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# Morphometric and Meristic Analysis of *Lates niloticus* (Linnaeus, 1758) (Teleostei: Latidae) from Lake Nasser and the River Nile, Egypt

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## ABSTRACT

The present study aimed to provide data on the effect of the High Dam on the morphological and meristic characteristics of *Lates niloticus* from two different Egyptian freshwater environments; Lake Nasser in Aswan City and the River Nile in Assiut City, Egypt. Therefore, twenty-six specimens of *L. niloticus* were collected from each site. The morphological characteristics and related index ratio to the standard length were determined. The results showed that the fish specimens from Lake Nasser were longer (mean 30.5± 8.8cm TL) than those from the Nile River (27.6± 4.2cm TL), and a strong correlation was detected between the different morphometric parameters to the standard length with different morphometric indices. The t-test showed significant differences between the total length, predorsal fin distance, postdorsal fin distance and prepectoral fin distance ($P< 0.01$). The means of indices related to the standard length, total length, predorsal fin distance, postdorsal fin distance, and prepectoral fin distance of *L. niloticus* collected from Lake Nasser are about 118.2, 44.2, 81.6, and 32.9 % SL, respectively, and are larger than the same indices of *L. niloticus* collected from the Nile River in Assiut City (109.3, 40.5, 77.0 and 26.7% SL, respectively). On the other hand, the other morphometric and all meristic parameters for the two locations showed insignificant differences. These findings suggest that differences in some morphometric characters may be due to the biometry of the species being influenced by the differences in the environments of Lake Nasser and the River Nile. Therefore, the continuous study of morphological features, that are related to the dams' constructions, environmental changes, as well as genetic confirmation, is recommended.

## INTRODUCTION

Morphometric and meristic measurements are widely used to identify differences between fish populations **(Farrag *et al.*, 2015; Zubia *et al.*, 2015; Sartimbul *et al.*, 2018; Heneish & Rizkalla 2021; Farrag, 2022)**. These measurements are influenced by the differences of environmental factors, such as temperature, salinity, water quality and food availability **(Muchlisin *et al.*, 2013; Abed *et al.*, 2020; Rumahlatu *et al.*, 2020)**.

Perches (Latidae) form a family of large piscivorous fishes that have a highly valuable value in the commercial, artisanal and recreational fisheries **(Koblmüller *et al.*, 2021)**. Lates perches comprises eleven species which inhabit marine, brackish and freshwater habitats in the Indo-Pacific region and in the African freshwater systems. Seven Lates species inhabit in large African freshwater systems (**Froese & Pauly, 2009; Iwatsuki *et al.*, 2018; Fricke *et al.*, 2021; Koblmüller *et al.*, 2021)**, but only one species, *Lates niloticus*, occurs in the Nile River, Egypt **(GAFRD 2019)** and Lake Nasser **(El-Far *et al.*, 2020)**. The Nile Perch, *L. niloticus*, is a freshwater species endemic to African rivers and lakes including the Nile, Chad, Senegal, Niger and the Congo River basins **(Froese & Pauly, 2009; Basiita *et al.*, 2018)**. After the High Dam construction in Egypt, the River Nile was divided into two regions (before the dam from the southern part and after the dam toward the North). Before the construction of the dam, Lake Nasser, spanning an extensive 500 km2, served as a vast reservoir of water and fisheries. However, after the dam's completion, the River Nile underwent significant changes over time, affecting its fisheries resources and the availability of food. One day after the other, the quantities and sizes of the fishes in the River Nile became lower and smaller than those in Lake Nasser. The indicator for such variations and their effects on the fisheries included morphometric and meristic features, which may be considered as a primary indicators **(Farrag, 2022)**. In spite of the fact that the Nile perch is considered an important fish species, there are no sufficient data on its being influenced by the High Dam. The regular studies on the environmental status show that aquatic communities is crucial for the full assessment of the complete environmental situation of Lake Nasser and its khors (**Abdel Gawad & Abdel-Aal, 2018; Rizk *et al*., 2020; Shalloof *et al.*, 2020)**.

The morphometric and meristic measurements of fishes can diverge among stocks mainly due to the mixed influences of the genetics, environmental factors, and development stages **(Wimberger, 1992; Cadrin, 2000)**. These measurements were studied by several authors for taxonomy, sex validation and population defferentiation **(Mekkawy & Mohammad, 2011; Harabawy *et al.*, 2012; Safi, 2014; Mahmoud *et al.*, 2016; Jawad *et al*., 2021, 2022; Farrag, 2022; Farrag *et al.*, 2023)**. Therefore, this study aimed to provide the information on the influence of morphological and meristic characteristics of *L. niloticus* from two different Egyptian freshwater environments, Lake Nasser in Aswan City, as well as the River Nile in Assiut City due to the differences in the ecology of the two locations.

## MATERIALS AND METHODS

Samples of *L. niloticus* were collected during 2019 from Lake Nasser at Aswan (23° 58' 32.02" N, 32° 51' 21.58" E) and the River Nile at Assiut City (27° 11' 34.36" N, 31° 11' 24.70" E), Egypt (Fig. 1).

A total of 26 specimens of *L. niloticus* (Fig. 2) were collected from each site and taken to the laboratory.

Fourteen morphometric measurements were evaluated to the nearest millimeter using a divider and a measuring board from the left side. These were: total length (TL), standard length (SL), predorsal fin distance (PRDF), postdorsal fin distance (PODF), prepectoral fin distance (PRPF), preanal fin distance (PRAF), preventral fin distance (PRVF), head length (HL), head depth (HD), maximum body depth (MAXBD), minimum body depth (MINBD), preorbital distance (PRO), postorbits distance (POO) and eye diameter (ED). These measurements are diagrammatically represented in Fig. (3).


**Fig. 1.** Map showing the sampling areas, Lake Nasser (Aswan City), and the River Nile (Assiut City) in Egypt

**Fig. 2.** External feature of *L. niloticus* collected from Lake Nasser, Egypt

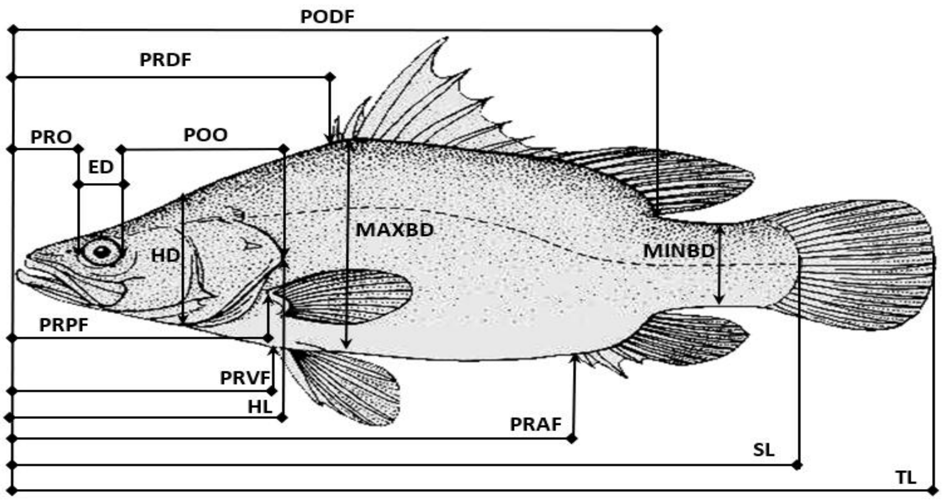



**Fig. 3.** Morphometric characters measured showing: **TL**: Total length, **SL**: Standard length,

**HL**: Head length, **HD**: Head depth, **MAXBD**: Maximum body depth, **MINBD**: Minimum body depth, **PRDF**: Predorsal fin distance, **PODF**: Postdorsal fin distance, **PRPF**: Prepectoral fin distance, **PRAF**: Preanal fin distance, **PRVF**: Preventral fin distance, **ED**: Eye diameter, **PRO**: Preorbital distance, and **POO**: Postorbital distance **(Source of photo: FAO Fish Finder, 1994)**

The morphometric index to each character was given as percentage to the standard length by using the following formula:

Morphometric Index = (morphometric measurement / standard length) x 100

The linear regression equations were used to obtain the relation between the standard length (SL) and each morphometric characters as given in the following equation:

$$Y = a + bX$$

Where, Y is the variable morphometric character; X is the independent character (standard length), and a & b are the constants whose values can be determined by the least square method.

Five meristic characters including the dorsal fin spines (DFS), the dorsal fin soft rays (DFR), the caudal fin rays (CFR), number of scales on lateral line (SLL) and total number of gill rakers (TGR) were counted. Statistical analyses including the mean, standard deviation, and correlation coefficient were conducted in accordance with the methodology outlined by **Snedecor and Cochran (1982)**. Data were analyzed using SPSS (1997) program, version 25. Differences between means were compared using t-test at $P<0.01$ level. Microsoft Excel 365 was used to plot the relationships.

## RESULTS

### Morphometric characters

Descriptive statistics for morphometric measurement are given in Table (1). The total length of *L. niloticus* specimens investigated from Lake Nasser were ranged from 24.1 to 37.8cm TL with a mean length of 30.5± 8.8cm, while those from the River Nile were ranged from 23.8 to 37.3cm TL with a mean length of 27.6± 4.2cm. Both of them have slightly a similiar range, ensuring consistent results and avoiding bias related to differences in length. The regression analysis between the standard length and other measurements were estimated and represented in Table (2) and Fig. (4), which confirmed that there is a strong correlation between length-length relationships.

The statistical analyses showed that the specimens collected from Lake Nasser were larger than specimens collected from the River Nile with significant differences in means of total length (TL), standard length (SL), predorsal fin distance (PRDF), postdorsal fin distance (PODF), prepectoral fin distance (PRPF), and preanal fin distance (PRAF). While, insignificant differences were found in preventral fin distance (PRVF), head length (HL), head depth (HD), maximum body depth (MAXBD), minimum body depth (MINBD), preorbital distance (PRO), postorbital distance (POO), and eye diameter (ED).

**Table 1.** Descriptive statistics of different body measurements of *L. niloticus* from Lake Nasser and the River Nile, Egypt

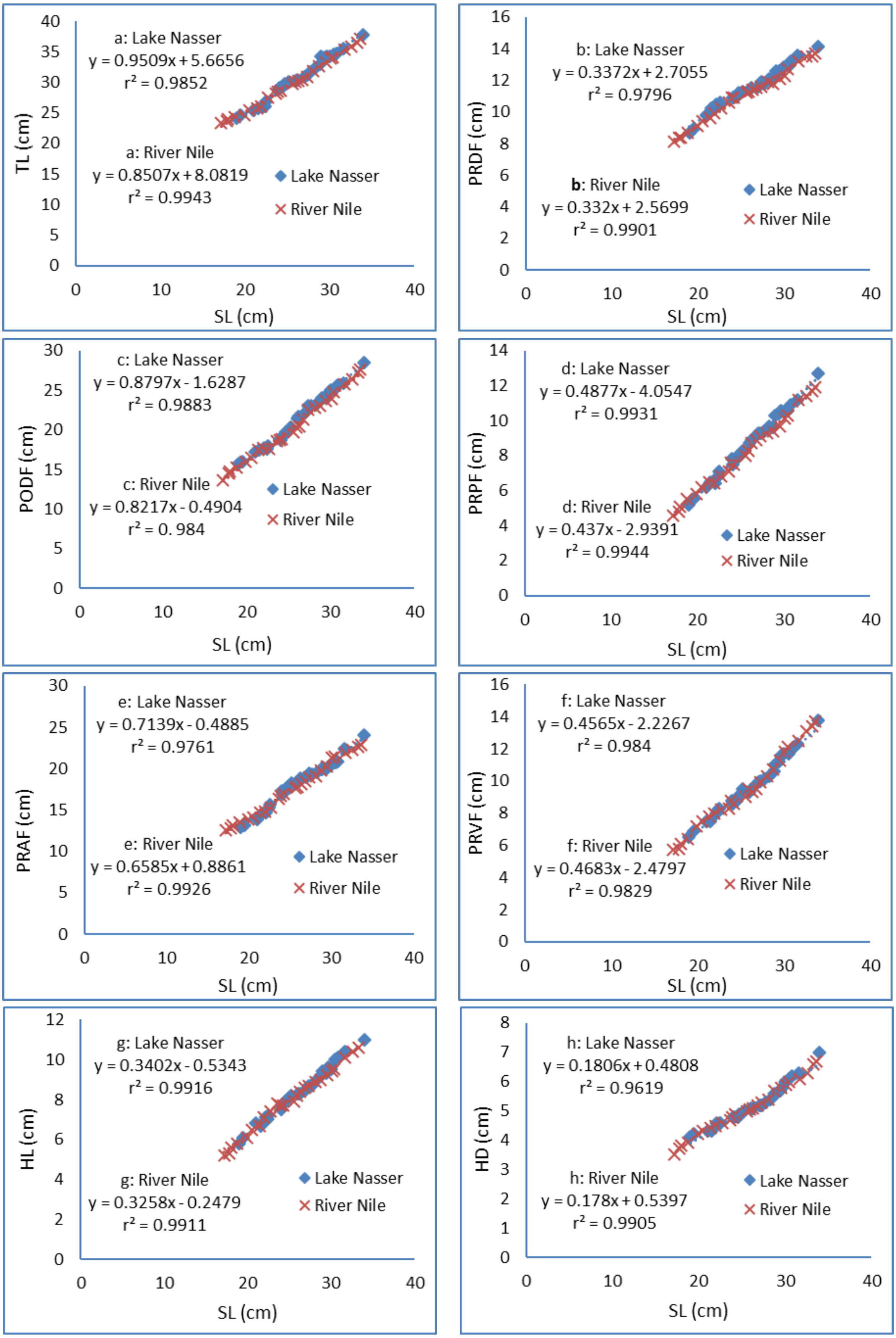
| Measurement | Lake Nasser | | The River Nile | |
|---|---|---|---|---|
| | Range | Mean± SD | Range | Mean± SD |
| TL | 24.1-37.8 | 30.5±8.8* | 23.8-37.3 | 27.6±4.2* |
| SL | 19.0-34.0 | 26.1±3.7* | 17.2-33.6 | 25.3±4.9* |
| PRDF | 8.7-14.1 | 11.5±1.3* | 8.1-13.7 | 10.9±1.6* |
| PODF | 15.7-28.5 | 21.4±3.4* | 13.7-27.6 | 20.3±4.1* |
| PRPF | 5.2-12.7 | 8.7±1.8* | 4.6-11.9 | 8.1±2.1* |
| PRAF | 12.9-24.1 | 18.2±2.7* | 12.6-22.9 | 17.5±3.2* |
| PRVF | 6.5-13.8 | 9.7±1.7 NS | 5.7-13.7 | 9.4±2.3 NS |
| HL | 5.8-11 | 8.3±1.3 NS | 5.2-10.9 | 8.0±1.6 NS |
| HD | 4.1-7.0 | 5.2±0.7 NS | 3.5-6.7 | 5.0±0.8 NS |
| MAXBD | 5.2-10.7 | 7.7±1.3 NS | 4.7-10.2 | 7.3±1.6 NS |
| MINBD | 1.8-4.3 | 2.9±0.6 NS | 1.6-4.2 | 2.7±0.7 NS |
| PRO | 0.9-3.5 | 1.9±0.6 NS | 0.6-3.35 | 1.8±0.8 NS |
| POO | 2.3-5.1 | 3.5±0.7 NS | 1.8-5.1 | 3.4±0.9 NS |
| ED | 1.1-1.9 | 1.4±0.2 NS | 1.1-1.88 | 1.4±0.2 NS |

SD: Standard deviation; * Difference is significant at the 0.01 level; NS: Difference is insignificant.

**Table 2.** Regression analysis between the different body measurements and standard length of *L. niloticus* from Lake Nasser and the River Nile, Egypt

| Correlates | Lake Nasser | | | The River Nile | | |
|---|---|---|---|---|---|---|
| | a±SE | b±SE | $r^2$ | a±SE | b±SE | $r^2$ |
| SL vs TL | 5.666±0.616 | 0.951±0.023 | 0.985 | 8.082±0.340 | 0.851±0.013 | 0.994 |
| SL vs PRDF | 2.706±0.257 | 0.337±0.010 | 0.979 | 2.570±0.175 | 0.332±0.007 | 0.990 |
| SL vs PODF | -1.629±0.507 | 0.880±0.019 | 0.988 | -0.490±0.435 | 0.822±0.017 | 0.984 |
| SL vs PRPF | -4.055±0.215 | 0.488±0.008 | 0.993 | -2.939±0.173 | 0.437±0.007 | 0.994 |
| SL vs PRAF | -0.488±0.591 | 0.714±0.022 | 0.976 | 0.886±0.300 | 0.658±0.012 | 0.992 |
| SL vs PRVF | -2.227±0.308 | 0.456±0.012 | 0.984 | -2.480±0.326 | 0.468±0.013 | 0.982 |
| SL vs HL | -0.534±0.165 | 0.340±0.006 | 0.991 | -0.307±0.158 | 0.328±0.006 | 0.991 |
| SL vs HD | 0.481±0.190 | 0.181±0.007 | 0.962 | 0.540±0.092 | 0.178±0.004 | 0.990 |
| SL vs MAXBD | -1.662±0.204 | 0.360±0.008 | 0.988 | -0.991±0.106 | 0.330±0.005 | 0.996 |
| SL vs MINBD | -1.359±0.090 | 0.163±0.003 | 0.989 | -0.899±0.094 | 0.144±0.004 | 0.985 |
| SL vs PRO | -2.534±0.125 | 0.171±0.005 | 0.981 | -2.394±0.115 | 0.167±0.003 | 0.983 |
| SL vs POO | -1.399±0.114 | 0.191±0.004 | 0.987 | -1.425±0.063 | 0.190±0.002 | 0.996 |
| SL vs ED | 0.027±0.029 | 0.055±0.001 | 0.990 | 0.110±0.029 | 0.052±0.001 | 0.988 |

SE, Standard error, $r^2$, coefficient of determination.


a: Lake Nasser
y = 0.9509x + 5.6656
r² = 0.9852
a: River Nile
y = 0.8507x + 8.0819
r² = 0.9943
Lake Nasser
River Nile
TL (cm)
SL (cm)
b: Lake Nasser
y = 0.3372x + 2.7055
r² = 0.9796
b: River Nile
y = 0.332x + 2.5699
r² = 0.9901
Lake Nasser
River Nile
PRDF (cm)
SL (cm)
c: Lake Nasser
y = 0.8797x - 1.6287
r² = 0.9883
c: River Nile
y = 0.8217x - 0.4904
r² = 0. 984
Lake Nasser
River Nile
PODF (cm)
SL (cm)
d: Lake Nasser
y = 0.4877x - 4.0547
r² = 0.9931
d: River Nile
y = 0.437x - 2.9391
r² = 0.9944
Lake Nasser
River Nile
PRPF (cm)
SL (cm)
e: Lake Nasser
y = 0.7139x - 0.4885
r² = 0.9761
e: River Nile
y = 0.6585x + 0.8861
r² = 0.9926
Lake Nasser
River Nile
PRAF (cm)
SL (cm)
f: Lake Nasser
y = 0.4565x - 2.2267
r² = 0.984
f: River Nile
y = 0.4683x - 2.4797
r² = 0.9829
Lake Nasser
River Nile
PRVF (cm)
SL (cm)
g: Lake Nasser
y = 0.3402x - 0.5343
r² = 0.9916
g: River Nile
y = 0.3258x - 0.2479
r² = 0.9911
Lake Nasser
River Nile
HL (cm)
SL (cm)
h: Lake Nasser
y = 0.1806x + 0.4808
r² = 0.9619
h: River Nile
y = 0.178x + 0.5397
r² = 0.9905
Lake Nasser
River Nile
HD (cm)
SL (cm)

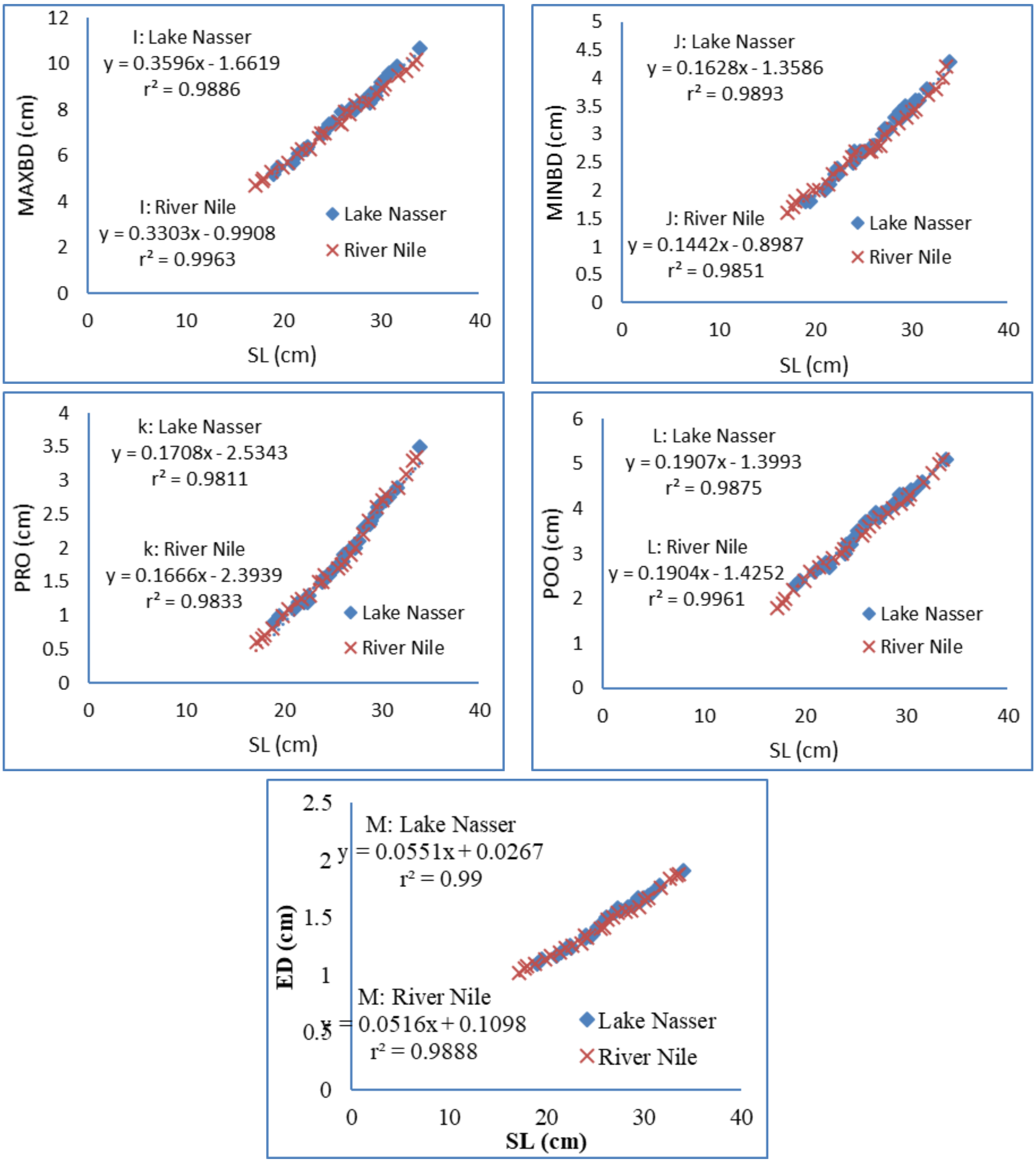



**Fig. 4.** Relationships between different morphometrics of *L. niloticus* from Lake Nasser and the River Nile, Egypt showing: **a**: Total length and standard length, **b**: Pre dorsal fin distance and standard length **c**: Post dorsal fin distance and standard length, **d**: Pre pectoral fin distance and standard length, **e**: Pre anal fin distance and standard length, **f**: Pre ventral fin distance and standard length, **g**: Head length and standard length, **h**: Head depth and standard length, **i**: Maximum body depth and standard length, **j**: Minimum body depth and standard length, **k**: Pre orbital distance and standard length, **l**: Postorbital distance and standard length, and **m**: Eye diameter and standard length

The index ranges and mean values of morphometric characters related to the standard length for *L. niloticus* collected from Lake Nasser and the Nile River are given in Table (3). It showed significant differences between the total length (TL), predorsal fin distance (PRDF), postdorsal fin distance (PODF) and prepectoral fin distance (PRPF) at 0.01 level. The indices of the total length, predorsal fin distance, postdorsal fin distance and prepectoral fin distance of *L. niloticus* collected from Lake Nasser are about 118.2, 44.2, 81.6 and 32.9% SL, respectively, and are larger than the same indices of *L. niloticus* collected from the River Nile (109.3, 40.5, 77.0 and 26.7% SL, respectively). While, there were no significant differences between the other morphometric indices related to the standard length of *L. niloticus* specimens, which were collected from the two locations. These morphometric indices are preanal fin distance (PRAF= 69.4 and 69.3% SL), preventral fin distance (PRVF= 36.9 and 36.4% SL), head length (HL= 31.9 and 31.5% SL), head depth (HD= 20.1 and 19.7% SL), maximum body depth (MAXBD= 29.4 and 28.9% SL), minimum body depth (MINBD= 10.9 and 10.7% SL), preorbital distance (PRO= 7.1 and 6.8% SL), postorbital distance (POO= 13.6 and 13.2% SL), and eye diameter (ED= 5.3 and 5.1% SL). They have nearly the same proportions of the standard length of *L. niloticus* (from Lake Nasser and the River Nile, respectively).

**Table 3.** Index ranges and mean values of different morphometric characters of *L. niloticus* from Lake Nasser and the River Nile, Egypt

| Morphometric character | Lake Nasser (Aswan) | | The Nile River (Assiut) | |
|---|---|---|---|---|
| | Index range | Mean±SD | Index range | Mean±SD |
| TL/SL | 111.2-126.8 | 118.2±7.3* | 109.3-135.5 | 117.2±3.9* |
| PRDF/SL | 41.5-47.5 | 44.2±1.7* | 40.5-47.2 | 43.2±2.1* |
| PODF/SL | 77.9-84.6 | 81.6±1.7* | 77.0-82.8 | 80.1±1.6* |
| PRPF/SL | 27.4-37.4 | 32.9±2.5* | 26.7-35.4 | 31.6±2.4 * |
| PRAF/SL | 66.2-72.2 | 69.4±1.7 NS | 67.4-73.3 | 69.3±1.5 NS |
| PRVF/SL | 34.2-40.6 | 36.9±1.4 NS | 32.6-40.8 | 36.4±2.1 NS |
| HL/SL | 30.5-32.9 | 31.9±0.5 NS | 29.8-33.1 | 31.5±0.7 NS |
| HD/SL | 19.0-21.6 | 20.1±0.6NS | 19.2-21.1 | 19.7±0.5 NS |
| MAXBD/SL | 27.1-31.5 | 29.4±1.1 NS | 27.3-30.4 | 28.9±0.9 NS |
| MINBD/SL | 9.2-12.6 | 10.9±0.8 NS | 9.3-12.5 | 10.7±0.7 NS |
| PRO/SL | 4.7-10.3 | 7.1±1.4 NS | 3.5-10.0 | 6.8±1.9 NS |
| POO/SL | 12.1-15.0 | 13.6±0.9 NS | 10.5-15.2 | 13.2±1.2 NS |
| ED/SL | 5.5-5.8 | 5.3±0.09 NS | 5.4-6.0 | 5.1±0.1NS |

* Difference is significant at the 0.01 level, NS: Difference is insignificant.

Meristic counts which are presented in Table (4) revealed that *L. niloticus* in Lake Nasser and the River Nile which are characterized by the dorsal fin with 7– 8 spines (DFS) and 9– 14 rays (DFR), while the caudal fin rays (CFR) have 18- 19 rays. The Number of scales on lateral line (SLL) was 64- 74 scales, and the total number of gill rakers (TGR) was 12- 14 gill rakers. Statistically, insignificant differences were recorded in the meristic characters of *L. niloticus* from the two locations.

**Table 4.** Meristic counts of *L. niloticus* from Lake Nasser and the River Nile, Egypt

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **The Dorsal fin spines (DFS)** | | | | | | | | |
| | N | 7 | 8 | 0 | 0 | 0 | 0 | Mean±SD |
| **Lake Nasser** | 26 | 12 | 14 | - | - | - | - | 7.54±0.51 |
| **River Nile** | 26 | 11 | 15 | - | - | - | - | 7.58±0.50 |
| **The Dorsal fin soft rays (DFR)** | | | | | | | | |
| | N | 9 | 10 | 11 | 12 | 13 | 14 | Mean±SD |
| **Lake Nasser** | 26 | 4 | 4 | 6 | 6 | 4 | 2 | 11.31±1.52 |
| **River Nile** | 26 | 3 | 4 | 6 | 6 | 4 | 3 | 11.50±1.53 |
| **The caudal fin rays (CFR)** | | | | | | | | |
| | N | 18 | 19 | 0 | 0 | 0 | 0 | Mean±SD |
| **Lake Nasser** | 26 | 11 | 15 | - | - | - | - | 18.58±0.50 |
| **River Nile** | 26 | 12 | 14 | - | - | - | - | 18.54±0.51 |
| **Number of scales on lateral line (SLL)** | | | | | | | | |
| | N | 64 | 66 | 68 | 70 | 72 | 74 | Mean±SD |
| **Lake Nasser** | 26 | 5 | 6 | 5 | 4 | 3 | 3 | 68.23±3.31 |
| **River Nile** | 26 | 6 | 5 | 6 | 5 | 1 | 3 | 67.92±3.22 |
| **Total number of gill rakers (TGR)** | | | | | | | | |
| | N | 12 | 13 | 14 | 0 | 0 | 0 | Mean±SD |
| **Lake Nasser** | 26 | 9 | 11 | 6 | - | - | - | 12.88±0.77 |
| **River Nile** | 26 | 7 | 12 | 7 | - | - | - | 13.00±0.75 |

## DISCUSSION

The objective of this investigation was to add some clues for the ecologically and biologically effects of the dams on the morphometric measurements of the same species generally and especially for *Lates miloticus* from two separate areas (Lake Nasser and the River Nile, Egypt). Since, the different factors, such as food availability and ecological variants, may cause some variations in morphometrics (**Soliman *et al*., 2018; Farrag, 2022)**.

The variability in body shapes within species may occurred due to the variations in growth, development, and maturation **(ICES, 1996; Pawson & Jennings, 1996; Begg *et al*., 1999)**. In the present study, the significant differences of some morphometric characters that were recorded between *L. niloticus*, collected from Lake Nasser and the River Nile, may be attributed to the environmental changes, such as water quality and food availability **(Ujjainia & Kohli 2011; Sartimbul *et al.*, 2018; Soliman *et al*., 2018)** as well as the difference in temperature **(Abed *et al*., 2020; Rumahlatu *et al.*, 2020)**. Lake Nasser that has good water quality and abundance of nutrients provides good conditions for growing high-quality freshwater fish **(Aly *et al.*, 2018)**.

Lake Nasser is considerd the ideal example for food variability, compared to the rest of the River Nile. Many studies have been performed for its ecology and the status of aquatic communities (**El-Haweet *et al*., 2008; Abdel Gawad & Abdel-Aal, 2018; Rizk *et al.*, 2020; Shalloof *et al.*, 2020; Zaher & Aly 2021; Abdel-Aal *et al*., 2023)**. The annual Nile flood during August which originated from the Ethiopian Highlands is the most important factor affecting Lake Nasser ecosystem, including the distribution, abundance, and community composition of organisms (e.g. planktonic algae, epiphytic algae, zooplankton, macroinvertebrates, etc.) **(El-Serafy *et al*., 2009; Abdel Gawad & Abdel-Aal 2018; Goher *et al.*, 2021)**.

In the present study, the significant differences in the morphometrics were found as confirmed indicators of lower food valiabilty in the River Nile than that of Lake Nasser. Moreover, the temperature in Lake Nasser is higher than that of the River Nile, particularly toward the North. The good condition of food variability in Lake Nasser, as reported by **Aly *et al.* (2018)**, contributes to an increase in fish growth and condition, which are more relative to morphometric measurements. While, the insignificant differences that were observed in the meristic characters of *L. niloticus* from the two locations may be due to changes in environmental factors, suggesting that it is still the same species and has not evolved into a separate or subspecies. These criteia of water quality were affected by the construction of the High Dam, aligning with the findings of **Abdel-Aal *et al.* (2023)**, who studied the ecological status of Lake Nasser, Egypt, before operating the Grand Ethiopian Renaissance Dam. This concept agrees with the studies of **Jeffrey and Vesk (1997)** and **Leterme *et al.* (2006)** who stated that, the density and composition of phytoplankton and trophic status can affect the food web structure in the aquatic ecosystems. Furthermore, **Naesje *et al*. (2004)** reported that, the morphological variation among the fish populations could be induced by ecological factors interacted with fundamental genetic roles. Therefore, this study is considered among few studies on the crucial species in Lake Nasser and the River Nile. Moreover, it reflects the effects of environmrntal changes due to the dam construction via the morphological characteristics and may be used as a sample guide for such species which has insufficient data. However, more studies are recommended to be performed based on the current measurements of the species under study and other factors in addition to further studies related to climatic changes and other dams' construction, as well as the genetic and biochemical compostion.

## CONCLUSION

In conclusion, significant differences in morphometric indices were observed in the present populations of *L. niloticus* from Lake Nasser and the River Nile in Egypt. These differences may be attributed to variations in environmental factors between habitats. While, the insignificant differences were recorded in the meristic characters of *L. niloticus* from the two locations. The variations in morphometrics have confirmed the effects of the ecological variations between the two areas and the need for further continuous studies relevant to dams constuction.

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