REPRODUCTIVE DYNAMICS OF THE MAIN SPECIES OF FISH IN THE MUNICIPAL RESERVOIR OF SÃO JOSÉ DO RIO PRETO*

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ABSTRACT

The objective of this study was to investigate the reproductive dynamics of fish of the Characidae (*Serrapinnus notomelas, Hemigrammus marginatus, Hyphessobrycon eques, Piabina argentea, Steindachnerina insculpta*) and Poecilidae (*Poecilia reticulata*) families in the Municipal Reservoir of São José do Rio Preto, SP, Brazil. The populational structure was evaluated with regard to sex ratio, classes of length, and the estimate of the mean size of the specimens at first maturation, from February 2002 to January 2003. The sex ratio was similar for *S. notomelas, H. eques and P. argentea*. However, for the other three species, the difference between males and females was higher than 5%. The captured species, with the exception of *P. argentea*, exhibited significant differences between the sexes in the month that follows the rain season. It was also verified that the males of the studied species, with the exception of *P. reticulata*, were predominant in the lower classes of length. For *S. notomelas, H. eques* and *S. insculpta*, the males showed higher values of L_{50} than the females, the opposite of what occurred with the only species of Poecilidae captured, possibly because they are viviparous and keep the embryos in their abdominal cavity.

Key words: Characidae, First Maturation, Populational Structure, Reproductive Dynamics, Reservoir, Poecilidae

ESTRUTURA DA POPULAÇÃO DAS PRINCIPAIS ESPÉCIES DE PEIXES DA REPRESA MUNICIPAL DE SÃO JOSÉ DO RIO PRETO, SP, RIO PRETO, AFLUENTE DO RIO TURVO, DRENAGEM DO RIO GRANDE

RESUMO

O presente trabalho teve como objetivo investigar a dinâmica reprodutiva de peixes das famílias Characidae (*Serrapinnus notomelas, Hemigrammus marginatus, Hyphessobrycon eques, Piabina argentea, Steindachnerina insculpta*) e Poecilidae (*Poecilia reticulata*) da Represa Municipal de São José do Rio Preto, SP, rio Preto. A estrutura populacional foi avaliada quanto à proporção entre os sexos, a classes de comprimento e a estimativa do tamanho médio da primeira maturação, de fevereiro de 2002 a janeiro de 2003. A proporção entre os sexos foi aproximadamente a mesma para *S. notomelas, H. eques* e *P. argentea*, entretanto, para as outras três espécies, a diferença entre machos e fêmeas foi maior que 5%. Todas as espécies capturadas (exceto *P. argentea*), apresentaram diferenças significativas entre machos e fêmeas em pelo menos metade dos meses em que foram coletadas. A maioria apresentou diferença significativa entre machos e fêmeas no mês que precede o período chuvoso. Verificou-se também, que se excetuando *P. reticulata*, os machos das espécies analisadas predominaram nas menores classes de comprimento. Para *S. notomelas*, *H. eques* e *S. insculpta*, os machos apresentaram valores de L_{50} superiores aos das fêmeas, o oposto ocorreu com a única espécie de Poecilidae capturada, que pode ser explicado pelo fato de ser vivípara e necessitar de um maior tamanho para o desenvolvimento dos embriões na cavidade abdominal.

Palavras-chave: Characidae, Estrutura Populacional, Dinâmica Reprodutiva, Primeira Maturação, Poecilidae, Reservatório

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INTRODUCTION

The number of fish species in the world has been estimated at about 32,000, and approximately 25% (about 5,000) of that total inhabits the South American Continent (ROBERTS, 1972; BÖHLKE *et al.*, 1978 and FISHBASE, 2008). Forty-one percent of the species (13,500) live in fresh water, mainly in tropical areas (NELSON, 1984). According to BÖHLKE *et al.* (1978), the number of freshwater fish species in South America was over 5,000 then. Twenty years later, SCHAEFER (1998) increased that estimate to 8,000 species. Only in the state of São Paulo, from about 300 species (LANGEANI, 2001), 166 are present in the basin of the Alto Paraná river (CASTRO and MENEZES, 1998). The ichthyofaunistic composition of the Municipal Reservoir of São José do Rio Preto was recently studied by ANDRADE (2003) and CAMPOS (2005) in two dammed stretches of water located in urban areas subjected to that environmental impact.

ANDRADE (2003) registered 31 species of fish: Characidae (8 spp); Acestrorhynchidae (1); Serrasalmidae (2); Anostomidae (2); Curimatidae (2); Erythrinidae (2); Synbranchidae (1); Gymnotidae (1); Callichthyidae (2); Loricariidae (3); Cichlidae (6) and Poeciliidae (1). Among these species, 20 were constant, staying in the reservoir solely to release their eggs and larvae, and the other six, *Serrapinnus notomelas, Hemigrammus marginatus, Hyphessobrycon eques, Piabina argentea, Steindachnerina insculpta* and *Poecilia reticulata*, were considered resident for presenting the complete cycle in the reservoir.

The flooded areas cease to produce agro-pecuary subsidies, submerge forests and urban areas, among other ecosystems, provoking an environmental imbalance inside the hydric system, interrupting the reproductive cycle of many reophilic fish, modifying areas of spawning and larvae development. The introduction of exotic species is another problem faced by the resident species in a reservoir, because since they do not have a natural predator in the new environment, they may become abundant (BRAGA, 2001). Due to the consecutive damming of rivers, the fish species tend to adapt to the new ecological conditions in order to be able to perform the reproductive cycle satisfactorily (SUZUKI and AGOSTINHO, 1997). In the "Lobo" dam, *Leporinus friderici*, a typical reophilic species (GODOY, 1975), completes all its life cycle in that lentic environment (BARBIERI and GARAVELLO, 1981). In the "Barra Bonita" dam, GENNARI-FILHO and BRAGA (1996) found a few mature individuals of *Astyanax schubarti* when compared to *Astyanax bimaculatus*. As *A. schubarti* performs total spawning, a possible reproductive migration to the tributaries was suggested. In the river Grande, which has successive dams, several species of migratory fish have used the affluents for reproduction (SANTOS and FORMAGIO, 2000). Thus, when an environment becomes modified or unsuitable for the complete development of the life cycle of a species, it must adapt to the new conditions, otherwise it will be eliminated.

The objective of the present study was to evaluate the behavior of these resident species that inhabit the reservoir, regarding the sex ratio, structure in length and the size at the beginning of the first gonad maturation in natural environment, and also to gather information that would allow the fish culture under experimental and commercial conditions. The study of the biology of these species of fish will contribute to a broader knowledge of this ecosystem.

MATERIAL AND METHODS

The reservoir is located in the central region of the town and had its origin from the damming of the Preto river in order to supply water to the population, with a total area of approximately 5 km², maximum depth of 2.5 m and length of 4 Km. It presents a strangulation in its middle section caused by a second dam, dividing the reservoir into two distinct sectors, the old and the new reservoirs (BOZELLI *et al.*, 1992; ANDRADE, 2003).

This present study was based on data obtained with *Serrapinnus notomelas*, (Eigenmann, 1915); *Hemigrammus marginatus* Ellis, 1911; *Hyphessobrycon eques*, (Steindachnerina, 1882); *Piabina argentea* Reinhardt, 1867; *Steindachnerina insculpta* (Fernández-Yépes, 1948) and *Poecilia reticulata* (Peters, 1859) collected monthly from February 2002 to January 2003 (8:00 and 10:00 a.m. at Points 1 and 2, respectively), in the municipal reservoir of São José do Rio Preto, SP (20º 48 ' 31''S and 49º 22' 06''W).

Two points of sampling were established in the new portion of the reservoir, since it is closer to the source of the river, far from the center of the town and therefore more preserved and more suitable for the capture: 1) near the first dam (Point 1) and 2) in the opposite side of the dam, receiving the water directly from the Preto river (Point 2) (Figure 01).

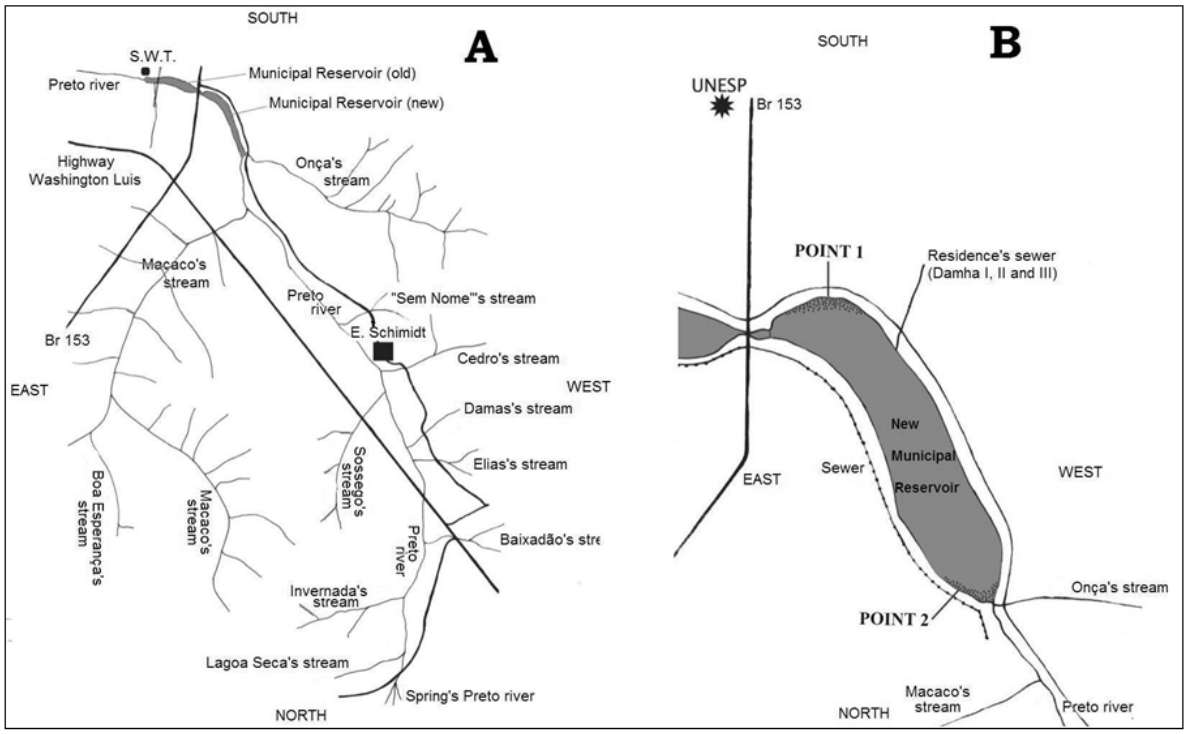

Figure 1: (A) Drainage map of the Preto river ; (B) municipal reservoir of São José do Rio Preto with the two points of collection

In order to obtain representative samples of the population, including specimens of varied lengths, cast nets with different mesh sizes (7.2 x 9.6 mm; 20.9 x 24.3 mm), drag nets (122.7 x 177.2cm), two sieves of different mesh sizes and diameters and a fishing rod with hook were used in the capture.

The period of collection lasted for approximately one hour at each point, always respecting the same time at each point (ANDRADE, 2003). The amount of throws of the cast nets was constant throughout the collection. The areas covered by the drag nets and sieves are crosshatched in the map (Figure 01B). It is important to emphasize that each device was handled by the same person in all the collections. The objective of the collections was to capture specimens of different sizes, stages of maturation and in several different places (embankments, hidden in the riparian and/or floating vegetation). The fish were immediately put into 10% formalin solution for fixation according to ANDRADE (2003).

The fish collected had the standard length (LS) expressed in millimeters. Sex identification was then carried out (VAZZOLER, 1996).

The specimens of each species, considering the two points as one population, were divided in standard length classes to show the size distribution according to the Sturges Formulation (SILVA and SOUZA, 1987).

In order to determine the structure of the population, regarding the sex ratio in the samples per month, total period and standard length classes, the chi-square method was applied (χ^2) to test the possible differences between the proportions obtained.

The frequency distribution of the standard length classes was obtained so as to know the structure of the population regarding the composition in length, considering all the individuals in the total period of collection and for each sex per period.

In order to estimate the mean length from the beginning to the first gonad maturation (L_{50}), males and females were grouped separately in two categories: young (immature gonads) and adults (gonads at all the other stages: initial maturation, intermediate maturation, final maturation and mature) throughout the studied period. The distribution of percent frequency of young and adults per standard length class was obtained and the results were put in graphics. The median, which corresponds to the mean length in which 50% of the individuals initiate the process of gonad maturation, was determined graphically (L_{50}), as well as the

standard length in which all the individuals become adult (L_{100}).

RESULTS AND DISCUSSION

The sex ratio was approximately the same for *Serrapinnus notomelas*, *Hyphessobrycon eques* and *Piabina argentea*, while for the remaining species (*Hemigrammus marginatus*, *Steindachnerina insculpta* and *Poecilia reticulata*), the difference between males and females was higher than 5% (values of $\chi^2 > 3.84$, written with an asterisk, indicate that the difference between males and females in that species was significant, or higher than 5%) (Figure 2).

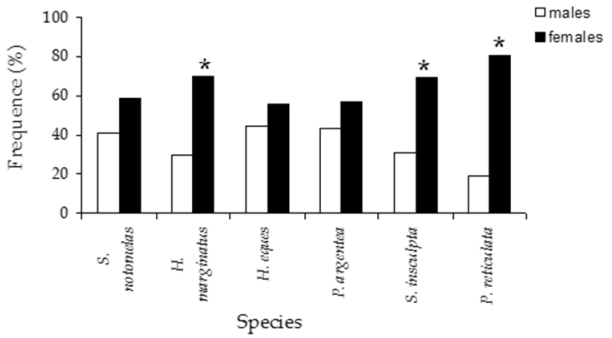

Figure 2: Sex ratio from December/2001 to March/2002 in the municipal reservoir of São José do Rio Preto

The monthly sex ratios are presented in Figure 3. The values of $\chi^2 > 3.84$, written with an asterisk, indicate that the difference between males and females in that month and point was significant, which means that it was higher than 5%.

Five species, *S. notomelas, H. marginatus, H. eques, S. insculpta* and *P. reticulata* (except *P. argentea*) presented significant differences between males and females in at least 50% of the months when they were collected and in April, a month that follows the rain season in the region, which occurs from December to March (Andrade, 2003) (Figure 3).

According to NIKOLSKY (1969), the sex ratio in fish is 50% males and 50% females. However, that relationship may change with regard to the growth rate, behavior or mortality (VAZZOLER, 1996). The individuals collected during the studied period were predominantly females. The same was verified by MARCUCCI (2005) when studying *Loricariichthys platymetopon* in the Capivari reservoir. Differently from our results, NASCIMENTO (2006) attested that 65% of the individuals collected in the Santa Branca reservoir were male. The same was observed by WOOTTON (1998) for species that present external fecundation, moving from one environment to the other, searching for more suitable places for their progeny.

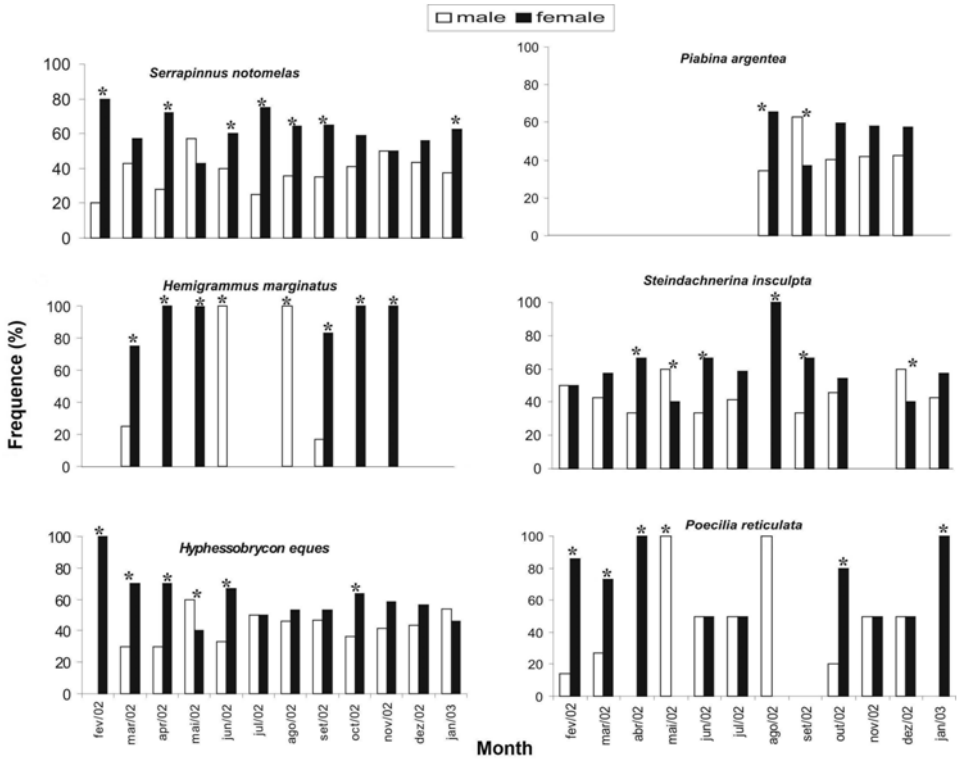

Figure 3: Monthly distribution of males and females in the Points 1 and 2 (*significantive values of χ^2)

Ecologically, the proportion of males to females is not much discussed (MARCUCCI, 2005), and it may occur among populations of the same species, and in different periods inside the same population, but it is usually an adaptation that ensures the predominance of females when the conditions are very favorable to the production of eggs, for example during the colonization of a new environment or when the species suffers intensive fishing (NIKOLSKY, 1963). Commercial capture is not observed in the São José do Rio Preto reservoir, probably due to the presence of a larger number of females so that they can lay their eggs. Furthermore, environmental factors must influence the reproductive cycle of the fish species mentioned above.

Observing the frequency distribution of the occurrence of males and females, it is possible to verify that, with regard to standard length classes, the males predominated in the lower standard length classes in five of the six captured species: *S. notomelas* (10.7 ├ 16.2mm); *H. marginatus* (11.7 ├ 21.8mm); *H. eques* (11.1 ├ 16mm); *P. argentea* (10.9 ├ 22.8mm); *S. insculpta* (17.3 ├ 40.2mm) (Figure 4). On the other hand, Figure 4 shows that the females were predominant in the highest standard length classes. In the case of *P. reticulata* (Figure 4F), the proportion of females was always higher than that of males, and no male specimen was found in the population above 16.00 mm.

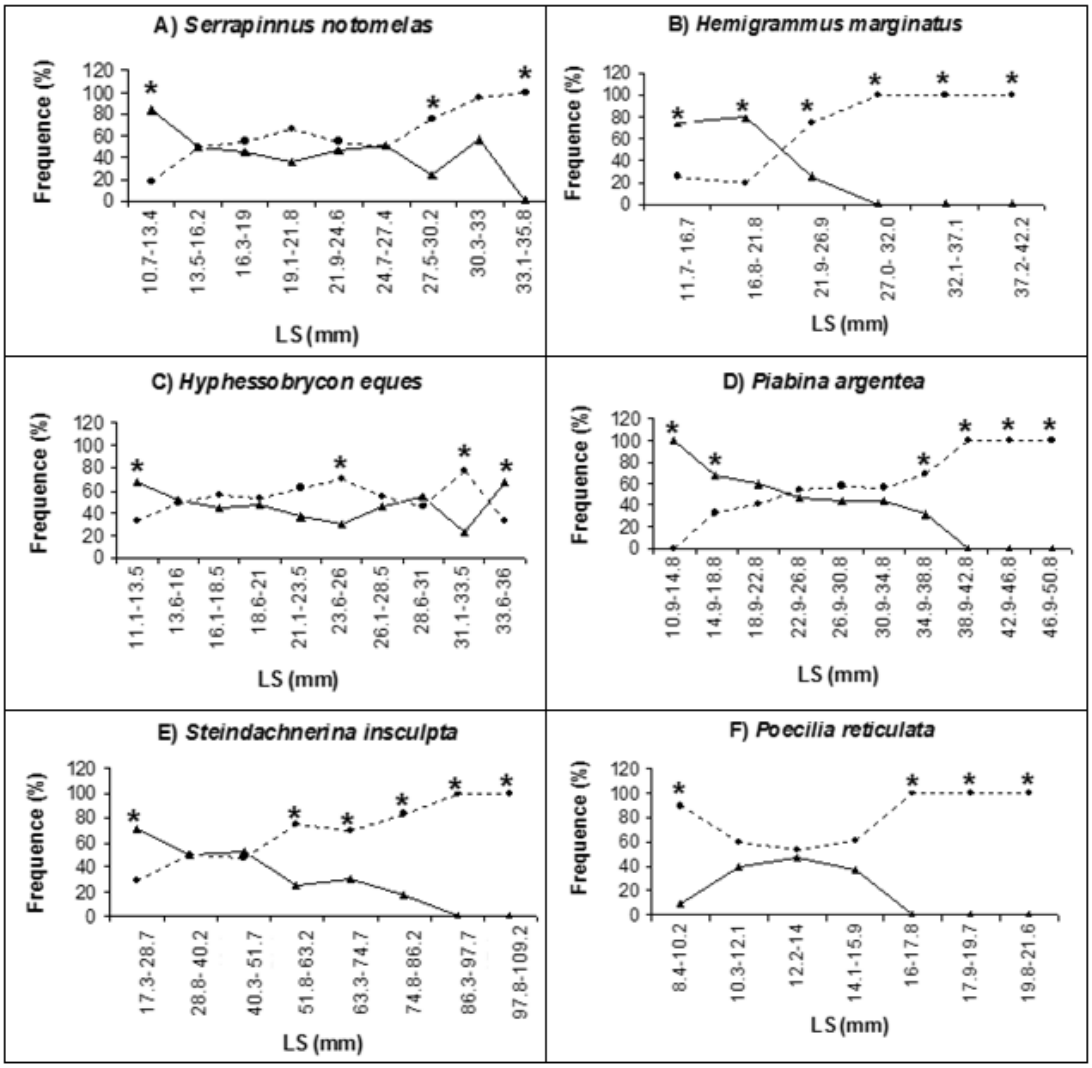

Figure 04: Sex ratio for standard length classes at Points 1 and 2. (*significant values of χ^2)

The variation in body size seems to be generalized among fish, and may be considered as sexual dimorphism, with predominance of females in the higher classes of length, mainly related to the number of eggs (fecundity) (NIKOLSKY, 1963; GROSS and SARGENT, 1985 and LOWE-MCCONNELL, 1999).

NIKOLSKY (1963) reports that the males tend to be larger in fish species that defend their progeny, as can be observed in *Liposarcus anisitsi* (CRUZ and LANGEANI, 2000).

One of the ways to determine how the species explores the environment and performs its life cycle is the knowledge of the length in which the first gonad maturation occurs (ORSI et al., 2002). The L_{50} is explained as being the mean standard length in which 50% of the fish population reach the stage of gonad maturation, or in other words, initiate their reproductive activity. Females may reach gonad maturation before males, vice versa or both sexes reach the maturation in the same length; it depends on the species studied and place.

The graphic analysis showed that males presented higher values of L_{50} than the females in *S. notomelas, H. eques* and *S. insculpta* (Figures 5A, C and E). The opposite occurred in *P. reticulata* (Figure 5F).

In *P. argentea* (Figure 5D), both sexes reach the mean length of the first gonad maturation (L_{50}) at 24.4 mm. However, in the species *H. marginatus* (Figure 5B), mature males were not collected, so the values were estimated only for the females.

VAZZOLER and MENEZES (1992), VAZZOLER (1996) and SUZUKI and AGOSTINHO (1997) explained that the reason why larger females present higher values of L_{50} could be associated to an increased egg production. The case of *P. reticulata* can be explained by the fact that it is viviparous and needs a larger size for the development of the embryos in the abdominal cavity. However, our results (female 11.6 and male 11.2 mm) do not corroborate the ones obtained by DUSSAULT and KRAMER (1981) and NASCIMENTO and TOLEDO (1985), because the values found were lower.

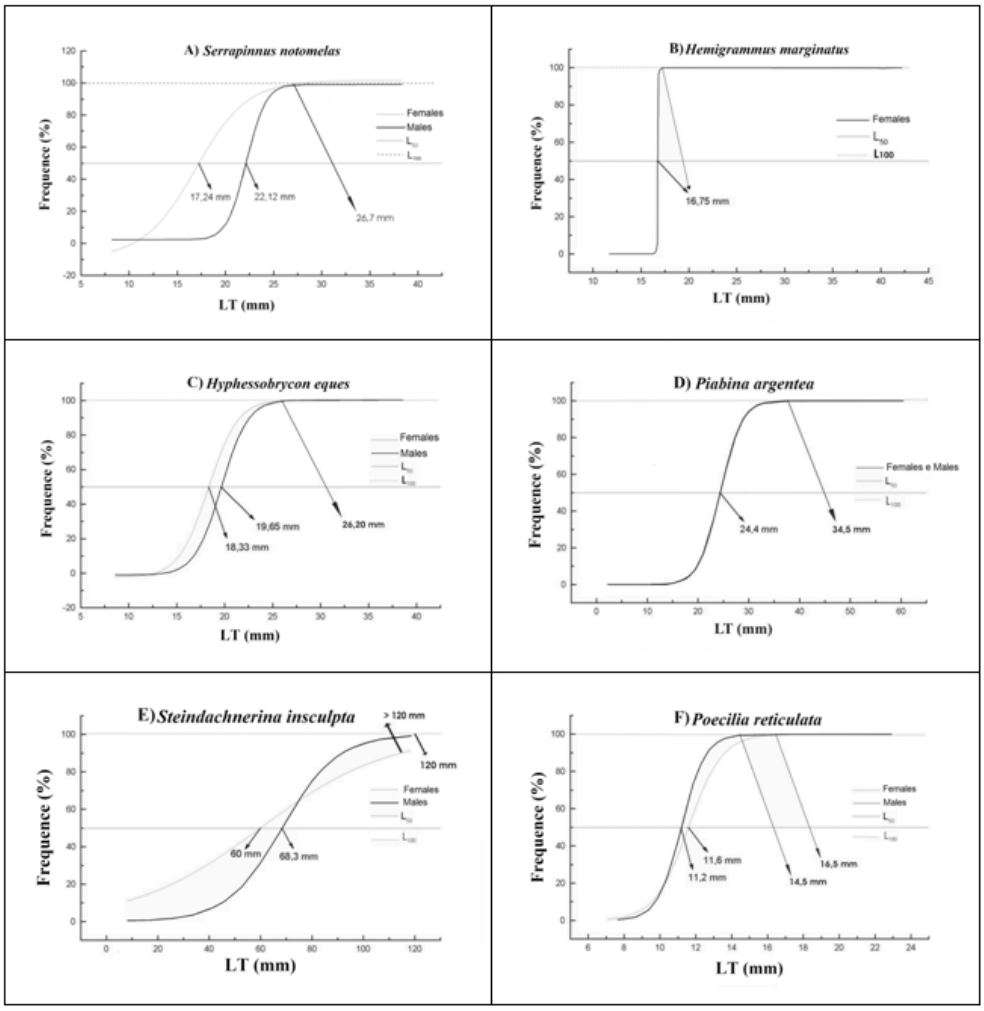

Figure 5: Average size of 1st gonadal maturation in the Points 1 and 2

SATO *et al.* (2003) verified that the females, which perform reproductive migration usually, present higher values of body size than other fish. KRYZHANOVSKY (1975) attests that adaptations for reproduction and development suffer the influence of ecological factors, mainly during the embryonary period. Those adaptations reflect in the life cycle of the adult fish, defining the type of migration, the capacity to occupy new environments, and the limits of their distribution.

The biology and ecology of the tropical icthyofauna is poorly known. More detailed information about the reproductive dynamics of *S. notomelas, H. marginatus, H.eques, P. argentea, S. insculpta* and *P. reticulata* may be useful for the conservation and management of the wild population of those species, and also to ensure the sustainability of the freshwater ornamental fish trade.

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