A preliminary investigation of the epizooitic algae present on *Lavigeria* snails in the littoral region of Lake Tanganyika

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**Introduction**

Benthic algae in the littoral region of Lake Tanganyika serve as chemical modulators transforming inorganic chemicals into organic forms, represent habitats for other organisms, provide food for snails and cichlid fish and are important in stabilizing the substrata of community existence. These algae represent an evolutionary diverse group of photoautotrophic organisms that contain chlorophyll a and possess unicellular reproduction. There is high algal species richness in Lake Tanganyika although endemicty is not great. The total number of algal taxa is 927, belonging to 184 genera (Patterson, 1998). These algal groups are mostly diatoms, green and blue-green algae. Preliminary microscopic analysis has shown that a diverse community of organisms exists on the shells of snails. Since the nature of the substratum strongly influences benthic algal communities (Lowe and Pan, 1996) I thought it would be interesting to analyze the epizooitic algae present on *Lavigeria* snails.

**Objectives**

This study attempts to measure the biomass of the epizooitic algae present on three species of snails both living and dead, in the littoral region and compare that biomass with that contributed by the surrounding substrate. Further, a cursory microscopic examination of the epizooitic algae was accomplished as a springboard for further research.

**Null Hypotheses**

1. No difference will be found between the biomass present on three species of *Lavigeria* and the rocks.  
2. No difference will be found between the biomass present on a comparison of the three species of living, *Lavigeria* snails.  
3. No difference will be found between the biomass present on living and dead *Lavigeria* snails.

**Methods**

**Study Site**

The study site chosen for this experiment was South Jakobsen’s Beach, Lake Tanganyika (4° 54.64’S 29° 35.92’ E). This is a relatively undisturbed location located on the eastern shore of Lake Tanganyika, southwest of Kigoma. This site offered easy access to swimmers and had been studied many times before by Nyanza researchers. Previous papers yielded data regarding snail densities (McIntyre & France, 1998) and measurements of benthic biomass (Solomon, 2001) on rocky substrates.

**Gastropod Measurement**

A digital calipers, Fowler Ultra Cal Mark III was utilized to make the following measurements.

1) Height: Maximum height measured from the apex to the basal inflection of the aperture.  
2) Width: Maximum width of the shell and any extensions of shell sculpture measured perpendicular to Height.  
3) Lip Thickness: Apertural lip thickness measured at the widest point of the lower and outer apertural inflection with calipers inserted a standard 2mm from the lip and between horizontal ribs.  
4) Aperture-apex: Preapertural height measured from the upper intersection of the last whorl at the aperture to the apex.
Surface area of the snails was determined using the formula for a cone and subtracting the surface area of the aperture:

\[
\text{Surface Area of the Snail} = \pi r L - (\text{Ap.L} \times \text{Ap.W})
\]

Other methods were tried including volumetric ones and tin foil measurements but did not provide good results.

**Algae Observation and Identification**

Adult snails were first placed on a dissecting scope for preliminary analyses. Observations were recorded regarding algal type with reference to position on the shell and checked for the presence of microfauna. Next the snail was scraped clean with a scalpel and distilled water and the slurry examined using 100x magnification on an Olympus compound microscope with identifications provided by Dr. Christine Cocquyt.

**Quantification of the Standing Stock of Benthic Algae:**

I quantified the standing algal stock growing on both living and dead shells of three species of *Lavigeria* (*L.grandis, L.coronata* and *L. nassa*) and from rocks in the same habitat. Fifteen snails of each species and nine rocks were collected from three meters water depth. An attempt was made to collect snails of the largest sizes within each species (as a proxy for keeping age constant) and were taken from the tops of randomly chosen rocks.

The rocks and the snails were stored in lake water, kept in the dark, and taken back to the lab where they were processed within 24 hours for analyses. The periphyton was sampled by placing a 3cm bottle cap over the center of the upward facing rock and scrubbing the surrounding area clean of algae with a wire brush. Then the area under the cap was exposed and scrubbed again to collect the algal slurry. The snails were entirely scraped clean of algae with a wire brush. The slurry was measured with a graduated cylinder and a sub-sample was poured through a 25mm Gelman glass filter using a vacuum pump to increase filtration. Chlorophyll a was extracted from the filter by placing the disk into a 10ml solution of 90% ethanol and stored in a refrigerator for 24 hours. The sample tubes were then analyzed by first inverting them three times and placing them into a centrifuge for 5 minutes to increase homogenization of the solution. Fluorometric analyses with Aquafluor, Turner Systems followed immediately. Acidification with 0.1mL of 1N HCl/mL of extract was then used to control for absorbance by phaeopigments (Solomon, 2001). Chlorophyll a concentration per sq.cm. of snail and rock was then calculated using:

\[
\text{Chlorophyll a in } \mu\text{g/cm}^2 = 0.0009(F_{\text{pre}} - F_{\text{post}}) \left\{ \frac{\text{EVl}}{v\alpha} \right\}
\]

The standing stock of rocks at depths of 0.2, 0.6, 1.0, 2.0, 4.0, and 6.0 meters, as suggested by Solomon, 2001 were also calculated for contextual and historical reasons (McIntyre, pers. comm.). The sample collection procedure was similar although the analysis used a fluorometer and not a spectrophotometer.

A nested analysis of variance was calculated using SYSTAT v. 4.0 to test for the effect of snail species and live/dead status on chlorophyll a/sq.cm.

**Results**

Algae was concentrated on the spires of shells and along the outside lip of the aperture. The microscopic analyses indicated that the rocks had greater algal diversity than the snails. Typical benthic diatoms such as *Rhopalodia, Epithemia, Gomphonema, Nitzschia, Cymbella, Encyonema, Gomphocymbella* and *Gomphonitzschia* were observed on both snails and rocks. The blue-green alga, *Gloeotrichia* and various nitrogen fixers were also observed. Many green algal forms were evident, but were unidentifiable with our microscopes. The rocks had a greater number of blue-green nitrogen fixers present.
Chlorophyll a values measured on rocks ranged from $12.75 \pm 2.30 \mu g/cm^2$ (mean ± SE) at 0.6m to $4.27 \pm 0.44 \mu g/cm^2$ at 6.0m. The greatest variation was shown on the rocks at shallow depths (Fig. 1 a&b). Chlorophyll a averaged $7.1 \pm 1.4 \mu g/cm^2$ at 3 meters, the depth of snail collections.

Chlorophyll a values for live snails did not differ significantly ($p=0.8620$). Values ranged from $10.74 \pm 1.42 \mu g/cm^2$ for L. nassa, $9.018 \pm 1.33 \mu g/cm^2$ for L. grandis and $8.761 \pm 0.66 \mu g/cm^2$ for L.coronata (Fig. 2).

Chlorophyll a values for dead shells differed highly significantly from live snails of the same species ($p=0.000$). The values were similar between snail species for dead shells as well, with $4.349 \pm 0.851 \mu g/cm^2$ for L. grandis, $3.493 \pm 0.89 \mu g/cm^2$ for L.nassa and $3.285 \pm 0.608 \mu g/cm^2$ for L.coronata (Fig. 2).

Lavigeria nassa was the only species of snail that had a notably higher amount of chlorophyll a per sq.cm than the surrounding rock, although the averages from all snail species were higher than the rock averages (Fig. 2).

Discussion

Initial microscopic impressions were that the diversity of algae was greater on the rocky substrate. Particularly noticeable was the diversity and abundance of the blue-greens with their obvious heterocysts on the rocks. Studies of phytoplankton have shown that phosphorus enrichment leads to communities dominated by nitrogen-fixing cyanobacteria. In previous aquatic studies, Rhopalopodia and Epithemia have been shown to be nitrogen specialists. Gomphonema on the other hand has been shown to be a phosphorus specialist (Stephenson, 1996). This genus was prevalent on the rocks collected from Jacobsen's beach.

Benthic algae have little control over removing themselves from a resource poor environment. Attachment to a snail however, might provide these epizootic forms with a means of moving toward light or entering a more resource rich environment. Snails have been shown to release nutrient rich waste and release CO$_2$. There is precedent for considering snail shells as an especially attractive habitat for algae. The red algae Boldia erythrosiphon thrives under the high manganese environment found on shells of freshwater pleurocerid snails (Stephenson, 1996).

Past biomass studies on rocks show similar results to those in this study after logarithmic transformation (Solomon, 2001). However, there was great variability in the data set this year. The rocks were collected at “Babyland”, a highly patchy environment which might explain my variable results.

Although the contribution of epizootic algae on snails to the total biomass of the littoral region was not overwhelming (snails contribute 0.3mg/m$^2$ while rocks contribute 50mg/sq.m) it is still notable that snail shells provide a unique habitat. This contributes to the patchiness of an already diverse environment, adding yet one more layer to the complexity of the diverse Tanganyikan benthos.

Suggestions for Further Research:

It has been said that life is the ultimate monitor of environmental quality (Lowe and Pan, 1996). Aquatic organisms integrate into their metabolism all of the biotic and abiotic parameters available to them. An analyses of the epizootic algae present on snails could eventually serve as an indicator of environmental pollution in Lake Tanganyika.

Many more questions were raised than answered during this research. What kinds of algae are present on the snails? Was the community different than that found on the surrounding substrate? Was it purely happenstance or did it serve some purpose for the snail or the algae in question? Did the snail reap benefits in protection from crab predation? Or did the algae impede the snail's movement? Did the algae grow on the snail to attract fish grazers who in turn brought nutrients? Did the algae produce any drag effects on the snail? Did the sculpturing of the snail provide any niches for algal growth? What did the algae receive from the snail? A free ride to nutrients or increased exposure to light? Did different species of algae grow at different times in the life history of the snail? Could this be an algal dispersal mechanism? Are the algae
attracted to the high mineral content of the shell itself? Were there differences in the snails at disturbed vs. undisturbed sites? Did the algae provide a habitat for a “snail community? What morphological differences exist as algal adaptations for attachment to the snail? Could algal growth be a selecting agent influencing morphology of the snail? These questions will be answered by future Nyanza participants.

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References

Cocuyt, C. Personal communication. 20 July. 2002.


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**Figure 1a:** Chlorophyll versus Depth

![Chlorophyll versus Depth](chart.png)
**Figure 1b:** Mean Chlorophyll versus Depth

**Figure 2:** Chlorophyll for Snails