DIURNAL ZOOPLANKTON DIVERSITY AND SPECIES COMPOSITION UNDER FOUR DOMINANT AQUATIC VEGETATION TYPES IN THE PALO VERDE MARSH

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Abstract: Because greater physical complexity of sub-surface habitat provides greater protection from visual planktivores, zooplankton diversity and abundance should increase with increasing complexity. We sampled zooplankton in four habitat types in the Río Tempisque marsh at Palo Verde National Park, Costa Rica, and found marginally significant differences in diversity between them, with highest diversity in the highest complexity habitat type and lowest diversity in the lowest complexity type. We also found patterns in copepod and cladoceran abundance which contradict predictions based on diel migration patterns in the temperate zone.

Key Words: cladocerans, copepods, diversity, Eichhornia crassipes, Typhus latifolia

INTRODUCTION

Predation, refuges and availability of resources may influence the spatial distribution of zooplankton in freshwater systems. Because zooplankton have visual predators, sub-surface structure of aquatic plants enhances refuge during daylight, with structure of higher complexity providing greater protection (Pennak 1978).

Thus, we hypothesized that zooplankton diversity, in patches of dominant aquatic plants in the Palo Verde marsh, would increase with the complexity of plant sub-surface structure. Specifically, we predicted that zooplankton diversity would be highest under water hyacinth, which has a relatively complex floating root system, lower under mixed-species vegetation (containing cattail, water hyacinth and other species), lower still under cattail stands, and least in open water. We also sought to compare our results with previous work in the Palo Verde marsh to elucidate effects of the decline of native plant assemblages on zooplankton populations.

METHODS

On 13 January 2005, we took three zooplankton samples under each of the four vegetation types in the Río Tempisque marsh at Palo Verde National Park, Costa Rica. Four types of floating and emergent vegetation were defined as (1) water hyacinth (*Eichhornia crassipes*), (2) cattail (*Typhus latifolia*), (3) mixed vegetation (cattail, water hyacinth, *Mimosa dormiens, Neptunia* spp., *Thalia geniculata, Heteranthera spicata* and other species) and (4) open water without emergent or floating vegetation.

At each patch, a tube sampler was lowered into the water column to a few cm above the sediment. Both ends of the tube were then stoppered, the water within the tube was homogenized, and a portion of the sample was poured into a container for later analysis. Depth at each sampling site

was recorded. We made qualitative assessments of the relative complexity of sub-surface vegetation structure for each vegetation type, by examining root and stem structures in the sampled areas of the marsh.

We preserved samples in isopropyl alcohol and counted and identified all zooplankton in a 15% subsample by volume, for each of the 12 samples. Cladocerans were classified by morphotype. Copepods were recorded as adult or nauplii stages or as parasitic morphotypes. No distinction was made among ostracod types. Rotifers were noted as present, but not counted. Diversity was calculated with a Shannon-Weiner diversity index. Several one-way ANOVAs and a multiple comparisons post-hoc test were performed using JMP 4.0.0.

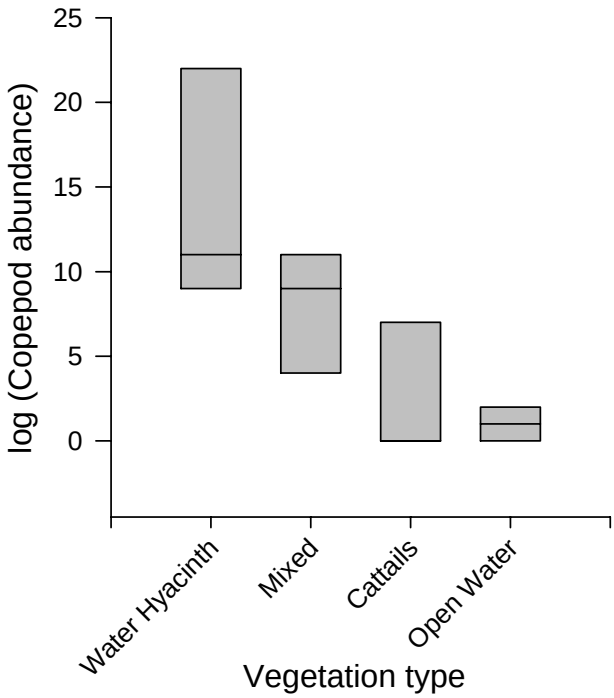

Figure 1. Zooplankton diversity assessed by counting morphotypes in three samples taken under each of four aquatic vegetation types in the Palo Verde marsh. Vegetation types on the x-axis are in order of decreasing sub-surface structural complexity. Diversity was quantified by the Shannon-Weiner index. Data were normalized by logarithmic transformation.

RESULTS

There was a marginally significant difference in log-transformed zooplankton diversity among the four vegetation types, with more complex vegetation supporting more diverse zooplankton assemblages ($F = 3.30$, $df = 3, 8$, $P = 0.08$; Fig. 1). Log-transformed abundance of total cladocerans did not differ among vegetation types ($F = 2.05$, $df = 3, 8$, $P = 0.19$), but log-transformed total copepod abundance was significantly greater in the water hyacinth patch than in the cattail and open water patches ($F = 7.52$, $df = 3, 8$, $P = 0.01$; Tukey HSD post-hoc, $\alpha = 0.05$; Fig. 2).

DISCUSSION

Though there was no significant difference in diversity among vegetation types for our limited sample, trends in the data were consistent with our predictions. Poulin et al. (1998) found greater zooplankton abundances in patches of chorizo (*Neptunia plena*) than in patches of water hyacinth, and identified chorizo as possessing a more complex floating root structure. Since 1998, invasive water hyacinth has replaced so much of the chorizo in the marsh that chorizo was not available to be tested in this study. Thus, the overall complexity of sub-surface structure in the Palo Verde marsh may have decreased with the decline of native plant assemblages. This trend may have, in turn, reduced zoo-

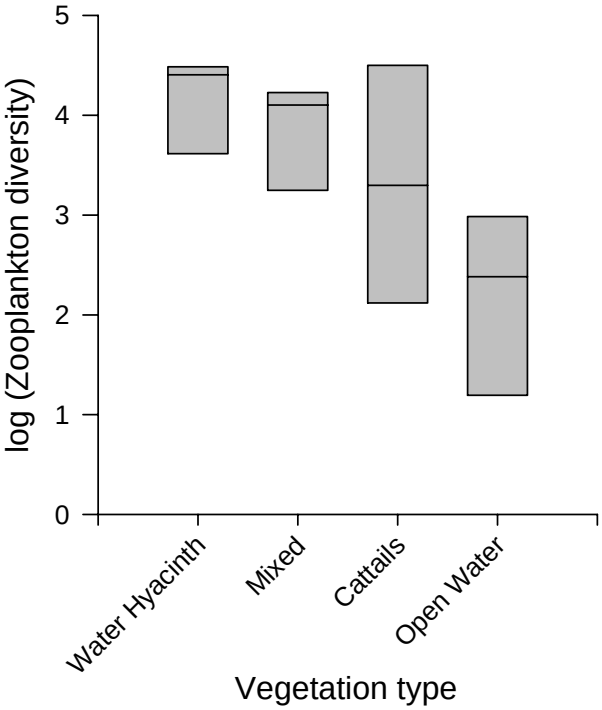

Figure 2. Copepod abundance assessed by counting individuals in three samples taken under each of four aquatic vegetation types in the Palo Verde marsh. Vegetation types on the x-axis are in order of decreasing sub-surface structural complexity. Data were normalized by logarithmic transformation.

plankton diversity or abundance in the marsh, by reducing refuge availability and increasing predation pressure.

In the temperate zone, cladocerans usually exhibit stronger diel migration than copepods because they are slower and more conspicuous, and hence experience stronger fish predation pressure (Pennak 1978). Because planktivorous fish occur in the Palo Verde marsh (Venegas 2002), we expected to observe the strongest effects of refuges on cladoceran abundance. Instead, we observed positive effects of structural complexity only on copepod abundance, in agreement with the observations of Poulin et al. (1998).

These results imply that some unstudied factor influences the distribution of zooplankton in the Palo Verde marsh. Copepods may be the more preferred or more easily-obtained prey in this system. Resource availability may have a greater influence on the diurnal distribution of zooplankton than predation pressure, or divergence in resource use between cladocerans and copepods may drive differences in their relative abundances in different microhabitats. Alternately, contrary to assumptions underlying our hypothesis, invertebrate predators of cladocerans may inhabit complex vegetative structures, displacing prey to less complex habitats.

Sampling for zooplankton in fish exclosures, or assessing the abundance of invertebrate predators of zooplankton among vegetation types, could reveal predation risks for copepods and cladocerans in this system. Measurement or manipulation of the distribution of phytoplankton, suspended detritus, and other important components of zooplankton diet, could shed light on the influence of food resources on zooplankton distribution.

LITERATURE CITED

Pennak, R.W. 1978. Fresh-water invertebrates of the United States: Second edition. John Wiley and Sons: New York.

Poulin, D. L., R. F. Douzinas, A. M. Eaken, J. R. Mooney and D.R. Rubenstein. 1998. Diurnal zooplankton distribution in relation to aquatic vegetation in a tropical marsh. Dartmouth Studies in Tropical Ecology, p. 11-13.

Venegas, M. M. 2002. Peces presentes en los humedales temporales del Parque Nacional Palo Verde, Guanacaste, Costa Rica. Escuela de Ciencias Biológicas, Universidad Nacional de Costa Rica: Costa Rica.

EFFECTS OF HABITAT STRUCTURE AND PREY AVAILABILITY ON ABUNDANCE OF THE LYNX SPIDER *PEUCETIA VIRIDENS*

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Abstract: To test the hypothesis that *P. viridens* abundance varies with habitat structure and insect abundance, we quantified habitat structure as well as numbers of insects and *P. viridens* caught with sweep nets. Spider abundance varied among habitats and increased with flower number. Neither habitat nor insect abundance in sweep net samples affected *P. viridens* abundance. *P. viridens* abundance may be driven more by pollinator abundance (which probably responds to flower number) than by the abundance of insects within the vegetation.

Key Words: oxyopidae

INTRODUCTION

Spider abundance may respond to physical habitat structure and prey abundance (Arango et al. 2000, Foelix 1996). Some spiders select habitats with greater prey abundance, though some do not (Foelix 1996). We hypothesized that abundance of *Peucetia viridans* (Oxyopidae), the green lynx spider, would increase with increasing prey abundance and would respond to differences in physical habitat structure. Because we focused on physical habitat structure and its effect on prey availability, we examined insects within the vegetation, rather than flying insects visiting the patch.

METHODS

We sampled four 1 m^2 plots in each of three habitat types at Palo Verde National Park in Costa Rica: areas dominated by *Justicia comata* (Acanthaceae), a mix of low grass and *J. comata*, and low grass only. *J. comata* was producing abundant flowers at the time of sampling. In each plot, we counted the number of flowers and visually estimated percentages of green and brown vegetative ground cover. To estimate mean plant height, we measured the height of three haphazardly selected plants in each plot. In *J. comata* plots, we counted the number of stems per plot. In mixed and low grass plots where this was not practical, we counted stems in three haphazardly placed quadrats of 222