

Life history traits of Endler's fish (*Poecilia wingei*)

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Abstract. Poeciliid fishes present a wide variety of litter size, length at birth, age, total length and weight at sexual maturation in their life histories. This study determined these traits of *Poecilia wingei* under laboratory conditions. 10 litters and 122 fries were studied. The following results were obtained: a litter size of 17.33 ± 4.68 fries, which had an average total length at birth of 7.75 ± 1.97 mm; the males reached sexual maturity at an age of 37.33 ± 8.08 days with a total length of 18.44 ± 3.51 mm and a weight of 1.67 ± 0.21 g. The results of this study show a part of the life history of Endler's fish (*P. wingei*).

Key Words: livebearer fish, ornamental fish, *Poeciliidae*, reproductive biology.

Introduction. Species of the family *Poeciliidae* are the most popular ornamental fish produced in Singapore, Malaysia, Indonesia, Thailand, India, China, and are widely distributed in the world (Miller et al 2009; Arevalo-Rivera et al 2010; Velasco-Santamaría & Corredor Santamaria et al 2011; Gavrioloaie et al 2016). Some poeciliids have been reproduced and the information necessary for their cultivation on a large scale is provided. Such is the case of the guppy *Poecilia reticulata* and the swordtail *Xiphophorus helleri*, where new varieties of shape and color were developed through selective breeding (Fernando & Phang 1985; Tamaru et al 2001).

Endler's fish is a relatively new species, being considered *P. reticulata* until recently (Poeser et al 2005). Thus, the information about its reproductive biology is scarce. This study focused on males, since for *P. wingei*, as in the majority of livebearer fish, males present a high pigmentation and are more attractive for the ornamental fish market than the females (Urriola Hernández et al 2004a; Poeser et al 2005). The color and shape are the most important attributes for the commercial value of ornamental fish (Mandal et al 2010).

The objective of this study was to determine some aspects of the life history (fertility, litter size, length at birth, age at sexual maturation and total length at maturity) of Endler's fish. These aspects are important for its biology, commercial value and management in captivity, including reproduction, especially as *P. wingei* has an increasing popularity among aquarists in recent years (Gavrioloaie et al 2016).

Material and Method

Broodstock. The study was carried in the Culture Fish and Aquatic Health Laboratory from the "Instituto Tecnológico de Boca del Río", México, from April to September 2018. The fish were obtained directly from an exotic fish import company. 15 fish were used for the experiment, 12 females and 3 males of *P. wingei*, blue Japan variety. The fish were quarantined for 20 days using Polyguard®. The organisms were kept separated by sex, until the females reached sexual maturity. The breeders were fed with commercial flake food Tetracolor® (40% crude protein). The females were considered mature when they presented the gravid spot on the abdomen (Llanos & Scotto 2014). The fish were distributed in 3 breeding lots, using a sexual proportion of 4:1 (females to males), according to the proportion used in poeciliid fish (Tamaru et al 2001). Each reproductive lot was placed in a 20 L aquarium provided with a mechanical-biological filter, an

aquarium heater controlled by one thermostat calibrated at a temperature of 27-28°C and plastic raffia strips to prevent the cannibalism of the females (Llanos & Scotto 2014).

Offspring. The pregnant females were monitored every two hours from to 10:00-18:00 each day. When females gave birth the newborn fish, they were immediately separated in litters and placed in 15 L aquariums, each provided with a mechanical-biological filter and a thermostat. Litters obtained during two months were considered.

Water parameters. Water parameters were measured twice a week using a multiparameter water sensor and colorimetric test Nutrafin® (Table 1). Water exchange was carried out weekly, and the evaporated water was replaced daily to avoid sudden changes in the water parameters.

Feeding. The newborn fish were fed only with the nematode *Turbatrix aceti* at a concentration of 650 org mL⁻¹ (15 mL per tank), which was estimated using a Sedgewick Rafter camera, every two hours from 10:00 am to 6:00 pm during the first day. From the second day until the beginning of the development of the gonopodium in males, they were fed with commercial food flakes (at 10:00, 14:00 and 18:00 h) and with 15 mL *T. aceti* per tank at 12:00 and 16:00 hours. Adults and juveniles were fed with commercial food flakes Tetracolor® with 49% crude protein, at 3% of their biomass, supplied three times a day (at 10:00, 14:00 and 17:00 h).

Fish measurement. For determining and noting the age, biometrics (weight and total length of the organisms) were performed once a week until sexual maturation was reached in males, because the males are those that present commercial interest due to their colors (Urriola Hernández et al 2004a; Poeser et al 2005).

An analytical balance (0.01 g precision) and a digital vernier (0.1 mm precision) were used for the measurement of newborn fish. A glass tube filled with water was used to prevent stress (Figure 1).

During the biometrics, the analysis of the anal fin was performed using a light microscope (Leica® eZ4-16), the sexual maturation age being considered when the gonopodium was fully developed (Řežucha & Reichard 2014). The fertility of the reproductive females was determined by the number of fries per litter, since these previously represented the embryos produced by females (Schoenherr 1977).

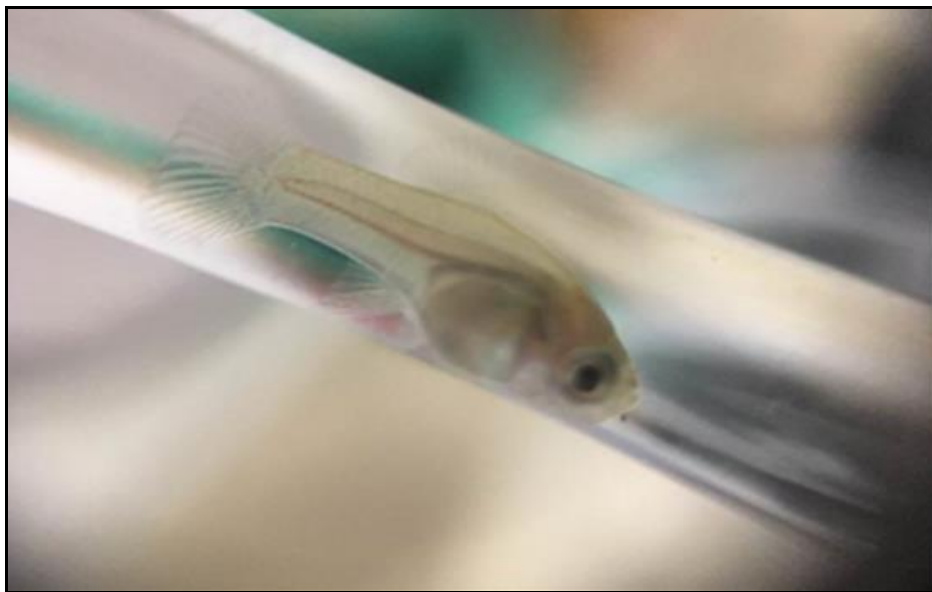


Figure 1. *Poecilia wingei* inside the glass tube during the measurement.

Statistical analysis. The Pearson correlation test was applied to identify possible associations between weight, total length, litter size, and sexual maturation age. All data were analyzed with the statistic software Statistica® v10.0, with a significance level of $p < 0.05$ in all cases.

Results and Discussion.

Parameter values of water quality during the study are presented in Table 1.

Table 1

Water quality parameters measured during the study

Parameter	Range value
pH	7-7.5
NO ₃ (mg L ⁻¹)	0
Ca (mg L ⁻¹)	20-25
NH ₃ (mg L ⁻¹)	0
NO ₂ (mg L ⁻¹)	0
GH (mg L ⁻¹)	110-120
KH (mg L ⁻¹)	90-95
Fe (mg L ⁻¹)	0
PO ₄ (mg L ⁻¹)	2-2.5
Temperature (°C)	27-28
Oxygen (mg L ⁻¹)	5.6-6

Note: GH - general hardness; KH - carbonate hardness.

Regarding the offspring obtained, 10 litters were obtained with 122 fries (Figure 2) in total, 83 females and 39 males, with a sex ratio of 1:2.11 (males to females). The total mean length at birth (Figure 3) of the total number of fries was 7.75 ± 1.97 mm. The mean number of fries per litter was 17.33 ± 4.68 individuals, which corresponds with the fertility of the females. The males reached the sexual maturation at the age of 37.33 ± 8.08 days, when they reached a mean total length of 18.44 ± 3.51 mm, and a mean weight of 1.67 ± 0.21 g.

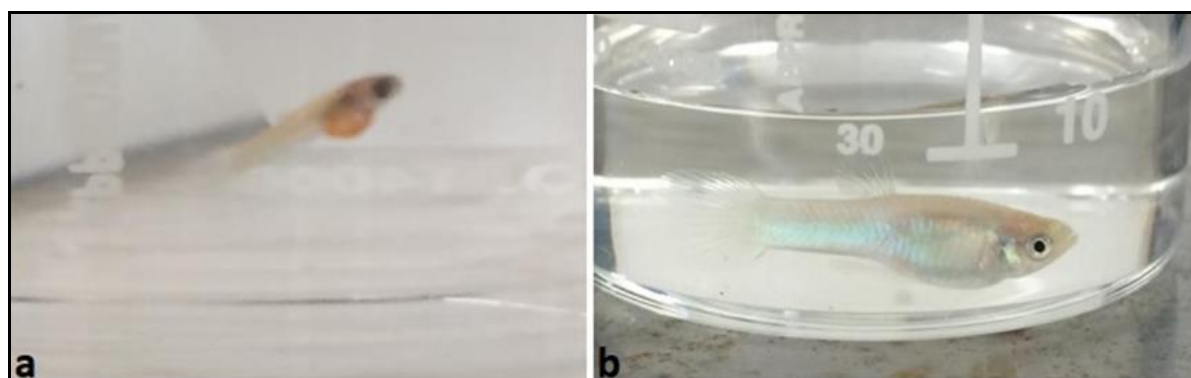


Figure 2. Newly born *Poecilia wingei* (2a); 6-weeks-old male reaching sexual maturation, where the beginning of the characteristic pigmentation of the variety Japan blue is observed (2b).

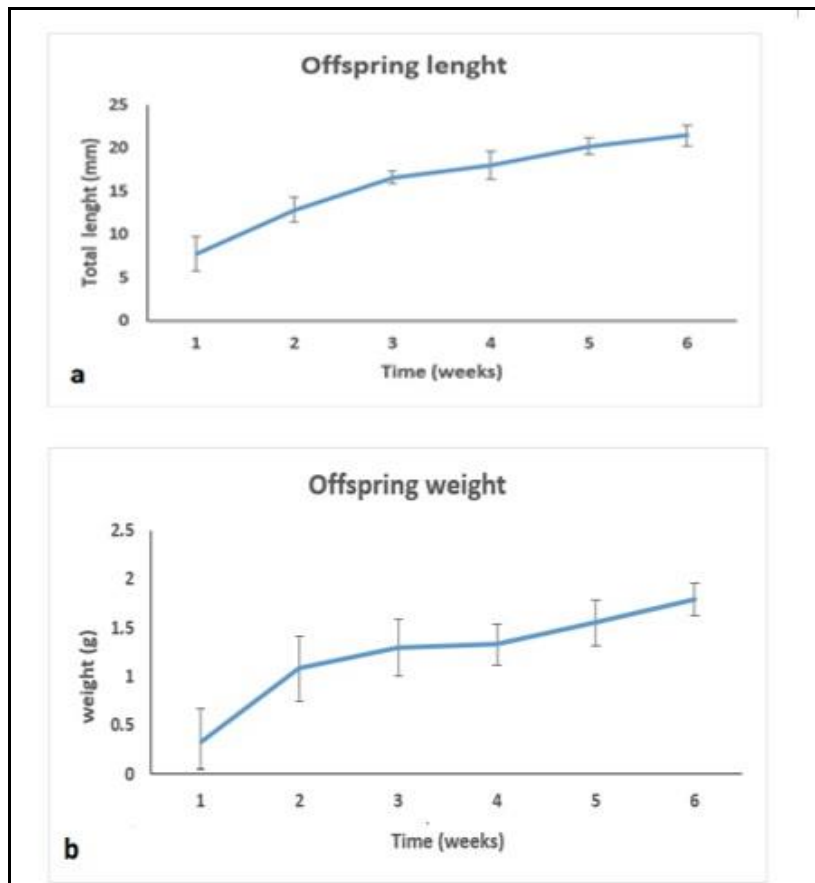


Figure 3. The mean total length (3a) and mean weight (3b) of offspring obtained from *Poecilia wingei*; n=122, bars indicate \pm SD.

Positive correlations were founded between age at sexual maturity and total length ($p < 0.0003$); weight and total length ($p = 0.009$); age at sexual maturity and weight ($p = 0.03$). No correlation was found between litter size and total length ($p = 0.7$), or between weight and litter size ($p = 0.8$).

The sexual proportion used in the conformation of the reproducers was adequate since all the females were pregnant. It coincided with the proportion used in the reproduction of the ornamental variety "mystical blue" of *Xiphophorus helleri*, 4:1 (Tamaru et al 2001), which could be related to the competition between males for females and to the fact that both species belong to the same family (Barreiro Buceta 2013). The sex ratio obtained in this study is very close to previously reported ratios for *P. reticulata*, of 1:2.06 and 1:1.87 (Rood & Reznick 1997; Maya-Peña & Marañón-Herrera 2001). This can be attributed to the fact that *P. wingei* is closely related to the common guppy, so their life histories can be similar in some traits (Poeser et al 2005).

The total length at which the males reached sexual maturity is similar to previously reported lengths for *Poecilia reticulata*. There is a record of sexually mature males at a total length of 17.8 ± 2.24 mm (Urriola Hernández et al 2004b), although it differs from that reported for *Phalloceros caudimaculatus*, where males reached sexual maturity at 16-31 mm (Arias & Reznick 2000). *X. helleri* males mature at a total length of 25 to 30 mm (Stickney 2000). The offspring total length at birth in this study was lower than that of *X. helleri* (8-10 mm) registered in previous studies (Tamaru et al 2001). In this study, the males reached sexual maturity faster than in other studies on the same species, where males reached maturity after of 3-4 months (Řežucha & Reichard 2014). This could be due to the different type of feed, or due to the lower water temperature (23-25°C). Feed and temperature are factors that affect the development of life histories in poeciliid fish (McKenzie et al 1983; Haney & Walsh 2003; James & Sampath 2003).

The total length was similar to that of *P. reticulata* (7.12 ± 0.09 mm) (Tamaru et al 2011; Ojanguren et al 2005), and these results can be attributed to the fact that *P. wingei* is closely related to the guppy (Schories et al 2009). Regarding the weight at sexual maturity, it differs from that reported for *P. reticulata* (0.05 ± 0.36 g) in previous studies (Urriola Hernández et al 2004b). However, it coincides with the weights reported for *X. helleri* between 31-50 mm, where sexually mature males had 1.67 g (Arevalo-Rivera et al 2010).

Regarding the litter size and fertility of the females, they differ from other fish of the same family. It has been found that *Brachyrhaphis rhabdophora* produces 9.6 ± 2.43 offspring per litter (Reznick et al 1993). *P. reticulata* has a wide range of fries per litter, between 7.89 and 197.58 (Urriola Hernández et al 2004a). *Xiphophorus pygmaeus* has an average number of offspring of 5.2 ± 1.83 per litter (Morris & Ryan 1992). However, it resembles the litter size of females of the godeid *Xenotoca variata*, which produce on average 17 fries per litter (García-Ulloa et al 2011). There are previous studies that indicate the influence of temperature on life histories of poeciliids (McKenzie et al 1983; James & Sampath 2003). In this study, the *P. wingei* were maintained a temperature of 28°C.

Finally, the age of sexual maturity in males differed from that of *P. reticulata*, previously reported at 48-62 days (Reznick & Bryga 1996), and two months (Houde 1997), *Poecilia latipinna*, at two months (Snelson 1984), and *X. helleri*, at 9-12 weeks (Stickney 2000). This can be attributed to the fact that the smallest poeciliid species reach sexual maturity in less time, as a reproductive strategy (Meffe 1985). During this study, the males reached sexual maturity before other fish of the same species, reported in other studies (Režucha & Reichard 2014), where males reached maturity after 3-4 months. It approaches the sexual maturation period of *P. reticulata*, at 45 days (Reznick 1980).

Conclusions. *P. wingei* showed a successful reproduction using the sexual ratio 1:4 (male to female). The lengths of the fries at birth and at sexual maturity are similar to those reported in guppies. Weight showed similarity to that of *X. helleri*. The weight during the study showed a tendency to uniformity when approaching sexual maturity. No relationships were found between litter size and the length and weight of the offspring.

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

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