MACROINVERTEBRATES ASSOCIATED WITH *VALLISNERIA AMERICANA* AND *TRAPA NATANS* IN TIVOLI SOUTH BAY

A Final Report of the Tibor T. Polgar Fellowship Program

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ABSTRACT

Aquatic vegetation is an important part of river ecosystems, as a primary producer and as habitat for fish and invertebrates. The invertebrate communities associated with vegetated areas are not well understood. I assessed the benthic and plant dwelling invertebrate communities in the Hudson River outside of Tivoli South Bay, NY The dominant species of plants at the site were *Vallisneria americana* and *Trapa natans.* Samples of *Vallisneria americana* and *Trapa natans* were taken to estimate plant biomass in July and August. Sediment cores and a Downing sampler were used to collect benthic invertebrates and phytofauna (plant-dwelling animals). In many cases, the species of plant and/or location of the plant influenced the invertebrate communities. The most common invertebrates were oligochaetes, chironomids, *Sida*, and *Hydra*. *T. natans* had overall higher average densities of invertebrates than *V. americana*, and both kinds of vegetation supported much denser invertebrate populations than nearby unvegetated sediments.

INTRODUCTION

River ecosystems are productive and diverse, containing different microhabitats, which support diverse aquatic communities. Unfortunately, rivers are understudied and their dynamics are relatively unknown. Aquatic vegetation associated with rivers has been particularly understudied, but may be important in river ecosystems.

Vegetated beds are areas of high nutrient exchanges (Schoeberl 1988), and high rates of primary production. These areas provide refuge for invertebrates and juvenile fish from visual predators, as the vegetation reduces visibility. Both experimental and comparative studies have shown that the abundance and species richness of benthic freshwater macroinvertebrates is higher in habitats containing high densities of submerged macrophytes than in those having low densities (Gerking 1962, Crowder and Cooper 1982, Dvorac and Best 1982, Gilinsky 1984, Rabe and Gibson 1984, Gregg and Rose 1985, Hershey 1985, Diehl 1988, Anderson et al. 1990, Diehl 1992). These results were found in areas that contained fish, which suggests a refuge effect for the submerged vegetation. A combination of these conditions allows secondary consumers such as invertebrates and small fish to prosper.

Aquatic vegetation influences macroinvertebrate community structure by affecting both the physical characteristics of a habitat and the biotic interactions that occur there (Crowder and Cooper 1982, Heck and Crowder 1991, Feldman 1992). It is believed that many biotic and abiotic factors vary among aquatic plants species, with likely consequences on invertebrate community structure.

In the Hudson River, the vegetation beds are dominated by two species of aquatic vegetation: Trapa natans (water chestnut) and Vallisneria americana (water celery) (Findlay et al. 1997). These plants are structurally divergent (Figures 1 and 2) and influence the habitat differently.

Trapa natans (Figure 1) is a floating-leaved plant with large rosettes that float on the water's surface. Native to Eurasia, it was introduced to America in the late 19th century by a botanist. The plant was deliberately introduced to Collins Lake near Schenectady, New York in 1884. It entered the Mohawk River in the 1920s and finally into the Hudson River in the 1930s (Mills et al. 1997). It is a nuisance plant because its thick beds impede boating and other recreational activities. The rosettes release oxygen into the air, and the roots deplete the oxygen from the water column. As a result, the beds of Trapa can become anoxic in late summer (Schoeberl, 1988). The effects of these conditions on the biota are relatively unknown.

Vallisneria americana (Figure 2) is a submerged plant with ribbon-like leaves. The majority of the biomass is located underwater. The leaves introduce oxygen into the water column, and the roots use the oxygen, reducing the chance of the severe oxygen deficit found in the T. natans.

Phytofauna, or plant dwelling invertebrates, are another important part of vegetated aquatic ecosystems. They also serve as food for fish. These invertebrate communities have also been understudied in the Hudson River. Phytofaunal biomass and

Figure 1. Trapa natans

composition may be determined by several factors. Some authors have suggested that the abundance of littoral invertebrates is correlated with the biomass and species composition of their macrophyte substrate (Vincent et al. 1982, Downing 1986, Cyr and Downing 1988a, Lalonde and Downing 1992). Another theory is that a high macrophyte biomass may lead to less water turbulence, reducing the dislodgment of the invertebrates from the plants (Lalonde and Downing 1992). The phytofaunal biomass may be related to the epiphytic algae growing on the plants, because epiphyton-grazing invertebrates constitute a large proportion of the phytofauna (Lalonde and Downing 1992).

My work is part of a broader multi-year effort to study the functions of vegetation beds in the tidal Hudson River. I am interested in the benthic and phytofaunal (plant dwelling) invertebrates in macrophyte beds in the tidal freshwater region of the river. My goals are to determine the species composition and density of invertebrates in the sediment of the vegetated bed. Secondly, I have determined the species composition of epiphytic invertebrates on the two different species of macrophytes contained within the same bed.

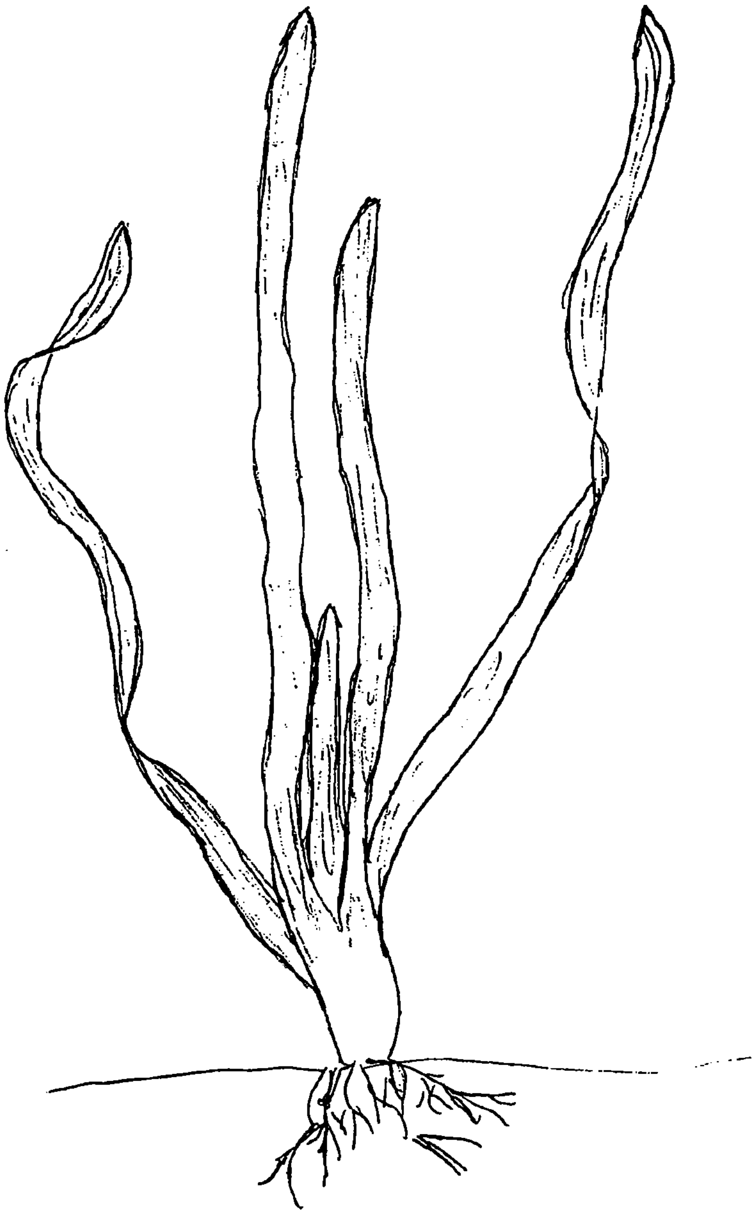

Figure 2. Vallisneria americana

STUDY SITE

The study site was located just outside Tivoli South Bay around Cruger Island (Figure 3). The bed was sampled around low tide, when the depth was approximately 1 m. The sediments were organic also having a large amount of clay particles. The eastern edge of the bed was bordered by the railroad tracks, and the western edge lay along the channel of the Hudson River.

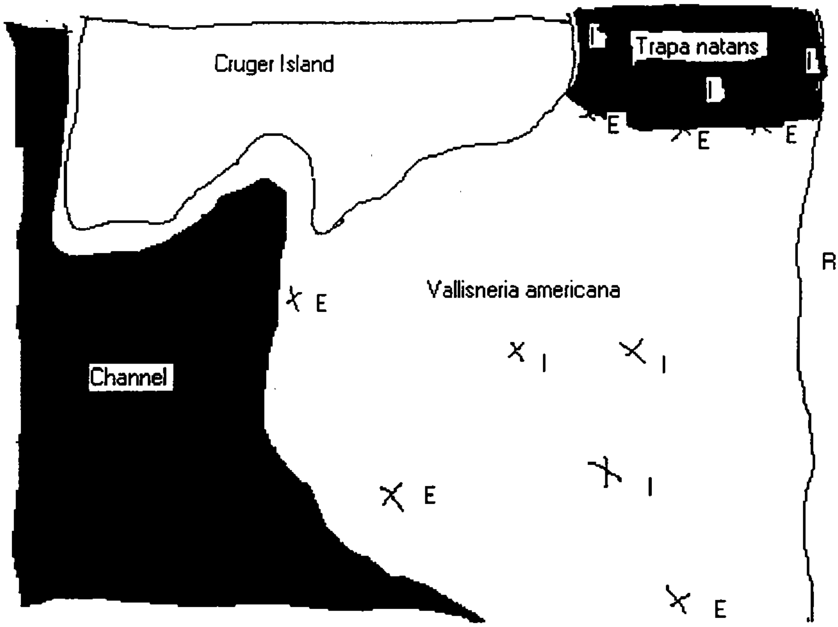

Figure 3. Schematic diagram of the study site, showing the placement of edge (XE) and interior (XI) samples.

METHODS

We divided the area of the bed that was predominately V. americana into three outside edge sites (E) and three interior sites (I) (Figure 3). The area of the bed containing predominantly T. natans was also divided into three outside edge and three interior sites (Figure 3). Each site was haphazardly chosen and sampled at or near low tide. Samples were collected in both July and August, 2000.

Plant biomass

The biomass of T. natans was determined by clipping the rosettes from a known area and weighing the clipped plant matter. Clippings were placed in plastic bags and taken to the lab in a cooler, then rinsed to remove excess silt before drying. The clippings were dried at 60° C for at least 24 hr before weighing. The biomass of T. natans was computed using the following formula:

T. natans biomass= dried weight of plant (g) /area of plant clipping (m^2)

V. americana was sampled differently from T. natans. Because of low visibility, V. americana was unclippable in both July and August, therefore a large PONAR grab (0.05 m^2) was used to sample the V. americana. Eight collections of the plant were taken at haphazard sites along the edge and interior of V. americana. Roots were removed from the collected plants, which were placed in bags and taken to the lab in a cooler. In the lab, the plants were rinsed of excess silt and dried at 60° C for at least 24 hrs. The biomass of the V. americana was determined using the following equation:

V. americana biomass= dried weight of plant/ $0.05m^2$.

Invertebrate communities

We sampled animals living in the sediments and on the plants separately. We collected sediment-dwelling invertebrates by hand-coring with a 20.02 cm^2 plastic tube. At each sampling site, three replicate cores were sieved through a 500 μm mesh sieve and pooled into a jar containing 5 % buffered formaldehyde. Therefore, at each site an area of 60.06 cm^2 of river bottom was sampled. Three sites in deep water (3-5 m) just outside the bed were sampled as well. The deeper sediment samples outside the bed were sampled using a petite PONAR grab (0.02 m^2). At each site, three grabs were sieved through a 500 μm mesh sieve and preserved in 5% buffered formaldehyde. All sediment samples were resieved through a 500μm mesh screen in the lab. The organisms were sorted into major taxonomic groups using a 6 X objective dissecting microscope.

Phytofaunal samples were collected using a 60 X 20 X 30 cm Downing sampler (Downing1986, Jackson 1997). At each sampling site, two (T. natans) or three (V. americana) samples were taken and pooled. The samples were sieved through a 500 μm mesh sieve and preserved in 5% formaldehyde. Before sorting the phytofaunal samples under the dissecting scope, each jar was vigorously shaken to dislodge the organisms from the plants. The sample fluid was re-sieved in a 500μm sieve six times, until most of the invertebrates were dislodged. The invertebrates rinsed off the plants were sorted under the 6 X objective of a dissecting scope. The blades of the plants were examined individually under the 6X objective of the dissecting microscope. The total count of invertebrates per sample was determined by adding the number of rinsed invertebrates to the number of invertebrates left on the leaves.

Following sorting, the leaves of the plant were dried at 60° C for at least 24 hrs and weighed to determine the dry weight of the plant. The number of organisms/g of dried plant was calculated using the following equation:

$$\# \text{ org/g dried plant} = \text{number of organisms counted/weight of plant}$$

After determining the # of organisms/ weight of plant, and average biomass of the plant, the # of phytofauna/ m^2 of river bottom can be determined:

$$\# \text{ org/m}^2 = \# \text{ org/g plant} \times \text{g plant/m}^2$$

The results of the invertebrate counts were analyzed using two-way ANOVA. The independent factors were generally species of plant and location of the sample, either in the interior or on the outside edge of the bed. The values were determined to be significant at the $p = 0.05$ level. Invertebrate densities were square-root transformed prior to analysis.

RESULTS

Plant biomass

T. natans had much higher biomass than V. americana in both months (Figure 4). There was also a strong effect of month, month*species combined, and the interaction between month *species*location. The figure also shows an interesting pattern occurring in the T. natans. The July biomass of T. natans shows the highest biomass located inside the bed. Conversely, the August biomass of T. natans is highest on the outside edge.

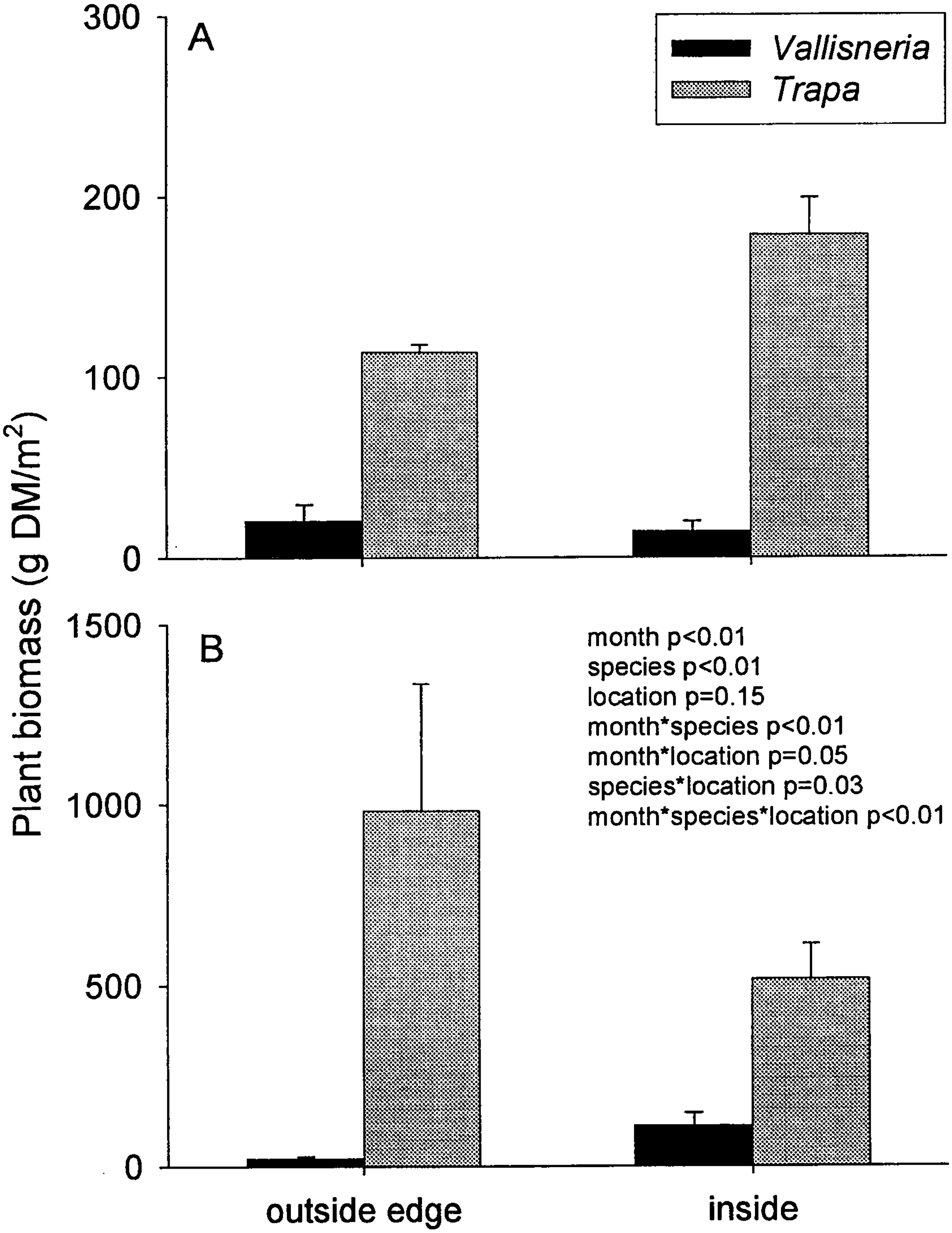

Figure 4. Plant biomass in July (A) and August (B) 2000. Note the differences in scales on the y-axes. Bars show the standard error.

Invertebrate Community

Table 1. Average densities (#org/m^2) of common invertebrates in benthic samples from plant beds at the study site.

Taxa	July	August
Oligochaete	1472	622
Chironomidae	245	123
Hydra	150	0
Nematoda	145	42
Sida	84	10
Amphipoda	52	45
Gastropoda	34	4
Turbellaria	11	5

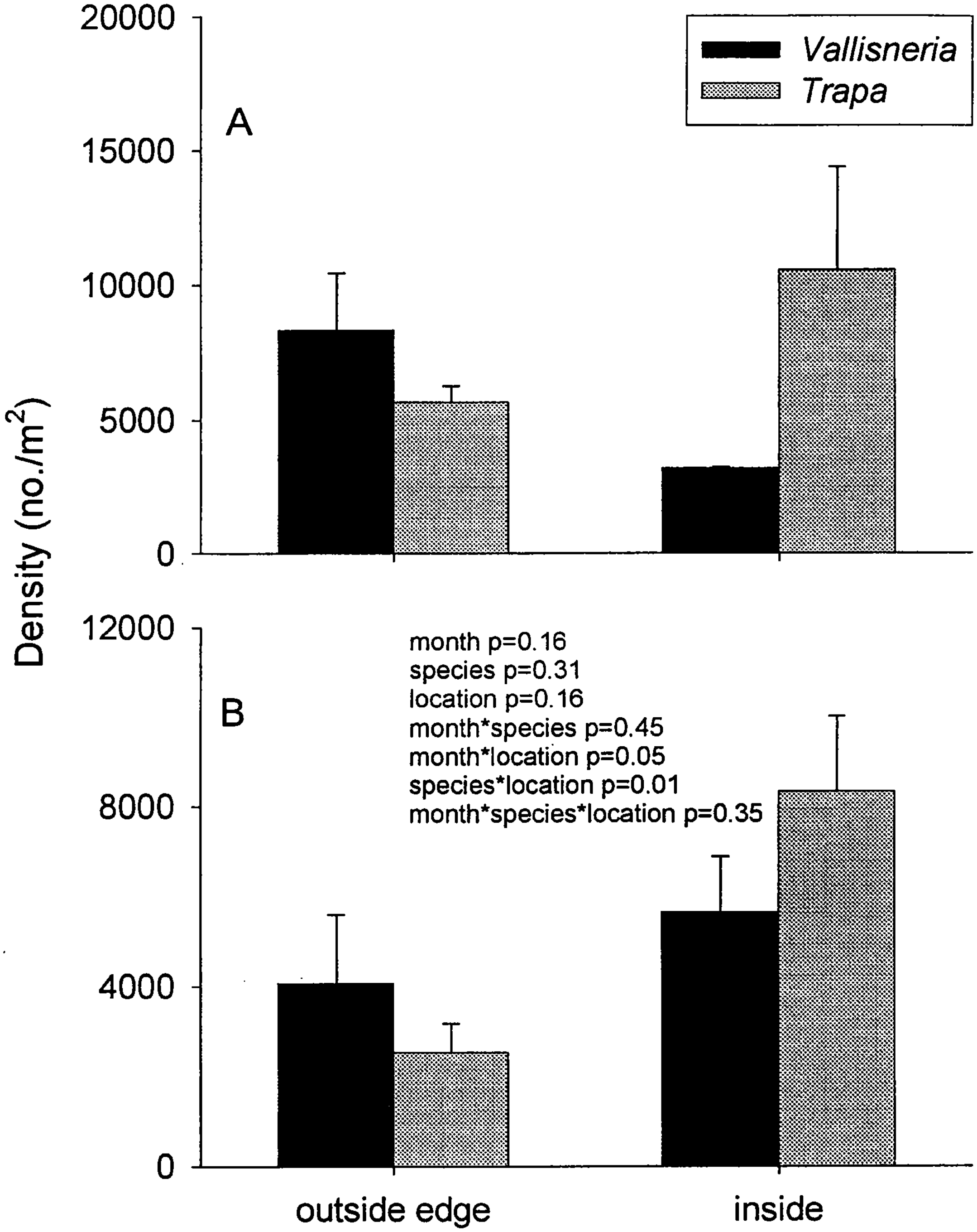

Figure 5. Density of benthic invertebrates ($\bar{x}$ ± SE) in core samples from the study area in July (A) and August (B). Note difference in scale.

In benthic samples, the interactions between species*location and month*location were significant (Figure 5). T. natans benthic invertebrate density was much higher inside the bed than any other sampling site. Conversely, V. americana showed a much higher density of invertebrates on the outside edge of the bed, though these densities are lower than what was found in T. natans.

After the analysis of the total benthic density was completed, three of the most common benthic animals (oligochaetes, chironomids, Sida) were statistically analyzed. For oligochaetes (Figure 6), the month, the interactions between month*location and month*species*location significantly affected density. Oligochaete densities were especially high along the outer edge of the V. americana bed in July. In August, the oligochaete densities increased in the inside of both T. natans and V. americana.

In July and August, T. natans had a much higher density of chironomids than V. americana (Figure 7). This is statistically supported because the only significant variable is the species of plant (Figure 7).

In July and August, T. natans had more Sida than V. americana (Figure 8). The V. americana had so few Sida in July, that densities were not visible on the figure. Densities were much higher inside the T. natans bed than outside for both months. The density of Sida inside T. natans during August (329 ind/m^2) was much less than in July (2193 ind/m^2). The only significant variable is the species of plant (Figure 8).

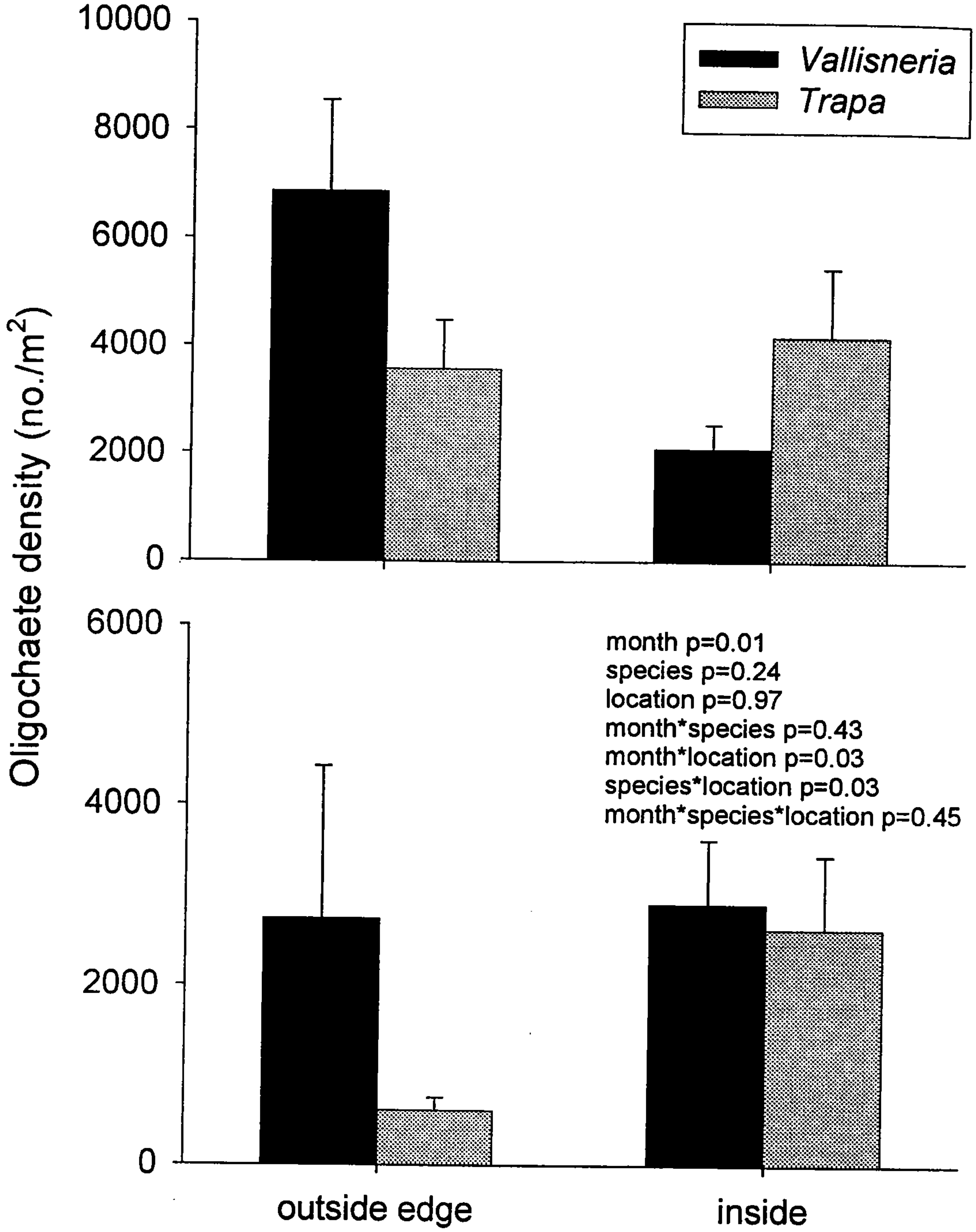

Figure 6. Density of benthic oligochaetes in July (A) and August (B). Bars are standard errors. Note differences in scale.

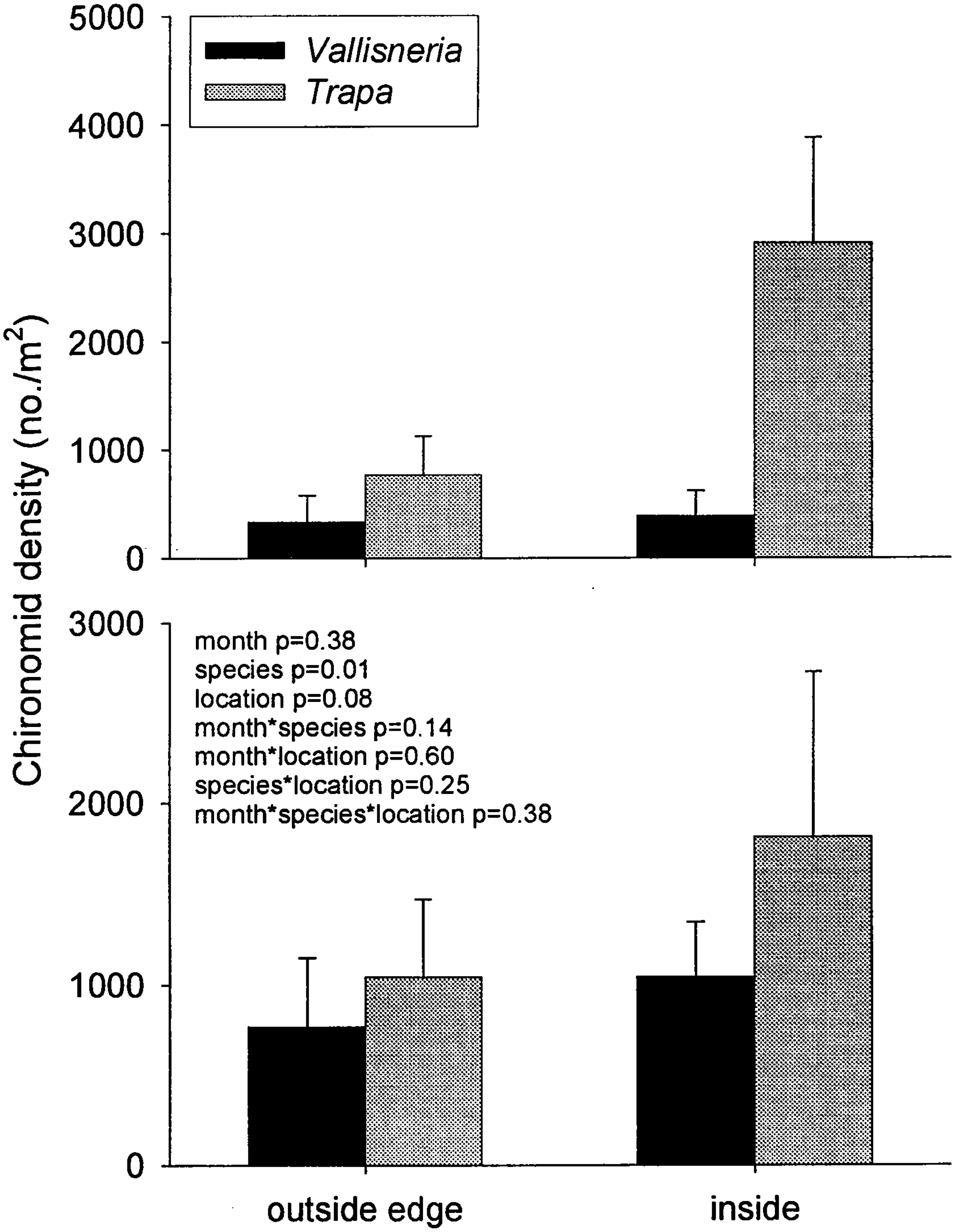

Figure 7. Density of benthic chironomids in July (A) and August (B). Bars represent one standard error. Note differences in scale.

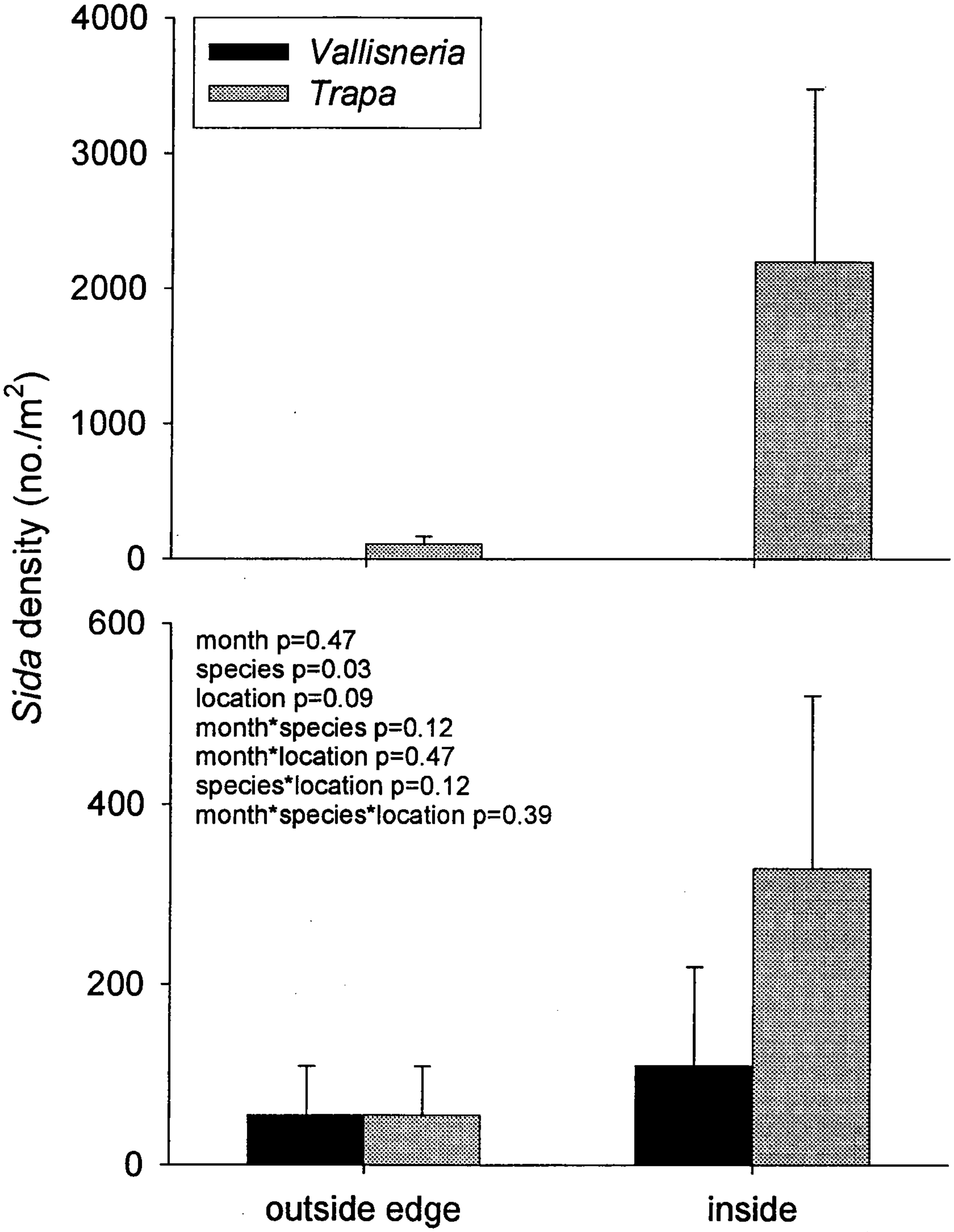

Figure 8. Density of benthic Sida in July (A) and August (B). Bars represent one standard error. Note differences in scale.

The phytofauna (plant-dwelling animals) was dominated by oligochaetes, chironomids, the cladoceran Sida, and Hydra (Table 2).

Table 2. Average densities (#ind/m^2) of common invertebrates in phytofaunal samples from the plant beds at the study site.

Taxa	July 2000	August 2000
Chironomidae	1516	504
Sida	966	112
Hydra	157	54
Oligochaete	78	282
Amphipoda	24	156
Nematoda	24	6
Gastropoda	2	1

In both months, plant species, sampling location, and their interaction significantly affected densities of phytofauna, but the pattern was very different (Figure 9). In July, T. natans had a much higher density of phytofauna than V. americana, but in August the pattern was reversed in the inside beds of each plant species. In July, the inside of the T. natans bed supported more invertebrates than the outside edge. In August, the phytofauna on T. natans was higher on the outside edge of the bed. This is supported by the significance of the interaction between the species of plant/month (Figure 9). In August, V. americana had a much higher density inside the bed than on the outside edge.

Phytofaunal oligochaete densities tended to be higher inside the plant beds than along their edges (Fig 10). The significant variables were month, location, species*location and month*species*location. In August an inverse relationship to July was noticed, where V. americana was highest inside the bed and T. natans was highest on the outside edge the bed (Figure 10).

Month, plant species, sampling location, the interaction between month*species and month*species*location all significantly affected the phytofaunal chironomid densities (Figure 11). The most significant variable was the interaction between month/species of plant. The location of sample was also highly significant, which may help to explain the interesting relationship in T. natans in August. Also, the amount of plant-dwelling chironomids significantly increased in August in the V. americana bed.

In July (Figure 12), only the interaction between month and species of plant was significantly related to the density of Sida. In July T. natans had more Sida than V. americana. In August, again, the T. natans had more Sida on the outside edge than the inside.

Density of phytofaunal Hydra populations was significantly affected by month and species of plant (Figure 13), with much higher densities on V. americana than T. natans. In both months, the density of Hydra was most dependent on the species of plant. Much higher densities of Hydra were found in August.

The presence and species of vegetation has a strong influence on invertebrate densities. The comparison between vegetated and non-vegetated areas is shown in Figure 14. As is shown, the month, vegetated vs. non-vegetated habitats (plants vs. open water), sediments vs. plant, and the interaction between vegetated/non-vegetated and sediment/plant are all signifigant. By comparison, the channel areas (open water), have much lower densities of invertebrates than the vegetated habitats. From July to August,