



Contribution to vital statistics of a guppy *Poecilia reticulata* Peters (Pisces: Cyprinodontiformes: Poecillidae) pond population in Santa Marta, Colombia

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Abstract. Vital statistics of a population of a non native freshwater fish, the guppy *Poecilia reticulata* Peters, 1859 from a semi-abandoned pond nearby Santa Marta, Colombia, are reported. Estimates include growth, mortality, length-weight relationship, sex ratio and male versus female numbers and sizes. Von Bertalanffy growth parameters were found typical of the species, growth form was isometric for both sexes and under lab versus field conditions, and females were significantly more numerous and bigger than males. Results were compared to published data and the plasticity of this species is discussed.

Key words: Guppy, *Poecilia reticulata*, demography, Colombian Caribbean.

Resumen: Contribución a las estadísticas vitales de una población del guppy *Poecilia reticulata* Peters (Pisces: Cyprinodontiformes: Poecillidae) en un estanque en Santa Marta, Colombia. Se reportan estadísticas vitales de una población de un pez no nativo de agua dulce, el guppy *Poecilia reticulata* Peters, 1859 de un estanque semi-abandonado en la vecindad de Santa Marta, Colombia. Los estimados incluyen crecimiento, mortalidad, la relación peso-longitud, la proporción de sexos y la abundancia y tamaños de los machos versus las hembras. Se encontró que los parámetros de crecimiento de von Bertalanffy son los típicos de la especie, que la forma de crecimiento es isométrica para ambos sexos y bajo condiciones tanto de laboratorio como de campo y que las hembras fueron significativamente más numerosas y grandes que los machos. Los resultados se comparan con datos publicados y se discute la plasticidad de la especie.

Palabras clave: Guppy, *Poecilia reticulata*, demografía, Caribe Colombiano.

Introduction

The guppy *Poecilia reticulata* Peters, 1859 is an ovoviviparous freshwater fish of low waters native to northern South America and the Antilles (Rodríguez, 1997). It was introduced into Colombian waters, as well as in several other tropical countries, in the 1940s for the biological control of mosquito larvae that are vectors of infectious diseases like malaria (COPESCAL 1996, Rojas *et al.* 2004). Welcomme (1988) reports its

establishment in the basins of the Magdalena and Orinoco rivers. As *P. reticulata* is also a very popular fish for aquarists it is much likely that it has spread into other water bodies in Colombia. For instance, Calle *et al.* (1998) describe a toxicity essay with *P. reticulata* individuals obtained from wild populations in a locality 2000 m high inland.

Poecilia reticulata has been used as biological model in a variety of studies including

behavior, (Smith *et al.* 2002), life history evolution, (Bronikowski *et al.* 2002), water quality, (Araujo *et al.* 2006), genetics, (Paterson *et al.* 2005, Magellan & Magurran 2007), and ecotoxicology, (Brown 1978). This study presents vital statistics (body growth, mortality, length-weight relationship) of a population in captivity but abandoned (see below) and test hypothesis on male to female proportion and relative size. Such data are lacking in Colombia and could be useful for management of this invasive species.

Material and Methods

The pond whose population was studied is located in the rural area nearby the city of Santa Marta (11°08' N, 74° 13' W, approximately) and was in a semi-abandoned state at the time of the study, i.e., under uncontrolled conditions. The water of the pond originates from a natural water course and cycles through the pond to compensate for evaporation. Apart from guppy, the pond contained other fishes like carps (*Cyprinus carpio* Linnaeus, 1758) and others, frogs, and aquatic vegetation. Feeding of fishes in the pond based mainly on pond production, although at some points in the history of the pond artificial food was used. Pond dimensions were 12 m² of surface area by 0.5 m in average depth.

For the sake of the study the pond was emptied and 231 individuals (about half of the population) were measured (total length in mm) and their sex determined. Six pregnant females were taken to the lab and kept in individual vessels. Newborns were counted (45 and 64 per female) and reared in the lab. From the time point of birth total length and weight were monitored every three days from a sample of 17 to 20 individuals, on occasions 30 individuals, taken randomly, during 157 days (5.2 months). All fish were feed *ad libitum* with fish meal.

The von Bertalanffy growth function (VBGF, defined below) was fitted to the pairs of age (months) and total length (mm) data by means of the program FiSAT (Gayanilo *et al.* 2005).

$$L_t = L_\infty (1 - e^{-K(t-t_0)})$$

where L_t is length at age t in months, L_∞ maximum theoretical size the fish would reach if it was to live indefinitely, K is the rate at which L_∞ is approached and t_0 is the age a fish would have had at length zero if it had always grown according to the VBGF. Because maximal size reached under lab conditions was smaller than maximal size in the pond, 35.5 mm vs 39.8 mm, respectively, the last one was taken as L_∞ and the routine in FiSAT estimated K and t_0 .

In order to allow comparison with growth rates in the literature ϕ' was calculated (Pauly & Munro 1984).

$$\phi' = \log K + 2 \log L_\infty$$

Lengths measured in the field were converted to age (months) by means of the estimated von Bertalanffy parameters obtained in the foregoing steep and mortality Z per month was estimated by mean of catch curves (Pauly 1984).

$$\ln(N_i/\Delta t_i) = a + bt_i$$

where N_i is the number of fishes in size class i , Δt_i is the time of residence in the size class i , t_i is the age corresponding to the mean size in size class i and b with opposite sign is Z , total mortality. As this population is not subject to fishing mortality, Z is equal to M , the natural mortality.

The weight-length relationship was calculated with the expression below by taking logarithms (natural logs) at both sides. Calculations were done for the pairs of data obtained in the lab (no separate sexes), for separate sexes using the field data and for the complete data set.

$$W = aL^b$$

where W is weight in mg, L is total length in mm, a (called condition factor) and b (called allometric index) are fitting constants.

Following hypotheses were tested: that proportion of males to females was 1 to 1 and that females were bigger and heavier than males. Resampling techniques, whereby a reference distribution is created and the likelihood of the observed statistic (the observed males to females proportion, for instance) is derived from it (Good 2005), were used for this purpose and routines for the effect were written with the program Statistics 101, v. 1.0.6 (<http://www.statistics101.net/>). Bootstrap 95% confidence intervals were fitted to mean weight and length with the percentile technique

Results and Discussion

Estimated growth parameters were: $L_\infty = 39.8$ mm, $K = 0.21$ month⁻¹, $t_0 = -0.91$ month (Fig. 1) and $\phi' = 2.524$ (K on a monthly basis). Mortality rate Z was 0.406 month⁻¹ (Fig. 2). Of the 231 individuals sexed in the field 119 were females, 82 were males and 30 could not be sexed. The proportion females to males was 1.45:1 which is significantly different from 1:1 ($p < 0.05$). Females were significantly larger and heavier than males ($p < 0.05$, see Table I). Interestingly the weight length relationship was virtually identical ($W = 0.0084L^{3.0447}$, Fig. 3) for lab data, for separate sexes (field data) and for the complete data set.

Table I. Comparison of female and male mean total length (mm) and weight (mg) of a pond population of the guppy *Poecilia reticulata* Peters 1859 near Santa Marta, Colombian Caribbean. CIi and CI_s= inferior and superior 95% bootstrap Confidence Intervals.

Sex	Total Length			Weight		
	Mean	CI _i	CI _s	Mean	CI _i	CI _s
Females	22,0	20,6	23,5	147,9	123,7	173,7
Males	18,7	17,3	20,1	85,8	69,6	103,4

Growth pattern of this guppy population is typical of the species. The value of ϕ' (with K on a yearly basis) of 1.59 is virtually identical to the mean and median, 1.62 and 1.61, respectively, of the ϕ' values found in FishBase (Froese & Pauly 2007), although most estimates come from aquaria or lab conditions for separated sexes, whereas the population studied here comes from a semi-abandoned pond and estimations were done for sexes together. It may well be that the estimations found here represent the balance between males and females in body growth.

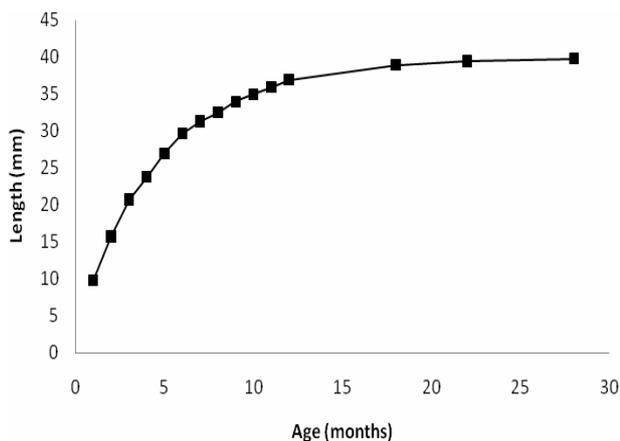


Figure 1. von Bertalanffy growth curve of the guppy *Poecilia reticulata* in a semi-abandoned pond nearby Santa Marta, Colombia. Each point represents individuals belonging to that age class. For parameters see text.

The allometric index b is very close to 3 which signal to isometric growth, i.e. the guppy grows in equal proportion in all dimensions. This is so regardless of sex (no sexual dimorphism in growth form), growing conditions (lab versus natural conditions) or size as the size range (7.4 mm to 39.8 mm) for which the allometric index found here applies, is broad, from well represented newborns to adults (the oldest individual is about 28 months old) which suggest that there is no ontogenic change in growth form either. For combined male and female data Urriola *et al.* (2004) found an allometric index of 3.3, somewhat different to the one found here. Moreover, they find sexual dimorphism in this feature for the guppy population

they studied, which is in contrast to the findings here. The reason of this discrepancy may partly be found in the size range used in Urriola *et al.* (2004): 17.8 mm to 51.5 mm that would not include early juveniles. These phenotypic differences among populations are suggestive of a plastic species.

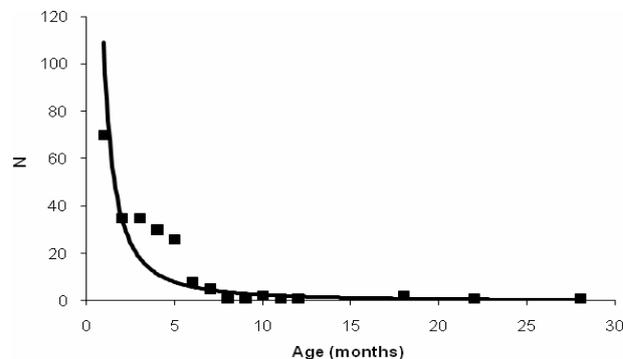


Figure 2. Mortality schedule of a population of the guppy *Poecilia reticulata* in a semi-abandoned pond nearby Santa Marta, Colombia. For estimated value of natural mortality see text.

The identical condition factors (fitting constant a) suggest that feeding conditions were equally good for both sexes in the field and that field conditions were equally good to those in the lab, where individuals were feed *ad libitum*, i.e., under excess food. It should be noted that in FishBase there are no values reported on this aspect (weight length relationship), nor on mortality Z or M (Froese & Pauly 2007). It is an indication that vital statistics for this species are scarce, notwithstanding its popularity among aquarists and as biological model.

The number of newborns per female in this population suggests the need of a revision on this feature. For instance, Balon (1990) mentions a range of 20 to 40 newborns per female, much less than the range found here (45 to 64). This result probably signals to the effect of better feeding conditions in the lab (plentiful food and lower newborn mortality) versus field conditions.

Females were significantly larger and heavier than males, which is a well known feature of this species, e.g., Urriola *et al.* (2004), with females almost doubling males. Females were almost 50% more abundant than males. This concurs with what has been found for wild populations e.g., Rodd & Reznick (1997), who also found that females were notoriously more abundant than males, but is contrary to findings in ponds, e.g., Urriola *et al.* (2004). Petersson *et al.* (2004) studying wild populations found that sex ratio was a dynamic feature varying in time and space. Rodd and Reznick (1997) attributed their results to differential predation, assuming that the colored and smaller size

of guppy males render them more susceptible to predation. Petersson *et al.* (2004) explain their results by the added effect of differential swimming abilities among males of slow and rapid water flows and movement decisions by individuals. In the case of this pond population a likely explanation for the predominance of females is differential predation. The pond contained not only guppies but also carps, other fishes and vertebrates like frogs (probably *Bufo* sp) that might well explain the sex ratio found.

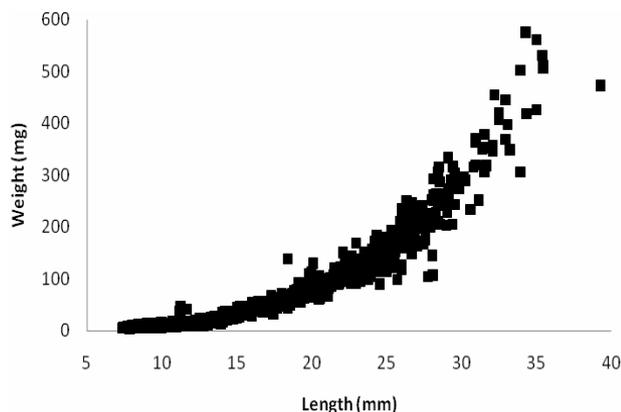


Figure 3. Length weight relationship of individuals of the guppy *Poecilia reticulata* reared in the lab from females collected from a semi-abandoned pond nearby Santa Marta, Colombia. Each point represents an individual. For fitted parameters see text.

The guppy is a robust species that shows great plasticity in the realization of its life history. As a species that has invaded Colombian waters and is now well established an assessment of its impact and ecological role is indeed worthwhile and necessary. The present study represents a first step in that direction.

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