous feeding at the end of the 6 DAH. It was also noticed that the larvae were mostly immobile on the aquarium floor until 5 DAH, started to swim freely after exogenous feeding and used the entire water column from the 7th day. At the end of the 9th day, the back height increase, which is seen in the balloon variety, was observed for the first time. It was observed that the swim bladder was single-lobed and also did not show segmentation during all larval development stages.

In some studies, the development of tissues and systems is observed in the early larval stages of fish. Histological and microscopic methods are used for this. With these methods, especially the structural metamorphosis of the digestive system and its transformation into a functional stomach can be determined. (Önal et al., 2008; Ramezani-Fard et al., 2011). These ontogeny methods are specially used for altricial fish larvae.

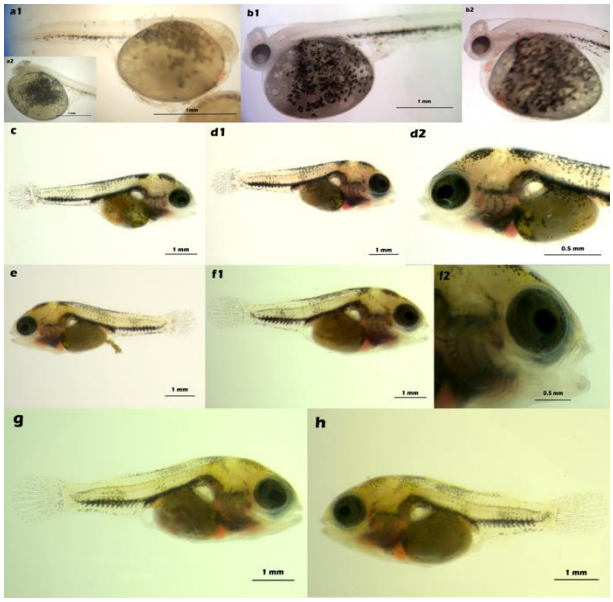

Figure 5. Developmental stages from newly hatched prelarvae to 11th day.

(a1-a2: 1th hour, b1-b2: 3 DAH, c: 6 DAH, d1-d2: 7 DAH, e: 8 DAH, f1-f2: 9 DAH, g: 10 DAH, h: 11 DAH)

Species-specific pigmentation on both sides along the dorsal and lateral line up to the tail was firstly observed on the 13th day.

Table 2. Descriptions of images about morphometric measurements

Figures	Descriptions	Figures	Descriptions
a	1th hour, TL 3204 µm, YD: SA 1396µm, LA 1919 µm	**g**	10 DAH, TL 7479 µm
b	3 DAH, TL 4415 µm, YD: SA 957µm, LA 1284 µm	**h**	11 DAH, TL 7633 µm
c	6 DAH, TL 6142 µm, MS 182 µm	**ı**	13 DAH, TL 8563 µm, MS 454 µm
d	7 DAH, TL 6602 µm	**i**	15 DAH, TL 9450 µm, MS 521 µm
e	8 DAH, TL 6698 µm	**j**	17 DAH, TL 9510 µm, MS 529 µm
f	9 DAH, TL 7399 µm, MS 360 µm		

* TL: Total Length, YD: Yolk Sac Diameter, MS: Mouth Gap Size. SA: Short axis, LA: Long axis
** The larvae at the images were kept at 26.9-28.7 °C throughout the sampling.

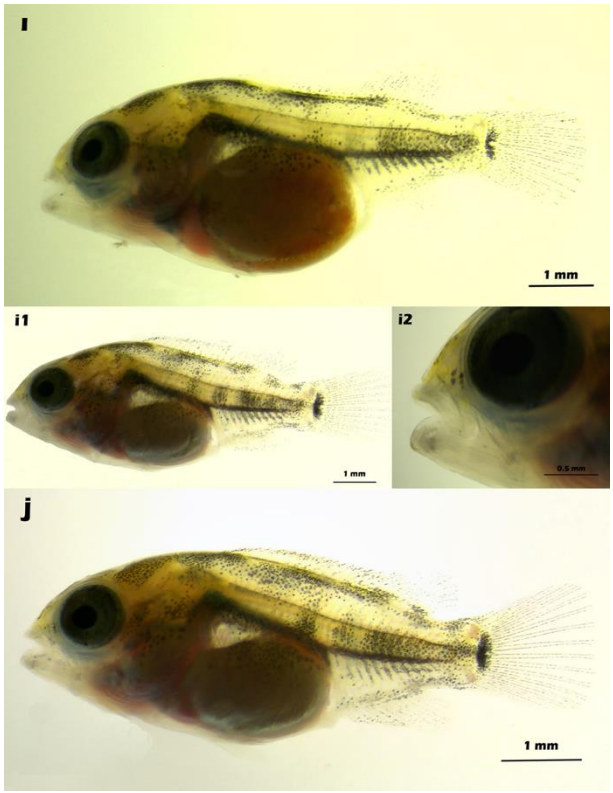

Figure 6. Developmental stages of post-larvae from 13th to 17th day.

(ı: 13 DAH, i1-i2: 15 DAH, j: 17 DAH).

Larvae started to take particulate pellets at the end of the 21st day. In line with the data obtained, the early stage measurement and feeding procedures of the larvae are summarized in Table 3.

The early-stage growth formula of Jack Dempsey calculated with the exponential relationship model is $y = 4.097e^{0.052x}$ (R^2 = 0.8669, n=30). 'y' in the formula; means the total length (TL), and x stands for the days (DAH). Growth rates of body characters according to total length were estimated according to the allometric equation $Y = aX^b$ (Figure 7). From the prelarval stage, ED showed isometric growth, while PrAM and PoAM parameters showed negative allometric growth. And also From the postlarval stage, PrAM and PoAM showed negative allometric growth. BH showed positive allometric growth from the postlarval stage. It has been observed that the body has a balloon appearance by massing, especially from the 9th day of the larva.

4. Conclusions and Recommendations

Further developmental studies are needed as its ontogeny may differ greatly among species (Kunz, 2004). Eggs of *R. octofasciata* have an elliptical form, with the longitudinal axis longer than the transverse axis (Figure 4). The egg is encircled by the chorion, a diaphanous cover that clings tightly to the egg (Figure 4). The vitellus (yolk sac) is carved out of broad deep-yellow yolk globules/platelets of diversity dimensions, giving it a grainy view, as for the Jack Dempsey and closely-related Neotropical cichlids (Kunz, 2004; Oldfield, 2011; Chellappa et al., 2005; Kratochwil et al., 2015) (Figures 4a, 4b). The micropyle has a funnel or cone-shaped form. The blastodisc progressively separates from the yolk and forms a more evident, distinctly determined cell at 12 hours. The cytoplasm is uniform, but darker than in another teleost (Kimmel et al., 1995; Meijide and Guerrero, 2000) (Figure 4a).

Table 3. Early larval morphometric measurements and feeding protocol up to post-larval stage

DAH	Morphological Measurements/Descriptions (n:30)	Feeding Procedures
1	TL min 3201, max 3255, 3220±20 µm	*not exogenous feeding*
3	TL min 4303, max 4455, 4404±51µm	*not exogenous feeding*
6	The yolk sac absorption (Almost all of the larvae) Mouth opening, MS 182±23 µm	*Egg yolk*
7	TL min 6600, max 6619, 6609±7µm	*Egg yolk*
8	MS 360±14 µm, TL min 6698, max 6721, 6710±9 µm	*Egg yolk*
10	TL min7479, max 7499, 7491±8 µm	*Egg yolk +Artemia*
13	MS 454±14 µm, TL min 8563, max 8607, 8585±19 µm	*Artemia*
15	MS 521±11 µm, TL min 9417, max 9450, 9436±12 µm	*Artemia*
17	MS 529±19 µm, TL min 9510, max 9565, 9530±21 µm	*Artemia +Particulate pellets*
21	MS 801±30 µm, TL min 9850, max 9889, 9872±15 µm	*Particulate pellets*

* TL: Total Length, YD: Yolk Sac Diameter, MS: Mouth Gap Size.

It is thought that the low amount of eggs in the first reproductions is related to the first egg laying of the broodstocks. Fecundity for the species is stated as 500-800 in previous studies (Riehl and Baensch, 1991; Coleman, 2002). These egg amounts are similar to the fecundity values obtained in the study.

Melanophores seem on the upper of the yolk sac. The pericardial sac develops between the anteriormost area of the yolk and the head area. The embryo slightly lifts the head a little from the yolk (Figure 4c). Some melanophores begin to appear on the dorsal of newly hatched prelarvae (Figure 5a).

After spawning, the eggs adhere to one another and to the substrate with the mucus they secrete. In laboratory conditions, they adhere to petri dishes. Like *Amphilophus xiloaensis* (Kratochwil et al., 2015) and *Parachromis managuensis* (Arık, 2013) eggs, Jack Dempsey eggs are sticky and the chorion does not swell during the zygote period.

The timing of larval development of *Oreochromis niloticus*, a species of cichlid, is alike to that of other mouth-brooding tilapias; slower than tilapias that lay eggs on the substrate. In *O. niloticus* 18 stages (stages 1-18) have been described for embryonic development, which is divided into seven stages called zygote, cleavage, blastula, gastrula, segmentation, pharyngula and hatching periods. Seven stages (stages 19-25) have been identified for larval development, which is divided into two stages: early larval and late larval. A pneumatic duct unites the swim bladder to the digestive tract, and the swelling of the swim bladder and the start of feeding happen at approximately the same time (Morrison et al., 2001; Fujimura). and Okada, 2007).

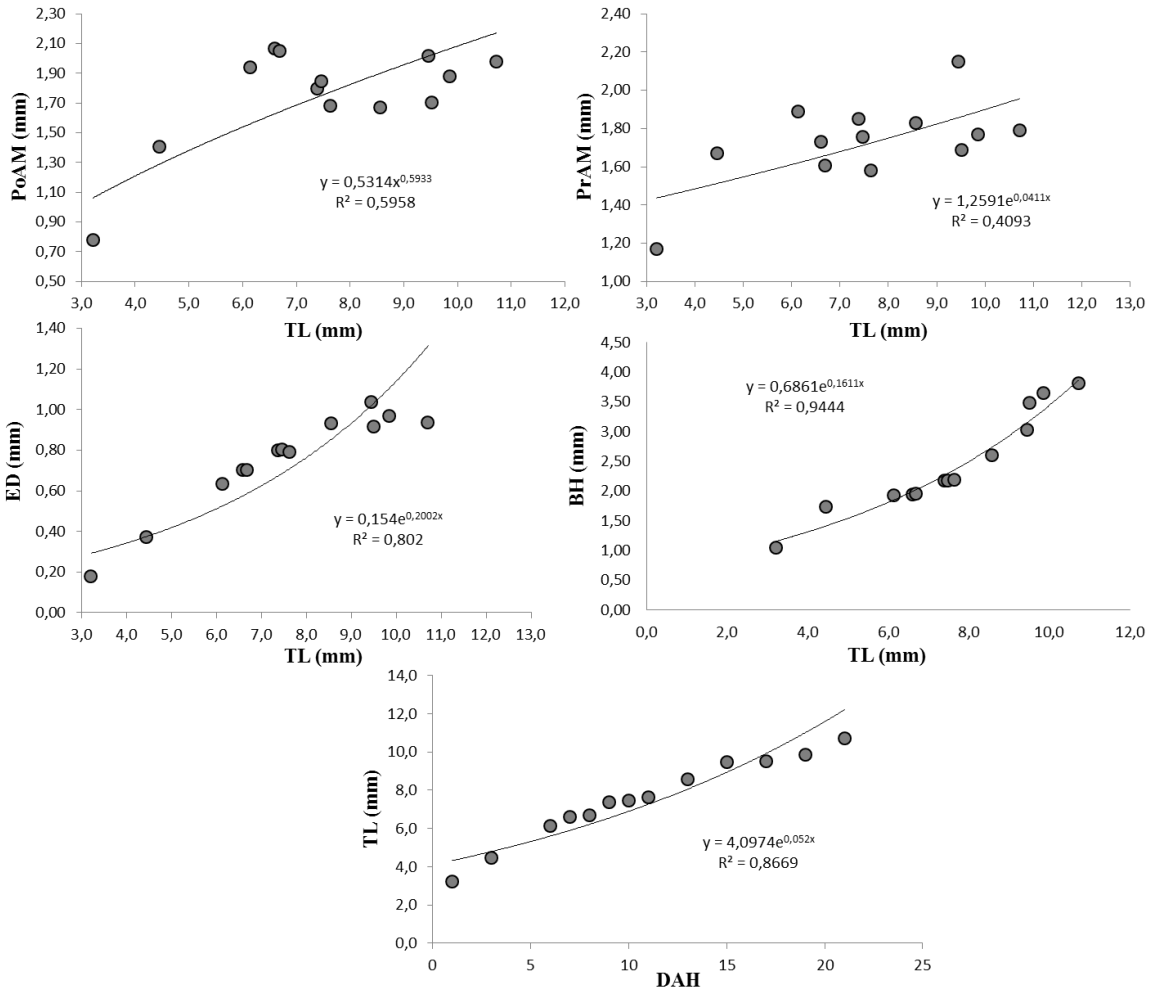

Figure 7. Allometric development curves of morphometric characters during the larval developmental stage and their relationship graphs according to the total length.

Longitudinal and transverse axes of eggs of *A. xiloaensis* were 2.14 ± 0.09 mm and 1.42 ± 0.07 mm, respectively.

At a water temperature of 25±0.5 °C, cleavage in *Cichlasoma dimerus* is completed in 10 hours and the first somites emerge at 26 hours of development. Larvae hatch at the beginning of the third day. After 5 days, the fry swims freely and starts to take nourishment from the outside. Because the yolk sac is not fully absorbed until after 2 or 3 days, the fry continues to be fed both endogenously and exogenously for a while. The juvenile phase is achieved on the 42nd day after laying (Meijide and Guerrero, 2000).

Alimentation/environmental cases affect muscle build-up in Pacu (*Piaractus mesopotamicus*) altricial larvae and juveniles. Ontogeny of the pacu sensory system projects the larvae-environment mutual effect. Differentiation of the pacu digestive tract is carried out before the complete metamorphosis. Larval

characteristics regression and skeletal improvement take place in pacu with 20 mm (Portella et al., 2014).

Powder feeds are not given in the early life stages of fish. Because the enzyme activity of the fish is limited and the digestive system is not developed. At this stage, various zooplankton species (*Artemia* sp., *Brachionus plicatilis* and infusoria e.g.) are given. In the first feeding, the live baits to be given are determined according to the size of the mouth gap. Especially, live baits are the highest cost in larval feeding in commercial fish culture (Person Le Ruyet et al., 1993; Önal, 2006). Therefore, determining how long zooplankton feeding will be followed by powder artificial baits depends on the mouth gap size and digestive system. So, these physiological and morphometric developments are closely related to the effective use of microscopic and histological methods in altricial fish larvae ontogeny studies.

In some ornamental fish, water quality parameters (EC, temperature and pH etc.) that have a reproductive trigger effect were determined. When Jack Dempsey was evaluated (27.30±0.41 °C, EC 21.1±1.2 µS/cm, pH 6.10±0.21 and DO 7.17±0.11 mg/L), it was determined that did not need any different special conditions for growth.

Before the absorption of the yolk sac, mouth opening occurs and exogenous feeding begins in larvae (6 DAH). When the larval metamorphosis of *R. octofasciata* is examined, it is seen that the yolk sac is absorbed for relatively long time. Endogenous and exogenous feeding continue together. In the jaguar cichlid (*Parachromis managuensis*) the vitellus absorption that occurs on the 4th day has been reported (Arık, 2013).

The newly opening mouth gap size of the larvae (182 µm) is small compared to other species. This situation allows the egg yolk based feeding period (6 DAH). The larvae started to get Artemia in 10 DAH and particulate pellets in 17 DAH (Table 3).

About the growth of many ornamental fishes of commercial importance, there is no scientific literature. It is thought that the data on the larval development of the Jack Dempsey, which is a commercially important and popular aquarium fish, will contribute to the knowledge.

In recent years, the ornamental fish trade is a multi-billion dollar industry, with more than 2500 species of fish, mostly freshwater species, found in more than 125 countries (Dey 2016). In general, Jack Dempsey's balloon variety is one of the species with high commercial returns that can be preferred by hobbyists due to its rounded lines and attractive colours. Therein for the aquarium fisheries sector needs to master the larval development of this species.

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