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**TEMPORAL VARIATION IN THE ABUNDANCE OF
Poblana alchichica IN NEAR-SHORE HABITAT
OF THE HIGH ELEVATION LAKE, LAGO DE ALCHICHICA,
PUEBLA, MEXICO**

**Variación temporal en la abundancia de *Poblana alchichica*
en un hábitat ribereño del lago de alta elevación,
Lago de Alchichica, Puebla, México**

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ABSTRACT

The distribution and abundance of organisms within a pond or lake can reflect the result of a variety of factors. We examined the abundance of the endemic fish, *Poblana alchichica*, in Lago de Alchichica, Puebla, Mexico, as well as how the abundance varied among months. Dissolved oxygen, temperature, and salinity varied among months. The abundance of *Poblana alchichica* peaked in December and February. For the months when fish were observed, their abundances were positively related to dissolved oxygen concentration and were generally not related to temperature. Our results provide evidence that there is substantial seasonal variation in the abundances of *Poblana alchichica* and that within months, their distributions are likely driven by dissolved oxygen than either temperature or salinity.

Key words: Abundance, dissolved oxygen, *Poblana alchichica*, salinity, seasonal variation, temperature.

RESUMEN

La distribución y abundancia de organismos dentro de un cuerpo de agua puede reflejar el resultado de variedad de factores. Examinamos la abundancia del pez endémico, *Poblana alchichica*, en el lago de Alchichica, Puebla, México, así como la variación de la abundancia entre los meses del estudio. El oxígeno disuelto, temperatura y salinidad variaron entre los meses. La abundancia de *Poblana alchichica* fue mayor en diciembre y febrero. Durante los meses en los que se observaron a los peces, su abundancia fue relacionada positivamente con la concentración de oxígeno disuelto, y por lo general no presentaron relación con la temperatura. Nuestros resultados muestran evidencia clara de variación estacional en la abundancia de *Poblana alchichica*, y cómo su distribución se asocia más probablemente con oxígeno disuelto que con temperatura o salinidad.

Palabras clave: abundancia, oxígeno disuelto, *Poblana alchichica*, salinidad, variación estacional, temperatura

INTRODUCTION

The distribution of organisms within a pond or lake can reflect the result of a variety of factors. For example, the abiotic or physical characteristics of the environment can influence where fish are found (e.g, Penczak *et al.*, 2004; Sosa-López, 2007). In other cases, biotic factors such as macrophytes, predators, or competitors, can affect their distribution (e.g., Martin and Saiki, 2005; Rinke *et al.*, 2009). Changes in these factors may also be responsible for explaining, or partially explaining, seasonal variations in the distribution and abundance of fish (e.g., Mueller *et al.*, 2000; McKenna *et al.*, 2008). The status of endemic species *Poblana alchichica* (Atherinidae) is difficult to assess due to habitat condition, intrinsic biological vulnerability and human impact (Alcocer *et al.*, 2010). According to these authors, *Poblana alchichica* fits the threatened species risk category (SEMARNAT, 2002) because of its reduced distribution area “and several risk factors endanger the survival of this silverside by altering its habitat and by diminishing its population size”. For these reasons, *Poblana alchichica* should be changed to the category, in danger of extinction, because of factors like habitat destruction, detergents discharged into the littoral zone, and domestic wastewater discharged into the same area around the lake. We examined the abundance of this endemic fish in the Lago de Alchichica, Puebla, Mexico. We also examined how the abundance varied among months throughout the year. In particular, we were interested in determining the effect of dissolved oxygen, temperature, and salinity on the distribution and abundance of these fish. Both temperature and dissolved oxygen are frequently important in explaining the distribution of fish, both within and among ponds, lakes, and rivers (e.g., Mueller *et al.*, 2000; Järvalt *et al.*, 2005; Murray and Innes, 2009). Other fish species continental from central-south Mexico, without evolutionary link to *Poblana alchichica*, *Poeciliopsis fasciata* (Poeciliidae) distribution is influenced by salinity and dissolved oxygen levels in a riverine system, the Río Salado (Woolrich-Piña *et al.*, 2010).

MATERIALS AND METHODS

Lago de Alchichica is a crater lake approximately 1.5 – 2 km in diameter in Puebla, Mexico (elevation = 2300 m a.s.l, Fig. 1). The vegetation surrounding the lake is thorny scrub. *Poblana alchichica* is a fish of medium size with prognathous mouth, dorsal fin with 5 flexible thorns, the second dorsal present a small thorn, anal extensive fin with 13 to 16 radioes, pectoral 11 to 13 radioes. Scutellation complete 40 to 52 in a longitudinal series. Without pore in the lateral line (De Buen, 1945). Types serial number GWP 00632, 00635, 00637 and 00638 deposited in the Laboratorio de Ecología UBIPRO, FES Iztacala UNAM, were occupied for the identification of the fish studied. We conducted surveys of near-shore habitat in the Lago de Alchichica monthly from September 2009 to May 2010 to determine the distribution of *Poblana alchichica*. We surveyed 32 sites around the shoreline of the lake. Surveys took place from 1030 to 1530 h. Each site consisted of an approximately 6 m long x 1 m wide section of shoreline. We used a seine to collect *Poblana alchichica* from each site. At each site, we also measured salinity, temperature, and dissolved oxygen using a DO/conductivity meter (YSI Model 85 Handheld), ~ 2 m from the shoreline and at a depth of ~ 40 cm. The data followed a normal distribution, for this reason we used ANOVA to compare salinity, temperature, dissolved oxygen, and abundance of *Poblana alchichica* among months. We used separate multiple regressions for each month in which this fish was present to examine the relationship between dissolved oxygen, temperature and abundance of *Poblana alchichica* (salinity showed no variation within months and so was not included in these analyses).

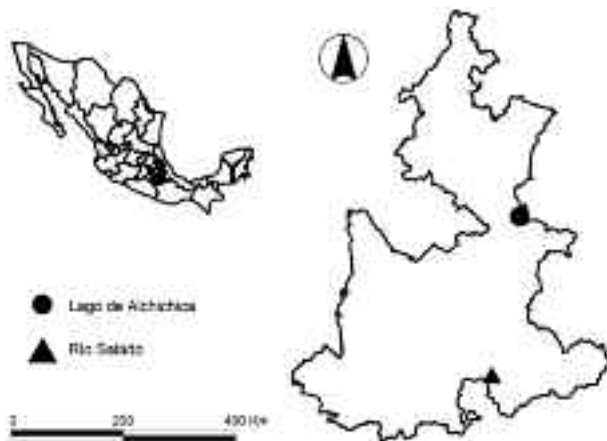


Figure 1. Geographic localization of Lago de Alchichica, Puebla, Mexico.

RESULTS

Dissolved oxygen levels varied among months, with September having lower levels than the other months (Fig. 2A; $F_{4,155} = 740.7$, $P < 0.0001$). Temperature also significantly

varied among months, with a decrease in December (Fig. 2B; $F_{4,155} = 900.9$, $P < 0.0001$). Salinity varied among months, with levels in May being higher than the other months (Fig. 2C; $F_{4,155} = 43.1$, $P < 0.0001$).

The abundance of fish varied among months with the highest abundances in December and February (Fig. 2D; $F_{4,155} = 34.55$, $P < 0.0001$). For all months in which fish were observed, their abundances were positively related to dissolved oxygen concentration and were not related to temperature, although in December there was a positive relationship between fish abundance and temperature that approached significance (Table 1).

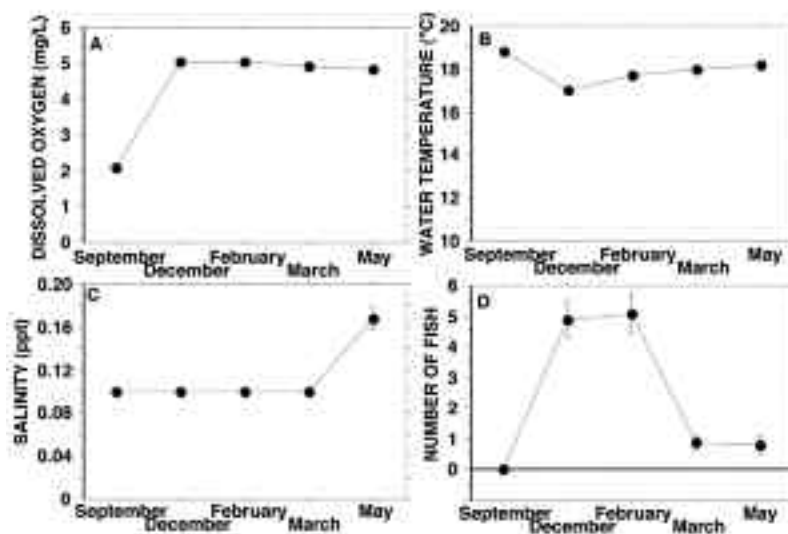


Figure 2. Monthly variation in A) mean dissolved oxygen concentration, B) mean temperature, C) mean salinity, and D) mean abundance of *Poblana alchichica* in the Lago de Alchichica. Means are given \pm 1 SE.

	R2	Overall P	Intercept	DO	Temperature
February	0.53	< 0.0001	80.0NS	7.93***	-6.49 NS
March	0.17	0.065	0.59 NS	1.43*	-0.37 NS
May	0.22	0.027	-34.0 NS	2.28**	1.28 NS
December	0.26	0.013	-314.1 NS	10.5**	15.6 NS(0.08)

Table 1. Results of multiple regressions of the abundance of *Poblana alchichica* in Lake Alchichica, Puebla, Mexico on dissolved oxygen concentration (DO) and temperature in the months for which we observed these fish in our surveys. N = 32 in all cases. NS: not significant, *: $P < 0.05$, **: $P < 0.01$, ***: $P < 0.0001$.

DISCUSSION

The lack of seasonal variation studies on *Poblana alchichica* or other atherinids fishes does not reveal which factors are related to its abundance through time. This is the only study

that has focused on the distribution and abundance of this species in relation to the bathymetry of Lago de Alchichica (Alcocer *et al.*, 2010).

Our results show that there is substantial seasonal variation in the abundance of *Poblana alchichica*. Peaks in abundances occurred in December and February. In other saline system, the Río Salado in Puebla, Mexico, *Poeciliopsis fasciata* were only present from November to February (Woolrich-Piña *et al.*, 2010). In Sonora, Mexico, *Poeciliopsis* spp. densities are highest from April through June (Schenk and Vrijenhoek, 1986). Thus, *Poeciliopsis* spp. populations appear to vary seasonally, perhaps in correlation with seasonal variation in precipitation or other climatic variables.

Within months, the distribution of *Poblana alchichica* was related to dissolved oxygen, but generally not to temperature. This result is similar to the results of Woolrich-Piña *et al.*, 2010, in the Río Salado, where other fish, *Poeciliopsis fasciata* are found in sections of the river that have higher dissolved oxygen concentrations but sections of the river with and without fish do not differ in temperature. Some species of *Poeciliopsis* are known to have a relatively good tolerance for high temperatures (Carveth *et al.*, 2006) and so the temperature range found in the Lago de Achichilca may not be great enough to influence their distribution, at least relative to dissolved oxygen, which appears to be the driver of the distribution of *Poeciliopsis fasciata* and *Poblana alchichica* in both river (Woolrich-Piña *et al.*, 2010) and lakes (this study).

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