CULTURE OF FOUNDERS AND BREEDING OF THE BAY SNOOK *Petenia splendida* (PISCES: CICHLIDAE) IN A RECIRCULATION AQUACULTURE SYSTEM

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Abstract

The Bay Snook P. splendida is a Neotropical Cichlid of Southeastern Mexico. Their natural populations have been diminishing in the last years for multiple factors. With the main objective to aid in the development of their culture technology with purposes of conservation and restocking natural populations, two experiments were carried out. In the first experiment a founder population of 162 offspring two months old (1.5±0.42g) were cultured in a 5,000-L recirculation aquaculture circular tank during 330. In the second experiment, eight females and eight males of one year of age (55.1 to 53.9g) were introduced in a 5,000-L brooder recirculation aquaculture circular tank. The results indicated at the end of the experiment founders reached 38.7g and 15.8cm. For the second experiment, 11 spawning events were recorded in one year with a total of 6 840 eggs, with high survival rates. The experiments demonstrated the feasibility of culture of this species in recirculation aquaculture systems.

Key words: Bay Snook, *Petenia splendida*, growth performance, reproduction, culture, recirculation aquaculture system.

1.0 Introduction

The Bay Snook locally known as "Tenguayaca" *Petenia splendida* (Günther 1862) is a Neotropical Cichlid from the Southeastern México. It is an active predator fish with moderate aggressively, characterized by posses a big protractile mouth that can open and extend to catch fishes of big size (Waltzek & Wainwright, 2003). The males could reach up to 45 cm of total length (TL) and females at least 30 cm. The females are substrate spawners and present synchronic multiple spawns (Pérez-Vega, 2006). The brooders prefer zones of one meter of depth for spawning, and the first maturation size is about 14 cm TL for both sexes. Females laid their eggs on a nest; they can lie from 200 to 2,500 eggs per spawn depending on their body size. It is an omnivorous species with a carnivorous tendency especially in adult state and can live together with other species of fishes (Reséndez-Medina & Salvadores-Baledón, 1983).

This species along with other Cichlids of Southeastern Mexico has been strongly exploited for decades, and nowadays, natural populations are notably reduced. Other factors have also influenced in this dismissing, among them are the severe changes in natural habitats; drastic annual hydraulic fluctuations as a consequence of the climatic change and the presence of exotic fishes intentionally or accidentally introduced, that had affected and limited their growth and development of native Cichlids, such is the case of the introduction of species of tilapia (*Oreochromis spp*.), the jaguar guapote (*Parachromis managuensis*), and most recently the evil fish *Plecostomus spp*. (Pérez-Vega, 2006).

The investigations realized on this species are scarce and diverse. Reséndez-Medina and Salvadores-Baledon (1983) described aspects on the biology of *P. splendida* in a coastal lagoon; Chávez et al. (1987) and Chávez, Mattheeuws and Perez (1989), evaluated the fishes of Southeastern Mexico and they analysed their potential for culturing. Wainwright et al. (2001), Waltzek and Wainwright (2003) and Hulsey and García de León (2005) described the ram use as a suction mechanism for prey-capture, the functional morphology of the protrusion mandible and the relationship with specialized structures of fed. Lamothe-Argumedo, Salgado-Maldonado and Pineda-López (1997), Salgado-Maldonado et al. (2005) and Salgado-Maldonado (2008) reported on gut parasites of different species of Mexican Cichlids. Valtierra-Vega and Schmitter-Soto (2000), described their feeding habitat; Soria-Barreto and Rodiles-Hernández (2008) their habitat; Pérez-Vega (2006) and Pérez-Vega et al. (2006) described reproductive aspects of two Neotropical Cichlids, including *P. splendida*; Arias-Rodríguez and Ibarra-Castro (2008) reported on the mitotic and meiotic chromosomes of several Mexican Cichlids species, and recently Pérez-Sánchez and Páramo-Delgadillo (2008) rendered information on the culture of Southeastern Cichlids in Mexico.

In order to gain detailed information on the life history of *P. splendida* and their adaptation and development under control conditions, here we studied the growth performance and breeding of the Tenguayaca in recirculation aquaculture systems.

2.0 Methods

The experiments were conducted in the Planta Experimental de Producción Acuícola, PEXPA (Aquatic Experimental Production Plant, AEPP) at the Autonomous Metropolitan University campus Iztapalapa; Mexico D.F.

2.1 Growth performance

The culture was initiated with 162 fingerlings (TL 5.2±0.57cm and TW 1.5±0.42g) of *P. splendida* proceeding from Tabasco State, Mexico. Fry were introduced in a recirculation 5,000-L circular-tank (54 org/m^3). The duration of the experiment was 330 days. Water recirculation was maintained 24 hours a day with a Dolphin PA-2500 submergible ¼ hp pump connected to two 19-L biofilters. The pump maintained a constant water flow of 13 L/min with an entire change of water every four hours. Water quality was maintained throughout the experimental period as follow: water temperature 28.8±1.9ºC, dissolved oxygen 6.1±0.49mg/L, pH 6.9±0.2, nitrite 0.4±0.21mg/L, nitrate 7.7±3.38mg/L and total ammonia nitrogen 0.01±0.0mg/L.

The Tenguayaca were fed with rainbow trout commercial food containing 42% of crude protein; 16% of lipids; 5% of fibre and 11% ashes (El Pedregal, Silver Cup, Toluca, Mexico). At the beginning of the experiment 8% of the total biomass of food was subministered in two rations (10:00 and 16:00h) and after that, food quantity was adjusted to 4%. Every thirty days and throughout the entire experiment the total weight (TW) in grams were registered with a digital balance Ohaus, model Adventure (Ohaus, Co., Pine Brook, New Jersey, USA) with a precision of 0.05g, and total length (TL) in centimetres with an graduated ichthyometer in centimetres and millimetres.

The growth performance indicators were calculated according to Hashim *et al*. (2002), as follow: days of culture; average initial total weight (g); average final total weight (g); gain of average total weight (g), daily growth of total weight (g/day); average initial total length (cm); average final total length (cm), gain of average total length (cm); daily growth of total length (cm/day); yield (kg/m^3); specific growth rate (SGR, %/day); relative growth rate (RGR, %), condition factor (CF) and feed conversion ratio (FCR).

2.2. Breeding

Eight males and eight females of twelve months of age and selected from the founder population were introduced in a 5,000-L circular tank connected to a recirculation aquaculture system. At the time of introduction females had a total weight (TW) of 55.1±9.54g and a total length (TL) of 18.6±2.59cm and the males 53.9±14.16g and 18.7±4.81cm respectively, maintaining a relationship 1:1 male: female. Brooders were fed daily with 2% of the total biomass during the experimental period using the same commercial food utilized in founder culture and divided in two rations (10:00 and 16:00h). The experiment had duration of one year. Water quality parameters in this tank were maintained as follow: water temperature 28.3±1.4ºC, dissolved oxygen 6.2±0.76mg/L, pH 8.1±0.1, nitrite 0.1±0.14mg/L, nitrate 6.7±12.3mg/L and total ammonia nitrogen 0.06 ± 0.57mg/L.

Throughout the experimental period, the number of spawns per female, total number of fingerlings, and survival rate were registered, also, the following performance indicators: a) average total weight of females (g), b) average total length of female (cm); c) average total weight of male (g); h) average total length of male (cm); i) average production of fingerlings per female; j) total fingerlings production per female every fifteen days; k) total production of fingerlings; l) average total weight of fingerlings (m); average total length of fingerlings (cm); n) total consumed food per brooder and o) cost of food per brooder per year.

2.3 Statistical analysis

Data were emptied in an Excel spreadsheet (Microsoft Office 2003). The dispersion and central tendency statistics were calculated, as well as the coefficient of variation (CV = SD/M x 100, were: SD = standard deviation and m = mean). With the same software the growth curves, weight-length linear correlation and number of spawns *vs*. number of eggs were plotted. Graphs of frequency of number of observations *versus* total weight of brooders were realized with the Statistica Software, version 10 (Statsoft Inc. Tulsa, Oakland, USA).

3.0 Results

3.1 Growth performance

The monthly average values of total weight (TW) and total length (TL) of the founder population throughout the 330 days of culture are shown in Figure 1. The weight-length correlation is showed in Figure 2. The cultured Tenguayaca exhibited an alometric growth with a b value of 2.82 and a high correlation coefficient (97.6%). The growth performance indicators of the founder populations are shown in Table 1.

Sex determination was possible at the sixth month of culture according to the external morphology of the gonopore (Fig. 3), yielding at the end of the culture period a sex ratio of 2: 1 (female: male).

3.2 Breeding

At the time of the introduction in the brooders-tank, males had an average total weight (TW) of 56.5±8.6g and a total length (TL) of 20.4±2.0cm, and the females 55.1±9.5g of TW and 18.6±2.6cm of TL, respectively.

The reproductive performance indicators registered in brooders-tank along the year of culturing are shown in table 2. Data indicated the pertinence of the management of eight females and eight males in 5,000-L circular-tanks with a density of 5 brooders/m^3. A total of 11 spawns were registered in one year with a total production of 6,840 eggs (Fig. 4).

4.0 Discussion

4.1 Growth performance

The Snook Bay *P. splendida* exhibited high adaptation during the experimental time in spite of their high density (54 org/m^3). This fact, demonstrated that they can support high culture densities, accepted rainbow trout food and not problems were detected for adaptation to the recirculation system. During this neither time the Tenguayaca not exhibited aggressive or cannibalism behaviours, and indicated a high survival rate (near of 100%). The fishes showed a conspicuous tendency to gain weight and length along the experimental period; however, they gained more weight than length, maintaining an alometric growth. The male reached slightly more weight than female. There is a consensus for the optimum conditions of water quality for *P. splendida.* Some authors indicate that the species have thermal preferences from 30.7 to 31.9ºC (García, 2003), similar to other Neotropical Cichlids as *C. urophthalmus*, for which an optimum range from 28 to 33ºC is reported (Caso-Chávez, Yañez-Arancibia & Lara-Domínguez, 1986; Martinez-Palacios, Chavez-Sanchez & Ross, 1996). Stauffer and Boltz (1994), reported a lethal temperature at 38 ºC with a preference of 32.8ºC. For the species *Vieja synspila* the breeding temperature is between 26 and 31ºC (Páramo-Delgadillo, 1984). Cochran (2008) reported the average values of water quality in natural conditions for several native Cichlids, among them, *P. splendida*, in the high basin of the Bladen River in Belize. He reported a water temperature of 24.1ºC, pH of 7.6, conductivity of 222µmos/cm; salinity 0.1g/L and dissolved oxygen of 7.6mg/L. These data suggest that the thermal preferences of *P. splendida* are similar to those of other Neotropical Cichlids. During the present experiments average water temperature was maintained up 28ºC obtaining excellent growth, higher survival and reproduction. Unfortunately, we do not have data on sub lethal or lethal limits of physic-chemical parameters in order to discuss the results obtained in the present research; moreover the average values of the main physic-chemical parameters registered in the recirculation aquaculture system permitted the culture of the Tenguayaca was in optimum conditions, as data demonstrated.

Although the food requirements for the species have not been established, the results of the present study indicate that the commercial food utilized in this work can maintain the species under controlled conditions. Empirical experiences indicate that in order to obtain the best growth in the species, 41.4 and 45.3% of crude protein is required. Thus, rainbow trout food with high level of protein (between 40 and 50%) can be used for culturing Tenguayaca without problem such as was evident in this work. However, it is necessary to conduct future studies focusing in the nutritional requirements of *P. splendida* under control conditions in order to improve their growth rate.

The growth rate of *P. splendida* registered in this research should be considered low in comparison to that reported for other cultured Cichlid species, such as tilapia *(Oreochromis spp.*). For instance, in the same period of time and in higher densities, tilapia can reach up to 800g, in contrast, *P. splendida* in a period of fourteen months of culture reached only up to 100 g in recirculating aquaculture systems and in densities of 50 org/m^3. Furthermore, comparisons of growth performance indicators among native Cichlids are not feasible, mainly because their culture practices have empirical bases and there are no databases available.

Management of Mexican Cichlids involve the application of traditional knowledge of the natural resource and the ecosystem, which have the bases of using primitive techniques of low cost and effort to obtain animal protein for human consumption (Barrientos-Medina & Chumba-Segura, 2007). Recently, Pérez-Sánchez and Páramo-Delgadillo (2008) reported the establishment of an aquaculture production recirculation system for Cichlids, and mentioned that the scale of production varies according to the needs of the producers, weather it is a family and multi-family recirculation aquaculture system was designed by Trasviña-Moreno and Cervantes-Trujano (2006) to obtain a production of 60 kg/m^3, but these authors did not mention the previous experiences realized with Mexican Cichlids and neither present precise data to confirm this asseveration, moreover this information is confuse because did not indicate if such yield belong to tilapia.

The growth performance indicators obtained in this experiment indicated a small daily gain of total weight and total length during the 330 days of culture (0.1g and 0.03cm respectively) in comparison to other Cichlid species such as Nile tilapia *Oreochromis niloticus* cultured in a density of 75 fish/m^3 in only 63 days, and also in recirculation aquaculture system, they showed a daily growth of 0.4g/day, a threefold than in Tenguayaca. Nonetheless, the result obtained in this research demonstrated the feasibility of culturing this species in recirculation aquaculture systems; although in these conditions they require of more than sixteen months to reach commercial sizes (up to 300g).

4.2 Breeding

Earlier reports indicate that *P. splendida* is able to reproduce all year around, reaching a mean fecundity of 2,400 eggs per female, and with a spawning season starting in March with a peak during the months of June and July. Under laboratory conditions, the reproductive period begins in mid-March and concludes at the end of October. However, the reproductive cycle can be manipulated using photothermal control and a 13 h light cycle to enable out-of-season spawning. A production of 120,000 fingerlings can be obtained in only four months from 10 couples with females of a minimum weight of 300g and fed with live feed (Pérez-Sanchez & Páramo-Delgadillo, 2008). This information indicates a high reproductive potential of the species under control conditions and their easy adaptation to culture systems, reinforcing the importance of promote their culture to maintain and preserve natural populations, which at the present times are submitted to strong anthropocentric pressures. In the present study, the management of five brooders per cubic meters showed the possibility of produce more tan 6,000 fingerlings with a normal photothermical conditions in one-year utilizing eight couples. Although this results are far away from those reported by Pérez-Sanchez and Páramo-Delgadillo (2008), it is important to point out that the culture conditions were different in each case, for instance, whereas they produced in the local natural conditions in Tabasco, State (20 meters above sea level), our results, in contrast, are reached at 2,000 meters above sea level, in México City. Thus, making impossible a reliable comparison, hence, contrasting differences in results can obey to several conditions related to aspects such as, the weather conditions, type of feed, density, size of tanks, size of brooders, and the culture systems.

5.0 Conclusions

The experiments demonstrated the feasibility of culture of this species in recirculation aquaculture systems and offer an alternative to produce fry for conservation and/or repopulation purposes.

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Table 1. Growth performance indicators of founder population of *P. splendida*.

Growth performance indicators	Value
Days of culture	330
Number of females	107
Number of males	55
Average initial total weight (g)	1.5
Average final total weight (g)	38.7
Gain of total weight (g)	37.2
Daily growth (g/day)	0.112
Average initial total length (cm)	5.2
Average final total length (cm)	15.8
Gain of total length (cm)	10.6
Daily growth (cm/day)	0.032
Yield (kg/m^3)	2
Specific growth rate (SGR, %/dia)	0.98
Relative growth rate (RGR, %)	3,779
Condition factor (FC, %)	0.98
Feed conversion ratio (FCR)	2.2

Table 2. Breeding performance indicators.

Indicators	Value
Water volume (m^3)	5
Relationship male: female	8:8
Average total weight of females (g)	55.0
Average total length of females (cm)	18.6
Average total weight of males (g)	56.5
Average total length of males (cm)	20.4
Average production of fingerling per female	855
Total production of fingerlings	6,840
Average production of fingerling every 15 days	285
Average total weight of fingerling (g)	0.05
Average total length of fingerling (mm)	0.5
Monthly food consumed per brooder (g)	20.6
Cost of food per brooder per year USD	25 cents

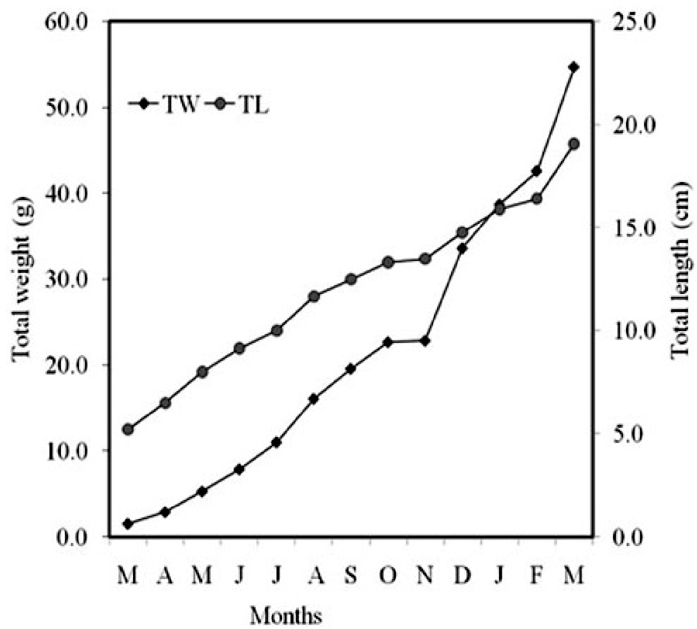

Fig. 1. Growth in total weight (TW) and total length (TL) of the founder population during the culturing period.

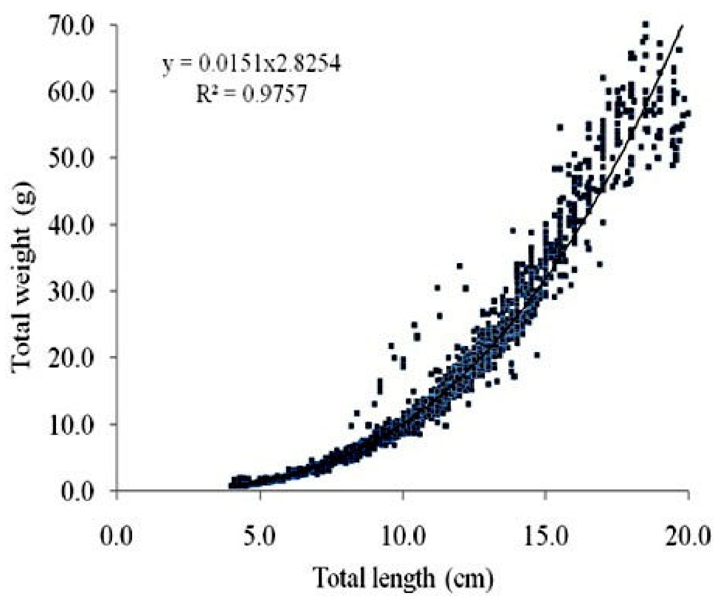

Fig. 2. Weigth-Length correlation of the founder population of Tenguayaca *P. splendida*.

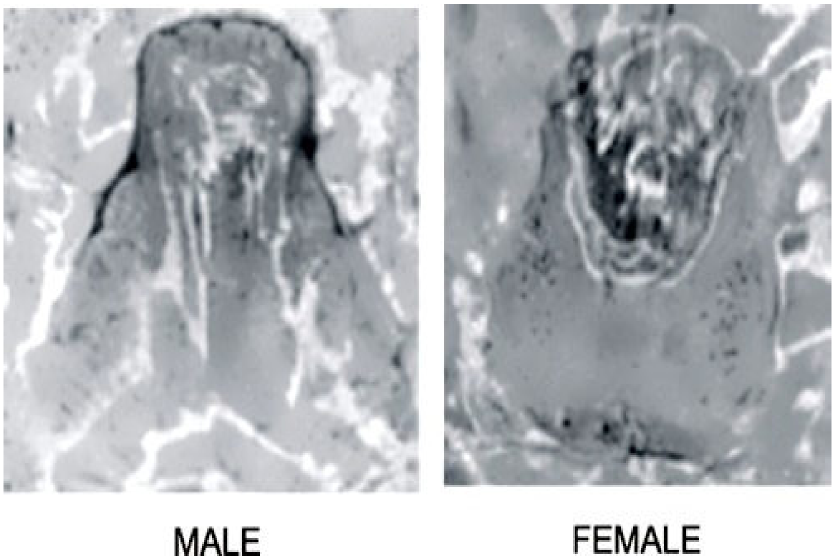

Fig. 3. Photography of the differential characteristics of the gonopore of a male and a female of *P. splendida*. Left a male and right a female.

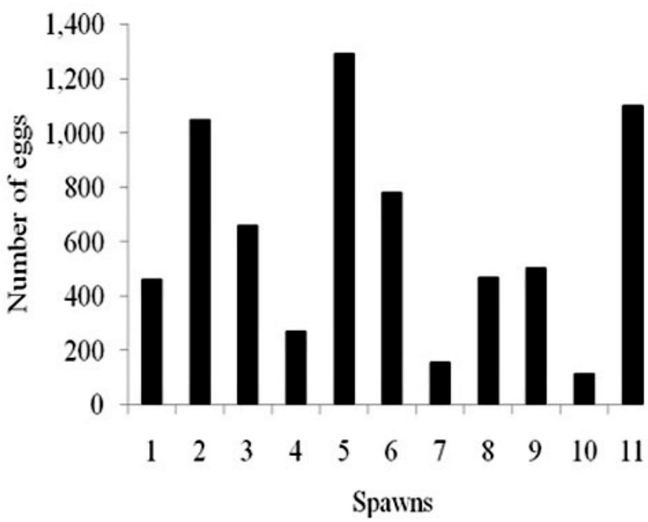

Fig. 4. Number of spawns and eggs produced in one year in 5,000-L brooder-tank.