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Fecundity of the *Hypostomus affinis* (Siluriformes, Loricariidae) in the Lajes Reservoir, Rio de Janeiro, Brazil

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Abstract: The armored catfish *Hypostomus affinis* is a widespread Loricariidae fish in the Lajes Reservoir (22°42'–22°50' S; 43°53'–44°05' W), the largest lentic environment in the Rio de Janeiro State, but little is known about their reproductive biology. One hundred and twenty five females, captured from January 1996 to December 1997, were used to assess ovarian development (29 were used to determine fecundity). The oocyte distribution by size-diameter classes revealed the occurrence of two modes suggesting an asynchronous development of the ovaries. The total fecundity ranged from 1235 to 4304, averaging 2374. An exponential relationship between fecundity and total length was determined, and a direct linear relationship was found between fecundity and total weight and gonad weight.

Key words: Fecundity, reservoir, Loricariidae, *Hypostomus*, reproductive biology, spawning.

The family Loricariidae includes species of fish commonly known as armored catfishes, that are characterized for having the body covered by bony plates, inferior mouth and developed lips (Nelson 1994). They are one of the most numerous groups of neotropical siluriformes fish, with about 600 recognized species. Its geographical distribution ranges from South America to Central America (Fowler 1954). Regan (1904) reported the occurrence of *Hypostomus affinis* Steindachner, 1886 in Paraíba do Sul river, in Southeast Brazil, where Lajes Reservoir is located. Oliveira and Silva *et al.* (1986) cited this species as a widespread fish in Lajes Reservoir. Mazzoni and Caramaschi (1995a) described patterns of temporal and spatial distribution of *H. affinis* in the lower reaches of the Paraíba do Sul river.

Studies on the reproductive biology of *H. affinis* in the Lajes reservoir are uncommon. On the other hand, there are several reports on

the reproductive biology for loricariid fishes in other areas in Southeast Brazil, such as Menezes (1949), Antoniutti *et al.* (1985), Barbieri and Santos (1987), Barbieri and Verani (1987), Bazzoli and Rizzo (1990), Caramaschi (1994), Agostinho and Gomes (1997), Benedito-Cecilio *et al.* (1997), Castro (1997), Alves *et al.* (1998). The reproductive biology of *H. affinis* in the lower reaches of the Paraíba do Sul river was studied by Mazzoni and Caramaschi (1995a, b, 1997) and Mazzoni and Peres-Neto (1994). Studies on fish fecundity are important to evaluate the reproductive potential of the species, allowing inferences about the behavior of these populations (Vazzoler 1996).

The present work aims to contribute to the knowledge of the reproductive biology of the armored catfish, by determining the type of ovarian development, the fecundity and its relationship to total length, total weight and gonad weight.

MATERIALS AND METHODS

The Lajes Reservoir (22°42'-22°50' S; 43°53'-44°05' W) is the largest water impoundment in Rio de Janeiro State, and is located in the municipalities of Barra of Piraí and Rio Claro, State of Rio de Janeiro. It has an area of approximately 30 km², and is 415 m above sea level. The water has an excellent quality, with no influences of antropic activities (Barroso 1989).

One hundred and twenty five females, captured from January 1996 to December 1997, were examined. Each fish was weighed (precision 0.1 g) and measured (precision 1 mm). Gonads were weighed (precision 0.01 g) after dissection.

The diameter of the oocytes in the different maturation stages were measured in a stereomicroscope fitted with an ocular micrometer (precision 0.1 mm). The ovaries were kept in Gilson's solution (Simpson 1951), in order to disperse the oocytes; then, they were transferred to 70% alcohol.

Five gonadal stages were defined based on macro and microscopic characteristics: immature (1), initial maturation (2a), advanced maturation (2b), partially spawned (4a) and totally spawned (4b). This classification followed Bazzoli and Godinho (1991), and was adapted for this particular species by Duarte (1999). Macroscopic characteristics were defined based on vascular irrigation, size, color and proportion of oocytes per development stages, and rate of abdominal cavity occupied by ovaries. Microscopic observations were based on the presence and predominance of different types of germinative lineage cells (oocytes I, II, III and IV) and on the presence/absence of empty follicles.

Fecundity was determined for 21 females, by counting vitelogenic oocytes (advanced maturation stage - 2b) whose diameter were higher than 2 mm. Relationship between the fecundity and total length, total weight and gonads weight was determined by adjusting the regression that better fitted to dispersion of points between the two variables, using the software Origin version 3.5.

RESULTS

Gonadal development: The distribution of oocyte diameter frequency in different maturation stages showed a very defined pattern (Fig. 1). Reserve oocyte stock showed diameter inferior to 1.0 mm and peaked at 0.3 mm. Advanced maturation (2b) and partially spawned (4a) stages presented numerous vitelogenic oocytes, whose diameter varied from 2.0 to 3.0 mm. These oocytes were absent in the totally spawned (4b) stage. Therefore, the analysis of the oocyte diameter distribution, plus the histological observations described by Duarte (1999), have indicated that *H. affinis* spawns in batches with asynchronic ovaries development.

Fecundity: Fecundity ranged from 1235 to 4304 oocytes, with an average of 2374 oocytes, and a standard deviation of 183.9. The relationship between the fecundity and the total length was exponential and it was expressed by the equation: Fecundity (Fec) = Total length (L)^b, that was determined by ordinary least square regression on logarithmized data: $y = a + bx$ (Table 1). Linear and exponential

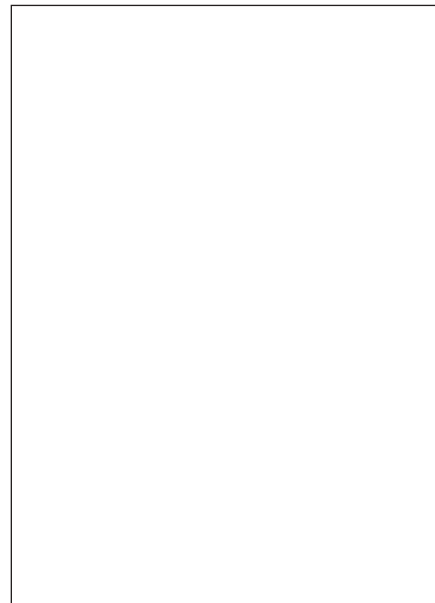


Fig. 1. Distribution of oocytes diameter frequency of *Hypostomus affinis*, in different stages of the ovary development.

regressions were: $\ln \text{Fec} = 1.95 + 1.64 * \ln L_t$; and $\text{Fec} = 7.04 L_t^{1.64}$.

Relationships between fecundity and total weight, and fecundity and ovaries weight were linear (Table 1). The equations that relate these parameters are the following: $\text{Fec} = 1110.4 + 3.5 * W_t$ ($r = 0.79$); $\text{Fec} = 1318.9 + 23.8 * W_g$ ($r = 0.60$).

DISCUSSION

The type of spawning in teleosts depends on the ovarian development, the frequency of spawning in the annual cycle and the extent of the reproduction period (Vazzoler 1996). Spawning type can also be indicated by the degree of eggs' adhesiveness (Sato and Godinho 1988), meaning that fishes that liberate free eggs are defined as total spawning, while those that liberate sticker eggs spawn in batches. The development of the oocytes in *H. affinis* is asynchronous, indicating that this species spawns in batches. Duarte (1999) found a wide spawning period for *H. affinis*, according to the variations in the gonadosomatic index (GSI), that peaks in March and April.

The distribution of oocyte-diameter frequency showed a reserve stock in all the maturation stages, but oocytes of larger size were presented only in the initial maturation (2a) and advanced maturation (2b) stages. Mazzoni and Caramaschi (1997) also found that *H. affinis* spawns in batches and that an ovarian asynchronous development for this species occur in the Paraíba do Sul river; they have defi-

ned a more restricted spawning period, ranging from September to February. In the Lajes Reservoir, this species showed a wider spawning period according to Duarte (1999).

Fecundity, defined as the number of vitellogenic oocytes in mature females (Bagenal 1978), was of 2374 oocytes, higher than *H. affinis* in the Paraíba do Sul river - 2350 (Mazzoni and Caramaschi 1997), *Plecostomus ancistroides* - 970 (Nomura *et al.* 1975), *P. hermani* - 132 (Nomura and Mueller 1980), but lower than *P. plecostomus* - 3000 (Azevedo 1938).

Marcet (1974) reported that it was very difficult to distinguish reserve oocytes from those ones that are already in the developing process; a common approach could be the yolk's presence to discriminate the latter ones. Araújo *et al.* (1998) refer to a transition stage from "mature to spawned", which corresponds to the partially spawned in this work (stage 4a).

The number of oocytes that completes the development during the spawn depends on the volume of the abdominal cavity which contains mature ovaries and the size of these oocytes (Vazzoler 1996). Despite the higher fecundity, the population of *H. affinis* is relatively low in Lajes Reservoir, probably due to the small number of available rocky substrate, habitat used by this species. According to Bagenal (1966), fecundity's variations should act as a regulator mechanism of the population, depending on the density, and this relatively high fecundity could be a mechanism to increase eggs and larval survival rate despite lack of adequate substrate.

Fecundity for *H. affinis* showed an exponential relationship with the total length.

TABLE 1
Relationship between fecundity and total length (L_t), total weight (W_t) and ovarian weight (W_g) for *Hypostomus affinis* in Lajes Reservoir, RJ, Brazil

Relationship	N	Ax	A	B	r ²
Fec x L_t	21	25 - 44	-1398.01	110.5137	0.513925
Fec x W_t	21	135 - 780	1110.373	3.523413	0.619463
Fec x W_g	21	14.9 - 90.1	1318.855	23.75957	0.348795

Fec = fecundity; L_t = total length (mm); W_t = total weight (g); W_g = total ovarian weight; n = number of individuals; Ax = amplitude of x (smallest - largest); a = constant of linear regression; b = allometric coefficient; r² = determination coefficient.

However, Mazzoni and Carasmachi (1995a) found a linear relationship between these two parameters, and Nomura and Mueller (1980) also found the same results for *P. hermani*. On the other hand, total weight showed a linear relationship with fecundity, coinciding with the findings for *H. affinis* by Mazzoni and Carasmachi (1995a), *Rhinelepis aspera* (Agostinho *et al.* 1986), and *P. hermani* (Nomura and Mueller 1980).

Hypostomus affinis has presented an asynchronous ovarian development and spawned in batches during a wide reproductive period.

Fecundity varied from 1235 to 4304 oocytes (average = 2374); and showed a significant exponential relationship with total length and a linear relationship with total weight and ovaries weight.

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RESUMEN

O cascudo *Hypostomus affinis* é uma espécie da família Loricariidae de ampla distribuição no Reservatório de Lajes (22°42'-22°50'S e 43°53'-44°05'W -RJ), o maior ambiente de água lenticas do estado do Rio de Janeiro, embora o conhecimento de sua biologia reprodutiva seja ainda escasso. Vinte e uma fêmeas capturadas entre janeiro de 1996 e dezembro de 1997 foram usadas, visando determinar a fecundidade. A distribuição por tamanho dos oocytos revelou a ocorrência de várias modas, sugerindo o desenvolvimento assíncrono dos ovários. A fecundidade total variou de 1235 a 4404, com média de 2374. Foi determinada uma relação exponencial entre fecundidade e comprimento total, e uma relação linear entre fecundidade e peso total, e entre fecundidade e peso das gônadas.

RESUMEN

Hypostomus affinis es un pez Loricariidae ampliamente distribuido en la Reserva Lajes (22°42'-22°50' S; 43°53'-44°05' W), el ambiente léntico más grande en el estado de Rio de Janeiro, pero se conoce poco sobre su biología reproductiva. Se usaron 125 hembras, capturadas desde enero 1996 hasta diciembre 1997, para determinar el desarrollo de los ovarios (29 fueron usadas para determinar fecundidad). La distribución de oocitos por clases de tamaño-diámetro reveló la ocurrencia de dos modos sugiriendo un desarrollo asincrónico de los ovarios. La fecundidad total varió de 1235 a 4304, promediando 2374. Se determinó una relación exponencial entre fecundidad y longitud total, y se encontró una relación lineal directa entre fecundidad y peso total y peso de gónadas.

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