Difference in the aquatic micro-invertebrate fauna of two common foliose epiphytic lichens

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Abstract: The aquatic micro-invertebrate fauna of common greenshield lichen (Flavoparmelia caperata) and rough speckled shield lichen (Punctelia rudecta) from the same individual red oak (Quercus rubra) trees, in Otsego County NY, were examined to determine if there were differences between their respective micro-invertebrate communities. Paired 2g lichen samples from the same tree were soaked in individual 50 mL baths of de-chlorinated water, sprayed off and the wash water was examined for aquatic micro-invertebrates. While the aquatic micro-invertebrate fauna of the two species of lichens consisted of the same three metazoan phyla: Tardigrada (water bears), Rotifera (rotifers), and Nematoda (roundworms), the common greenshield supported several times the density of water bears, twice the density of rotifers, and more roundworms. Species occurrence, richness, and community composition also differed. Difference found between aquatic micro-invertebrate communities of two similar lichen species on the same tree, indicate lichens may present some exceptional opportunities for ecological research.

INTRODUCTION

Epiphytic tree lichens, also referred to as corticolous lichens, are common throughout the world’s forests. Over 100 species of corticolous lichens have been reported from New York State alone (Harris 2004). They have been the subject of numerous studies in New York (Brodo 1966), North America (Culberson 1955, Carmer 1975, Schutte 1977) and around the world (Harris 1971, Wolseley & Aguirre-Hudson 1997, Mistry 1998).

Corticolous lichens provide unique aquatic micro-habitats, which are widely dispersed throughout the terrestrial forest. These micro-aquatic ecosystems undergo frequent desiccation and exposure to the elements allowing only the hardiest organisms to survive. Three aquatic micro-invertebrate phyla commonly occur on epiphytic lichens: Bdelloid rotifers, round worms and water bears (Culberson 1955; Gerson and Seward 1977). The abundance of these micro-invertebrates on corticolous lichens appears to be correlated with lichen biomass (Stubbs, 1989) and humidity (Meininger et al. 1985).

While the occurrence of micro-invertebrates on corticolous lichens has been known for decades, the distribution of aquatic micro-organisms among the many different species of epiphytic tree lichens has not been studied. In this study two corticolous lichens, common greenshield lichen (Flavoparmelia caperata) and rough speckled shield lichen (Punctelia

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Common greenshield (*F. caperata*) and rough speckled shield lichen (*P. rudecta*) were utilized for this study (Figure 1). These two epiphytic lichens were selected because they were not considered to be sensitive or rare (Walewski, 2007; Brodo, Sharnoff & Sharnoff, 2001). These two species also shared the same habitat growing in close proximity on the same trees. These qualities made these lichens ideal candidates for a community association study.

Figure 1. Common greenshield (*Flavoparmelia caperata*) and rough speckled shield lichen (*Punctelia rudecta*) utilized in this study.
This study was conducted in Otsego County, NY outside the city of Oneonta (42.4711, -75.0253). All samples were collected from a single stand of red oak (*Quercus rubra*) that had been logged within the last thirty years. Elevation of the collection site was approximately 1800 feet above sea level. Red oak trees were chosen because they supported an abundance of epiphytic lichens. The two lichens chosen for this study were the most abundant species in the sample area and therefore represented the least chance for harvesting impact.

Winter data were collected from 15 paired samples made during January-March 2011. Summer data was collected from June-July 2011, and also consisted of 15 paired samples.

This study used a variation of Romano’s (2003) techniques for the collection of water bears. Trees were selected that supported colonies of both lichen species so that the lichens could be collected in pairs, one of each species from the same tree. Lichens were scraped off the tree with a pen knife. Samples were then placed in individual sealable plastic bags.

In the lab, 2 grams of lichen were removed from each sample and weighed on a digital scale. Each sample was then placed in a glass finger bowl filled with 50 ml of de-chlorinated water. After soaking for one hour the lichen samples were sprayed off and removed from the water. The water remaining in the finger bowl was examined for aquatic micro-organisms with a dissecting microscope. All micro-organisms found in the wash water were then transferred to a glass slide, examined under a compound microscope and identified utilizing Pennak (1989).

RESULTS

**Community Composition**

The aquatic micro-invertebrate fauna occurring on greenshield and rough speckled lichen were dominated by rotifers (Figure 2). Overall, the aquatic micro-invertebrate community on these two lichens consisted of 73.1% rotifers, 16.6% round worms and 10.2% water bears. However, the community composition of aquatic micro-invertebrate fauna of greenshield lichens differed significantly from rough speckled lichen in both the winter and summer (Chi Square Test P < .001).

**Density**

The density of micro-organisms per gram on greenshield lichen (16.4/g) was significantly higher than the density on rough speckled lichen (10.1/g, Chi Square test P < .001). Greenshield lichen had a significantly greater density of water bears and rotifers than rough speckled lichen in both winter and summer samples (Chi Square Test P < .001). Round worm density was comparable in the winter, but the rough speckled lichens had significantly more round worms than greenshield lichen in the summer sample (Chi Square Test P < .05).
Rotifer density was nearly identical between the winter and summer samples on greenshield lichen (6.13/g winter, 6.22/g summer) and rough speckled lichen (3.45/g winter, 3.53/g summer). Water bears showed a significant increase in density from winter to summer, on both greenshield lichen (0.8/g winter, 1.23/g summer) and rough speckled lichen (0.15/g winter, 0.52/g summer). Round worms showed the sharpest increase in density from winter to summer samples. Round worm density increased from 0.42/g in winter to 1.57/g summer on greenshield lichen and from 0.37/g (winter) to 2.05/g (summer) on rough speckled lichen. The high density of round worms in the summer data for rough speckled lichen can be partially attributed to a single sample that contained over fifty individuals (nearly half of the total for all 15 samples).

Population Correlations

Paired samples of greenshield and rough speckled lichens were collected from the same tree. Because of this close physical association and microclimate similarity a strong correlation was expected in the aquatic micro-fauna of each paired sample. However, this was not the case. There was no significant correlation between water bear density (r = .396) and nematode density (r = .348) on paired samples of greenshield and rough speckled lichen from the same tree (P > .05). Rotifer density on greenshield lichen was significantly correlated to rotifer density on rough speckled lichens (Figure 2) in the winter (r = .785, P < .001), but not in the summer (r = .475, P > .05). These data indicate that in spite of the close proximity between greenshield lichen and rough speckled lichen on the same tree, population density of rotifers in the summer, and nematodes and water bears in the winter and summer were independent of each other.
Species Richness

Species richness was difficult to measure. Philodina was the only genus of Rotifera found in the samples and round worms were particularly difficult to identify. Permanent slides of round worms did indicate that they belonged to at least two different families (Reyda, pers. Comm.). Only water bears provided enough data to examine species richness.

Greenshield lichen had more species of water bears (4) compared to rough speckled lichen (3). This was because Hypsibius sp. was found exclusively on rough speckled lichen (Figure 4). Overall, the water bear community was quite different between the two species of lichens and between the winter and summer months (Figure 4).
Figure 4. Density of water bear genera on greenshield and rough speckled lichens during the winter and summer.

Relative Abundance

Macrobiotus sp. was the most abundant water bear on winter samples of rough speckled lichen, but was the least abundant species on common greenshield lichen in the winter (Figure 4). In the summer Milnesium tartigrada, a predatory water bear, was most numerous on both species of lichen.

In the winter Echiniscius sp., Hypsibius sp. and Milnesium tartigrada were significantly more abundant on greenshield lichen than rough speckled lichen (P < .01, Chi Square Test). In the summer the densities of all species of water bears were higher on the greenshield lichen than on the rough speckled lichen. However, in the summer only the Echiniscius sp. (P < .01) and Hypsibius sp. (P < .05) were significantly more abundant on greenshield lichen, although both Macrobiotus sp. and Milnesium tardigradum were close with a P value of < .06).

The density of Echiniscius sp. and Hypsibius sp. was lower in the summer than in the winter samples on both lichens (Figure 4). However, summer densities of Macrobiotus sp. were significantly higher on greenshield lichen (P < .001, Chi Square Test) and Milnesium tartigrada densities where higher on both lichens (P < .001, Chi Square Test) in the summer.
DISCUSSION

Significant differences were found in community composition, density, species occurrence, species richness and relative abundance, between common greenshield lichen and rough speckled shield lichen. The hypothesis that two lichens with similar growth forms, identical habitats, and the same microclimate would support similar communities of aquatic micro-fauna was not supported by the results of this study. Some other variables, besides those previously mentioned, are responsible for the differences observed in the aquatic micro-fauna of these two species of lichens. Although the two lichen species share the same habitat and form (foliose), the micro topography of the lichen surface does differ. This could offer micro-communal advantages/disadvantages (Brodo et al. 2001, Walewski, 2007).

Some micro-invertebrate populations have been known to undergo large population fluctuations throughout the year (Little, 1986). However, rotifer populations did not act this way on lichens. Rotifer density was remarkably constant between winter and summer samples on both common greenshield lichen and rough speckled shield lichen. Also, rotifers were the only taxa to demonstrate a correlation in density on paired lichen samples found on the same tree. Future research is needed to gather more population data.

Differences found between aquatic micro-invertebrate communities of two similar lichen species on the same tree indicate that the study of the aquatic micro-invertebrate fauna of epiphytic tree lichens may present some exceptional opportunities for ecological research. While the aquatic micro-invertebrate fauna of the two species of lichen consisted of the same three metazoan phyla: Tardigrada (water bears), Rotifera (rotifers), and Nematoda (round worms), the common greenshield supported three times the density of water bears, twice the density of rotifers and slightly more round worms. Further study is warranted with different species of lichen and at different times of the year. A closer examination of rotifer and round worm communities should also be carried out.

The ephemeral aquatic micro-habitat found on corticolous lichens is a unique and poorly understood ecosystem. The diversity and numbers of aquatic organisms found on the thalli of common greenshield lichen and rough speckled shield lichen was remarkable. Additional research including several more species of lichen, such as lignicolous, terricolous, and saxicolous lichens, may provide a better understanding of these overlooked aquatic ecosystems.

REFERENCES


