COMPARATIVE MOLECULAR ECOLOGY OF NATIVE AND LAKE KIVU INTRODUCED POPULATIONS OF THE LAKE TANGANYIKA POECILID FISH, *LAMPRICHTHYS TANGANICANUS*, EASTERN AFRICA

By

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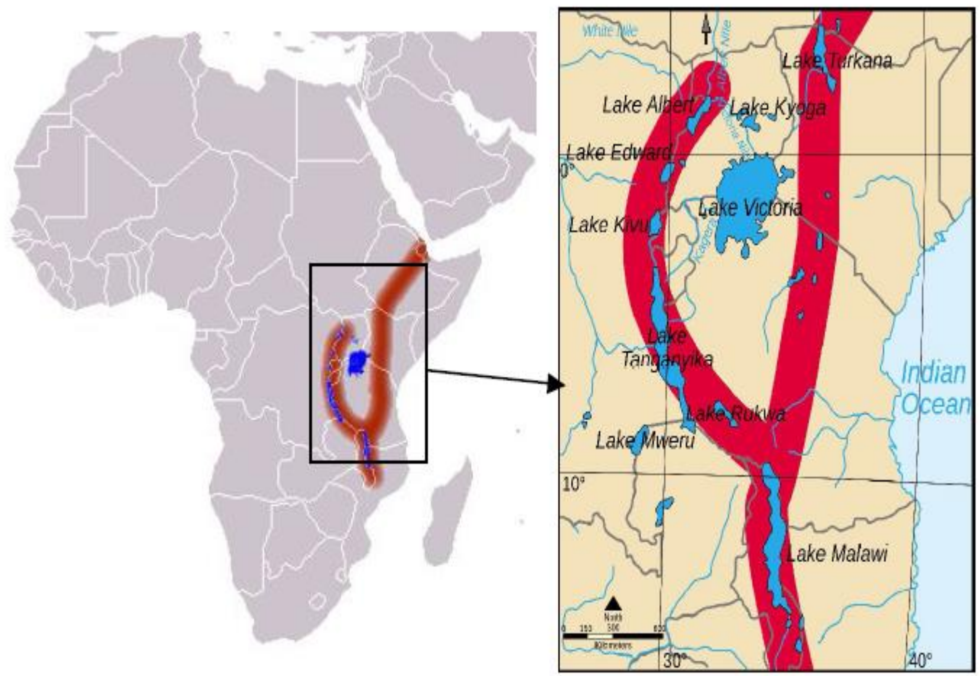
I. INTRODUCTION / Background

The Albertine rift region is famous for high Biodiversity , livelihoods of riparian and exciting geological events among others. It holds several lakes!

Lake Tanganyika, the most ancient of Albertine rift lakes containing several hundreds of endemic fish species (Poll 1986) with fascinating fish ecology making the lake a valuable microcosm for evolutionary studies between species(explosive speciation, adaptive radiation, phylogenetics)



I. INTRODUCTION / Background

The lake provides animal proteins to over 10 Millions of people in the 4 bounding countries being estimated to 45% proteins for riparian closed to the Lake (LTA, 2010).

I. INTRODUCTION / Background

Despite its importance,

Lake Tanganyika is threatened by: Pollution (sedimentation, industrial and urban discharge), overfishing, and use of unconventional fishing gears.

In its northern part,

Lake Tanganyika receives water drained by the Ruzizi River from Lake Kivu from 120km far away without remarkable mixture of fish species from both lakes.

I. INTRODUCTION / Background

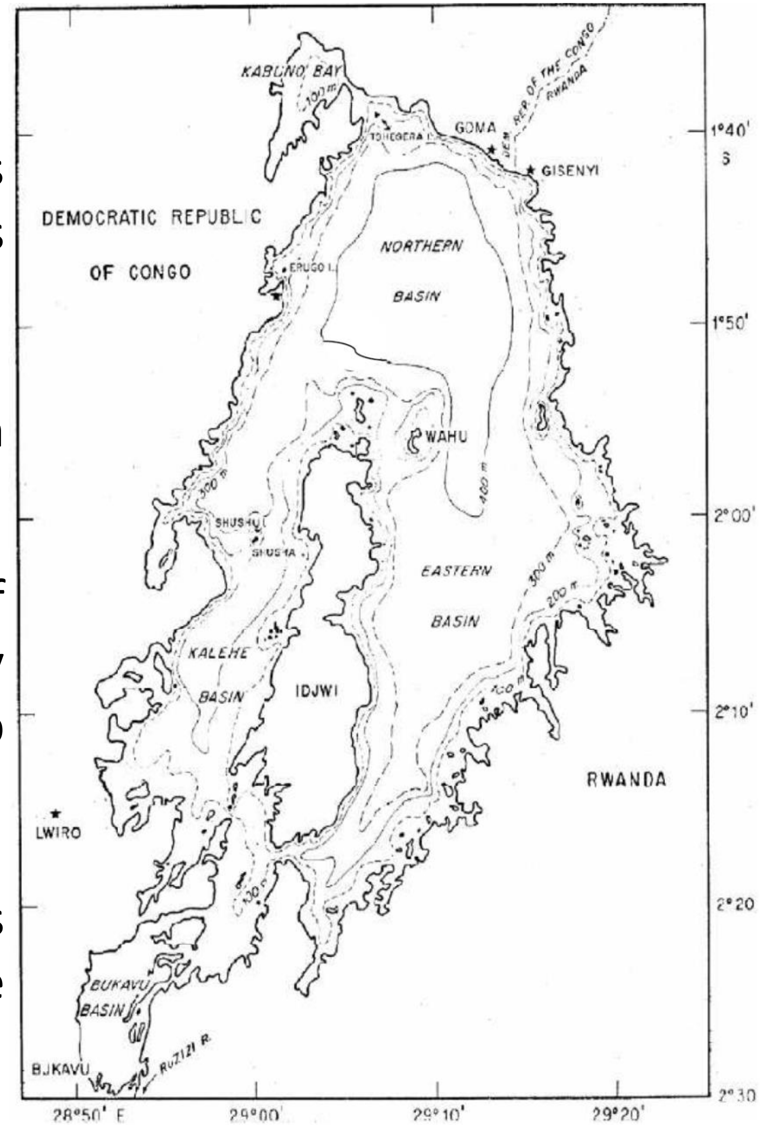
Lake Kivu,

- Relatively poor in fish species diversity compared to other great lakes of the Albertine rift

- Relatively Young and originated from volcanic eruption

- Famous for its huge amounts of methane and other gases physically dissolved in molecular form in the deep waters.

- Physicho-chemicals conditions deeply different from those of Lake Tanganyika



I. INTRODUCTION / Background

-Currently, 29 fish species are known from Lake Kivu and its tributaries:

19 Cichlids species: 15 Cichlids species belonging to *Haplochromis* genus are endemic to Lake Kivu

- Among fish species that live in Lake Kivu, 4 fish species are reported introduced

Limnothrissa miodon, *Oreochromis macrochir*, *Tilapia rendalli*, and recently *Lamprichthys tanganicanus*

I. INTRODUCTION / Background

Lake Kivu fisheries are many based on the exploitation of the introduced Clupeid fish, *Limnothrissa miodon* with a minimum sustained yield estimated at about 13500 tons a year

Since 2006, several individuals of the poeciliid fish species *Lamprichthys tanganicanus* are caught together with those of *Limnothrissa miodon* in Lake Kivu.

I. INTRODUCTION / Background

The presence of *Lamprichthys tanganicanus* into Lake Kivu may create some scientific concerns on the origin, period of introduction and its ecology in a new habitat known chemically different from Lake Tanganyika.

Lake Tanganyika is separated with Lake Kivu by natural barrier, the Ngomo falls in the upper Ruzizi River that prevents eventual fish community sharing between these lakes.

I. INTRODUCTION / Statement of the problem

Fish introduction has been considered as an ecological threat on indigenous species by competition, predation or hybridization and alteration of the ecosystem health (Marck et al. 2000)

Limnothrissa miodon:

Disappearance of the greatest Lake Kivu Cladoceran, *Daphnia curvirostris* (Dumont 1986) and significant impact on the body size of the cladoceran *Diaphanosoma excisum* (Isumbisho, 2006)

Decrease in genetic diversity in the introduced population (Hauser, 1996)

Nile Perch, *Lates niloticus*,

Most responsible of change in fish species composition in Lake Victoria.

I. INTRODUCTION / Statement of the problem

In addition, invasive species are subject to some adaptation behaviors to survive in and colonize the new environment during invasion (Siervers *et al*. 2012)

However, for *Lamprichthys tanganicanus*, as a New case:

No presumption can be formulated without carrying out investigations.

Captures are important in Lake Kivu

Geographic origin of Lake Kivu population founder is unknown.

Main objective of This Project

To identify ecological and genetic adaptation patterns of the introduced populations of the poecilid fish, *Lamprichthys tanganicanus* in lake Kivu

I. INTRODUCTION / Objectives

Specifically, this project aims in both Lakes Kivu and Tanganyika:

1. To characterize the distribution of *Lamprichthys tanganicanus* in Lake Kivu

2. To compare the reproductive strategies of *L. Tanganicanus* in both native and introduction habitats

3. To compare the diet of the tanganyika *killifish* in both native and introduction habitats

4. To characterize morphometric (phenotypic) parameters of both native and introduced populations

5. To compare the genetic structure (native and introduced) and define the geographic origin of *L. tanganicanus populations*

I. INTRODUCTION / Significance

Among the 4 introduced fish species in Lake Kivu, L. tanganicanus is the only one that has not yet previously been reported in any other reservoirs. Its recent invasion of Lake Kivu is a new case.

Baseline information missing!

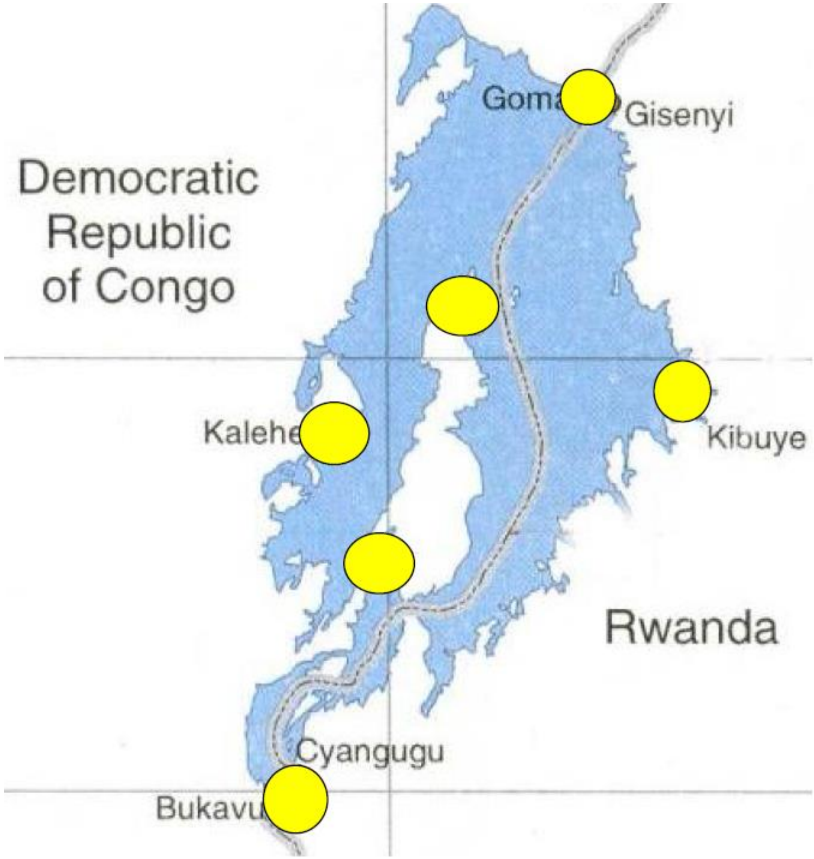
Its ecological characteristics and invasive status of invasive have not yet been investigated .

I. INTRODUCTION / Significance

In addition, the connectivity and genetic history of *L. tanganicanus* populations have not previously been investigated in any Lake.

Lake tanganyika geographic location of strains that invaded Lake Kivu is not elucidated up to now.

II. MATERIAL AND METHODS : SAMPLING SITE LOCATION



II. MATERIAL AND METHODS.

II.1. Study on the Reproductive strategies of *L. tanganicanus* in both Lakes Kivu and Tanganyika.

Field work

Fish sampling was conducted seasonally on both Lakes Kivu and Tanganyika using a set of experimental gillnet of 1,5m in depth and 30m in large, mesh size ranged from 9mmx9mm, 10mmx10mm and 15mmx15mm in all sampling sites

After fishing, catch was be kept into labelled containers with 10% formalin. Label of each container shows the time and date of sampling, name of the locality, sampling depth, substrate and geographic coordinates.

II. MATERIAL AND METHODS.

II.1. Study on the reproductive strategies of *L. tanganicanus* in both lakes Kivu and Tanganyika.

Lab work:

On each fish specimen, Sex, Weight (g), Standard Length (mm), Total length (mm) was recorded using a weighing scale and manual caliper.

After dissection, Gonads was carefully removed and weighed and development stage determined following Legendre and Ecoutin(1989).

Gonado-somatic index (**GSI**) was calculated using the formula proposed by Lagrer (1971).

The correlation between weight and Standard Length was computably generated through the regression coefficient with the help of SATISTIICA software.

II. MATERIAL AND METHODS

II. 2. Comparative study on the diet of the Tanganyika Poeciliid fish *Lamprichthys tanganicanus* in both Lakes Tanganyika and Kivu

Samples were monthly collected in the same sites.

On the field, a set of experimental gillnet of 1,5m in depth and 30m in large with 3 different mesh sizes was used.

Collected fishes were introduced into labelled containers with 10% formalin for preservation.

In the laboratory, fish samples were first weighed and measured

Each fish was dissected to remove the gut that was also be opened to analyse its contents.

II. MATERIAL AND METHODS

II.2. Comparative study on the diet of the Tanganyika Poeciliid fish *Lamprichthys tanganicanus* in both Lakes Tanganyika and Kivu

Food items from guts ware taxonomically identified using a microscope and microscope slide equipment described by Contente et al. (2012).

Individuals of each food item were identified to possible lowest taxonomic level and counted. In Total, 239 fish individuals have been dissected.

Diet data will be treated using methods largely used for expression of diet results following Hyslop, 1980, Lalèyè et al. 2006 and Contente et al.(2012)

II. MATERIAL AND METHODS

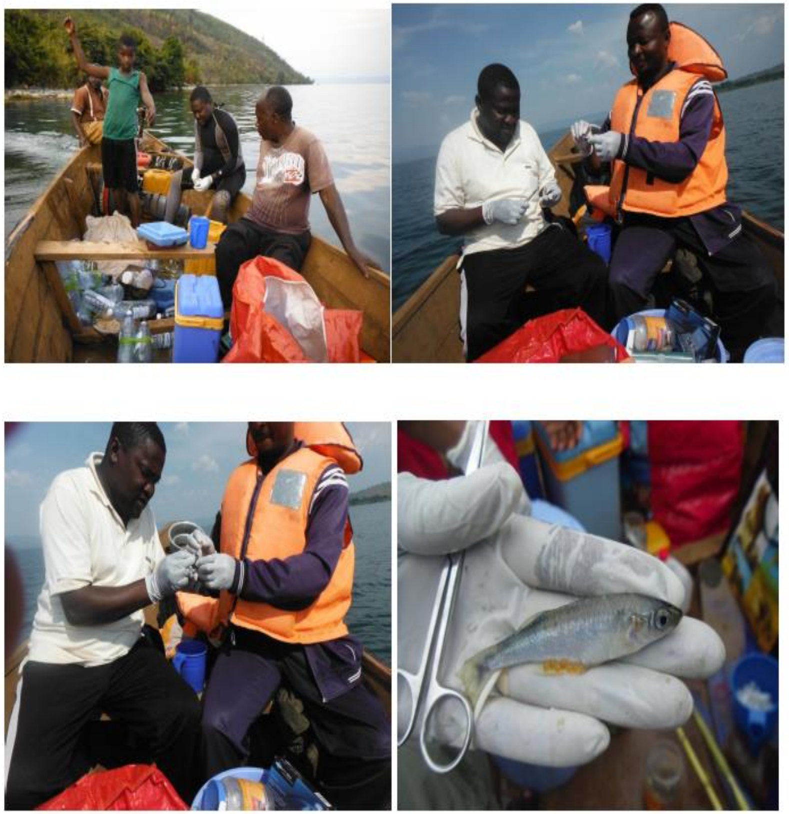
II. 3. Population Genetic study in both Lakes Kivu and Tanganyika: Origin of Lake Kivu killifish population.

Field work

After fishing, and before transferring the catch into formalin solution, samples of tissues were collected on each specimen.

On each specimen, the whole right pectoral fin of the fish was removed and kept into labelled vials containing 96% ethanol for preservation.

Cryo Vials containing fin samples were kept into fresh cool box being transferred in the laboratory at kept at room temperature.



II. MATERIAL AND METHODS

II. 3. Population Genetic study in both Lakes Kivu and Tanganyika: Origin of Lake Kivu killifish population

Lab work

Usual activities for molecular studies will be performed on each fish fin samples, these include:

-DNA extraction,

-PCR (Polymerase Chain Reaction) of DNA extracted samples will be carried out in a molecular Lab

- PCR products sequencing

II. MATERIAL AND METHODS

II.3. Population Genetic study in both Lakes Kivu and Tanganyika: Origin of Lake Kivu killifish populations

Data analyses

Both mitochondrial DNA and microsatellite data will be analysed using DnaSP version 5 and Arlequin ver.3.5 software to determine:

Genetic population structure per site in both lakes,

Haplotypes diversity per site,

Estimate of the size of population,

Origin of Lake Kivu population and other genetic parameters following (Menezes et al. 2012), Haynes (2009) and Verheyen et al.(2003).

II. MATERIAL AND METHODS

II.4. Characterization of phenotypic parameters in native and introduced populations of the Tanganyika killifish *Lamprichthys tanganicanus*

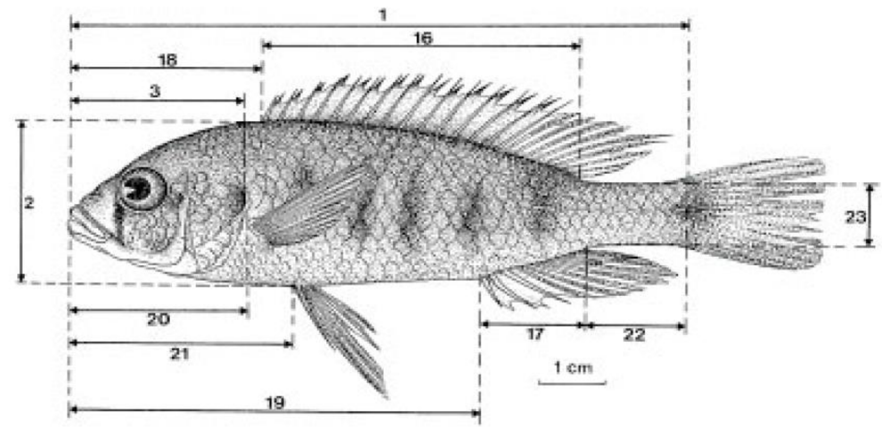
Lab work

Fish specimen were obtained from individuals that have undergone sampling of fins for genetic studies.

Manual caliper was used for measurements and all count data will be recorded using a binocular stereo microscope.

27 Measurements were recorded on each specimen.

We followed Wildecampes and Malumbres (2004) for measuring morphometric characters and Van der Zee and Sonnenberg (2011) for meristic records.



II. MATERIAL AND METHODS

II.4. Characterization of phenotypic parameters in native and introduced populations of the Tanganyika killifish *Lamprichthys tanganicanus*

Data analyses

Principal component analyses (PCA) techniques will be used to analyse morphometric and meristic data on the covariance matrix of log transformed measurements and the correlation matrix of raw meristcs.

Populations will be ranged in geographical groups to evaluate eventual geographic variations.

Differences in ratios of measurements (relative to head or standard length) and meristics for these will be tested using pair wise Mann Whitney U tests.

III. EXPECTED OUTPUTS

- Spatial and temporal distribution of the *L. tanganicanus* in both Lakes Kivu and Tanganyika

- Size at first maturity and growth of *L. tanganicanus* in both Lake Kivu and Tanganyika

- Diet of *L. tanganicanus* in both Lake Kivu and Tanganyika

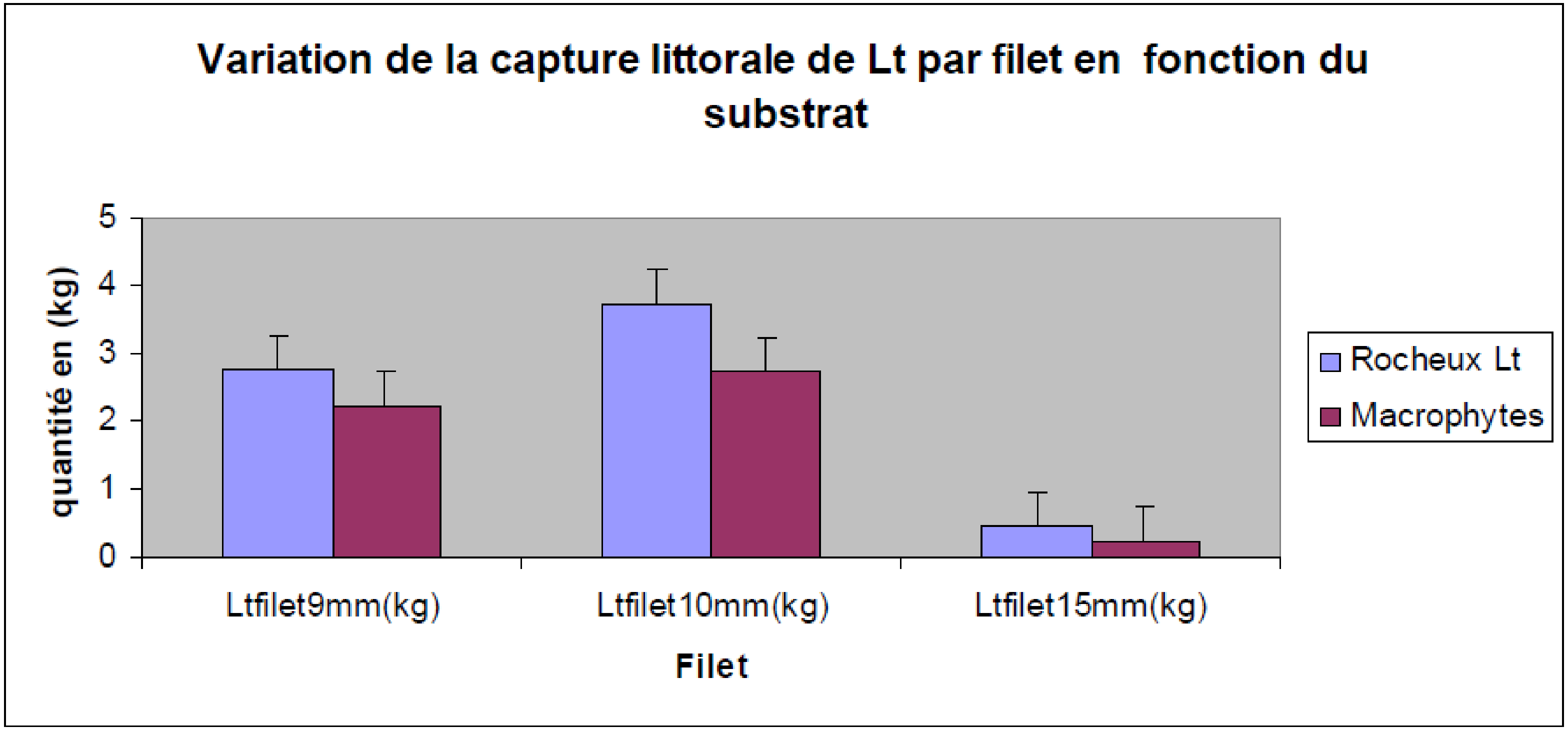
III. EXPECTED OUTPUTS

- Description of population genetics structure of *Lamprichthys tanganicanus* (killifish) in both Lakes Tanganyika and Kivu.

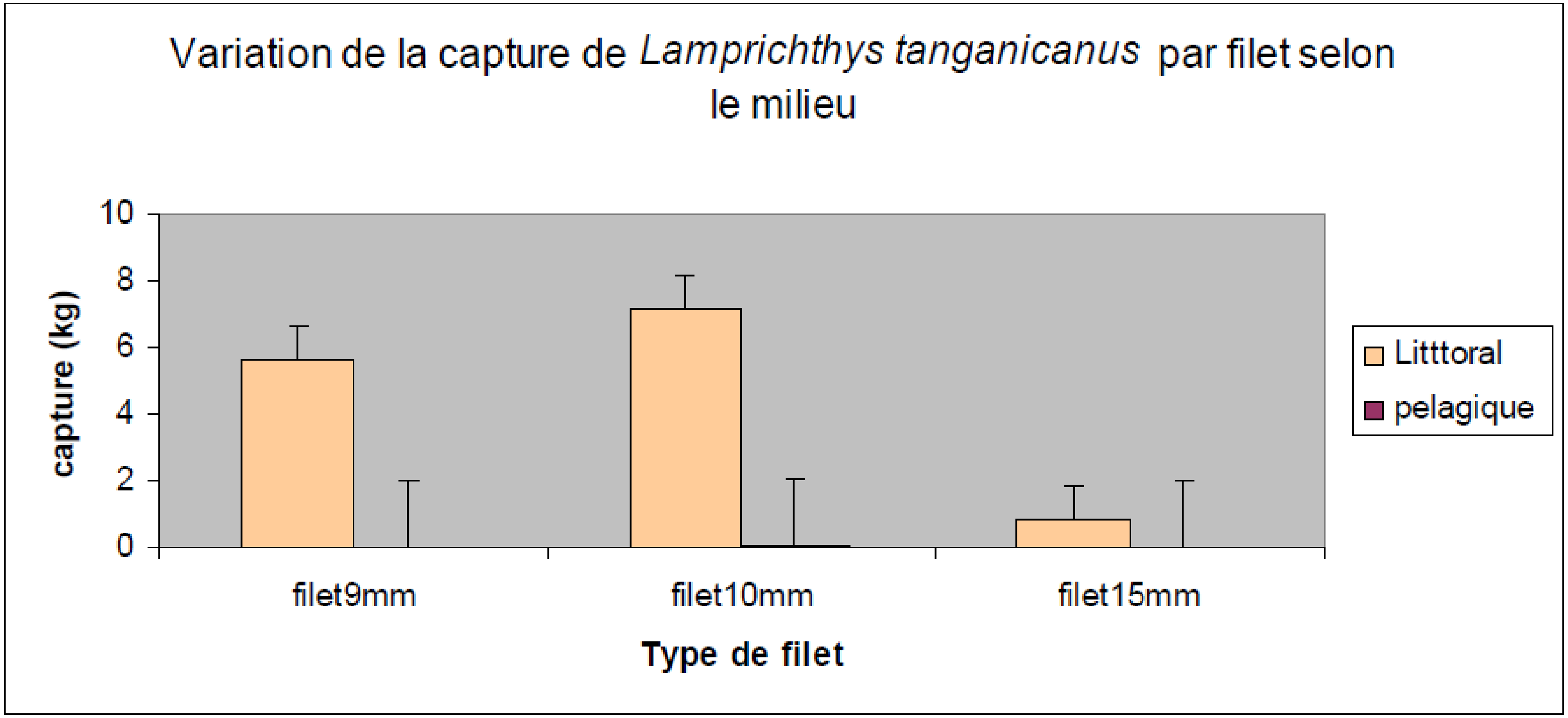
- Lake Tanganyika geographic origin of Lake Kivu killifish

- Morphological characterization of native and introduced populations of *L. tanganicanus*.

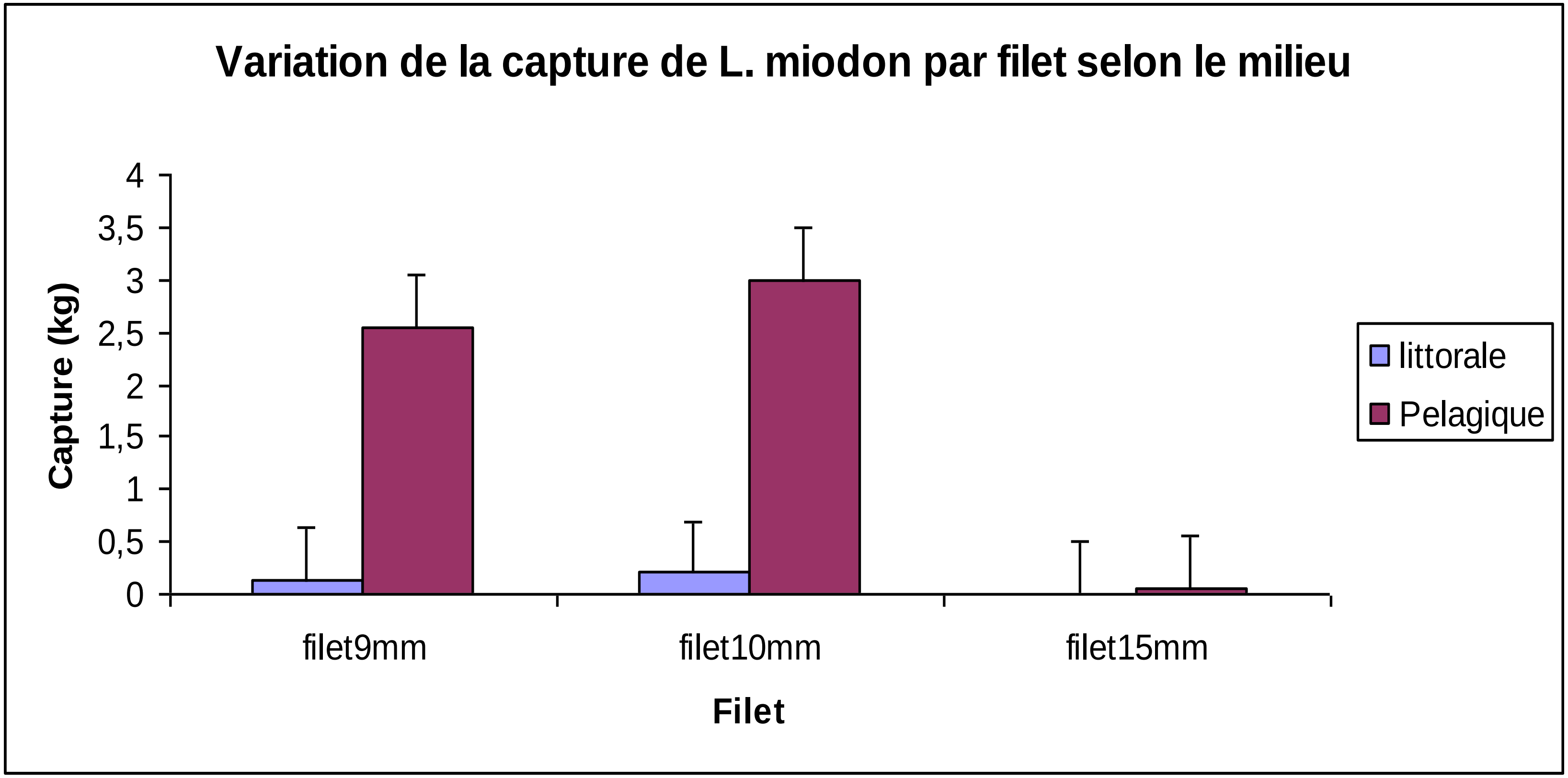
IV. Preliminary Results/Distribution



IV. Preliminary Results/Distribution



Preliminary Results/Distribution



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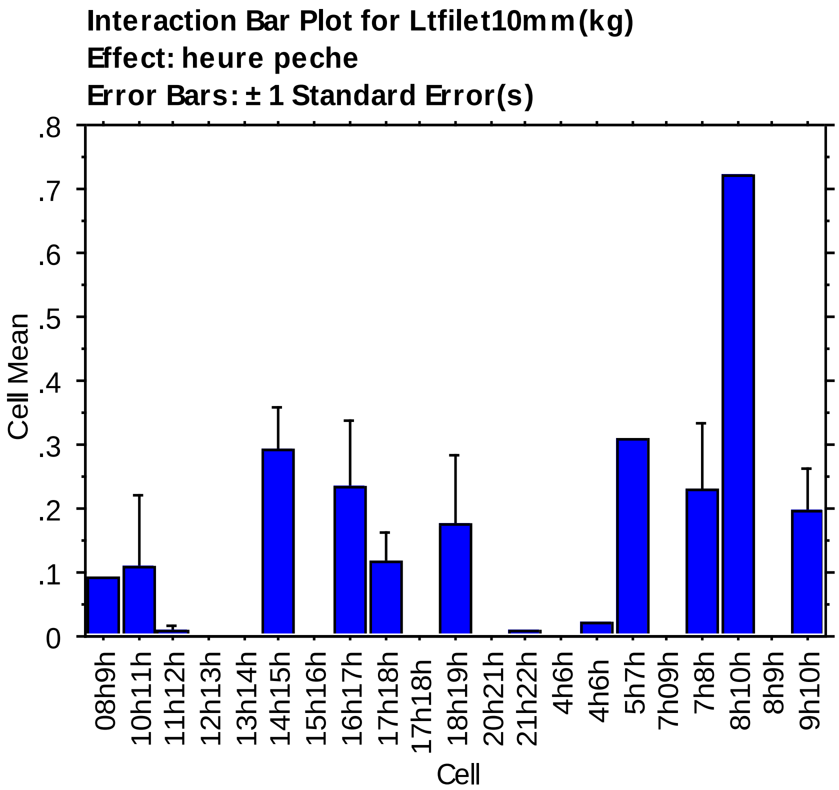
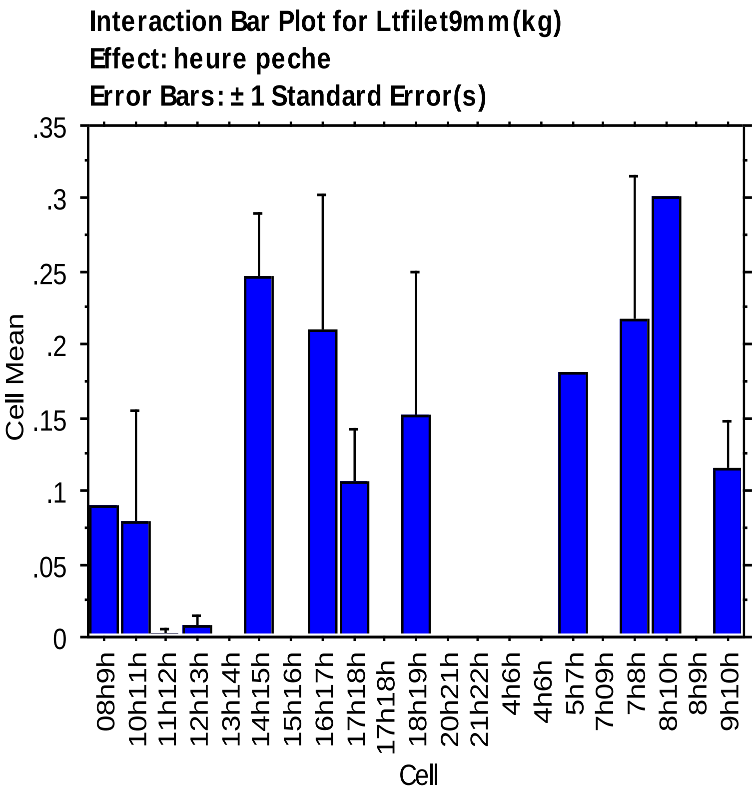
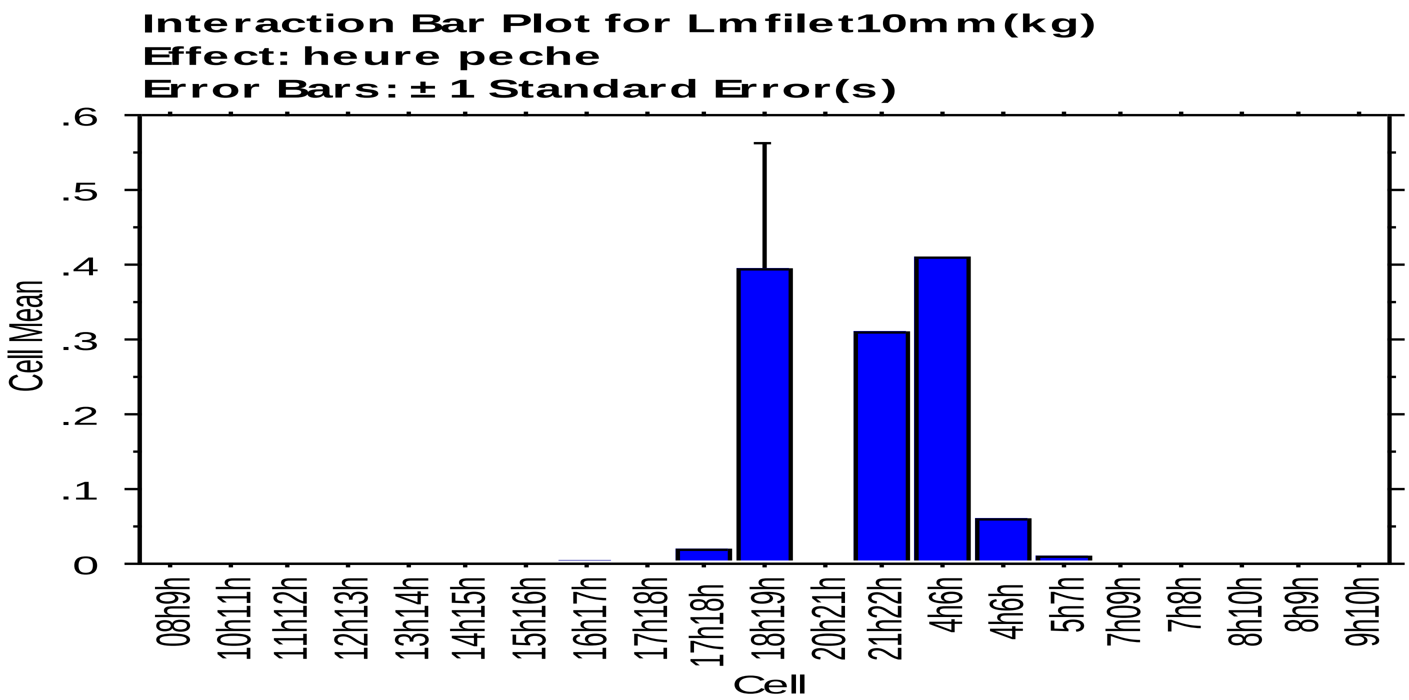




IV. Preliminary Results/Distribution



IV. Partial Results/Distribution

Depth range	net 9mm	Net 10mm	Net 15mm
1 m - 10 m	5,625	7,17	0,83
11 m - 20 m	0	0,04	0
Above 21 m	0	0	0

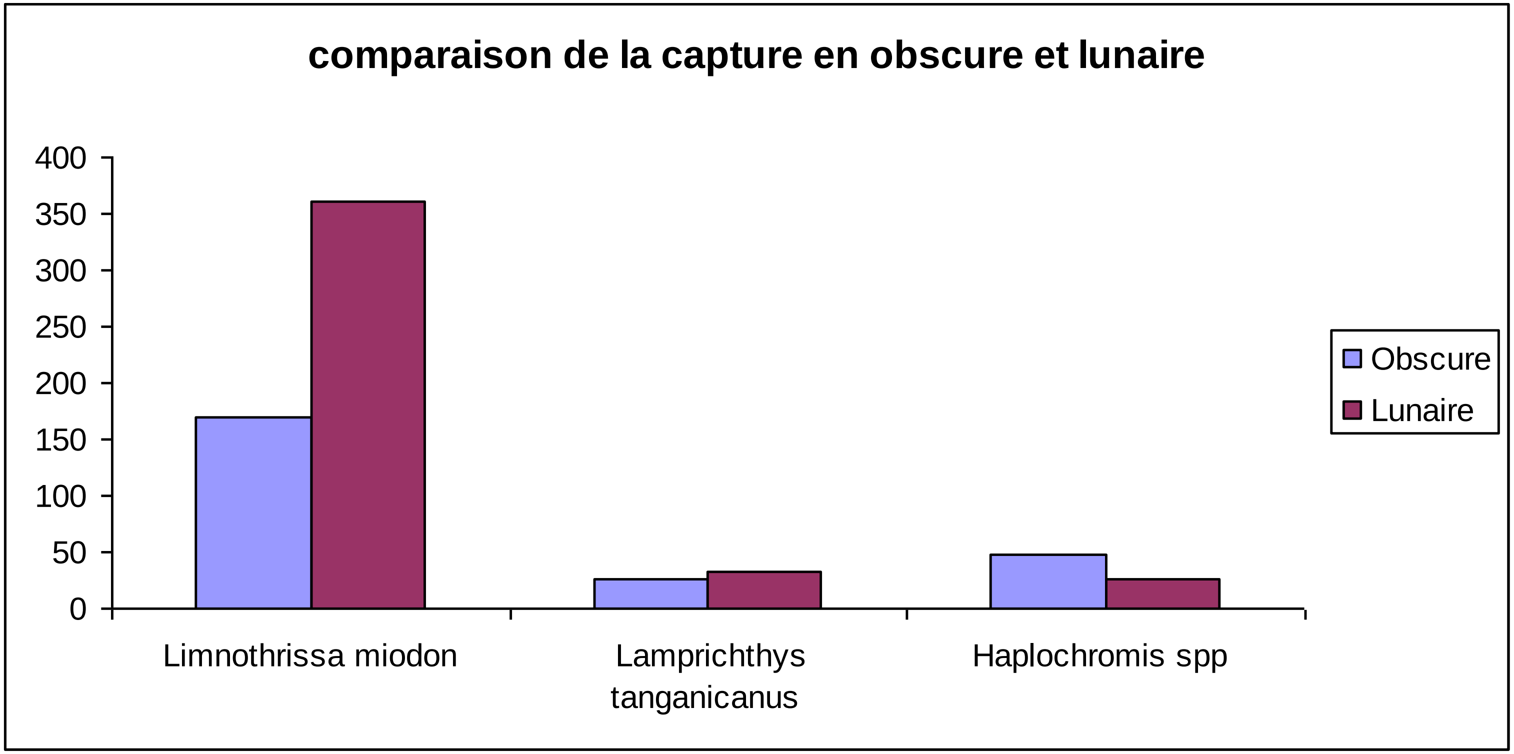
Figure : Capture globale en kg de *Lamprichthys tanganicanus* à différentes profondeurs

IV. Preliminary Results/Economic input of *L. tanganicanus* in Lake Kivu

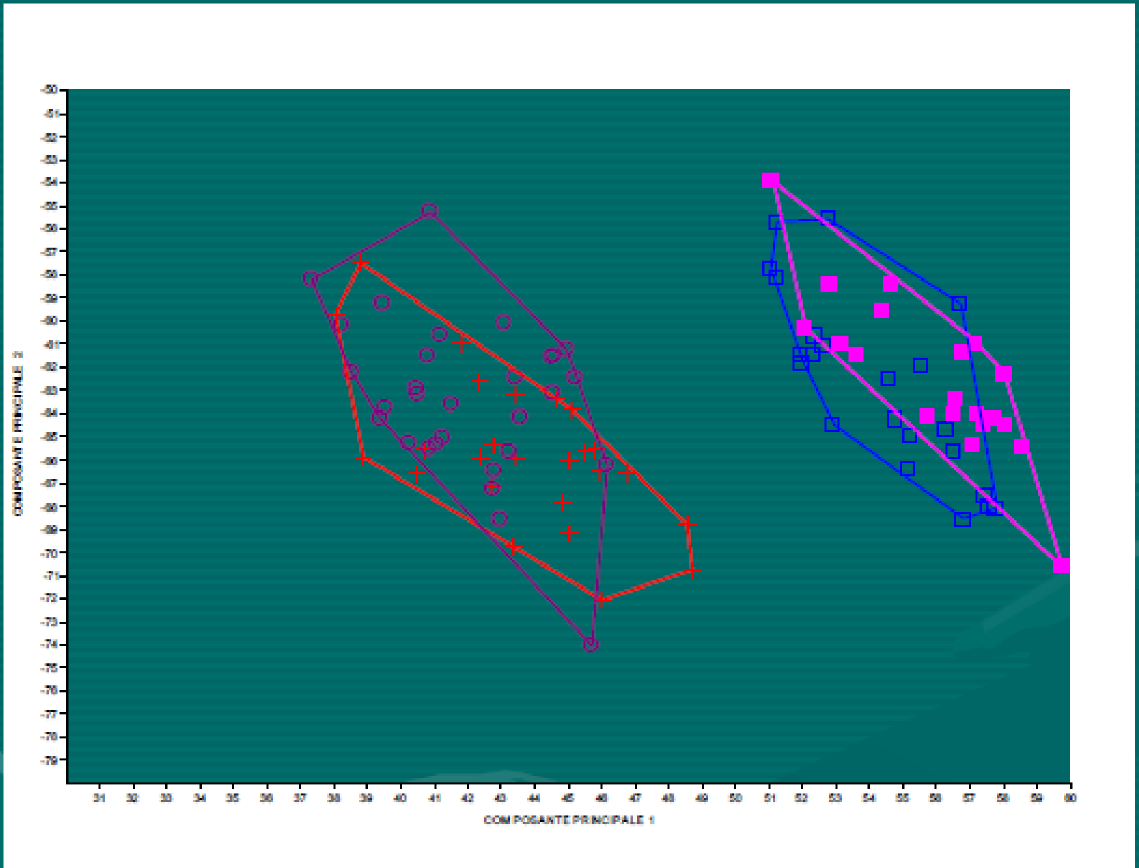
Captures totales par espèce dans 3 différents sites d'échantillonnage

Espèce/site (kg)	Coza	Nyakaliba	Kigezi	Total
Limnothrissa miodon	217	127,6	185,8	530,4
L. tanganyicanus	23,6	10,7	24,3	58,6
Haplochromis spp	40,22	12,6	20,4	73,22
Total (kg)	280,82	150,9	230,5	662,22

IV. Preliminary Results/Economic input of *L. tanganicanus* in Lake Kivu



IV. Preliminary Results/Morphometry

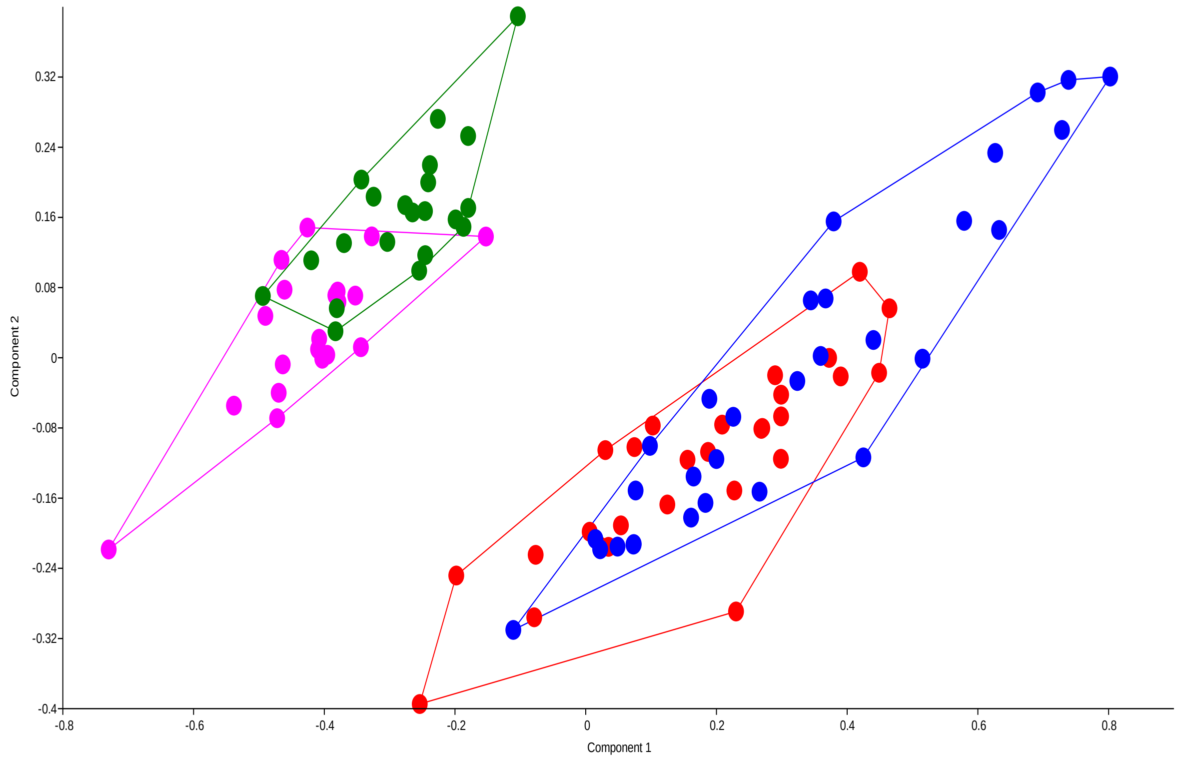


Les caractéristiques morphologiques des échantillons de *Lamprichthys tanganicanus* des lacs Kivu et Tanganyika sont semblables (Fig1)

Fig1. Analyse en composante principale des caractères métriques de *Lamprichthys tanganicanus* (en pourcentage) des MÂLES (cercles vides, Lac Kivu,n=26 ; Croix, Lac Tanganyika,n=30) et des FEMELLES (carrés vides, Lac Kivu, n=22 ;carrés pleins, Lac Tanganyika,n= 20).

IV. Preliminary Results/Morphometry

Male of Kivu:
blue spot,
n=29
Male of Tang:
Red spot,
n=24
Female of Kivu:
Green spots,
n= 19
Females of Tang:
Violet spots,
n= 21

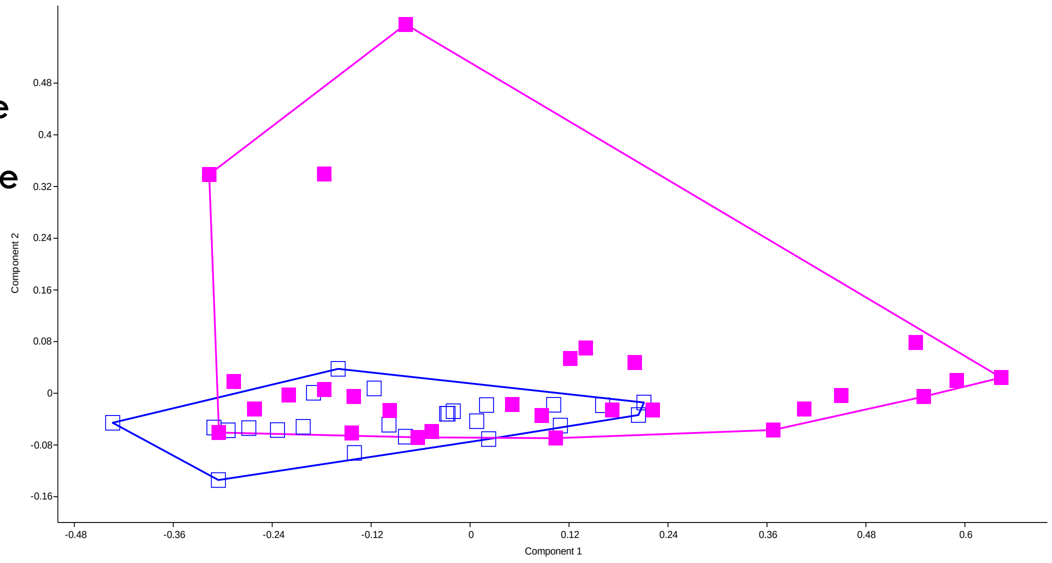


Preliminary Results/Morphometry

- Morphemetric characteristics of Lt, Unisexual PCA plot of Log-transformed value for males

Males from LK, n=29: filled square

Males from LT, n=24: empty square

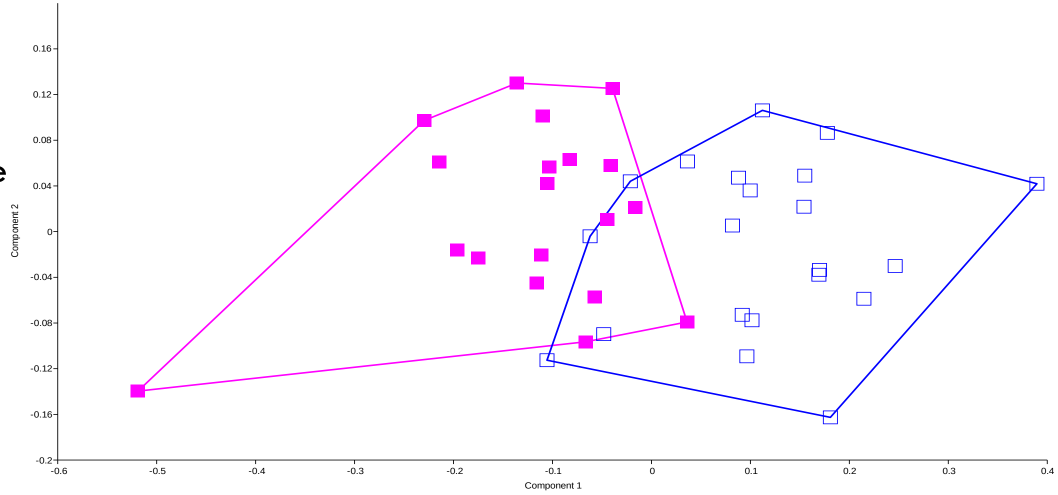


Preliminary Results/Morphometry

- Morphemetric characteristics of Lt, Unisexual PCA plot of Log-transformed values for females

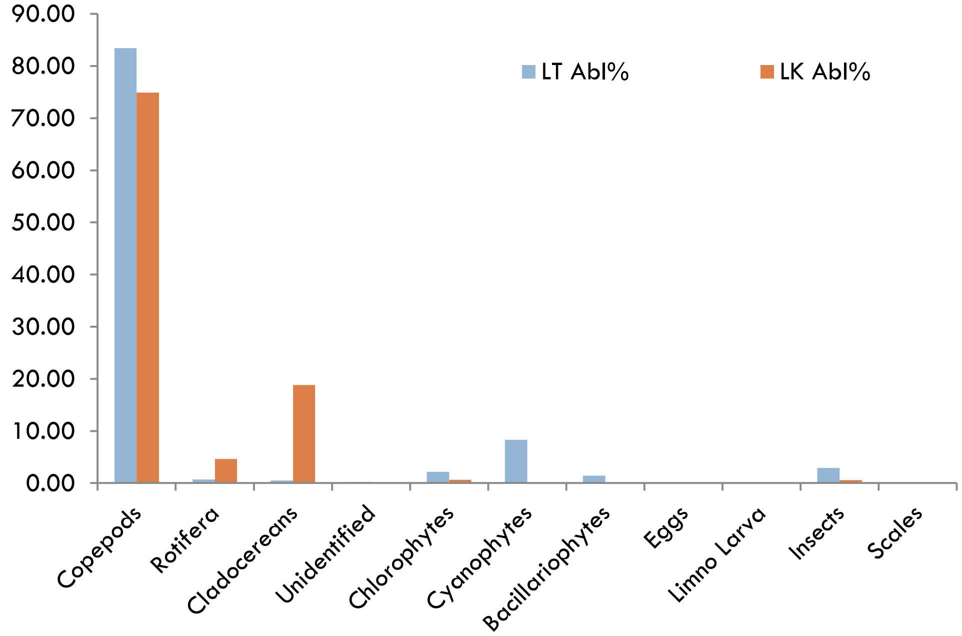
Females from LK, n=19: filled square

Females from LT, n=21: empty square



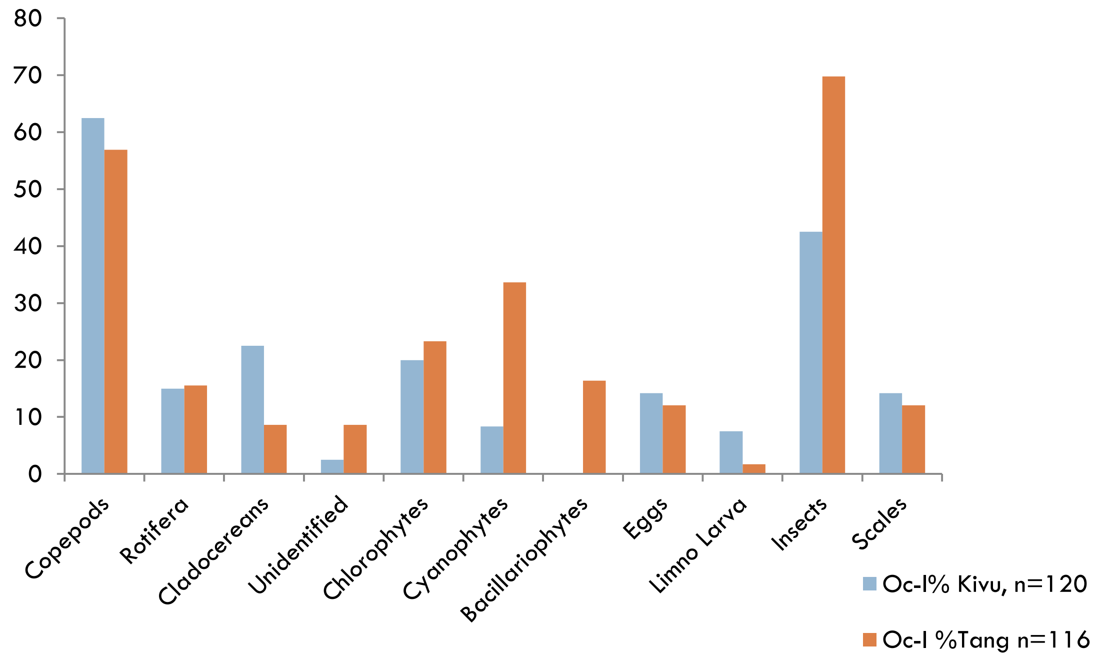
Preliminary Results: Diet

- Comparison of numeric Index in both Lakes



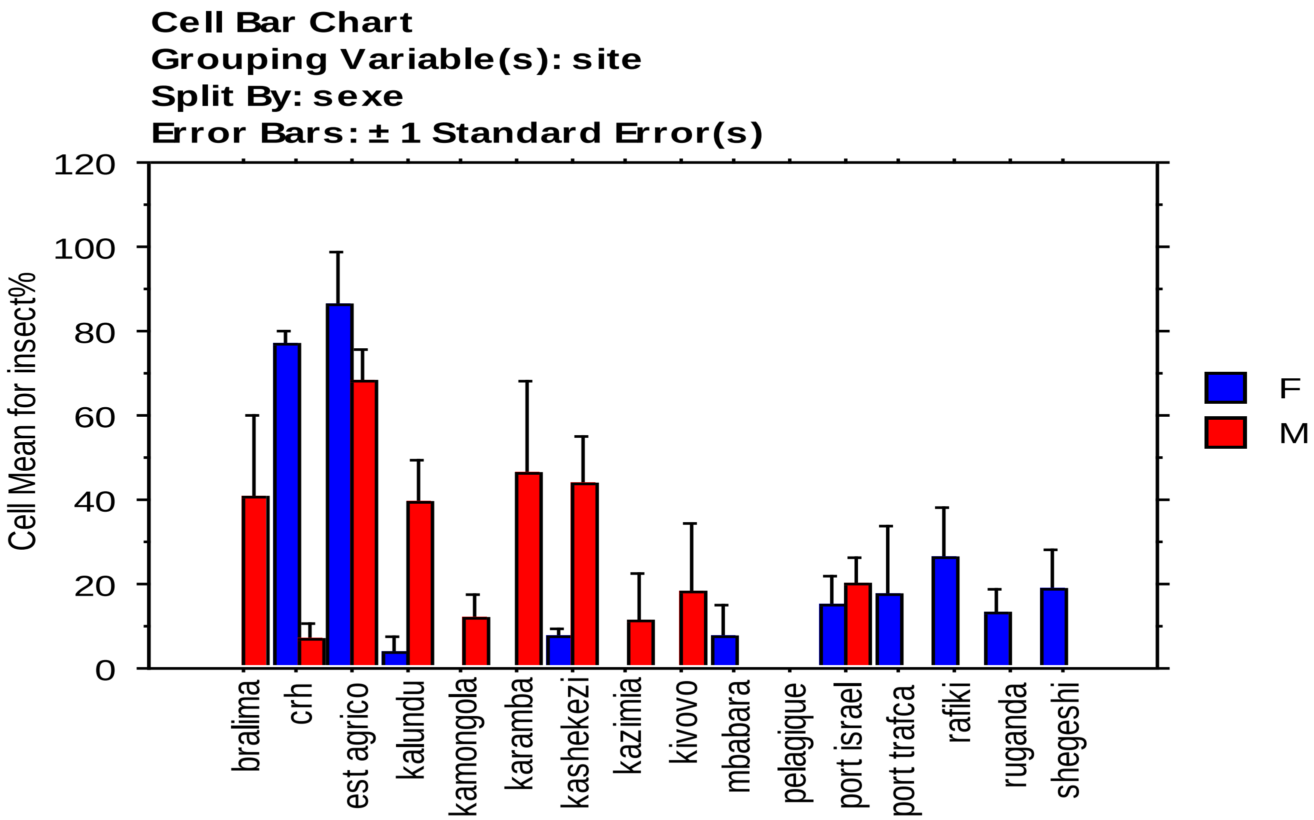
Preliminary Results: Diet

- Comparison of Occurrence Index in both Lakes



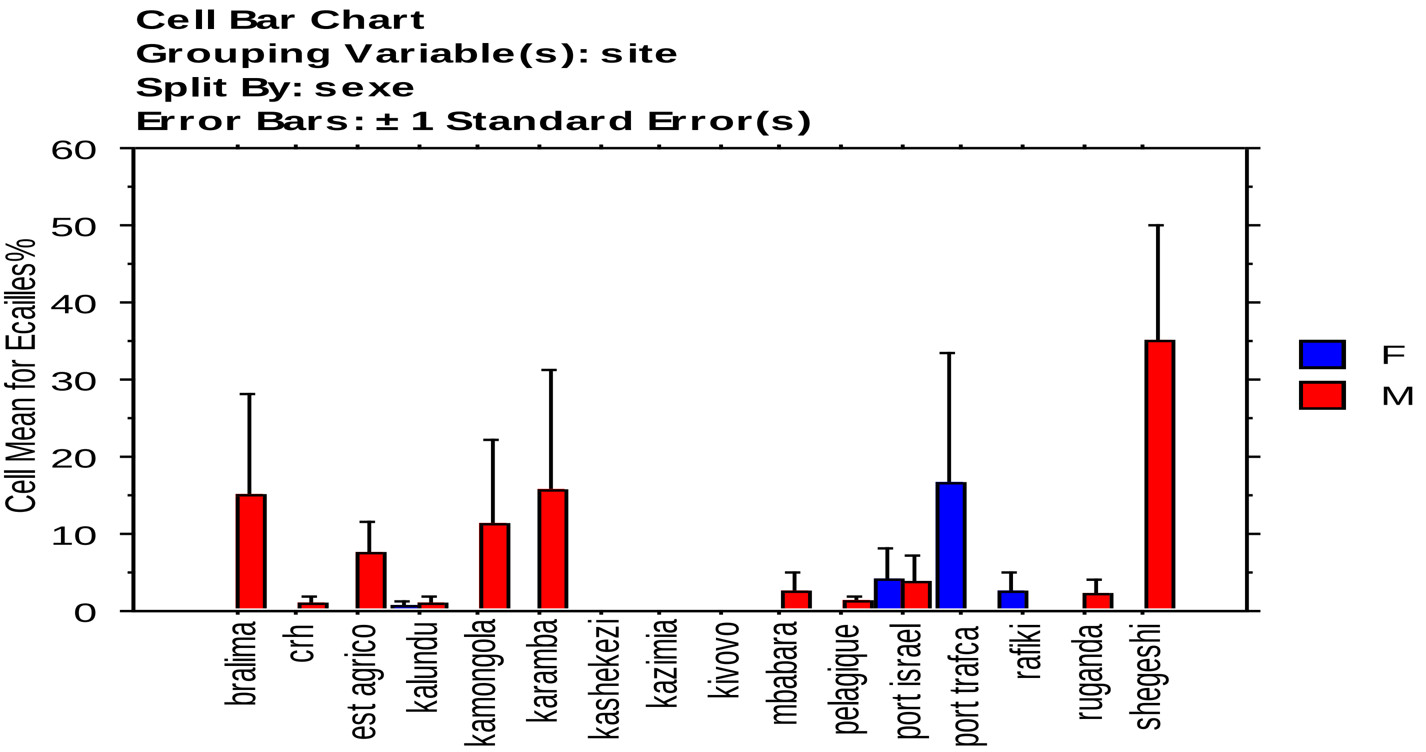
Preliminary Results: Diet

Variation of insects feeding within sampling sites and sex



Preliminary Results: Diet

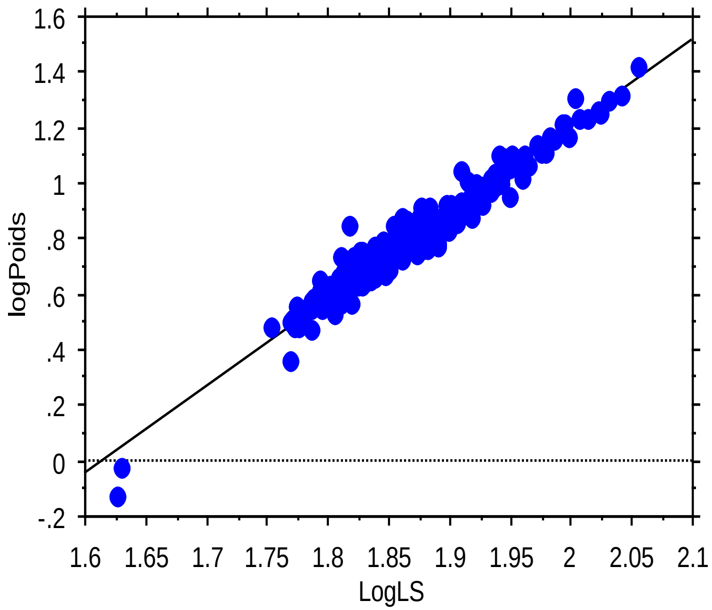
Variation of scales feeding within sampling sites and sex



Preliminary Results: Reproductive Strategies

Lake Kivu

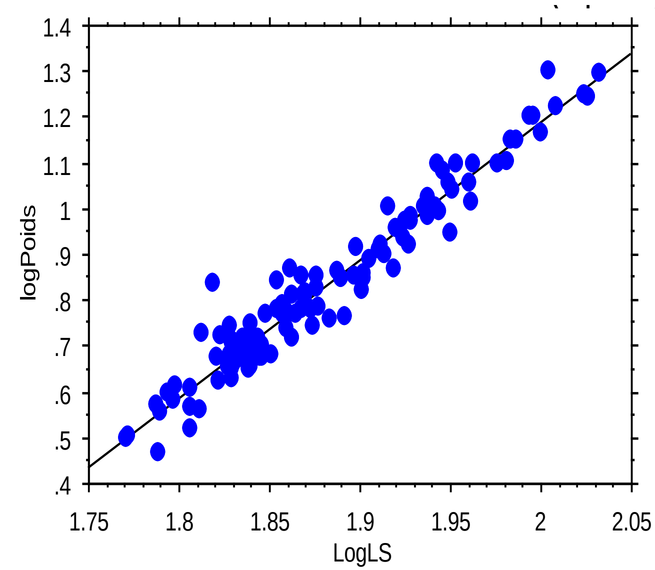
Regression plot Standard Length vs. Body weight, n=120



Y = -4.996 + 3.099 * X; R^2 = .952

Lake Tanganyika

Regression plot Standard Length vs. Body weight, n=120

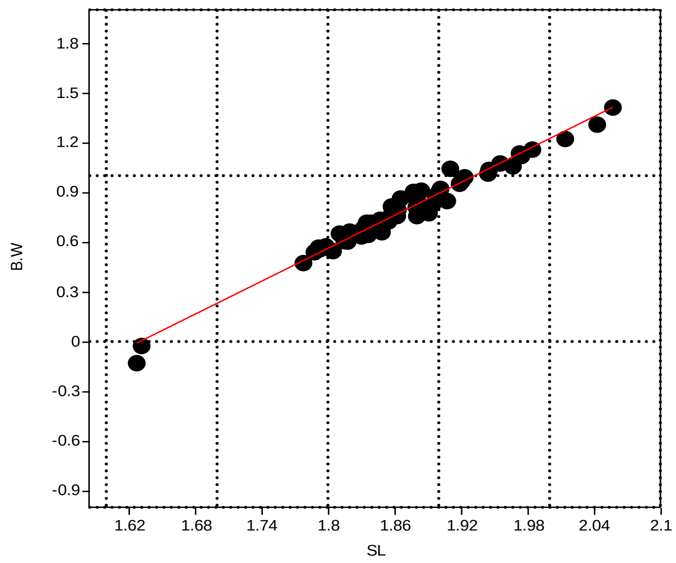


Y = -4.812 + 3 * X; R^2 = .944

Preliminary Results: Reproductive Strategies

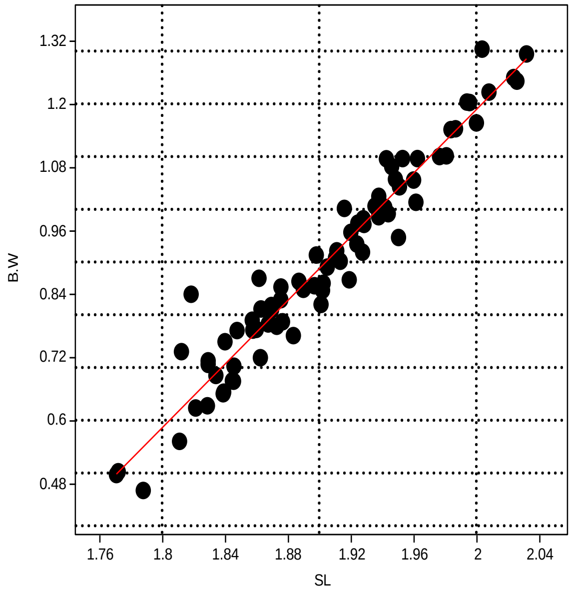
Lake Kivu

Linear Regression for males (SL vs Body weight



Lake Tanganyika

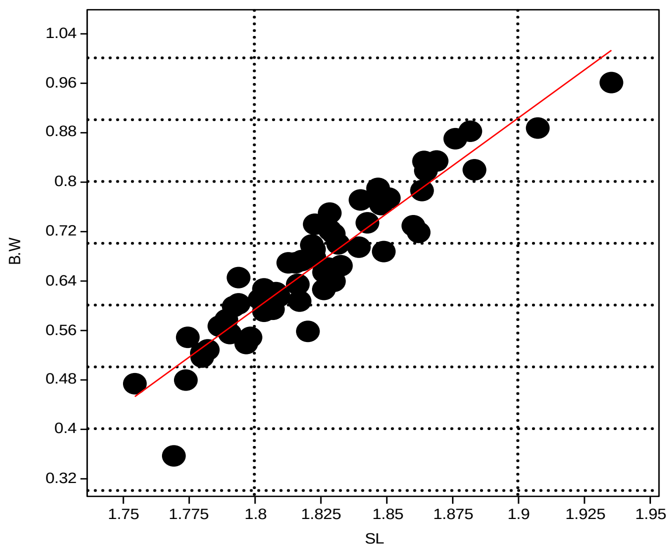
Linear Regression for males (SL vs Body weight



Preliminary Results: Reproductive Strategies

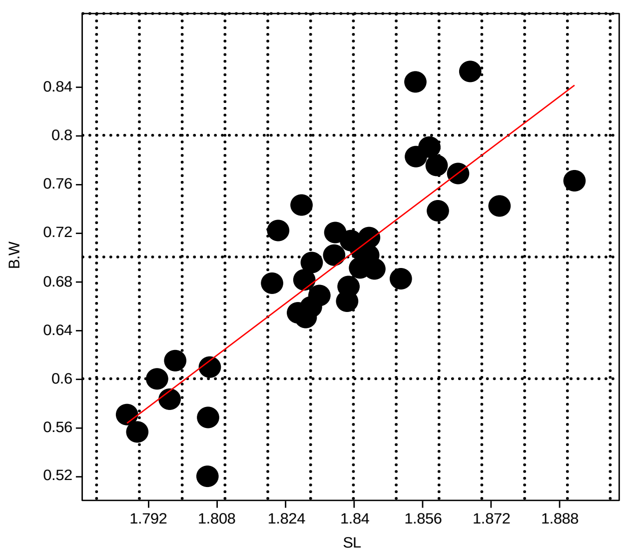
Lake Kivu

Linear Regression for females (SL vs Body weight, n=61



Lake Tanganyika

Linear Regression for females (SL vs Body weight, n=37



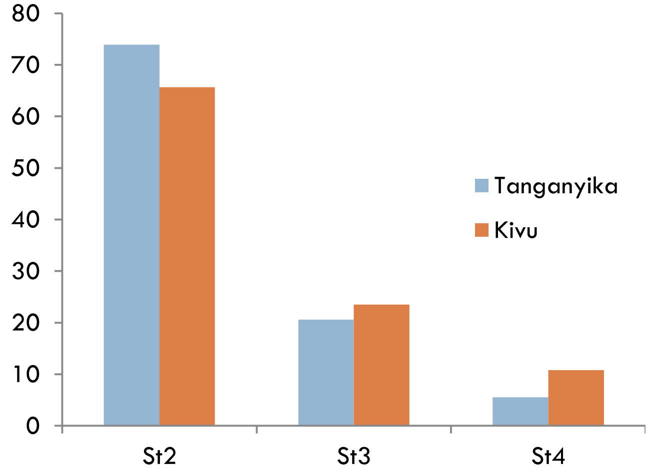
Preliminary Results: Reproductive Strategies

Frequency of female Gonad maturity stage

Lac	Stade de maturité	Nombre	Pourcentage
Tanganyika	2	3985	73,9
	3	1111	20,6
	4	297	5,5
Kivu	2	5998	65,7
	3	2150	23,5
	4	989	10,8

Evolution of female gonad maturing

n



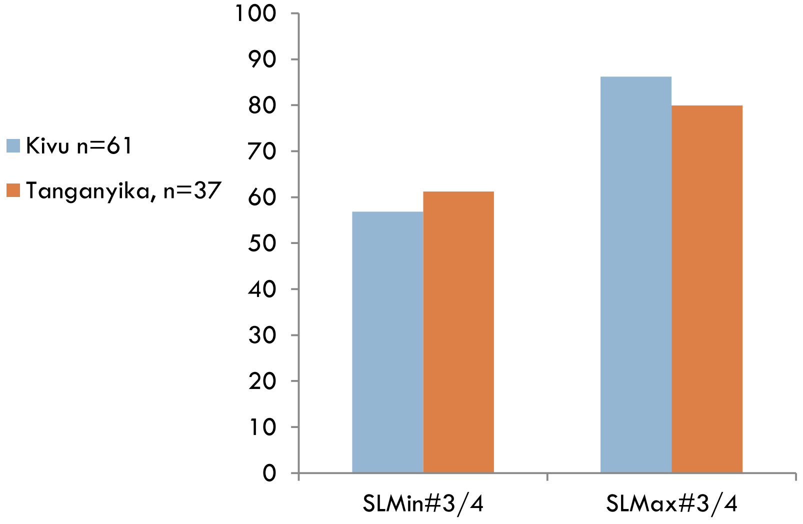
Preliminary Results: Reproductive Strategies

Absolute Fecundity

Lac	moyenne	écart-type	n	min	max
Tanganyika	145,7	42,6	37	62	242
Kivu	148,9	44,6	61	54	255

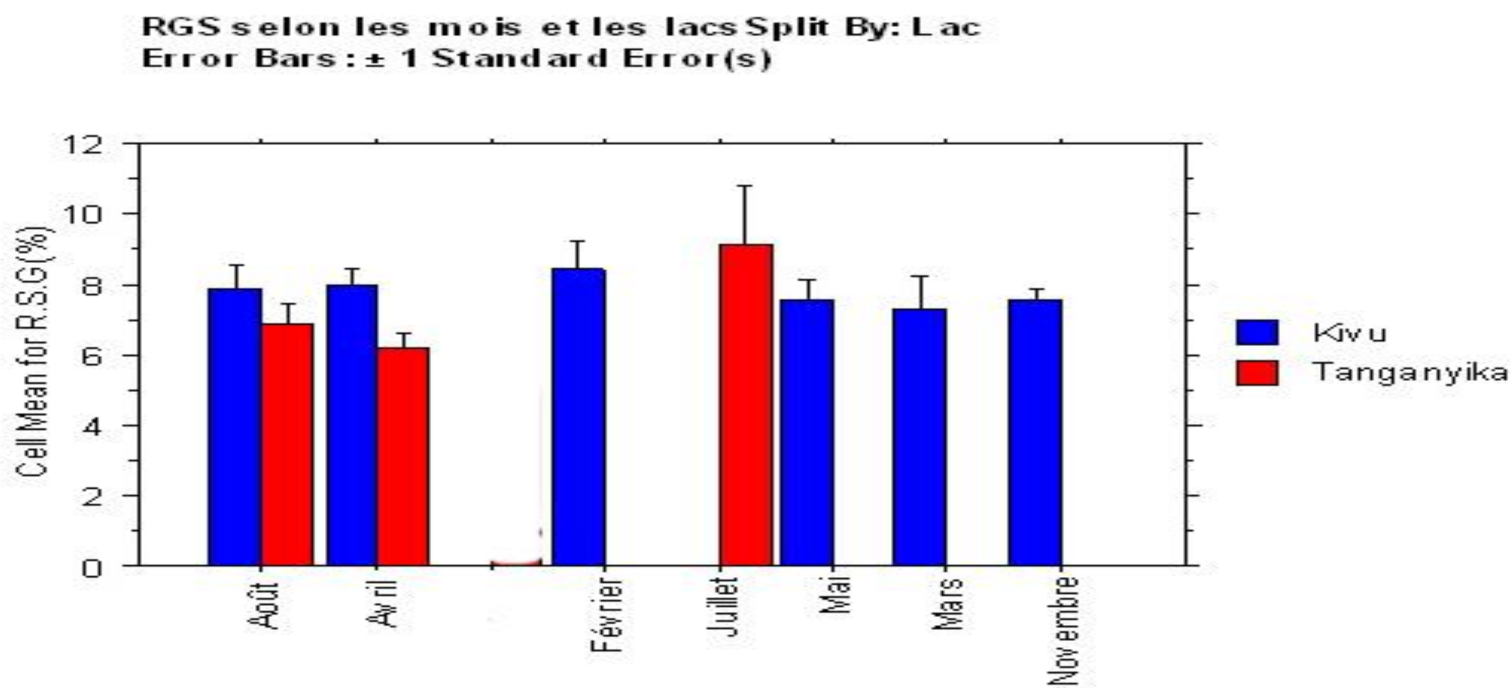
Size at first maturity

K=56.84mm; Tang=61.25mm



Preliminary Results: Reproductive Strategies

Variation of GSI within Lakes and Period of sampling



V. Further Research activities

- Data analyses for Diet and Reproduction strategies of *L. tanganicanus* (continued)
- Mophometric measurements to include samples from other localities (Tanzania, Zambia) and geo-morphemetric approach!
- Molecular analyses of samples from many localities

THANK YOU FOR YOUR LISTENING