UNICIENCIA 11
pp. 37-41
1994

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

Jorge Günther Nonell and Jorge Boza Abarca
Escuela de Ciencias Biológicas. Universidad Nacional
Heredia, Costa Rica
(Recibido: 6 octubre 1994/Aceptado: 6 mayo 1995)

ABSTRACT

Batch fertility and larval parameters of 32 spawns of the jaguar guapote (*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 larvales (peso fresco y % peso seco) y el peso de las hembras.

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 guapote (guapote tigre, *Cichlasoma managuense*) is a Central American piscivorous cichlid (VILLA 1982, BUSSING 1987) widely used to control recruitment of tilapia in ponds (DUNSETH and BAYNE 1978, TEICHERT-CODDINGTON 1994). Production of guapote fingerlings 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 obtai-

ned spontaneously. After hatching, the larvae were left a couple of days with the parents but taken out as wrigglers 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 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 hatching 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 m^2. The females defended the territory intensely always near the center, while the males defended a broader range but much less intensely. The remainder of the fishes moved away from the spawning sites and closer to water surface. No mortality was recorded because of these aggressions. 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 then 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 fungi attacks.

A significant positive correlation was obtained between batch fertility and female weight ($r=0.76, P\leq 0.001$) and a significant negative correlation between larval variability (coefficient of variation) and larval wet weight ($r=-0.83$, $P\leq 0.0001$). Correlations between larval weight and female weight (0.46, $P\leq 0.09$), % dry weight of larvae and female weight (0.23, $P\leq 0.41$) and between larval wet weight and % dry weight (0.27, $P\leq 0.33$) were low and not significant.

Table 1.

Results of the data on reproduction of *C. managuense.*

	Female weight (g)	Fertility	Wet weight (mg)	% dry weight	CV larvae
Average	249 ± 28.5	3200 ± 338	3.49 ± 0.1	18.33 ± 0.5	9.2 ± 0.4
Maximum	460	5800	4.29	22.08	12.0
Minimum	80	1115	2.70	13.38	6.1

CV: Coefficient of variation of larval wet weight.
± standard error (n = 20).

Table 2.

Repetitive spawning of female 6.

Days between spawns	Weight of female (g)	Batch-Fertility	Larval wet weight (mg)
1	405	5580	3.85
17	388	3843	
21	381	4455	3.6
39*	396	2983*	4.03
145	431	3582	

* abnormal spawn because of low fertilization.

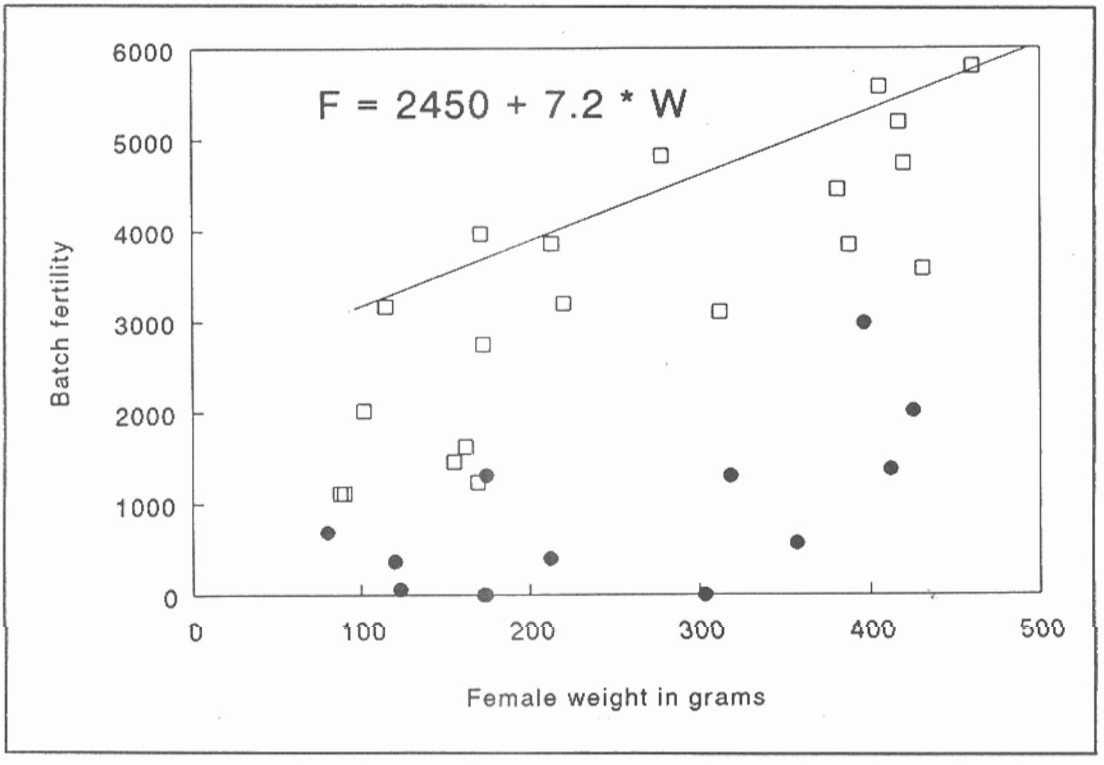

Figure 1. Relation between batch fertility and female weight in *Cichlasoma managuense*. Black circles: spawns not considered in the correlation analysis because of fungi attack. Regression line is F= 2450 + 7.2* W. W: female weight between 100 and 500 g.

Figure 1 shows the fertilities of all 32 batches, plotted against female weight. Black points are spawns invaded by fungi, probable 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.

Repetitive 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 repetitive spawnings 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 finds 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 spawns. 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, fungi 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 spawnings.

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 tilapia RANA (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 feeding level, fecundity, size of ova and interspawn interval. In our experiment the *C.m.* 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 repetitive spawning. These variables could therefore mask the relations between larval parameters and female size.

The prolific nature of the jaguar guapote 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 *et al.* (1993) quote DUNSETH and BAYNE (1978) with an absolute fertility of 6000 to 9000 mature ova in the jaguar cichlid, but this quotation is wrong, since DUNSETH and BAYNE (1978) report this as the fry production during 3 to 4 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 guapote, with more then 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 urophthalmus* (MARTINEZ-PALACIOS and ROSS 1992).

When compared with the wet weight of larvae of most marine and freshwater fishes (JONES and HOUDE 1986) the larvae of *C.m.* appear to be of relative big size, and similar to those of some tilapia species (*Oreochromis mossambicus* 3 mg, *O. niloticus* 11 mg, RANA 1990, recalculated). As happens with the larvae of tilapia, the larvae of *Cichlasoma managuense* are thus well adapted to survive longer periods of time on their yolk reserves.

ACKNOWLEDGMENTS

This work was supported in part by the programme UNA-LUW, between the Universidad Nacional, Heredia and the Agriculture University of Wageningen, Holland.

REFERENCES

Acosta-Nassar, M. and J. Günther. 1992. Growth of jaguar cichlid (*Cichlasoma managuense*) juveniles at different oxygen levels. UNICIENCIA, 9:3-5.

Bagenal, T.B. 1978. Aspects of fish fecundity. In: the Ecology of Freshwater Fish Production, S.D. Gerking, Ed., pp. 75-101.

Bussing, William A. 1987. Peces de las aguas continentales de Costa Rica. Ed. Universidad de Costa Rica, San José, 270 pp.

Dunseth, D.R. and D.R. Bayne. 1978. Recruitment control and production of *Tilapia aurea* (Steindachner) with the predator, *Cichlasoma managuense* (Günther). Aquaculture, 14:383-390.

Günther Nonell, Jorge and Jorge Boza-Abarca. 1991. Intensive rearing of juveniles of *Cichlasoma managuense* (Günther 1869) in recirculated systems. UNICIENCIA, 8:3-10.

Günther, J. and N. Gálvez. 1992. The effect of high densities on the growth of the jaguar cichlid *Cichlasoma managuense*, juveniles. UNICIENCIA, 9:33-39.

Günther, Jorge. 1988. Desarrollo del comportamiento agresivo del guapote tigre (*Cichlasoma managuense*, Cichlidae) en relación con el crecimiento y la coloración de juveniles en cultivo intensivo. UNICIENCIA, 5:3-21.

Günther, J., N. Gálvez-Hidalgo, J. Ulloa-Rojas, J. Coppoolse and J. Verreth. 1992. The effect of feeding level on growth and survival of jaguar guapote (*Cichlasoma managuense*) larvae fed Artemia nauplii. Aquaculture, 107:347-358.

Jones, A. and E.D. Houde. 1986. Mass rearing of fish fry for aquaculture. In: Realism in Aquaculture - Achievements, Constraints, Perspectives. M. Bilio, H. Rosenthal and C.J. Sinderman, Eds. European Aquaculture Society, pp. 351-373.

Lezama F., Edwin and Jorge Günther N. 1992. The routine metabolism of the guapote, *Cichlasoma managuense* (Günther 1869), related to body weight and temperature. Journal of Fish Biology, 41:373-380.

Martínez-Palacios, C.A., Cristina Chávez Sánchez y Miguel A. Olvera Novoa. 1993. The potential for culture of the American cichlidae with emphasis on *Cichlasoma urophthalmus*. In: Recent Advances in Aquaculture IV, J.F. Muir and R.J. Roberts, Eds., pp. 193-232. Blackwell Scientific Publications, Oxford.

Martínez-Palacios, C.A. and L.G. Ross. 1992. The reproductive biology and growth of the Central American cichlid *Cichlasoma urophthalmus* (Günther). J. Appl. Ichthyol., 8:99-109.

Rana, K.J. 1990. The influence of maternal age and delayed initial feeding on the survival and growth of previously unfed *O. niloticus* (L.) and *O. mossambicus* (Peters) fry. Aquaculture, 91:295-310.

Teichert-Coddington, David. 1994. Development of production technologies for semi-intensive fishfarming during the past decade in Central America. In: Investigación acuícola (Acuacultura y Pesca) en Centroamérica. J. Günther and K. Kleijn (Eds.). Universidad Nacional. Costa Rica.

Townshend, T.J. and R.J. Wootton. 1984. Effects of food supply on the reproduction of the convict cichlid, *Cichlasoma nigrofasciatum*. J. Fish Biology, 24:91-104.

Villa, Jaime. 1982. Peces nicaragüenses de agua dulce. Fondo de Promoción Cultural, Banco de América, 252 pp.

Wootton, Robert J. 1990. Ecology of Teleost Fishes. Chapman and Hall, London, 404 pp.