

## **Limnological patterns in relation to pelagic fish stomach contents in Lake Tanganyika (Kigoma, Tanzania)**

**Cris Oppert**  
**Kansas State University**

**Pierre-Denis Plisnier**  
**Project Mentor**

### **Introduction**

Lake Tanganyika is an extraordinarily ecologically diverse lacustrine system with over 650 endemic species (Coulter, 1991). The relatively low input and output of river systems in the lake results in an extremely long residence time. This creates a unique opportunity for the evolution of the lake. Ecological relationships between the abiotic and biotic interactions in Lake Tanganyika can be useful tools to help understand better the future conditions of the lake. Studies of the limnological environment, plankton, and pelagic fisheries catches are beneficial in providing information for the lake's fishing economy. Improved management strategies, for example, may possibly arise as a result of lake research.

To gain added knowledge about fish ecology, stomach contents of pelagic fish were analyzed to determine fish prey composition and numbers. Water chemistry and zooplankton tows were also examined. The study site was less than ten kilometers northwest of Kigoma, Tanzania. Results of the water chemistry analyses, zooplankton tows, and stomach contents were compared to determine relationships between the three, if any.

### **Objective**

This study is designed to correlate patterns between water chemistry, zooplankton composition, and stomach content of pelagic fish.

### **Methods**

Four night boat trips on the R/V Echo were undertaken to collect fish, water, and zooplankton samples in the pelagic zone. Water samples were taken at 20-meter intervals from 100 meters to the surface. Temperature, pH, and dissolved oxygen were measured as the water samples were taken. Water samples were further analyzed in a laboratory using a spectrophotometer. Turbidity, conductivity, nitrates, soluble reactive phosphorous, ammonia, silicates, and chlorophyll a were determined. Zooplankton tows were taken from 100 meters to the surface using a 100 mm net. Zooplankton abundance and composition was estimated under a microscope in a laboratory. Zooplankton and water chemistry analyses were performed as a part of research conducted by other Nyanza Project participants.

Local fishermen were towed to a site near where the water sampling was performed. Fishing was conducted from a catamaran using a lift net from ca. 100 meters to the surface. An estimate of the total weight of the fish catch was determined. Between 20 and 33 fish of each species were taken from each catch. In addition, age cohort sub-samples were also taken for *L. stappersii* (i.e. juvenile and adult). Stomach contents were preserved as soon as possible after catching the fish. This was done by either injecting the abdominal cavities of the fish with 10% formalin or by dissecting the digestive tract into vials filled with 10% formalin. Fish sub-samples were numbered and their total length determined. In a laboratory, stomachs were examined under a stereomicroscope to determine their relative fullness and composition. Fullness was approximated using a scale of 0 to 5, with 0 indicating an empty cavity and 5 denoting those which are very full.

## Results

The four night samplings were conducted on July 22 (4° 49' S, 29° 23' E), August 1 (4° 50' S, 29° 29' E), August 4 (4° 49' S, 29° 32' E), and August 8 (4° 49' S, 29° 33' E). Moon phases for July 22 was between full and half moon, half moon for Aug. 1, between half and new moon for Aug. 4, and new moon for Aug. 8. Species of fish caught included *Lates stappersii*, *Stolothrissa tanganyicae*, and *Limnothrissa miodon*. Total catch weights varied from 2 to 275 kg (fig. 1). Juvenile *L. stappersii* composed the majority of the catch by weight on July 22 and Aug. 1 (fig. 2). Adult *L. stappersii* and *S. tanganyicae* were the major catch species on Aug. 4 and Aug. 8, respectively. *L. miodon* was caught on only Aug. 4 and did not make up a significant proportion of the total catch.

Average length of juvenile *L. stappersii* increased from July 22 until Aug. 8 (fig. 3). Average length of *S. tanganyicae* increased from July 22 to Aug. 4, but decreased on Aug. 8. Profile length frequencies for juvenile *S. tanganyicae* (with the exception of the Aug. 8 sampling) and *L. stappersii* were composed of a high number of fish within a relatively narrow length range. Adult *L. stappersii*, on the other hand, showed a broad distribution of lengths (fig. 4). Length vs. weight profiles for *S. tanganyicae* and adult *L. stappersii* produced a positive correlation (fig. 5 and 6).

Fish was found in the most abundance for *L. stappersii* (fig. 7), with adult stomachs containing nearly all adult *S. tanganyicae*. *S. tanganyicae* stomachs were composed mostly of copepods and unknown material (fig. 8). Juvenile *L. stappersii* stomachs contained more calanoids than the smaller-sized cyclopoids whereas in *S. tanganyicae* stomachs the opposite was true (fig. 9).

Turbidity decreased for the first three sampling dates and increased on the last (fig. 10).

Chlorophyll a was highest on the first sampling date, lowest on the second, and at intermediate levels on the last two samplings (fig. 11). In contrast, total copepod numbers in the water column followed chlorophyll a levels in an inverse relationship. Ratios of cyclopoids to calanoids in the water column were 1.94 for July 22, 3.81 for Aug. 1, 5.63 for Aug. 4, and 4.19 for Aug. 8.

## Conclusions

Data obtained from this study suggests several predator-prey interactions in the food web dynamics of Lake Tanganyika. When copepod levels are low, algae is consumed in lower numbers resulting in higher chlorophyll a values (see July 22, fig. 11). In contrast, when copepod levels are high, chlorophyll a concentrations are lower (see Aug. 1, fig. 11). This, in turn, can effect population sizes of juvenile *L. stappersii* and *S. tanganyicae*. For example, an increase in copepod abundance from July 22 to Aug. 1 corresponds with an increase in the length frequency of both fish species (fig. 3). On July 22, juvenile *L. stappersii* composed most of the catch (fig. 2). This finding corresponds with the low cyclopoid:calanoid ratio observed on the same date and with the high number of calanoids found in juvenile *L. stappersii* stomachs (fig. 9). On Aug. 1, *S. tanganyicae* becomes a more significant portion of the catch. This also corresponds with the higher cyclopoid:calanoid ratio on this date and the higher number of cyclopoids found in *S. tanganyicae* stomachs.

The large percentage of adult *L. stappersii* caught on Aug. 4 corresponds with a low turbidity level. Clarity of the water column effects predator-prey relations between *L. stappersii* and *S. tanganyicae* (Coulter, 1991), with a decrease in *L. stappersii* numbers with increasing turbidity. Therefore, low turbidity combined with the half moon phase providing light could be providing the right conditions for the adult *L. stappersii* to

dominate the water column on Aug. 4. On Aug. 8, turbidity slightly increases and there is a new moon resulting in a drop in adult *L. stappersii* numbers.

Size of prey rather than their abundance appears to be more of a determining factor in prey selection. Juvenile *L. stappersii* are roughly twice the size of *S. tanganyicae*, and eat a more calanoids than the smaller cyclopoids. *S. tanganyicae*, however, eat cyclopoids. Adult *L. stappersii* eat almost entirely fish, all of which found were adult *S. tanganyicae*. These findings do not always agree with the zooplankton composition of the water column. For example, on July 22 there were roughly twice as many cyclopoids in the water column but stomach content of juvenile *L. stappersii* was about 90% calanoid.

### **Future Research**

These conclusions are based on general trends interpreted from data collection. Trophic level interactions are very complex and often will depend upon several factors which may or may

not be available in the data. For this reason, this type of study is best done over a long period of time with many sampling dates conducted.

One addition which would help increase the value of the data is an echo sounder. Using this device, it would be possible to find the depth where fish are present during the fish catches. This would be useful for making stronger correlations between the water chemistry, zooplankton, and fish.

### **Acknowledgements**

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### **References**

Coulter, G. Lake Tanganyika and Its Life. 1991

### Total Catch Weights

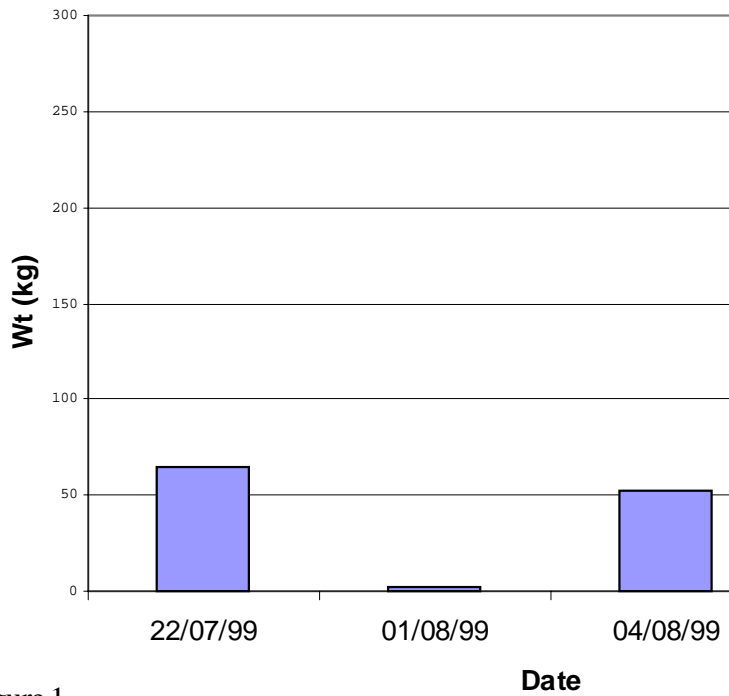


Figure 1

### % Composition (by weight) of Fish Catches

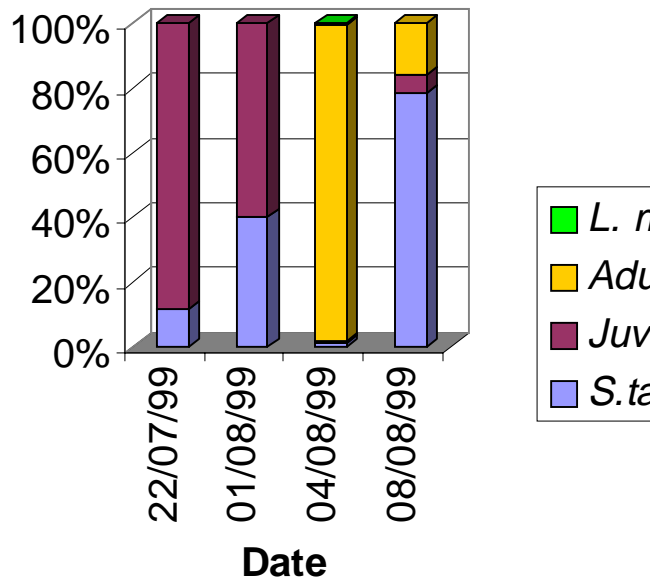


Figure 2

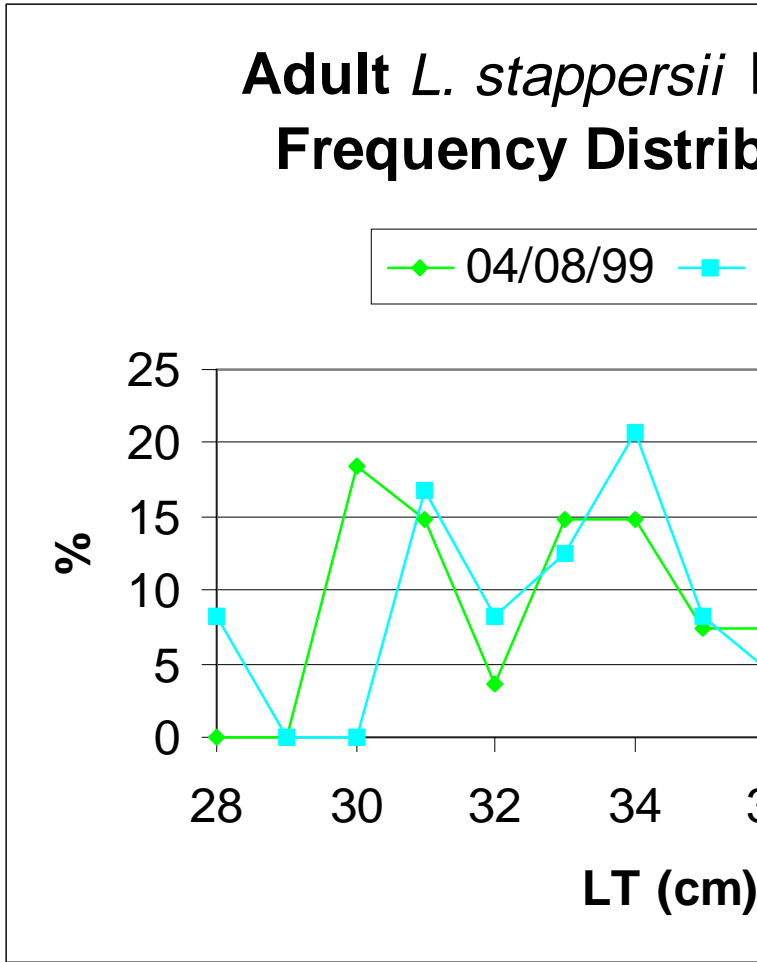


Figure 3

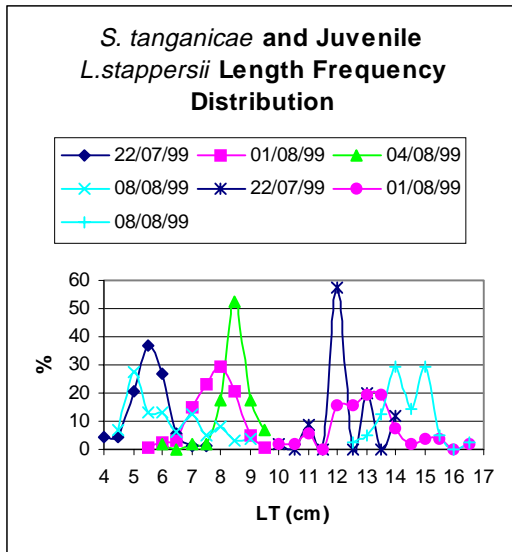


Figure 4

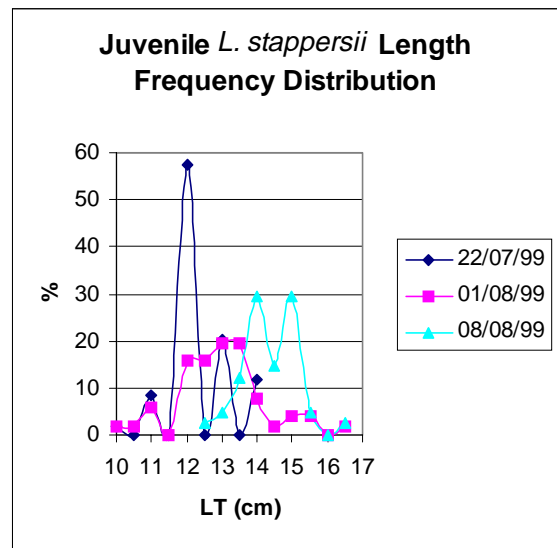


Figure 5

### Length vs. Weight of Adult *L*

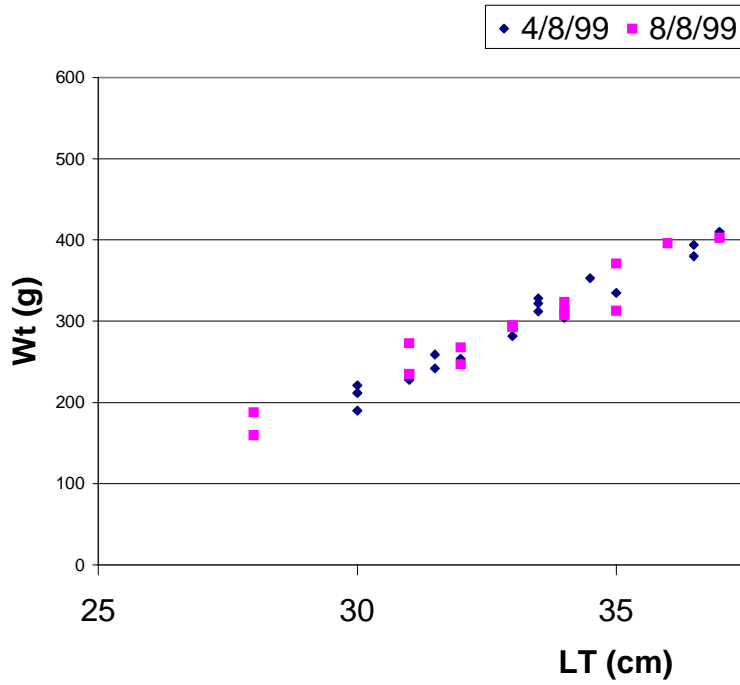


Figure 6

### Length vs. Weight of *S. ta*

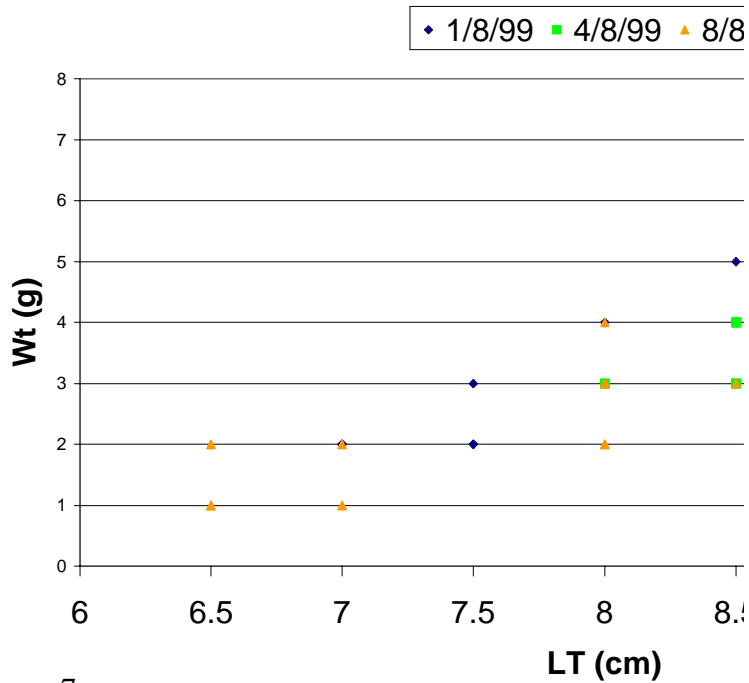


Figure 7

### % Copepods in Fish Sto

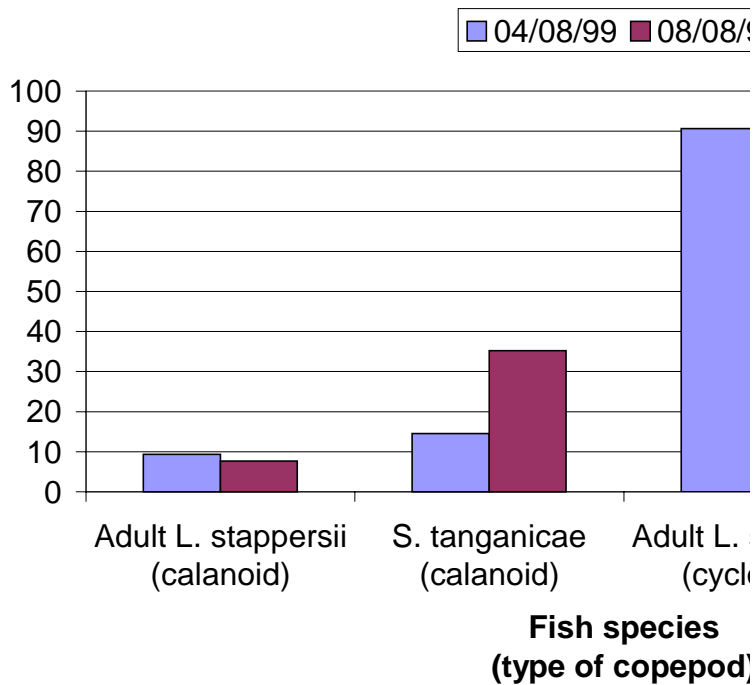


Figure 8

### Ratio of Copepods in Fish vs.

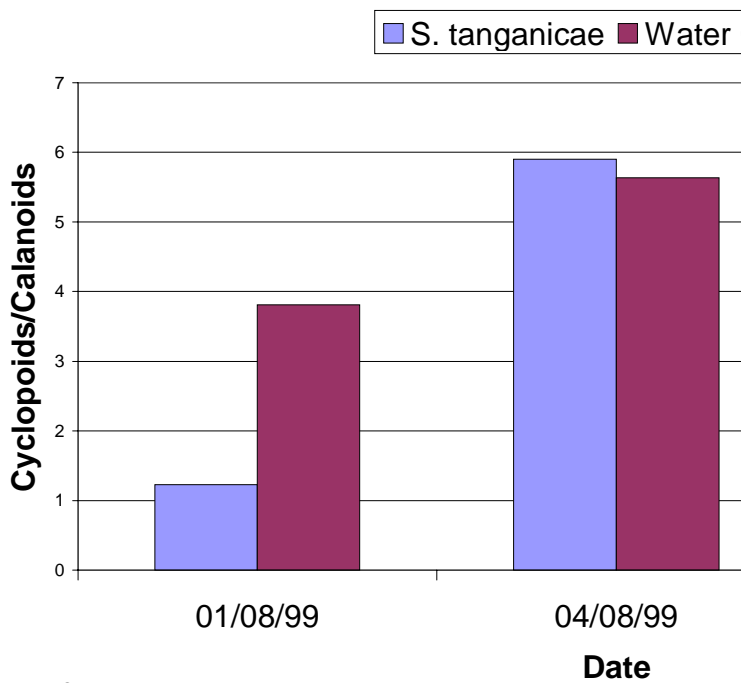


Figure 9

### Turbidity

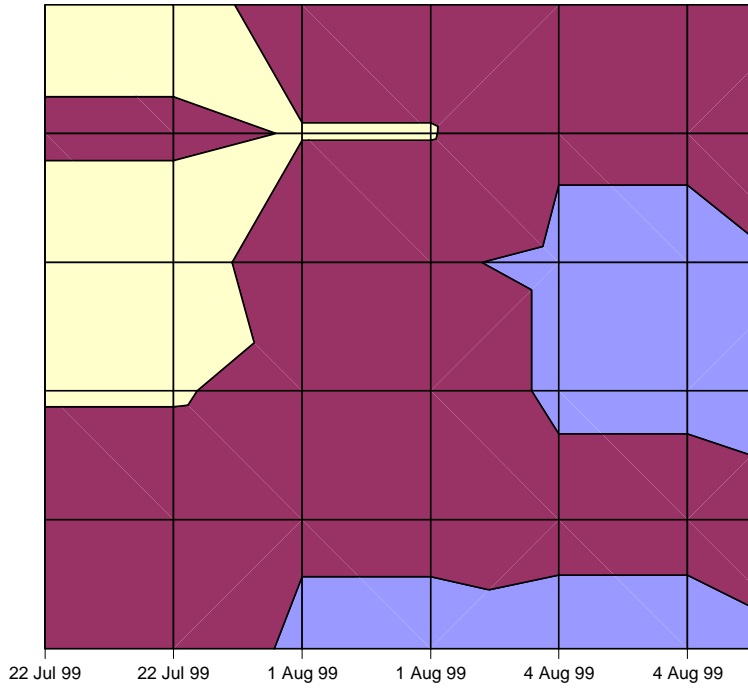


Figure 10

### Chlorophyll a

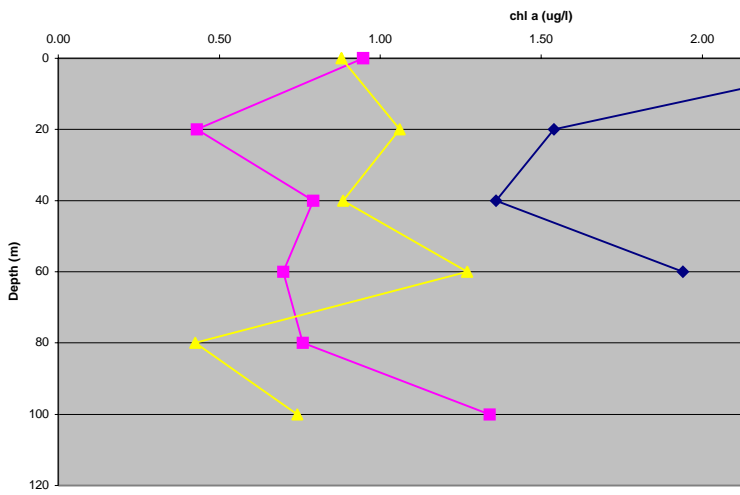


Figure 11