Natura Neotropicalis 28 (1): 7 - 13 (1997)

CHEMICAL CHARACTERISTICS AND TROPHIC STATUS OF LOBOS POND (BS. AS., ARGENTINA)

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ABSTRACT. After a fourteen months sampling program performed in Lobos pond, determinations indicated water characteristics of oligohaline oligopoiquilohaline and of sodium, bicarbonate-chloride type. Nutrients were in high concentrations (TN: 2 mg/l, TP: 460 µg/l). These data as well as chlorophyll (155 µg/l), respiration rates (0.2 mg O_2/l.h) and physiological indicators (P/C: 37.4; N/P: 6.0; Chl/C: 15.6; N/C: 152), confirmed that the pond is in a high degree of eutrophication. The influence of the input of the main tributary Las Garzas stream, as well as the recreational activities and the village located over the shore, are discussed.

RESUMEN. Características químicas y estado trófico de la laguna de Lobos (Bs. As., Argentina).

Luego de un programa de muestreos de catorce meses de duración, las aguas de la laguna de Lobos se caracterizaron como oligohalinas oligopoiquilohalinas y, en base a su composición iónica, como bicarbonatadas cloruradas sódicas. Altas concentraciones de nutrientes (TN: 2 mg/l, TP: 460 µg/l), de clorofila fitoplanctónica (155 µg/l), de respiración planctónica (0,2 mg O_2/l.h) así como indicadores fisiológicos (P/C: 37,4; N/P: 6,0; Chl/C: 15,6; N/C: 152), permiten clasificar este cuerpo de agua como de alto grado de eutroficación. Se discute la influencia del principal tributario, el arroyo Las Garzas, de la población ribereña y la actividad turística que soporta la laguna.

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0329-2177/97/28(1): 7 - 13 $2.00

INTRODUCTION

Lobos pond is a permanent pond or a third order lake (Ringuelet, 1972) located in the geomorphological unit called "Pampa deprimida" (Frenguelli, 1950), Province of Buenos Aires, and belongs to the Río Salado drainage basin.

The pond is a shallow water body with a main tributary, Las Garzas stream, and an outlet that drains through Vertedero stream to Cañada del Toro. Its geographical situation, some basic morphometric parameters and sampling points position are illustrated in Fig. 1.

Previous works about chemical characteristics mainly referred to salinity and ionic composition were reported by Ringuelet (1962) and Ringuelet *et al.* (1967).

Among the factors involved in the water quality of the pond, it could be mentioned the influence of Las Garzas stream that collects, previous reaching the pond, the raw sewage of Navarro (about 1000 inhabitants) and the wastewater of Lobos city with secondary treatment, the stable population of Villa Loguercio (500 inhabitants), placed along one side of the shoreline, as well as tourism and recreational activities such as fishing, boating and sailing.

The aim of this work was to evaluate the water quality and the trophic status of the pond and to discuss causes and consequences in relation to the results obtained.

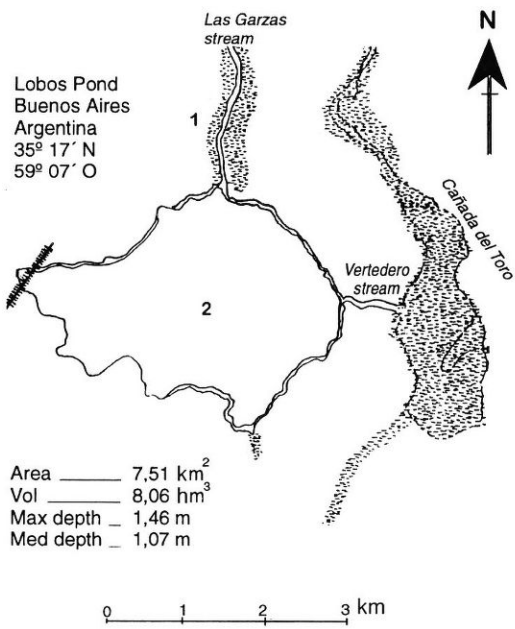

Fig. 1. Geographical situation and basic morphometric parameters of Lobos pond with main tributary Las Garzas stream and sampling points position.

Table 1. Average, maximum and minimum values of temperature, pH, dissolved oxigen (DO) concentration, DO saturation (percentage) and DO respiration.

	Lobos pond			Las Garzas stream		
	AVG	MAX	MIN	AVG	MAX	MIN
T°C	17.25	23.20	10.00	19.36	24.00	10.50
pH	8.61	9.34	7.78	8.40	9.20	7.66
DO (mg/l)	9.42	14.28	5.75			
DO sat.	98	157	66			
DO resp. (mg/l.h)	0.19	0.61	0.04			

MATERIALS AND METHODS

Water samples were collected from the centre of the pond and from the main tributary 1 km upstream the inflow, monthly between March 1986 and April 1987. They were taken by means of a Van Dorn type sampler and distributed in proper washed glass and plastic bottles for further analysis.

Temperature and turbidity (Secchi disk) were measured in the field.

Analysis of pH, specific conductivity, dissolved oxygen (Winkler, Alsterberg modification), carbonate and bicarbonate (sulphuric acid titration), calcium and magnesium (EDTA titration), total phosphorus (persulphate digestion to ortophosphate), ammonia (ORION selective electrode), total nitrogen (digestion to nitrate, Mackereth *et al.*, 1978) were performed in the laboratory.

After filtration through 0.45 µm pore filter (Millipore), nitrate (cadmiun reduction), nitrite (sulphanilamide and N- (1-naphtyl) ethylenediamine), orthophosphate (ascorbic acid method), sodium and potassium (flame emission photometry) and sulphate (turbidimetry, Tabatabai, 1974), were determined.

Total dissolved solids were calculated as the sum of major anions and cations.

Seston was determined by weight difference of dried (103 °C) filters (Whatman GF/C) after and before filtering known volumes of sample. On the same filters, particulate organic carbon was determined by oxidation with potassium dichromate (Strickland and Parsons, 1960).

Chlorophyll a was extracted with 90% acetone and measured spectrophotometrically (Golterman, 1971).

Planktonic respiration was calculated by differences in dissolved oxygen of samples incubated in the dark, at field temperature for 3-4 hours.

Physiological indicators of nutrient deficiency (ratios between carbon, nitrogen, phosphorus and chlorophyll a), were calculated according to Healey and Hendzel (1980).

RESULTS AND DISCUSSION

During the period studied, temperature varied between 10 and 23 °C without stratification in the water column. On rare occasions, up to 28 °C was measured in the upper 20 cm during calm weather on summer days.

It must be noted that after a heavy rainstorm (100

Table 2. Average, maximum and minimum values of dissolved solids, conductivity and ions concentrations.

	Lobos pond			Las Garzas stream		
	AVG	MAX	MIN	AVG	MAX	MIN
Dis. solids (mg/l)	1408.01	2050.50	489.90	3167.78	6656.80	426.00
Cond.20 °C (µS)	1947.92	2933.00	513.00	4479.50	8256.00	411.00
Ca^{+2} (mg/l)	32.80	53.10	17.10	83.31	154.90	17.10
Mg^{+2} (mg/l)	37.22	65.40	8.40	113.33	273.90	8.40
Na^{+1} (mg/l)	393.88	637.50	102.80	839.76	1770.00	87.50
K^{+1} (mg/l)	20.31	25.90	10.20	27.26	37.00	10.20
$CO_3^{=}$ (mg/l)	26.96	73.80	0.00	27.11	76.30	0.00
CO_3H^{-} (mg/l)	294.01	382.20	185.20	497.28	752.80	194.10
$SO_4^{=}$ (mg/l)	306.79	457.00	95.20	667.89	1543.60	70.70
Cl^{-} (mg/l)	323.85	518.20	62.10	969.77	2220.90	38.00
Cond. stream/Cond. pond.	2.50	5.31	1.05			

mm in two days) occurred at the end of September, a great change in the pond took place which was evidenced in the minimum values for all of the chemical data (Tables 1 - 4), obtained in the samples collected in October.

The pH was alkaline and above 8.0 with a maximum of 9.34 in February (Table 1) that determined, as a consequence, the presence of carbonate.

Dissolved oxygen varied between 5.75 and 14.7 mg/l and with some exceptions was always close to or above saturation level.

In terms of salinity, the pond presented the characteristics of oligohaline- oligopoiquilohaline, since the total dissolved solids ranged from 929 to 2050 mg/l with the exceptional value of 490 in October (Table 2).

Referring to the ionic composition , the predominant cation was always sodium and the dominance of anions fluctuated between chloride and bicarbonate with a considerable proportion of sulphate (Table 2). These results are in agreement with Ringuelet *et. al.* (*op. cit.*).

Las Garzas stream showed a similar composition but with average concentrations two times greater than those of the pond with the exception of October when both showed their lower values (Table 2). This fact may be related with the low mean slope of the region (less than 1:1000) which permits a great soil-water contact, increasing the salinity of the water draining through the soil to the stream. In the same way, the groundwater table, frequently exceeding the bottom level and draining into the pond and stream basins (Dangavs *et al.*, 1990), may act increasing the pond water salinity but in a much slower process.

As could be expected, salinity showed good correlation with specific conductivity according to the following equations:

Pond salinity (mg/l) = 363.15 mg/l + 0.568 x K (µmho/cm); $r = 0.89$; $P < 0.001$

Stream salinity (mg/l) = 184.96 mg/l + 0.699 x K (µmho/cm); $r = 0.95$; $P < 0.001$

Table 3. Average, maximum and minimum values of nitrogen and phosphorus concentrations.

		Lobos pond			Las Garzas stream		
		AVG	MAX	MIN	AVG	MAX	MIN
NO_3^- -N	(µg/l)	20	90	0	120	430	0
NO_2^- -N	(µg/l)	10	80	0	120	630	0
NH_4^+ -N	(µg/l)	390	1630	50	300	1630	30
inorg. N	(µg/l)	420	1630	50	520	1630	60
total N	(µg/l)	2000	3400	870	1300	2260	440
$PO_4^=$ -P	(µg/l)	30	240	0	220	670	10
total P	(µg/l)	360	710	80	460	1030	60
$PO_4^=$ -P/tP	(%)	7	34	0	45	79	17

No apparent seasonal patterns in ionic composition and nutrient concentrations were detected.

Average inorganic nitrogen in the pond accounted for 420 µg/l which is mostly in the form of ammonia, while in the stream (520 µg/l), one half was ammonia and the rest was divided between nitrite and nitrate (Table 3).

Annual mean values of total nitrogen (TN) and total phosphorus (TP) concentrations did not show significant differences between pond and stream (2000 and 1300 µg TN/l; 360 and 460 µg TP/l, respectively). Nevertheless, slight greater values of TN were detected in the pond waters during summer months (2300 µg TN/l), than in the stream (1300 µg TN/l).

Considering soluble phosphorus ($P\text{-}PO_4^-$), the value was significatively lower in the pond, 30 µg P/l, compared with 222 µg P/l of the stream. With these results, ratios of soluble P/total P of 7 % for the pond and 45 % for the stream may be calculated. This suggests that a mineralising process dominates in the stream or simply it serves as a transport of soluble phosphorus released in the discharges coming from Navarro and Lobos.

The soluble phosphorus that reaches the pond is assimilated and converted to particulate matter through the activity of the primary producers. The same occurs with nitrite and nitrate carried by the stream, which are rapidly taken up in the pond.

Total and organic nitrogen concentrations in the pond, exceeding those of the stream during the growing season, could be explained on the basis of the dominance of species of Cyanophyta reported by Boltovskoy *et al.* (1990), which nitrogen fixing capacity constitutes a surplus of N to the aquatic ecosystem.

Also the value of 18.2 % for the ratio particulate organic carbon/seston obtained in the pond, in relation to 7 % for the stream, confirmed the production of large amounts of biomass in the former. This biomass was mainly of phytoplankton origin as showed by chlorophyll a concentrations, which ranged from 90 to 294 µg/l with the exception of October (Table 4).

Physiological indicators of nutrient deficiency for N/C and P/C indicated, on average, no deficiency (Table 5). Results for the ratio N/P showed that nitrogen is the growth limiting nutrient in relation to phosphorus for algal growth, which is

Table 4. Average, maximum and minimum values of Secchi disk readings, seston, POC and chorophyll a concentration.

		Lobos pond			Las Garzas stream		
		AVG	MAX	MIN	AVG	MAX	MIN
Secchi	(cm)	18.36	30.00	13.00	24.00	30.00	15.00
Seston	(mg/l)	90.52	269.00	16.50	49.43	108.00	2.40
COP	(mg/l)	14.24	38.40	3.00	3.65	11.80	0.10
COP/Ses	(%)	18.27	44.25	5.23	7.18	11.80	4.17
Chor.	(ug/l)	155.77	294.00	12.00			

Table 5. Average, maximun and minimun values of some physiological indicators based on nutrient concentrations, calculated for Lobos pond. P, phosphorus; N, nitrogen; C, carbon and Chl, chlorophyll a. ND, no deficiency; MD, moderate deficiency and SD, severe deficiency.

	Lobos pond			
	P/C ND-MD-SD >20---<10	N/P ND-MD-SD <10--->20	Chl/C ND-MD-SD >20---<10	N/C ND-MD-SD >140--<80
AVG	37.4	6.0	15.6	151.98
MAX	76.4	15.2	79.5	341.86
MIN	1.8	0.7	0.0	21.06

in accordance to the dominance of Cyanophyta already mentioned. The value below 20 for the ratio chlorophyll a/C, suggested some kind of deficiency, which in the case of this pond could be the result of light limitation, taking into consideration that the average Secchi disk depth was of 0.18 m that is to say a photic zone at about 0.50-0.60 m depth.

Respiration rates ranged from 0.04 to 0.61 mg O_2 /l.h, with a mean value of 0.2 mg O_2 /l.h. These figures indicate organic concentrations much higher than those corresponding to unpolluted natural waters.

According to pH values, dissolved oxygen, chlo-

rophyll a, nutrient concentrations and respiration rates, this pond can be classified as a highly eutrophic system.

This situation is mainly due to the input of nutrient loads from the sewage of Navarro and Lobos cities, as well as agricultural nitrogen and phosphorus fertilizers from the drainage basin that enter the pond carried by the stream.

In addition, the village on the shore of the pond, does not have a sewage collection system and the domestic waters are delivered to earth septic tanks in close connection with the pond. The latter assumptions are reinforced in the results of bacteriological studies (Mariñelarena, 1990) that revealed total and faecal coliform bacterial numbers much higher than those corresponding to natural waters.

ACKNOWLEDGMENTS

The authors want to express gratitude to Mr. Jorge Jáuregui and Mr. Eduardo Burgueño for their effort in helping our field activities.

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Recibido/*Received*/: 31 enero 1996
Aceptado/*Accepted*/: 1 julio 1997