BATCH FERTILITY AND LARVAL PARAMETERS 
OF THE JAGUAR CICHLID (Cichlasoma managuense) 
SPAWNED IN THE LABORATORY

Jorge Günther Norell and Jorge Boza Abaurrea
Escuela de Ciencias Biológicas, Universidad Nacional
Herradura, Costa Rica

ABSTRACT
Batch fertility and larval parameters of 32 spawns of the jaguar cichlid (Cichlasoma managuense) in the laboratory were analyzed. Batch fertility was positively correlated with the female weight with spawns between about 3000 to 6000 larvae for females between 100 and 500 g wet weight. No significant correlation was found between larval parameters (fresh weight and % dry weight) and female weight.

RESUMEN
Se analizaron la fertilidad por puesta y los parámetros larvales de 32 puestas de guapote tigre (Cichlasoma managuense) en el laboratorio. Se demuestra una correlación positiva entre la fertilidad por puesta y el peso de la hembra, con puestas entre aproximadamente 3000 y 6000 larvas para hembras entre 100 y 500 g peso. No se encontró correlación significativa entre los parámetros larvais (peso fresco y % peso seco) el peso de las hembres.

INTRODUCTION
While most fish species used in aquaculture in Central America have been introduced from other parts of the World (Martinez-Palacios and Ross 1992), there is a growing interest in studying indigenous fishes with aquaculture potential (Martinez-Palacios et al. 1993). The jaguar cichlid (guapote tigre, Cichlasoma managuense) is a Central American piscivorous cichlid (Vella 1982, Busching 1987) widely used to control recruitment of tilapia in ponds (Dunsheet and Hayne 1978, Teichert-Coddington 1994). Production of guapote fry in large numbers for these purposes has however been reported to be difficult (Teichert-Coddington 1994). In our laboratory, aspects of the culture of the guapote tigre have been studied for several years (Günther 1988, Acosta and Günther 1992, Günther and Galvez 1992, Lezama and Günther 1992, Günther and Boza 1991, Günther et al. 1992) and the larvae are routinely reared. The aim of this paper is to report on the batch fertility (number of fry produced per spawn, Bagenal 1978, Wootton 1990) and larval parameters of Cichlasoma managuense in laboratory conditions.

MATERIALS AND METHODS
Husbandry conditions
About 15 fish (10 females and 5 males), born and raised up in the laboratory, were kept in each of two 2000 liter round tanks with recirculated water. The tanks were divided by incomplete radial partitions which allowed couples to defend their territories more easily. Temperature was kept between 26 and 30°C, with an average of 28°C. Oxygen was above 5 ppm, nitrite below 0.5 ppm. Several females were tagged with nylon threads passed through the dorsal muscle, in order to follow sequential spawns.

Data
In a one year period 32 spawns were obtained.
nal spontaneously. After batching, the larvae were left a couple of days with the parents but taken out as wriggles before they came into the freeswimming stage and transferred to a 200 l aquarium at 28°C. One or two days after freeswimming all the larvae were counted. A batch of about 50 to 100 larvae were weighed individually after gentle blotting on a drying paper. Percentage dry weight was determined after drying for 3 hours at 105°C.

The data were analyzed by regression and correlation analysis on the software STATGRAPHICS 5.0. Twelve spawns out of 32 were not included in the analysis because batching was evidently partial, probably because of fertilization problems.

RESULTS

Behaviour

In the tanks mate choice and spawning were spontaneous. Formation of couples was noticed when fishes (especially the female) began to clean the substrate on the bottom corner of the tank. The formed couples defended with aggressive displays small spawning territories of about 0.25 m². The females defended the territory intensely always near the center, while the males defended a broader range but much less intensely. The majority of the fishes moved away from the spawning sites and closer to water surface. No mortality was recorded because of these aggregations. On occasions 3 or 4 couples were spawning simultaneously in the tanks.

In some instances a male was tending simultaneously 2 females in their respective territories.

Male-female weight relation

Males were always much greater in size than females in formed couples. The weight of both members of the couple was determined on 6 occasions yielding a weight relation male-female of 2.0 ± 0.3 (confidence limit 95%).

Fertility and larval weight

Table 1 reports average, maximum and minimum values for female weight, batch fertility or number of freeswimming larvae, larval wet weight, % larval dry weight and coefficient of variation of larval wet weight.

A correlation analysis was carried out between female weight and batch fertility, larval wet weight, larval % dry weight and coefficient of variation of larval wet weight, taking only the spawns without fungal attacks.

A significant positive correlation was obtained between batch fertility and female weight (r=0.76, P<0.001) and a significant negative correlation between larval variability (coefficient of variation) and larval wet weight (r=-0.83, P<0.0001). Correlations between larval weight and female weight (0.46, P<0.05), % dry weight of larvae and female weight (0.23, P>0.05) and between larval wet weight and % dry weight (0.27, P>0.05) were low and not significant.

Table 1.

Results of the data on reproduction of C. managuense.

<table>
<thead>
<tr>
<th>Female weight (g)</th>
<th>Fertility</th>
<th>Wet weight (mg)</th>
<th>% dry weight</th>
<th>CV larvae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>249 ± 28.5</td>
<td>3200 ± 330</td>
<td>3.49 ± 0.1</td>
<td>18.33 ± 0.5</td>
</tr>
<tr>
<td>Maximum</td>
<td>460</td>
<td>5800</td>
<td>4.29</td>
<td>22.08</td>
</tr>
<tr>
<td>Minimum</td>
<td>80</td>
<td>1115</td>
<td>2.70</td>
<td>13.38</td>
</tr>
</tbody>
</table>

CV: Coefficient of variation of larval wet weight ± standard error (n=30).
Table 2.
Repetitive spawning of female 6.

<table>
<thead>
<tr>
<th>Days between spawns</th>
<th>Weight of female (g)</th>
<th>Batch-Fertility</th>
<th>Larval wet weight (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>405</td>
<td>5580</td>
<td>3.85</td>
</tr>
<tr>
<td>17</td>
<td>388</td>
<td>3843</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>381</td>
<td>4455</td>
<td>3.6</td>
</tr>
<tr>
<td>39*</td>
<td>396</td>
<td>2983*</td>
<td>4.03</td>
</tr>
<tr>
<td>145</td>
<td>431</td>
<td>3882</td>
<td></td>
</tr>
</tbody>
</table>

* Abnormal spawn because of low fertilization.

Figure 1. Relation between batch fertility and female weight in *Cichlasoma nigra*; spawners not considered in the correlation analysis because of fungi attack. Regression line is \( F = 2450 + 7.2^* W \). W: female weight between 100 and 500 g.
Figure 1 shows the fertilities of all 32 batches, plotted against female weight. Black points are spawns invaded by fungi, probably because of low fertilization (see below). The line has been traced through the highest values and gives a measure of the highest batch fertilities attainable between 100 (fertility about 3000) and 500 g (fertility 6000) female weight.

Reproductive spawning

Several females spawned again shortly after loosing the spawn. In one case a tagged female could be followed through 5 consecutive spawns in a period of 222 days (Table 2). After the first spawn this female spawned again with increasing delays of 2.5, 3, and 5.5 weeks. Thereafter it paused about 20 weeks before spawning again. No significant deterioration could be detected in reproductive spawns with respect to fertility or larval weight.

DISCUSSION

An allometric dependence of fecundity from fish size (length or weight) has been repeatedly reported (BAGENAL 1978, WOOTTON 1990). BAGENAL found an average exponent around 3 for the length relation. Because generally fish weight is related to length also with an exponent of 3, the exponent in the relation between fecundity and fish weight must be around unity (WOOTTON 1990). We propose a linear relation between the highest batch fertilities and female weight from 100 to 500 g. It is not clear what happens below 100 g. The relation of fertility to female weight should cut through the X-axis at the lowest possible weight of mature females.

Our observations confirm that the jaguar cichlid, as has been reported for other Cichlasoma species (MARTINEZ-PALACIOS and ROSS 1992, MARTINEZ-PALACIOS et al. 1993, TOWNSHEND and WOOTTON 1984) must be considered a multiple spawner. SANCHEZ (1974) cited in DUNSETH and BAYNE (1978) reports for C. managuense a mean spawning frequency of 43 days. One of our marked females spawned 4 times in 77 days, that is with a mean interspawn interval of about 25 days. Frequency of spawning depends however strongly on female condition (TOWNSHEND and WOOTTON 1984).

The hatching percentage of spawned ova was not assessed in our spawn. Partial fertilization could be recognized because unfertilized ova became rapidly covered with fungi after eclosion of the remaining eggs. Those spawns (12 out of 32) were not included in the correlation analysis. In the remaining spawns, fungal attack was very low making a high hatching percentage probable. DUNSETH and BAYNE (1978) report for C. managuense hatching percentages of over 90% in aquarium spawns. No significant correlation could be found between larval parameters and female weight. A positive correlation between female weight and larval wet weight was significant only at the 90% level. In two species of Cichlasoma BRENNER and RIMA (1990) found a definitive correlation between female age and the dry weight of ova. Some authors (TOWNSHEND and WOOTTON 1984, WOOTTON 1990) have demonstrated significant relations between food level, fecundity, size of ova and interspawn interval. In our experiment the Cm. spawners were fed approximately ad libitum, with no close control of feeding amounts. The variability of spawns with high hatching percentage could also be due to fatigue of females at reproductive spawning. These variables could therefore mask the relations between larval parameters and female size.

The prolific nature of the jaguar guppy has been stressed upon by RIEDEL (1965, cited in VILLA 1982) which reported a total fecundity of 15000 to 16000 ova in 180 g females. In multiple spawners, however, batch or spawn fecundity is obviously lower (BAGENAL 1978, WOOTTON 1990). SANCHEZ (1974, quoted in DUNSETH and BAYNE 1978) reports fertilities of 1500 to 2000 fry in rather small females of 14 to 16 cm. MARTINEZ-PALACIOS (1991) quote DUNSETH and BAYNE (1978) with an absolute fertility of 6000 to 9000 mature ova in the jaguar cichlid, but this statement is wrong, since DUNSETH and BAYNE (1978) report this as the fry production during 3 to 5 consecutive spawns, in coincidence with the data of SANCHEZ (1974). These fertilities compare well with our data in the lower range of female weight. Considering the highest fertilities obtained in this study, the jaguar guppy, with more than 5000 fry per spawn in 400 g females, shows indeed one of the highest fertilities among the Cichlasoma species (MARTINEZ-
PALACIOS et al. (1993), similar to the fecundity reported for Cichlasoma argentinae (MARTINEZ-PALACIOS and ROSS 1992). When compared with the wet weight of larvae of most marine and freshwater fishes (JOHNS and HOUDE 1986) the larvae of C. m. appear to be of relative big size, and similar to those of some tilapia species (Oreosornia macronemestrilis 3 mg, O. niloticus 11 mg, RANA, 1990) recalculated.

REFERENCES


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