LIFE HISTORY TRAITS OF ODONTOSTILBE PEQUIRA (STEINDACHNER, 1882) IN THE PANTANAL OF PORTO MURTINHO, MATO GROSSO DO SUL STATE, BRAZIL

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ABSTRACT
This study aimed to analyze the life history traits of females and males of Odontostilbe pequira, and correlate the recruitment of both sexes with the variation in the flood pulse of Paraguay River. The samplings were performed every month between February 2009 to January 2011, along the main channel of Paraguay River and its tributary (Amonguijá River) and the marginal lakes Criminosa and Flores. Length data were taken from 977 individuals of Odontostilbe pequira (564 females and 413 males). The equation that describes the relationship weight/length for females is Total weight=0.0000183*Standard length2.95, and for males, Total weight=0.0000105*Standard length3.10, with isometric growth for females and positive allometric for males. The asymptotic length (L∞) estimated for females was greater (39.59mm) than for males (37.57mm). Females also had higher growth rate (k=0.93 year⁻¹, Rn=0.35) and natural mortality rate (Z=1.56 year⁻¹) than males (k=0.82 year⁻¹, Rn=0.27, Z=1.45 year⁻¹). Through the growth curves, generated by the distribution of length classes, it was registered 3 complete cohorts for females, with longevity estimated at 3.22 years, and 4 cohorts for males with longevity of 3.65 years. The growth performance index values (φ) were close to 3 and similar between females (φ=3.16) and males (φ=3.06). The recruitment pattern was long for females and males of O. pequira, without significant variation in the recruitment distribution (p=0.77) between sexes. The recruitment peak occurred in July and June, for females and males, respectively. There was correlation between the recruitment and the water level of the river for both sexes (females: r=0.91, p<0.001, males: r=0.67, p=0.02).

Keywords: intraspecific variation; population biology; cheirodontinae; growth rate; recruitment.

RESUMO
TRAÇOS DE HISTÓRIA DE VIDA DE ODONTOSTILBE PEQUIRA (STEINDACHNER, 1882) NO PANTANAL DE PORTO MURTINHO, MATO GROSSO DO SUL, BRASIL. O presente trabalho tem como objetivo analisar os traços de história de vida de fêmeas e machos de Odontostilbe pequira, bem como, correlacionar o recrutamento de ambos os sexos com a variação no pulso de inundação do rio Paraguai. As coletas foram realizadas mensalmente entre Fevereiro/2009 e Janeiro/2011, ao longo da calha do rio Paraguai e seu afluente (Rio Amonguijá) e nas lagoas marginais Criminosa e Flores. Foram obtidos dados de comprimento de 977 indivíduos de Odontostilbe pequira (564 fêmeas e 413 machos). A equação que descreve a relação peso/comprimento para fêmeas é Peso total=0,0000183*Comprimento padrão2.95 e para machos Peso total=0,0000105*Comprimento padrão3.10, com crescimento isométrico para as fêmeas e alométrico positivo para os machos. O comprimento assintótico (L∞) estimado para fêmeas foi maior (39.59mm) que o estimado para os machos (37.57mm). As fêmeas também apresentaram maior taxa de crescimento (k=0.93 ano⁻¹; Rn=0,35) e mortalidade natural (Z=1.56 ano⁻¹) em relação aos machos (k=0.82 ano⁻¹; Rn=0.27; Z=1.45 ano⁻¹). Através das curvas de crescimento, geradas pela distribuição por classes de comprimento, foram registrados 3 coortes completas para as fêmeas, com longevidade estimada em 3,22anos, e, 4 coortes para os machos, com longevidade de 3,65anos. Os valores de índice de performance de crescimento (φ) foram
próximos de 3 e semelhantes entre fêmeas (\(\varphi = 3.16\)) e machos (\(\varphi = 3.06\)). O padrão de recrutamento foi longo para fêmeas e machos de \(O.\) pequira, não sendo observada variação significativa na forma da distribuição do recrutamento (\(p = 0.77\)) entre os sexos. O pico de recrutamento ocorre em Julho e Junho, para fêmeas e machos, respectivamente. Constatamos correlação entre o recrutamento e o nível do rio para ambos os sexos (fêmeas: \(r = 0.91; p < 0.001\); machos: \(r = 0.67; p = 0.020\)).

**Palavras-chave:** variação intraespecífica; biologia populacional; cheirodentinae; taxa de crescimento; recrutamento; diferença sexual.

### RESUMEN

**ESTRATEGIAS DE VIDA DE ODONTOSTILBE PEQUIRA (STEINDACHNER, 1882) EN EL PANTANAL DE PORTO MURTINHO, ESTADO DE MATO GROSSO DEL SUR, BRASIL.** El presente estudio tiene como objetivo analizar las estrategias de vida de hembras y machos de \(O.\) pequira y la correlación entre el reclutamiento de ambos sexos y la variación en el pulso de inundaciones del río Paraguay. El muestreo fue llevado a cabo mensualmente entre Febrero de 2009 y Enero de 2011 a lo largo del canal principal del Río Paraguay y su afluente (Río Amonguïjá) y los lagos marginales Crimosa y Flores. La información de la longitud fue obtenida de 977 individuos de \(O.\) pequira (564 hembras y 413 machos). La ecuación que describe la relación peso/longitud para las hembras es Peso total = 0.0000183*Longitud estándar\(^{2.95}\), y para los machos es Peso total = 0.0000105*Longitud estándar\(^{3.10}\), con un crecimiento isométrico para las hembras y alométrico positivo para los machos. La longitud asintótica (\(L_\infty\)) estimada para las hembras fue mayor (39,59mm) que la estimada para los machos (37,57mm). Las hembras también presentaron una mayor tasa de crecimiento (\(k = 0.93\) año\(^{-1}\), \(R_n = 0.35\)) y mortalidad natural (\(Z = 1.56\) año\(^{-1}\)) respecto a los machos (\(k = 0.82\) año\(^{-1}\), \(R_n = 0.27\), \(Z = 1.45\) año\(^{-1}\)). A través de las curvas de crecimiento, generadas por la distribución de clases de longitud, se registraron 3 cohortes completas para las hembras, con una longevidad estimada en 3,22 años, y 4 cohortes para los machos con una longevidad de 3,65 años. Los valores del índice de performance de crecimiento (\(\varphi\)) fueron cercanos a 3 y similares entre hembras (\(\varphi = 3.16\)) y machos (\(\varphi = 3.06\)). El patrón de reclutamiento fue largo para hembras y machos de \(O.\) pequira, sin registrarse una variación significativa entre sexos (\(r = 0.91, p < 0.001\), machos: \(r = 0.67, p = 0.02\)).

**Palabras clave:** variación intraespecífica; biología poblacional; cheirodontinae; tasa de crecimiento; reclutamiento; variación sexual.

### INTRODUCTION

Understanding the variations in life history traits is a key issue in the different ecology areas (Roff 2001, Stearns 1992), being used to describe reproductive strategies, ‘trade-offs’, and basic parameters of population dynamics (Winemiller 1989, Winemiller & Rose 1992). High plasticity and/or variation inter- and intraspecific in life history traits is widely reported for fish, with significant differences in reproductive aspects, variation in asymptotic length, in the growth rate and in longevity of populations in response to environmental variations (Stearns 1989, Wotton 1998, Rochet 2000, Mazzoni & Iglesias-Ríos 2002, Blanck & Lamouroux 2007). Although most studies have focused on variations between populations at species level (Winemiller & Rose 1992, King & McFarlane 2003, Mérona et al. 2009), the life history traits may vary between individuals (Hartz et al. 1998, Becker et al. 2003) and between other levels, according to the degree of analysis comparison. However, few studies on fish fauna have examined the trait variability at different levels, as for example, between orders and between latitudes (Rochet 2000, Blanck & Lamouroux 2007). Despite these detailed studies, analyses of trait variability between sexes are scarce (Barbieri et al. 2001, Martin-Smith & Armstrong 2002, Feitosa et al. 2004, Gomiero et al. 2007), and this difference is evidenced only in ecological theories (Vazzoler...
1996, Wotton 1998, Lowe-McConnell 1999) and speculated in several studies on populations that sought to understand the trend and particularity of their results (Braga 2006, Abilhoa 2007), as observed for Odontostilbe pequira (Steindachner, 1882) in Southern Pantanal (Tondato et al. in press). The significant variation in life history traits, like in the growth rates between sexes, may be a result from trade-offs among reproductive investment, growth and mortality (Stearns 1992, Hutchings & Jones 1998). Thus, by understanding the variation in life history aspects within a species provides knowledge on how natural selection works in natural populations (Roff 2002) and through the analysis between sexes, can show how sexes get adapted to conditions imposed, according to their portion, in the maximization of reproductive success, survival and population balance.

The species Odontostilbe pequira belongs to the subfamily Cheirodontinae, and has little sexual dimorphism. This subfamily is composed of small freshwater fish that reach a maximum of 40 mm standard length, mainly found in lentic environments and floodplains, and inhabits the majority of catchment areas of Central and South Americas (Malabarba 1998). Although having no relevance to fisheries, it has great importance for the food chain of fish fauna, besides economic potential (ornamental), as suggested by Pelicice & Agostinho (2005) for species of the same subfamily. In Brazil, studies on Cheirodontinae species examined the reproductive biology (Gelain et al. 1999, Oliveira et al. 2002, Gomiero & Braga 2007, Azevedo et al. 2010), diet aspects (Casatti et al. 2003, Pelicice & Agostinho 2006, Dias & Fialho 2009) and population biology (Lizama & Ambrósio 1999, Piana et al. 2006, Lourenço et al. 2008, Benitez & Suárez 2009). Nevertheless, only two studies were undertaken with O. pequira, investigating its reproductive aspects in Southern Brazil (Rio Grande do Sul State, Ibiúna-Mirim River) (Oliveira et al. 2010) and Southern Pantanal (Mato Grosso do Sul State, Paraguay River) (Tondato et al. in press), with no information about its population dynamic. In this way, the analysis on the dynamics of O. pequira, considered an opportunistic species (r-strategist) (Tondato et al.in press ), aimed to provide effective information about the life history traits of females and males (weight/length relationship, asymptotic length, growth rate, mortality and longevity), enabling the comparison between sexes and among phylogenetically related species, in addition the understanding of the influence of the flood (river level) on the recruitment of both sexes.

MATERIAL AND METHODS

The Pantanal is a sedimentary floodplain with an area of about 140,000 km², part of the Upper Paraguay River basin (Adámoli 1982). The rainfall ranges from 800 to 1,400 mm/year, with 80% between November and March (Fantin-Cruz et al. 2011). Also, the flood regime is unimodal, of essential importance for all system functions (Junk et al. 1989), since the high evapotranspiration prevents a significant contribution of the local rainfall to river level variations (Hamilton et al. 1996).

The study region is within the Pantanal of Porto Murtinho, located in southernmost region of Pantanal (Figure 1), municipality of Porto Murtinho, Mato Grosso do Sul State, Brazil. Given its geographical position and low slope of 1 cm/km in the North-South direction (Hamilton et al. 1996), the Pantanal of Porto Murtinho is characterized by the asynchrony between the period with the highest rainfall and temperature (November to March) and the flood period (June to August). The flood begins in the North of the floodplain (Cáceres, Mato Grosso State) along with the rainy period, slowly flows southward, resulting in lags from 3 to 6 months between the peak rainfall in the springs and the maximum flood in the Southern part, usually in June, out of the rainy period (Hamilton et al. 1996, Gonçalves et al. 2011). Once the Paraguay River has a meandering course in the study region, it also has marginal lakes formed by abandoned meanders (Figure 1), which are directly connected to the river and strongly influenced by its seasonality.

Monthly samplings were conducted between February 2009 and January 2011, under macrophyte stands along the main channel of the Paraguay River and in one of its tributary, the Amonguïjá River, and in the marginal lakes Criminosa and Flores (Figure 1). Fish were collected using drag nets and sieve nets (80x120cm) with 2 mm mesh size, fixed in 10% formaldehyde and preserved in 70% ethanol for identification, count, and obtaining biometric and biological data. In laboratory, the identification
was made using specialized literature (Britski et al. 2007) and voucher specimens were cataloged (11167) in the fish collection of the Department of Zoology, Federal University of Rio Grande do Sul, Porto Alegre, Brazil. After the identification, a casual subsample was selected with at least 30 individuals per month, to get the following data: sex, total weight (g), and standard length (mm). For the analyses, the data of months repeated on the two consecutive years were summed up, because we assumed that the analyzed parameters have no significant interannual variation.

The relationship between weight and length was obtained for each sex through a non-linear regression analysis, where the data of weight and length were directly adjusted by the power function: Total weight = a*standard length^b, where: a = constant, and b= allometric coefficient of growth. The parameters a and b were estimated by a non-linear regression for each sex. The type of growth was determined by analyzing the confidence interval of the growth coefficient (b): (1) if b=3, the growth is isometric, (2) if b>3, the growth is positive allometric, (3) if b<3, the growth is negative allometric (Orsi et al. 2002). Then, the difference in the growth type between females and males was estimated through overlapping the respective confidence intervals of the coefficient ‘b’. In this way, given no overlap in the confidence intervals between the sexes, these are considered statistically different. The asymptotic standard length for each sex was estimated from the largest individual caught, using the equation of Pauly (1983):  

\[ L_{\infty} = \frac{L_{\text{max}}}{0.95} \]

In order to analyze the growth rate, initially for each sex we built a bimonthly frequency distribution of individuals into length classes with interval of 3
mm. The growth curve with the respective growth rate (k) was obtained using the method ELEFAN I (Eletronic Lengths-Frequency Analysis) (Pauly & David, 1981), through the growth model of Von Bertalanffy: L(t) = L∞ (1 - exp[-k(t-t0)]), wherein: L∞=asymptotic length, k=growth rate (year⁻¹), t₀= nominal age at which the length is zero, t=age (months/year) (Bertalanffy, 1938, Gulland 1977). The ELEFAN I method is inserted in the FISAT software (FAO-ICLARM Stock Assessment Tools) (Gayanilo & Pauly 1997), which seeks the best combinations in estimating the parameters, based on the best fit, i.e., best values of Rn (goodness of fit index). This method uses an alternative technique suggested as a good option to determinate the growth parameters, based on the temporal distribution (displacement) of the modes of the growth frequency (Gomiero et al. 2007).

The total mortality (Z) defined here as equal to natural mortality (M) was achieved according to the empirical formula of Pauly (1980), using the information of growth parameters (L∞ and k) and the mean temperature (°C) of the environment where the species was collected, following the equation: \( \ln M = -0.0152 - 0.279\ln L\infty + 0.6543\ln k + 0.463\ln T°C \). The longevity for each sex was calculated by the value estimated according to the equation proposed by Taylor (1958): \( t_{max} = t_0 + 2.996/k \), with \( t_0 = 0 \), and, by observing the number of cohorts (1 cohort = 1 year) previously generated by the Von Bertalanffy model. The FISAT also provided the growth performance index (φ) for each sex using the equation proposed by Pauly & Munro (1984): \( \phi = \log k + 2\log L\infty \). The growth performance index allows us to know about the possibility to compare estimate parameters with parameters of other species or phylogenetically related groups, and should present values close to 3 and similar between sexes or related species as an indicative that the population parameters were properly estimated.

The recruitment pattern for each sex was obtained through the monthly frequency distribution of the standard length and of growth parameters (L∞ and k) previously estimated, using the routine included in the FISAT(Gayanilo & Pauly 1997). The analysis of the recruitment pattern for each sex was carried out through visual inspection throughout the year. Moreover, the Kolmogorov-Smirnov test was used to compare the distribution of recruitment between the sexes.

To check a possible relationship between the recruitment of each sex and variation in the historical river level (provided by the Agência Nacional das Águas-ANA), we used a Spearman correlation, once the assumption of data normality was not reached.

**RESULTS**

Length data from 977 individuals of *Odontostilbe pequira*, 564 females and 413 males, ranged from 13.7mm to 37.61mm. For females, it was possible to predict with accuracy of 94.8% the weight of individuals, with the model Total weight=0.0000183*Standard length².95, with confidence interval estimated for the coefficient (b) varying between 2.89 and 3.01 (α=0.05). For males, it was possible to predict with accuracy of 93.1% the weight of individuals, and the model generated was Total weight=0.0000105*Standard length³.10, with confidence interval estimated for the coefficient (b) varying between 3.03 and 3.18 (α=0.05) (Figure 2).

![Figure 2. Weight/length relationship for females and males of O. pequira in Paraguay River during the study period.](image)
There was no overlap between confidence intervals of the allometry coefficient (b) fitted by the non-linear regression between the sexes, indicating a significant difference in the growth type between females and males. For females, the growth can be considered isometric, where the speed of increase in weight is equal to length, once the confidence interval of ‘b’ (2.89-3.01) was not statistically different from 3. On the other hand, for males, the growth type can be considered positive allometric, where the speed of increase in weight is higher than in length, since the confidence interval of ‘b’ (3.03-3.189) was statistically higher than 3 (Figure 2).

The asymptotic length (L∞) for females of *O. pequira* was estimated at 39.59mm (lmax=37.61mm), while for males it was lower, estimated at 37.57mm (lmax=35.69mm). Females presented higher growth rate (k=0.93 year⁻¹, Rn=0.35) and natural mortality (Z=1.56 year⁻¹) than males (k=0.82 year⁻¹, Rn= 0.27, Z= 1.45 year⁻¹). The fit of the Von Bertalanffy growth curve for the estimated ages in months for each sex indicated that females and males spend around 12 months to reach the first maturity length (L₅₀) (females=24.2mm, males=22.2mm, Tondato et al. *in press*) (Figure 3). Also, through the growth curves, generated by distributing the length classes along the year, it was registered 3 complete cohorts for females, and 4, for males (Figure 4). Furthermore, for females it was estimated longevity of 3.22 years, while for males, the longevity estimated was 3.65 years. The values of the growth performance index (φ) were close to 3 and similar between females (φ= 3.16) and males (φ= 3.06), pointing out that the estimated parameters differ little from each other, and can be comparatively analyzed.

**Figure 3.** Von Bertalanffy growth curve fitted for the estimated ages in months of females and males of *O. pequira*, in Paraguay River. L₅₀ = first maturity length.

**Figure 4.** Growth curves of the cohorts of females and males of *O. pequira*, in Paraguay River between February 2009 and January 2011.

**Figura 3.** Curva de crescimento de Von Bertalanffy ajustada para as idades estimadas em meses de fêmeas e machos de *O. pequira*, no Rio Paraguai. L₅₀ = comprimento de primeira maturação.

**Figura 4.** Curvas de crescimento dos cortes de fêmeas e machos de *O. pequira*, no Rio Paraguai entre Fevereiro/2009 e Janeiro/2011.
The recruitment pattern of females and males of *O. pequira* was similar, without significant variation in the recruitment distribution (p=0.77) between the sexes over the year. Through graph analysis, it was verified that in both sexes the recruitment is long, although the period with the highest intensity is between March and September (Figure 5). For females, the maximum recruitment takes place between May and July, and for males, between May and August. Importantly, the highest recruitment for females occurs in July, whereas for males, in June (Figure 5).

A correlation was detected between the recruitment of both sexes and the historical river level (Females r=0.91, p<0.001 and Males r=0.67, p=0.020), suggesting that the entry of juveniles in the population is strongly associated with the river level, with the most intense pulse of recruitment of both sexes occurring with the highest river levels (Figure 5).

**DISCUSSION**

The significant variation in the growth type between the sexes of *O. pequira* indicates that females and males develop differently, characterizing an intraspecific phenotypic plasticity in response to adaptive variations of each sex to environmental conditions. A similar pattern is commonly found in fish population (Campos *et al.* 1993, Mazzoni & Silva 2006), being evidenced that differences between sexes in the values of ‘b’ can mean mere presence of a greater weight gain by one sex or sexual dimorphism (Menezes & Caramaschi, 1994). In addition, the isometric growth in females of *O. pequira* suggests that the energy gained is directed to a balanced investment in growth and weight, given the no-need to reserve energy due to the high availability of food resources and favorable temperature practically continuous in the study area. However, even under lower food supply, the amount of stored energy, proportional to the weight, increasing to a factor 3 with the body size, enables a greater resistance to food shortage periods (Metcalfe & Monaghan 2003). According to Lizama & Ambrósio (1999), species of the family Characidae tend to present an isometric growth, maintaining the shape throughout the life cycle. On the other hand, the positive allometric growth in males of *O. pequira* seems the most plausible in Cheirodontinae, since in Brazilian rivers and streams of the Upper Paraná River it was observed the same type of growth for *Serrapinnus notomelas* (Lizama & Ambrósio 1999, Lourenço *et al.* 2008, Benitez & Súarez 2009), supporting similarities related to phylogenetic proximity in different environments.

There is an inverse relationship between the allometry coefficient and the intercept of the adjusted line, the intercept being the condition factor, i.e., the parameter ‘a’ (Braga 1997). In females and males of *O. pequira*, the values of ‘a’ were similar (0.000018, 0.000015, respectively) to those found by Lourenço *et al.* (2008) and Benitez & Súarez (2009) for *S. notomelas* in streams of the Upper Paraná River basin (0.0000191, 0.0000007, respectively). Although the parameter ‘a’ can vary in fish of the same species or between species, according to location, average length of the population, and age (Gurgel 2004), the results did not indicate interspecific variability of the parameter ‘a’ between *S. notomelas* and *O. pequira* evidencing the strong expression of phylogenetic proximity which characterizes similarities in life history traits.

Differences in the parameters of growth and mortality can lead to different characteristics and strategies in life history of fish species (Nikolskii 1969, Heibo & Vollestad 2002), with spatial variations according to environmental conditions,
such as food availability, temperature, and population density (Lowe-McConnell 1999). Spatial variation in population parameters has been reported with different growth patterns exhibited by the same species in different environments (Wootton 1998, Benitez & Suárez 2009). For *O. pequira*, in Southern Pantanal, it was observed high values of growth and mortality rates, with values higher than recorded for the Cheirodontinae *S. notomelas* in streams of the Upper Paraná River basin, as well as a shorter longevity (Lourenço et al. 2008). This pattern was expected, since higher growth rates are common in species inhabiting floodplains, which can be related to the intense predation suffered from the moment of hatching (Lowe-McConnell 1999). Therefore, the faster they reach the theoretical maximum length the higher the chances for survival, once the smaller individuals are more vulnerable to predation (Reznick et al. 1996). Additionally, the high natural mortality of *O. pequira*, common in tropical fishes (Pauly 1980), is also offset by the high growth rate, consequent early maturity (around 12 months) and long reproductive period (Tondato et al. submitted), which corroborate adaptive advantages (Smith & Armstrong 2002) common to opportunistic species (r-strategist) (Winemiller 1989).

Once the growth rate of a population is directly influenced by offsets between fecundity, survival, and the mean generation time (Winemiller & Dailey, 2002), it is suggested that these parameters may work differently between the sexes (Braga et al. 2006). So the higher rates of growth and mortality observed in females explain their smaller length of first maturity, in relation to males, and the lack and/or lower proportion of females in the first length classes in this population (Tondato et al. submitted), considering that the fast growth decreases the probability of capture in the smaller size classes and anticipate the sexual maturity. The higher growth rate in females was also observed in other studies (Barbieri et al. 1986, 2001), and may be a result of trade-offs between costs (e.g. increased predation pressure) and benefits (increased rate of food acquisition) (Smith & Armstrong 2002). Thus, the highest growth rate in females of *O. pequira* was associated with fitness and survival, in order to minimize the effects of the high mortality, rapidly reaching larger lengths and maximizing the reach of sexual maturity in a shorter time period, as suggested by Blanck & Lamouroux (2007).

The growth rate presented by a species is usually opposite to the value of asymptotic length and longevity, regarding that, the higher the growth rate, the smaller is the asymptotic length and shorter longevity (Lizama & Vazzoler 1993, King 2007). Nevertheless, as observed above, females of *O. pequira* had higher growth rate, shorter longevity, highlighting the larger asymptotic length in relation to the males, without opposite relationship between k and L∞. Feitosa et al. (2004) and Gomiero et al. (2007) studying growth rates of *Salminus brasiliensis* and *Brycon opalinus*, respectively, also registered the highest growth rate and larger asymptotic length for females, but the k values were slightly higher (e.g.: female=0.56 and males=0.54, Gomiero et al. 2007). In this way, the highest k and L∞ in females of *O. pequira* can be explained by two hypotheses: 1) the difference in the growth rate between the sexes, with the higher value for females was not enough to reduce the asymptotic length of the females in relation to males, 2) the females maximize the reproductive investment, exceeding not only the males length, but also the maximum length, since in females of this species, the length is positively related to fecundity (Tondato et al. submitted). Furthermore, the highest growth rate observed for females of *O. pequira* leads to its shorter longevity in relation to males, despite males have shorter L∞ in a longer life period, suggesting that males have a lower investment in length, and direct the energy gained to participate in another reproductive year of the life cycle.

On the other hand, the energy expenditure of females on the reproduction and lower growth rate, lead to an earlier senescence than males, decreasing the longevity and justifying the high mortality. This may occur because according to Fontes-Filho (1989) the major natural factors for mortality are predation and diseases, which have action contrary according to the age, i.e., larger and older individuals are less predated, but are more susceptible to diseases, due to tissue degeneration and lower use of nutritive elements.

Despite the variations in population parameters between the sexes of *O. pequira*, the distribution way of entry of females and males in the population was not different suggesting that this recruitment pattern is similar between the sexes throughout the year. This result justifies the similar length
distribution between the sexes of O. pequira and its balanced sex ratio over time in the study of Tondato et al. (in press), because females and males recruit proportionally along the year. The long recruitment in females and males of O. pequira, with the maximum in July for females, and June, for males, also corroborated Tondato et al. (in press) for the same species, which evidenced a long reproductive period, with the highest reproductive intensity in July. Meanwhile, Oliveira et al. (2010) investigating the reproductive period of the same species in Southern Brazil (subtropical region) found two reproductive stages, one from September to October, and another from January to February, being evidenced spatial intraspecific variation in the recruitment of O. pequira, once the recruitment and reproduction are distinctly influenced by environmental conditions (Olden et al. 2006).

Although the pattern of long recruitment is typical of small sized species living in tropical freshwater environments (Lizama & Ambrosio 2003, Lourenço et al. 2008), for O. pequira, this pattern may indicate an adaptive variation in life history facing the uniqueness of the environment, since a long reproductive period does not correspond to the reproductive strategy for seasonal environments (Munro 1990, Vazzoler & Menezes 1992), which promotes the occurrence of species with short reproductive period associated with favorable conditions of the flood (Tedesco et al. 2008). However, in Southern Pantanal, the flood period does not match with rising temperature and high rainfall, suggesting that the long recruitment of O. pequira is related to a higher reproductive investment as an adaptive response, since according to King et al. (2003), for a better recruitment, fish should reproduce when the water level and temperature synchronously rise.

Also, the significant relationship between the recruitment of both sexes of O. pequira and the historical river level, with rise and more intense pulse in the recruitment with the increase (flood) and peak of the river level, indicates that the flood regime has a key role on the reproductive activity, as suggested by Tondato et al. (in press) for the same species in the study region, and by Bailly et al. (2008) for most fish species with varied reproductive strategies in the Upper Pantanal. This recruitment pattern seeks to maximize the reproductive success, given the low fecundity of the species, offset by multiple spawning and long reproductive period (Tondato et al. in press), which is associated with the long flood in the Southern Pantanal (up to six months) (Gonçalves et al. 2011). This association is due to the expansion of the flooded area in the plain, during the flood, which promotes access to new habitats, providing greater availability of food and shelter for the development and growth of larvae and juvenile (Junk et al. 1989, Lowe-McConnell 1999, Agostinho et al. 2004, Bailly et al. 2008, Tondato et al. 2010).

Finally, the tactics comprising a strategy may differ between environments so that each species or population ensures that new individuals are recruited (Wootton 1998), indicating that the high growth rate and shorter longevity of O. pequira, compensate the high mortality, through an early sexual maturity and long recruitment period. It is emphasized that the analysis of life history traits between sexes are indispensable to understand the variations in the intraspecific reproductive behavior, since in O. pequira, the variation between the sexes provided is essential to understand its population dynamics.

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