Spatial use of the nekton community in a subtropical shallow lake without piscivorous fish

(Lake Blanca, Uruguay)

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Introduction

Lake Blanca (34º54' S, 54º50' W) is a subtropical shallow eutrophic system without piscivorous fish. Their absence was caused by an extreme decrease in the water level in 1998-1999 (Mazzeo *et al.* 2003). The lake presents the typical biological structure of an exclusion experiment at ecosystem level. The nekton community is composed only by two species of fish: *Jenynsia multidentata* (Anablepidae) and *Cnesterodon decemmaculatus* (Jenyns, 1842) (Poecilidae), and a shrimp *Palaemonetes argentinus* (Nobili, 1901) (Mazzeo *et al.* 2003).

This shallow lake has an extensive and complex littoral zone. From the shore line to the open water area we observed, an emergent plants zone (*Schoenoplectus californicus* L. and floating mats dominated by *Typha latifolia* L.), a submerged plants zone (*Egeria densa* and *Ceratophyllum demersum* Planch), and finally external zone of emergent plants (only *S. californicus*).

The **objective** of this work was to determine the spatial pattern and diel distribution of the nekton community and it relationship with environmental variables. Finally, we speculate about the possible cascading effects.

Methodology

The samples were collected seasonally: from winter 2003 to autumn 2004. Three *strata* (habitats) were defined according to the presence and life-form of the plants (submerged SP, emergent EP and open water OW), taking randomly five replicates from each one at midday and midnight. Nekton samples were taken at surface and bottom using minnow traps (40x40x60cm, 5cm hole). The catches were identified, sexed, counted (|CPUE|= number caught . hour^{-1} . minnow trap^{-1})and measured in the lab.

We performed simultaneously sampling for physical and chemical analyses. Similarities between samples were explored by non-metric MDS (Kruskal, 1964). The relationship between the environmental conditions and use of the space of the nektonic community was explored by Mantel's tests. Significant differences in rank similarities between groups of samples were tested by ANOSIM (Clarke and Green, 1988), using 999 permutations. If significant differences were observed at a global level (P<0.05), the pairwise comparisons between sample groups were conducted (P<0.05/3; Bonferroni correction, (1935)). A Spearman correlations (Rs) were performed between variables analyzed.

Table 1. Results of two way crossed ANOSIM, global tests for differences among *STRATA* groups (averaged across all DEPHT groups), and between DEPHT groups (averaged across all *STRATA* groups).

		STRATA groups		DEPHT groups	
Season	**Hour**	**R**	**Significance level**	**R**	**Significance level**
Winter	Day	0.22	0.038 (1)	-	-
	Night	0.579	0.001(2)	0.001	0.40
Spring	Day	0.173	0.013 (3)	0.435	0.001
	Night	0.571	0.001 (4)	0.283	0.003
Summer	Day	0.585	0.001 (5)	0.525	0.001
	Night	0.657	0.001 (6)	0.345	0.005
Autumn	Day	0.174	0.026 (7)	0.215	0.026
	Night	0.19	0.007 (8)	0.012	0.403

(1)Winter day: 9 of the 30 samples don't contain individuals, and must be excluded. For DEPTH groups the analysis cannot be performed.

Table 2. Results of pairwaise tests of samples with significant differences between *STRATA* groups according with Bonferroni correction (see Table 1).

		SP –EP			*SP - OW*			*EP – OW*		
Reference table 1	Time	R	Significance level	Significant differences?	R	Significance level	Significant differences?	R	Significance level	Significant differences?
(1)	Winter day	0.027	0.407	no	The analysis cannot be performed			The analysis cannot be performed		
(2)	Winter night	0.327	0.011	yes	0.958	0.001	yes	0.427	0.008	yes
(3)	Spring day	0.04	0.242	no	0,294	0.006	yes	0,162	0.051	no
(4)	Spring night	0.509	0.001	yes	0.582	0.001	yes	0.746	0.001	yes
(5)	Summer day	0.54	0.001	yes	0,568	0.004	yes	0.658	0.001	yes
(6)	Summer night	0.402	0.002	yes	0.53	0.003	yes	0.944	0.001	yes
(7)	Autumn day	0.144	0.117	no	0.394	0,004	yes	-0,04	0,618	no
(8)	Autumn night	0.18	0,048	no	0.358	0.014	yes	0.042	0.233	no

Results

Community analysis

The differences among *strata* were always significant for season and diel variation (Table 1). SP and EP only presented significant differences during the day in the summer, while at night were always detected except in autumn (Table 2). The SP sites was significantly different from OW (for all the combinations of season and diel variation) (Table 2). Finally, EP and OW were significantly different for all the cases, excepted in autumn and at midday in spring (Table 2). Statistical significant differences were found between depths, with the exception of the nocturnal samples of winter and autumn (Table 1).

At specific level, the most clear spatial pattern were registered during spring and summer. The adults and YOY of *Jenynsia multidentata* showed a differential spatial use. The first one preferred EP bottom, while the second were associatted to surface of OW during day and night in spring and summer (Fig.1). Inverse correlations were detected between YOY and adults during the spring at midday, and during midnight in summer (Rs=-0.54, P<0.05; Rs=-0.48, P<0.10, respectively).

The shrimp presented a more complex spatial pattern. In spring the specimens with eggs, were found mainly in OW during the day and SP during the night, the specimens without eggs, were always in OW. In summer shrimp predominated in SP samples at midday and in OW at midnight (Fig.1). The inverse correlation between *J. multidentata* and shrimps, (Rs=-0.49, P<0.10; Rs=-0.56, P<0.05, day and night of summer respectively), indicate their differential spatial use.

The Mantel's test did not indicate significant relationship between the spatial pattern of nekton community and spatial variation of environmental variables.

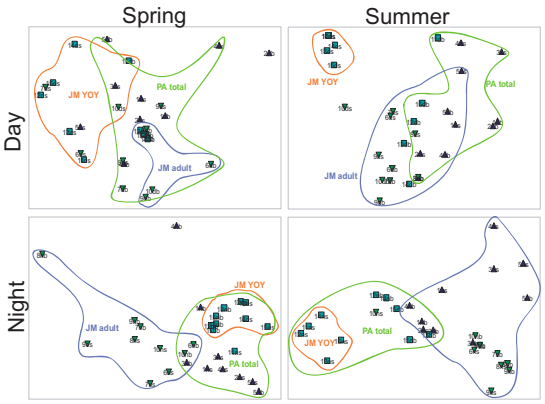

Figure 1. non-metric MDS for samples of spring and summer. We excluded *C. decemmaculatus* because it abundance was lower than 1,5% of fish. The preferred *strata* are indicated for each species and its differents life cycle stage. Stress < 0.15. ▼ SP, ▲ EP, ■ OW.

Conclusions

➢The nekton use of space was not explained by the physical and chemical conditions, biological interactions could be the main explanatory factors.

➢The distribution of *J.multidentata* depend on the life-cycle stage. The diurnal distribution of adult *J. multidentata,* located preferentially in vegetated and deeper parts, is consistent with the hypothesis of minimization of predation risk, in this lake represented by piscivorous waterfowl.

➢ The adults females of *J.multidentata*, larger and more abundant than males, could affect the space use of shrimps and fish (through competition, aggressive behaviour or cannibalism). The other species and YOY of *J. multidentata*, could be forced to move into less-safe habitats.

➢The high abundance of planktivores (*J. multidentata*), associated with the absence of piscivorous fish, and the important nutrient load in the system, could promote the development of phytoplankton bloom and a decrease in water quality.

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