

Investigation on limnological parameters in relation to composition of fish catches in Lake Tanganyika in the Kigoma area

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Introduction

Lake Tanganyika is the largest, deepest (1470m) and oldest of the western part of the East African rift lakes (Cohen *et al*, 1993). This lake is located between 3° 20' - 8° 45'S and 29° 05' - 31° 15'E. Its surface area is 32,600km² and its maximum length is 650km and mean width is 50km. During the dry season from May to September, the southeast winds tilt the thermocline northward over the entire lake. In the south basin, the thermocline is close to the surface resulting in an upwelling of nutrients into the epilimnion (Coulter, *et al* 1991).

The productivity of Lake Tanganyika, like the sea and probably like other large deep tropical lakes, depends to a large extent on the regeneration of nutrients from the water column. Nutrient rich waters are observed below the thermocline. Their accesses to the upper photic layers are highly dependent of hydrodynamic events driven by climatic conditions (Plisnier *et al*, 1999).

Also Lake Tanganyika has a vitally important pelagic fishery, composed of *Lates stapersii* (migebuga) and two sardines, *Stolothrissa tanganyicae* and *Limnothrissa miodon* (daga). Usually, fishing is done during the night. There is a very high variability in fish catches.

The objective of this study was to determine the limnological parameters in relation to the composition of fish catch. Especially, by studying per haul during the night fishing at different positions or sites on Lake Tanganyika in the off shore from Kigoma bay, we can try to understand possible relationships.

Materials and Methods

The following parameters were measured in the field: water temperature, dissolved oxygen, pH, conductivity and turbidity. In the laboratory, water samples were analyzed for soluble reactive phosphorus, alkalinity, nitrate, silica and chlorophyll a. The sampling depth for temperature and dissolved oxygen were done at every 10 meters and the rest parameters taken at a 20 meters interval up to 100 meters. Water temperature was measured using thermometer coupled to a dissolved oxygen meter (YSI model 58) connected with a cable reaching 90 meters depth. At a hundred meter water sampler with a capacity of 7.4 liters was used to collect water, thus temperature and dissolved oxygen at that depth was taken by dipping, carefully, an oxygen probe into the water sampler. pH was measured using an Orion pH meter (model 210A). Conductivity ($\mu\text{S}/\text{cm}$) was measured using a (Cole/Parmer) conductivity meter (model 19820-00). Turbidity measurements (NTU) were taken using a HACH turbidity meter (model 210A).

Water samples were collected in plastic bottles for soluble reactive phosphorus, nitrate, silica, alkalinity and chlorophyll a analysis in the lab. Alkalinity was determined by titrimetric method using a digital titrator with continuous stirring using a magnetic stirrer. Chlorophyll a was measured by reading absorbances at 665nm and 750nm using a spectronics 21D spectrometer after methanol extractions. The nutrients such as soluble reactive phosphorus, nitrate and silica were measured by using a HACH DR/2010 spectrophotometer.

Results

Generally, water temperature decreased with depth. The maximum and minimum water temperature was 26.0°C at the surface and 23.7°C at 100m on July 19 and on July 26 respectively. The thermocline was at 70m on 16th and 19th, July but after a storm it dropped to 85m, 75m and 75m on 24th, 26th and 30th July respectively (Figure 1).

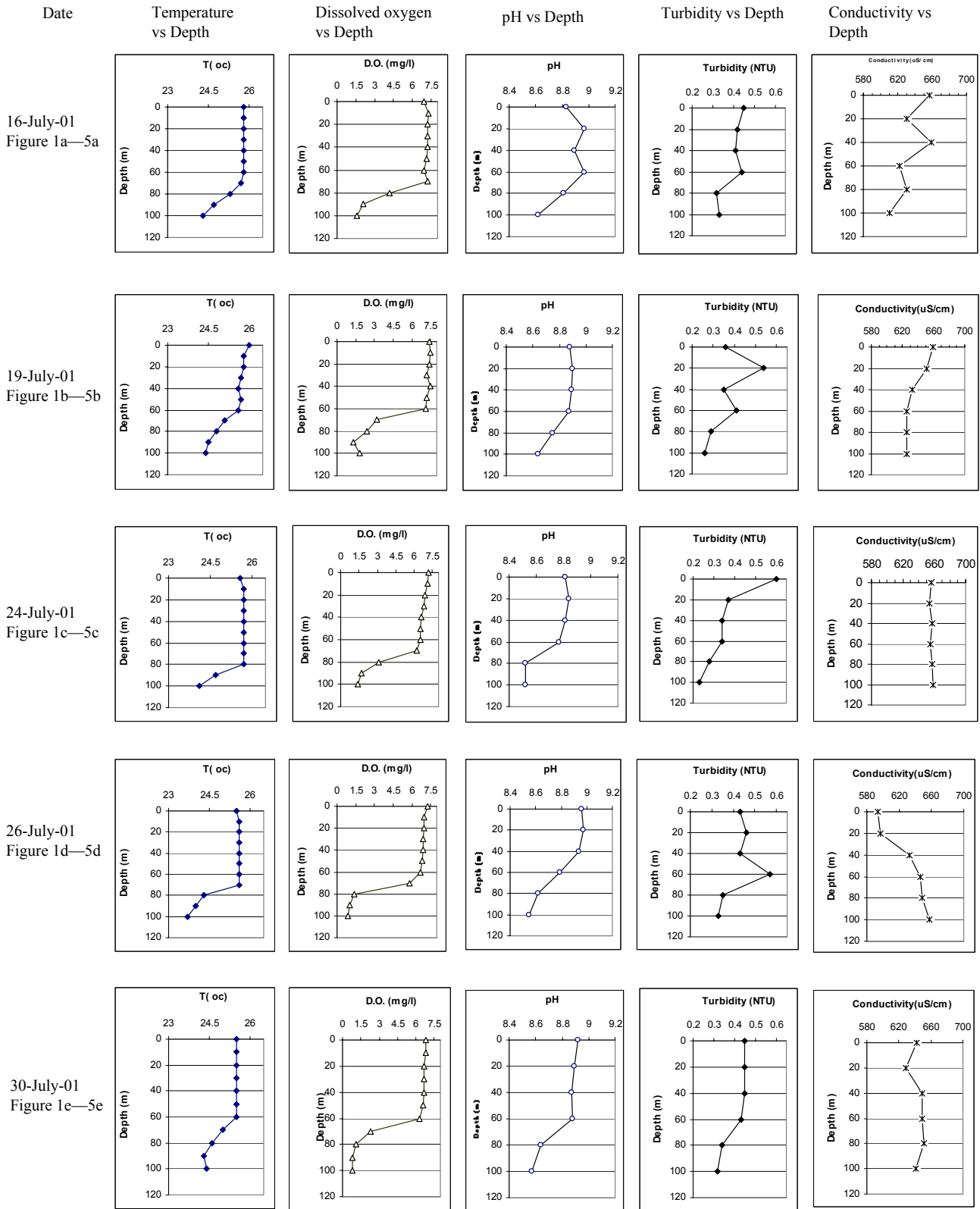


Fig. 1-5: Physical parameters v/s Depth

The study showed that pH was decreasing with depth yet showed deviation from the observed trend (Figure). The pH ranged between 8.96 at the water surface and 8.55 at 100m. The average pH was 8.76 (Figure 3).

The highest dissolved oxygen was 7.5mg/l at depth of 10m on July 19th. Dissolved oxygen profile remained generally constant from 0m to 60m deep. The oxycline was at 80m, 70m, 80m, 75m and 70m on July 16th, 19th, 24th, 26th, and 30th respectively (Figure 2 and Table 1).

Turbidity varied from one day to another. The average turbidity was 0.40 NTU, 0.37 NTU, 0.36 NTU, 0.43 NTU, and 0.41 NTU on 16th, 19th, 24th, 26th and 30th, July respectively. This said, the water was more turbid on July 26th and less turbid on 19th July (Table 1).

There was a significant variation in conductivity to everyday samples. On July 24th there was an increase in conductivity although at 20m and 60m it decreased. Also conductivity remained stable on other days except July 16th where it decreased sharply from 90m to 100m (Figure 5).

Nitrate remained constant from the surface to 60m where the chemocline was observed. The average nitrate concentration at the water surface was 0.02mg/l and 0.08mg/l at 100m (Figure 7).

Soluble reactive phosphorus concentration showed a decrease at 40m and then increased to 100m. Except on July 19th, when the concentration decreased rapidly from 90m to 100m. The average concentration at the water surface was 0.07mg/l and 0.16mg/l at 100m (Figure 8).

Silica trend showed an increase with depth. The average concentration of silica at the water surface was 1.25mg/l and 3.14mg/l at 100m (Figure 9).

Alkalinity profiles showed a high variability but generally increased with depth. The highest alkalinity (287 mg/l CaCO₃) was recorded on 24th July (Figure 6c).

Chlorophyll a concentration (0.75mg/l average) at the surface was lower compared with that at 20m and 40m was 0.81mg/l.

Fish catch showed some correlation with limnological parameters, especially turbidity. The *Lates stappersi* (adult) catches were very high on July 24th when turbidity was 0.36NTU. And *Stolothrissa tanganicae* catches were very high on July 26th where turbidity was 0.43NTU. Other species such as *Limnothrissa miodon* and *Lates stappersi* (juvenile) catch composition were generally low (Table 1 and Figure 4).

Discussion

The results show that nitrate and soluble reactive phosphorus average was 0.02mg/l and 0.07mg/l at the surface respectively. They showed a small increase at 100 meters. The lake water generally showed oligotrophic characteristics near the surface but have high concentration of nutrients in deep water, which depends on, to a large extent, the regeneration of nutrients from the hypolimnetic water (Plisnier *et al*, 1999). The decrease in nitrate and soluble reactive phosphorus on July 16th and 19th at 40m is probably due to considerable high primary production at the respective depth as it can be observed by Chlorophyll a concentration on the same dates.

The average pH for all sampling nights was 8.76. It was high in the photic zone where primary production is taking place (Figure.3). Deep water characterized by lower pH, compared to the surface, affected the pH in the surface waters at the end of the dry season. The nutrient rich deep waters probably strongly influenced primary production when it was brought near the surface. Consumption of HCO₃⁻ during photosynthesis results in higher pH values (Plisnier, *et al*, 1999).

Silica was low on the last three sampling nights (24th, 26th& 30th July) compared with the first two nights (16th & 19th July) (Figure.9). Since diatom algae use silica for their cell walls, this probably indicates plankton abundance on those nights. For that reason, silica can be a limiting element for phytoplankton

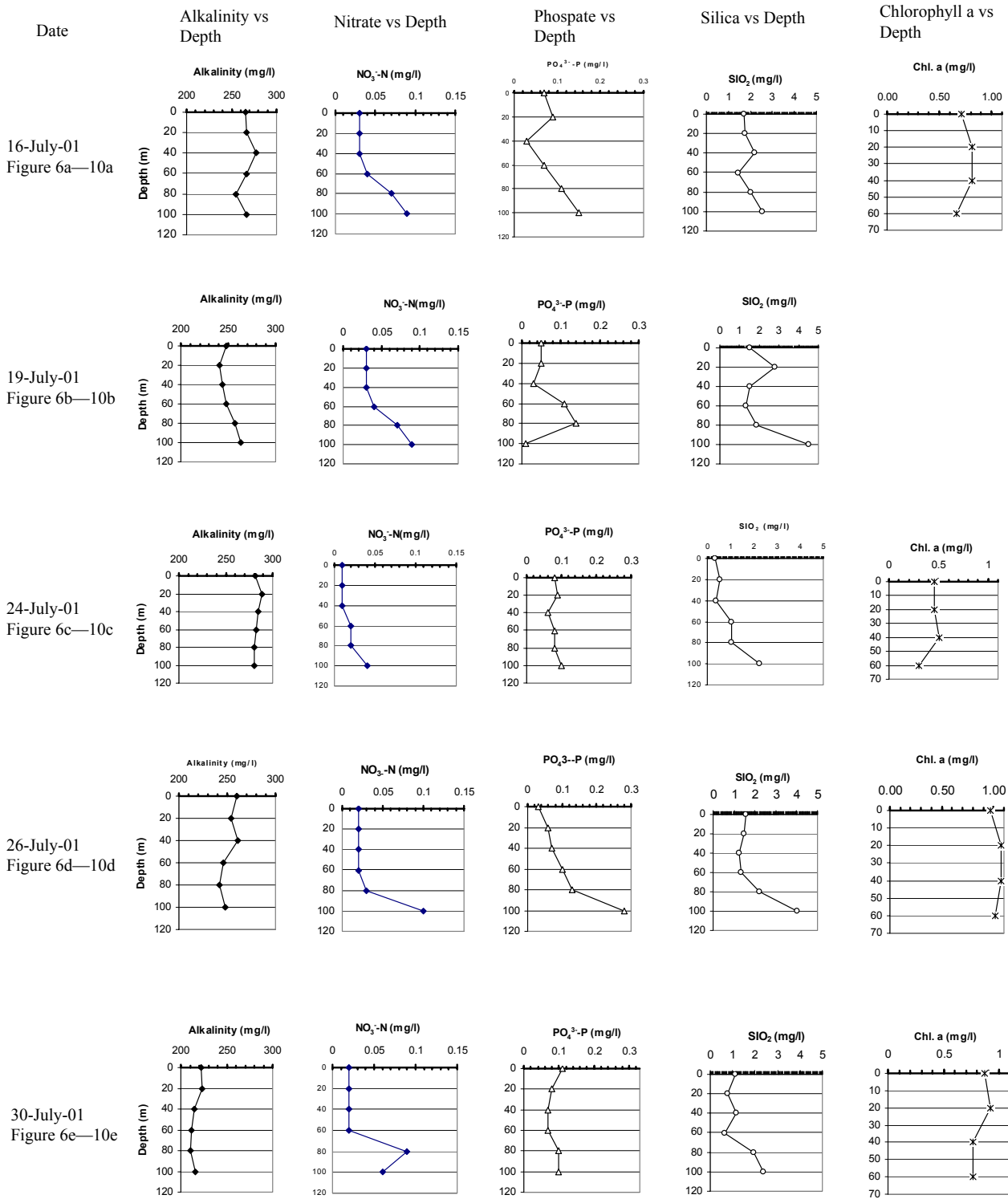


Fig. 6 - 10: Chemical Parameters v.s. Depth

Date	Thermocline	Turbidity	Oxycline	Sardine+ Juvenile.	Lates stappersi	Wind speed (m/s)	Lake conditions	Surface Temp. (°C)	Location (GPS)	0-15 m	15-30 m	30-45 m	45-60 m	60-90 m	Ave age	S.D.
16/07/01	70	0.4	80	80.7	19.3	2.4	Little calm	25.8	04°58'00" S 029°33'00" E	23.3	14.9	12.4	23.4	9.2	16.6	6.5
19/07/01	70	0.37	70	45.5	54.5	0.0	calm	26.0	04°47.37' S 029°30.61' E	28.8	17.2	27.8	6.1	1.6	16.3	12.3
24/07/01	85	0.36	80	0	100.0	2.4	calm	25.6	04°53'20.9" S 029°31'30.7" E	42.7	32.6	18.1	18.1	2.2	22.7	15.5
26/07/01	75	0.43	75	100	0.0	4.0	Little calm	25.5	04°51'27.2" S 029°30'28.0" E	32.2	24.1	27.8	43.4	4.3	26.4	14.3
30/07/01	75	0.41	70	100	0.0	5.2	calm	25.5	04°49'28" S 029°31'20" E	90.6	53.3	26.6	31.7	13.2	43.1	30.2

Table 1: Summary on limnological parameters, fish catch composition in percentage and zooplankton abundance at the different positions near Kigoma.

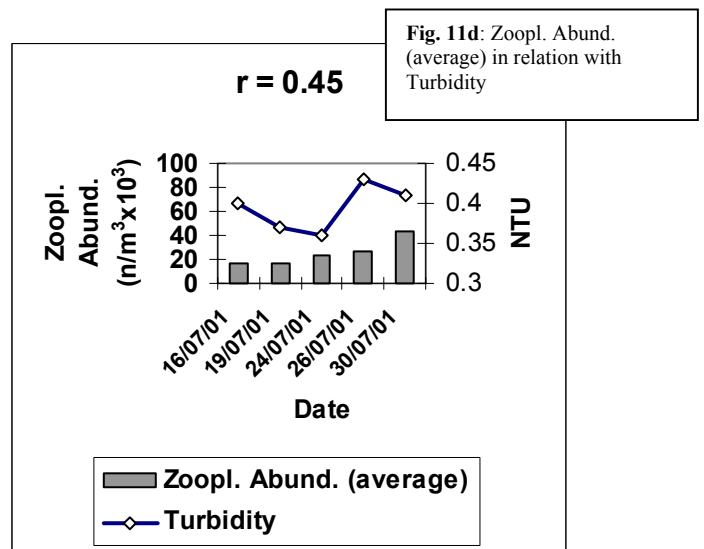
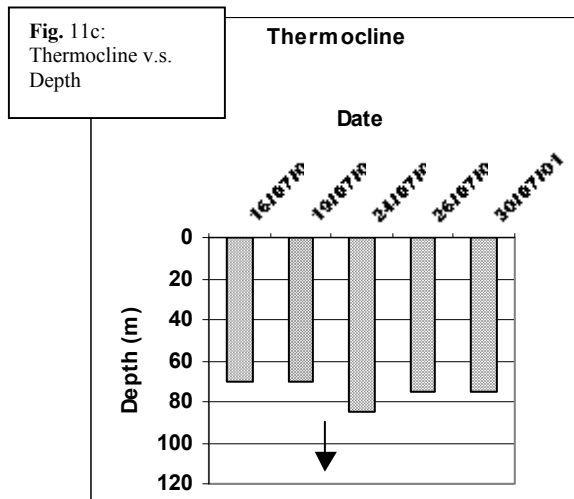
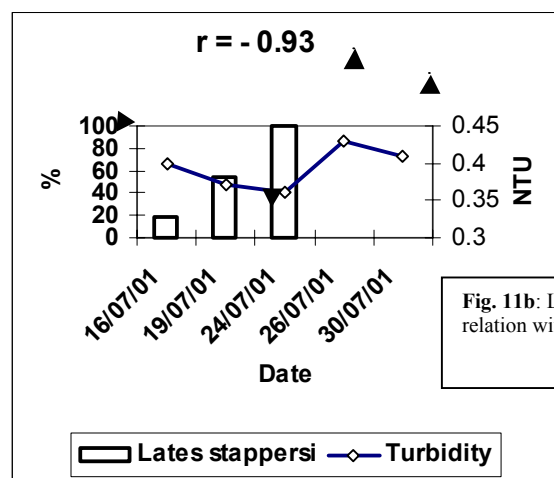
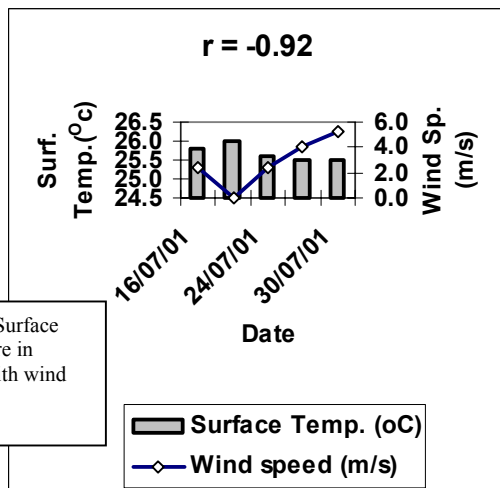
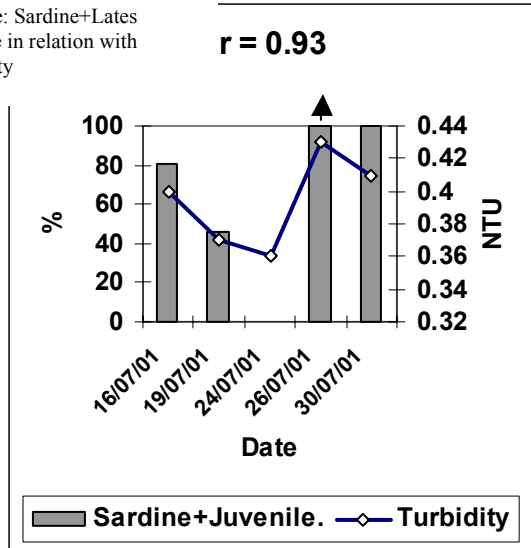


Fig. 11: Limnological parameters in relation with fish catch composition

Fig. 11e: Sardine+Lates juvenile in relation with Turbidity



growth when diatoms are the predominant algae (Plisnier, 2001). This is also shown by Chlorophyll a concentration on respective days (Figure 10).

Chlorophyll a concentration was generally higher at 20m and 40m (Figure 10). This may be attributed to high primary production. There is a general decline in Chlorophyll a concentration at 60m. This may partly be due to little light reaching the depth. Also Chlorophyll a concentration was high on the 4th and 5th nights. We recorded higher wind speed, which might have caused more mixing which in turn could have resulted into higher primary production (table 1).

On an average basis, turbidity was high on 26th and 30th of July (Table 1 and Figure 11). Turbidity in water is caused by suspended inorganic and organic matter such as clay, silt, carbonate particles, fine

organic particulate matter, and plankton (phytoplankton and zooplankton) and other small organism (Wetzel, and Likens, 1990). The observed high turbidity may have been caused by high concentrations of microorganisms (plankton and colonies of bacteria). Also turbidity showed to be very important parameter because the clupeid and *Lates stappersi* (juvenile) catches depends much on high turbidity when *Lates stappersi* (adult) is vice versa (Figure 11)

Water temperature remained almost constant to about 60m depth with the thermocline fluctuating between 70m and 90m during the sampling period. This fluctuation of thermocline could be explained by internal waves and wind mixing which might have caused dampening of the thermocline.

Dissolved oxygen, like temperature, remained almost constant to 60m with very sharp decline to almost 1.0 mg/l. We observed an oxycline between 70m and 80m (Figure.2). This is almost embedded in the thermocline.

Conductivity depends on dissolved solutes/free ions (nutrients) in the water column. It will increase, at a given temperature, whenever there is an abundance of dissolved nutrients (cations and anions) in the water. In Lake Tanganyika conductivity increases with depth (Kimirei & Nahimana, 2000). The general trend was depicted although there are signs that deeper waters were coming to the surface, probably due to internal waves and turbulence (Figure 5).

A large percentage of adult *Lates stappersi* caught on July 24th corresponded with a low turbidity concentration and half moon phase. Those conditions could possibly be favorable. On July 26th turbidity was high where catches for *Stolothrissa tanganyicae* was high also compared to other species (Table 1).

Conclusion

It seems from the results that fish catch of a certain species could be tied to limnological parameters, especially turbidity. The moon phases are probably also important. High turbidity correlated positively to *Stolothrissa tanganyicae* catch and inversely to *Lates stappersi* (Figure 11). However, this study of three weeks of limnological parameters cannot be considered conclusively because few data were collected and there were no strong hydrodynamic changes during the period of investigation.

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