water

MDPI

Supplemental Material

Changes in Planktivory and Herbivory Regimes in a Shallow South-American Lake (Lake Blanca Chica, Argentina) over the last 250 years

David Carrozzo [1], Simona Musazzi [2], Andrea Lami[3], Francisco E. Córdoba[4] and María de los Ángeles González Sagrario [5,*]

[1] Departamento de Biología, Universidad Nacional de Mar del Plata, J. B. Justo 2550, (7600) Mar del Plata, Argentina; davidrcarrozzo@gmail.com
[2] National Research Council (CNR),Water Research Institute (IRSA), Largo Tonolli 50, 28922 Verbania, Italia; simona.musazzi@irsa.cnr.it
[3]National Research Council (CNR),Water Research Institute (IRSA), Largo Tonolli 50, 28922 Verbania, Italia; andrea.lami@cnr.it
[4]Instituto de Ecorregiones Andinas (INECOA, CONICET-UNJu), Instituto de Geología y Minería, Universidad Nacional de Jujuy, Av. Bolivia 1661, Y4600GNE, San Salvador de Jujuy, Argentina; francisco.e.cordoba@gmail.com
[5]Instituto de Investigaciones Marinas y Costeras (IIMYC), Facultad de Ciencias Exactas y Naturales, Universidad Nacional de Mar del Plata, CONICET, J. B. Justo 2550, (7600) Mar del Plata, Argentina
* Correspondence: gonsagra@gmail.com, gonsagra@mdp.edu.ar

S1. Ephippial Assemblage

This study represents the first record of the ephippia of *Daphnia spinulata* Birabén 1917, *Daphnia obtusa* Kurz 1875, *Bosmina Leiderobosmina huaronensis* Delauchaux 1978, *Moina* sp. Baird 1850, *Ceriodaphnia* sp. Dana 1853, *Leydigia louisi* Jenkin 1934cf, *Pleuroxus* sp. Baird 1843 and *Chydorus sphaericus* (O. F: Müller 1776) group for the shallow lakes from the Pampa Plain.

Correspondance analysis were performed (*package vegan*) [1]on the ephippial assemblage, and the axes CA1 and CA2 were selected according to the Kaiser-Guttman criterion and the Broken stick model [2], explainining the 80% the data variance. *Bosmina*, *Chydorus sphaericus* group, *Ceriodaphnia* sp. and *Daphnia* species contributed with positive scores to CA1, being the first two the ones with the higest eigenvalues. All pelagic species (*Ceriodaphnia*, *Bosmina*, *Moina* and *Daphnia*) contributed with negative scores to CA2, while *Chydorus* and *Pleuroxus* with positive values.

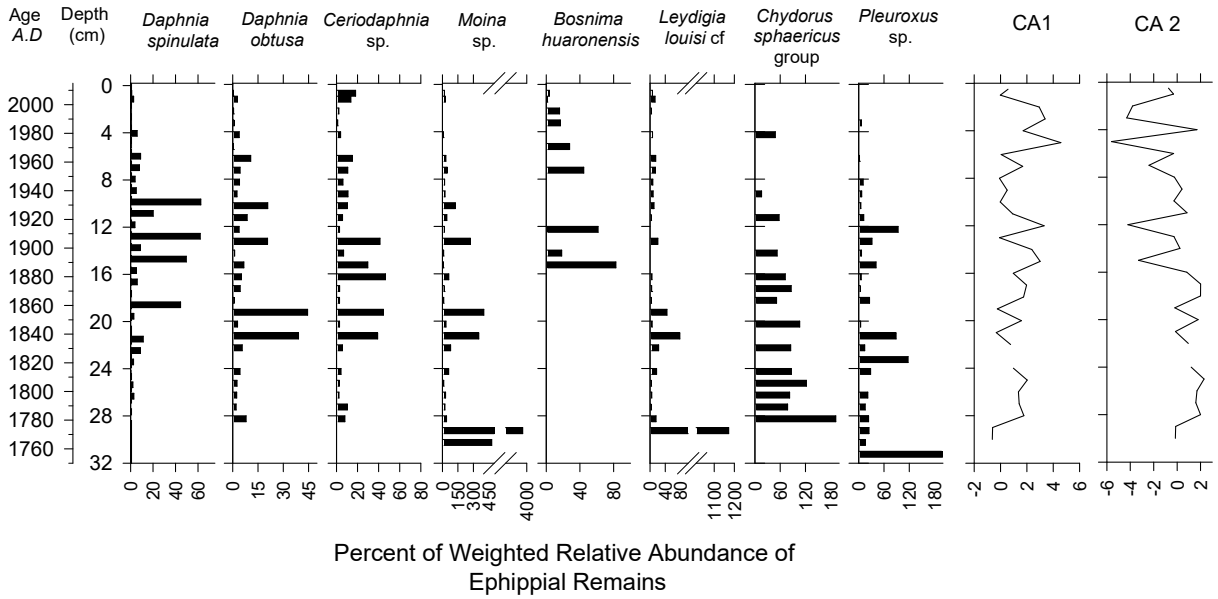

Figure S1. Ephippial stratigraphy of Lake Blanca Chica, including the scores from the first and second axes of the correspondence analysis.

GAMs were performed on the times series of the scores of correspondence analyses following reference [3]. The effect of the smooth resulted not significant (p>0.05) on the CA1 scores, whereas the fitted GAM on the scores of CA2 explained the 28.6% of the data deviance (effect of the smooth: p= 0.0025, F= 11.23, adjusted r^2= 0.26). The first derivative of the fitted trend and its simultaneous confidence interval deviated from zero along the whole time series, showing a decreasing trend that represent the decay of the contribution of littoral cladoceran species: *Chydorus sphaericus* group and *Pleuroxus* sp. (Figs. S1, S2).

All analyses have been performed using R version 3.5.1 [4].

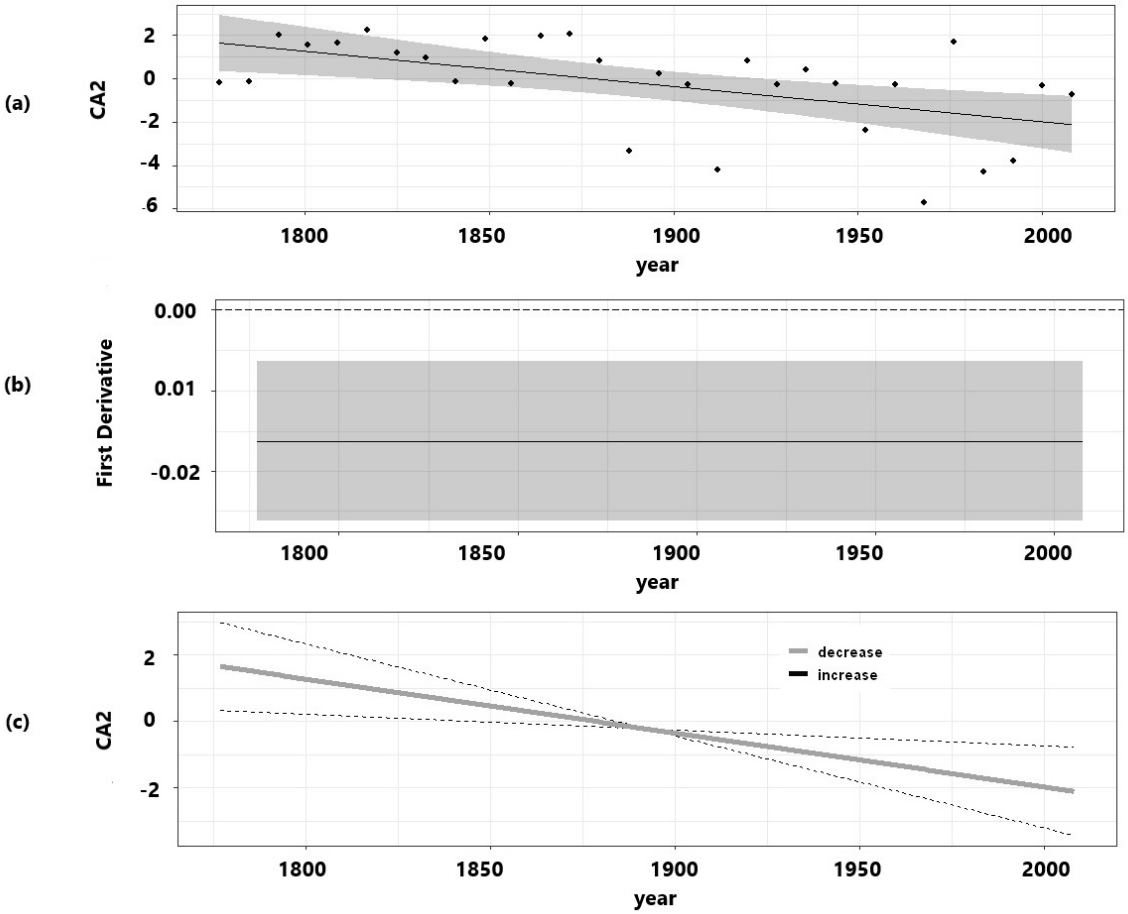

Figure S2. GAM fitted to the time series of scores of the second axis (CA2) of the correspondance analysis estimated for the ephippial assemblage in the sedimentary record of Lake Blanca Chica. (a) GAM-based trend fitted; (b) Estimated first derivative of the GAM fitted trend and the 95% simultaneous interval; (c) Period of transition.

In addition, the fitted GAM to the sum of total ephippia explained the 35.1% of data deviance (effect of the smooth: p= 0.0295, F= 4.35, adjusted r^2= 0.09, edf= 1.914), showing a decrease in the total abundance of ephippia after ca. 1915 (Fig. S3). As the Gamma distribution was used to model the data, and is the inverse of the Gaussian, the results should be interpreted as the opposite as the trend displayed. These results indicate a replacement of large and median zooplankton species by the small *B. huaronensis* after ca. 1880-1900 in agreement with the findings of González Sagrario and coworkers [5].

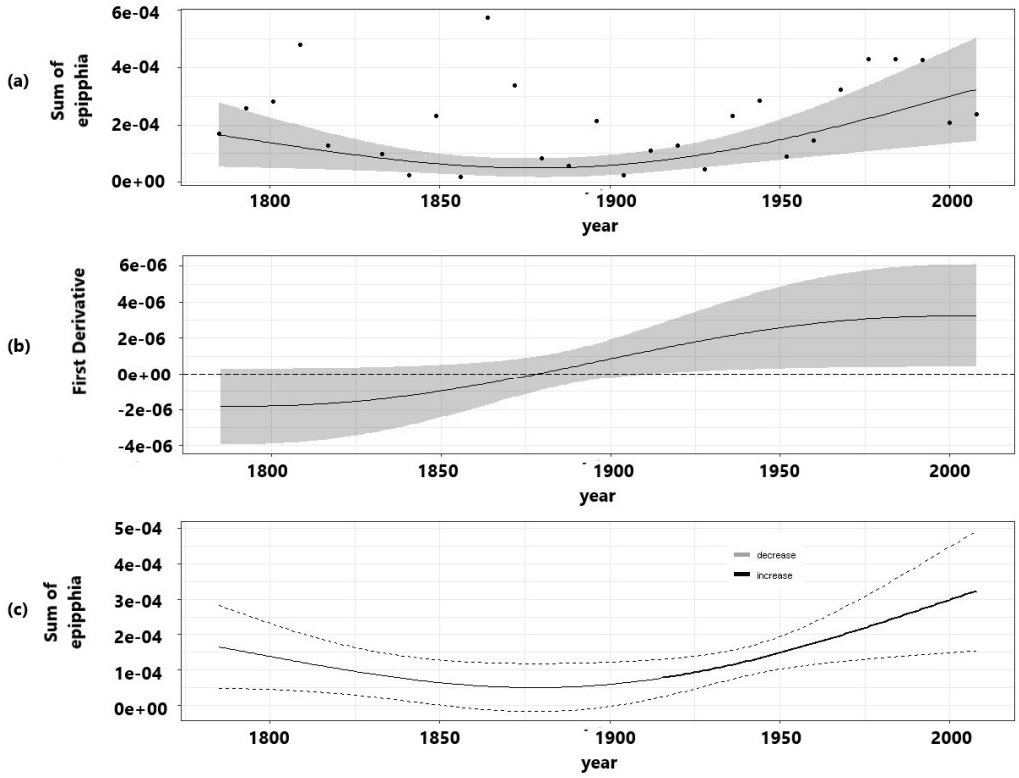

Figure S3. GAM fitted to the time series of ephippia (total sum) recorded in the sedimentary archive of Lake Blanca Chica. (a) GAM-based trend fitted; (b) Estimated first derivative of the GAM fitted trend and the 95% simultaneous interval; (c) Period of transition**.** Note: the Gamma distribution (the inverse of the Gaussian distribution) was used to model the data, thus the trend should be interpreted as the opposite.

S.2. Ephippia and mucrone size.

The variation in the size in the ephippia of *Moina* and *Daphania* species, and in the mucrone of *Bosmina huaronensis* are shown in Table S1.

Table S1. Descriptive statistics for the size of *Daphnia spinulata*, *Daphnia obtusa* and *Moina* sp. ephippia (μm) and *Bosmina huaronensis* mucrone (μm). Min.: minimum value, Max.: maximum value, Q1, Q3: first and third quartil, respectively.

	D. obtusa§	*D. spinulata*§	*Moina* sp.§	*B. huaronensis**
Min.	331.0	432.0	206.0	37.69
Q1	373.0	572.0	232.8	43.26
Median	401.0	635.5	258.0	55.87
Mean	440.6	660.9	254.6	53.89
Q3	486.0	729.0	274.0	59.18
Max.	779.0	1016.9	296.0	76.82

§: ephippia, *: mucrone.

References

1. Oksanen, J.; Blanchet, F.G.; Kindt, R.; Legendre, P.; Minchin, P.R.; O'Hara, R.B.; Simpson, G.L.; Solymos, P.; Stevens, M.H.H.; Wagner, H. vegan: Community Ecology Package. *R package version 2.2-1,* 2015. Available Online: https://www.R-project.org (accessed on 15 November 2018)

2. Borcard, D.; Gillet, F.; Legendre, P. *Numerical Ecology with R,* 1st ed.; Springer: New York, USA, 2011; pp. 319.

3. Simpson, G.L. Modelling palaeoecological time series using generalised additive models. *Front. Ecol. Evol.* **2018**, *6*, 149, doi:10.3389/fevo.2018.00149.

4. R Core Team. R: a language and environment for statistical computing. R Foundation for Statistical Computing: Vienna, Austria, 2017. Available Online: https://www.R-project.org (accessed on 15 November 2018)5. González Sagrario, M.A.; Musazzi, S.; Córdoba, F.E.; Mendiolar, M.; Lami, A. Inferring the occurrence of regime shifts in a shallow lake during the last 250 years based on multiple indicators. **2019,** *Ecol. Indic.* submitted.