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Diet study of *Nannothrissa stewarti* (Poll & Roberts, 1976) Clupeidae in Lake Mai-Ndombe, Democratic Republic of Congo

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In order to determine the diet of *Nannothrissa stewarti* in Lake Mai Ndombe, 667 specimens with total length between 9.0 and 49.84 mm were studied. These fish were sampled by active fishing during the 24 h cycle between September 2018 and October 2021. The vacuity (%) and intestinal coefficients were 38.71% and 0.69 ± 0.03, respectively, classifying *N. stewarti* as invertivorous. The calculated feeding indices showed that zooplankton are the essential prey (%F_{fi} = 88.8; %IP = 90.0; and %IRI = 90.8) while phytoplankton are the incidential prey. Larvae feed on cyclopoid, copepods, and *nauplius* while adults consume cladoceras, copepods, rotifers and phytoplankton. This fish begins its feeding activity early in the morning (5:00 am), his stomach fills up around 1:00 pm and empties completely around 1:00 am. Thus, *N. stewarti* in various steps growing ages both males and females are zooplanktons feeders.

Key words: Lake Mai-Ndombe, *Nannothrissa stewarti*, food indices, diurnal.

INTRODUCTION

Food is the only source of energy acquisition that the animal uses to accomplish its different functions (Lévêque et al., 1994; Lévêque and Paugy, 2006). The study of the diet of fish in the natural environment is an essential approach to the knowledge of their biology and ecology. Not only on the presence, abundance and availability of food potential in the natural environment, but also, it allows us to understand the relationships between fish and prey, as well as interspecific relationships (Rosecchi and Nouaze, 1987; Froese and Pauly, 1999; Kouamélan, 1999; Kouamé et al., 2006, Pwema et al., 2015; Thumithol et al., 2016). Stomach content analysis is one of the possibilities to know the feeding habits of fish (Kouamélan, 1999; Thumithol et al., 2016).

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Work on fish diets should also precede the implementation of conservation or management policies for ichthyological populations (Ouattara et al., 2014).

In Lake Mai-Ndombe, *Nannothrissa stewarti* (Clupeidae) constitutes 90% of all fish species landed in the shore seine fishery. It contributes to the animal protein supply of the population in this area (Micha et al., 2020). The concern would be on how its exploitation is done without respect for ecological principles and the maintenance of essential processes of conservation of critical habitats and other systems on which they depend, which could lead to the rarefaction or even extinction of species (Inogwabini et al., 2009; De Keyzer et al., 2020).

This work aims to determine the qualitative and quantitative diet of *N. stewarti* in Lake Mai-Ndombe based on food indices.

MATERIALS AND METHODS

Study environment

Lake Mai-Ndombe (Figure 1) is located at 1° 32' - 2° 43' South latitude and 18° 03' - 18° 36' East longitude. It is 146 km long, 18 km wide and covers 2300 km^2 (Ebengo, 2022).

Climatic data

According to Bultot and Griffits (1971), the Lake Mai-Ndombe region has an Af-type climate according to the Köppen classification. Analysis of 41 years of data revealed that the monthly and annual diurnal air temperature varies, respectively from 25.96 to 27.25°C, the average of 26.4 ± 0.49°C and from 25.69 to 27.3°C, the average of 26.5 ± 0.44°C. Consequently, the monthly and annual rainfall amounts are, respectively 69.91 to 153.61 mm while the mean is 115.42 ± 28.16 mm and from 1000.9 to 1740.7 mm, the mean is 1376.22 ± 184.34 mm.

Umbrothermal diagram for the Lake Mai-Ndombe region is as shown in Figure 2. The umbrothermal curve of Lake Mai-Ndombe indicates that the Lake Mai-Ndombe region does not experience the marked dry season, but a decrease in rainfall is observed in the months of June and July.

The diet of *N. stewarti* was determined from 667 fish caught from September 2018 to October 2021 at Lake Mai-Ndombe.

Sample collection

Fish were sampled using shore seines in February and September on a 24-h cycle from 2018 to 2021 (8:00 am, 12:00 pm, 4:00 pm, 8:00 pm, 24:00 am and 4:00 am) using two types of monofilament nets with 0.1 and 2.5 cm knots, 500 m length and 2 m drop.

Analysis of the samples

Method of studying the diet

Captured fish were measured to the nearest millimeter total length (TL) and standard length (SL) using a 200 mm long digital caliper (accuracy 0.1 mm). The fish were then weighed to the nearest gram using the "Digital pocket scale" model 200, precision 0.001 g, and then preserved in jars containing 4% formalin before the study of the stomach contents. In the laboratory, the fish were dissected and the digestive tubes preserved in pillboxes containing 4% formalin for adults. The stomach contents thus obtained were placed on a 25 × 75 mm slide, then diluted with 2 to 5 drops equivalent to 0.08 to 0.2 ml of distilled water to visualize the prey. As for the larvae they were crushed and immediately observed under microscopy because of their very tiny size. Observations of the digestive contents were made under a MOTIC (swift line) light microscope at 100x magnification. Prey were identified using the keys established by Dussart (1967a, 1967b, 1982), Bourrelly (1972), Harding and Smith (1974), and Descy et al. (2016).

For this purpose, we used the method of estimating the volume ingested and the relative proportions of each type of prey contained in the stomach or point (volumetric) method. In this method, each food item contained in the stomach is assigned a number of points based on its volume. A total of 16 points are assigned to the highest volume of the diet item and all other items are 16, 8, 4, 2, 1, and 0 points based on volume relative to the component with the highest volume (Manko, 2016).

Expression of results

Determination of fish size classes

Size classes of sampled specimens were determined from Sturge's rule (Scherrer, 1984):

$$NC = 1+ (3.3 \log10 N)$$

where NC is the number of classes; N: total number of individuals for the considered sample. The class interval is determined by the following relationship:

$$CI = \text{Maximum size - minimum size / Total number of classes}$$

Intestinal coefficient (IC)

The intestinal coefficient gives an indication of the diet of a fish. It was obtained according to the following relationship:

$$CI = Li / Ls$$

where Li is the length of the intestine (mm) and Ls is standard length of the fish (mm).

Coefficient of vacuity (CV)

The vacuity coefficient is the number of empty stomachs in relation to the total number of stomachs examined. Its formula is:

$$CV = (\text{Number of empty stomachs / Number of stomachs analyzed}) \times 100$$

Numerical index (N)

The numerical index is the percentage of the number of individuals of a prey category for the whole sample compared to the total number of prey. Its formula is:

$$N = (\text{Total number of individuals of the prey (i) / Total number of prey inventoried}) \times 100$$

Occurrence index (F_{fi})

The occurrence determines the number of stomachs in which a prey or a category of prey is present. It is expressed as a

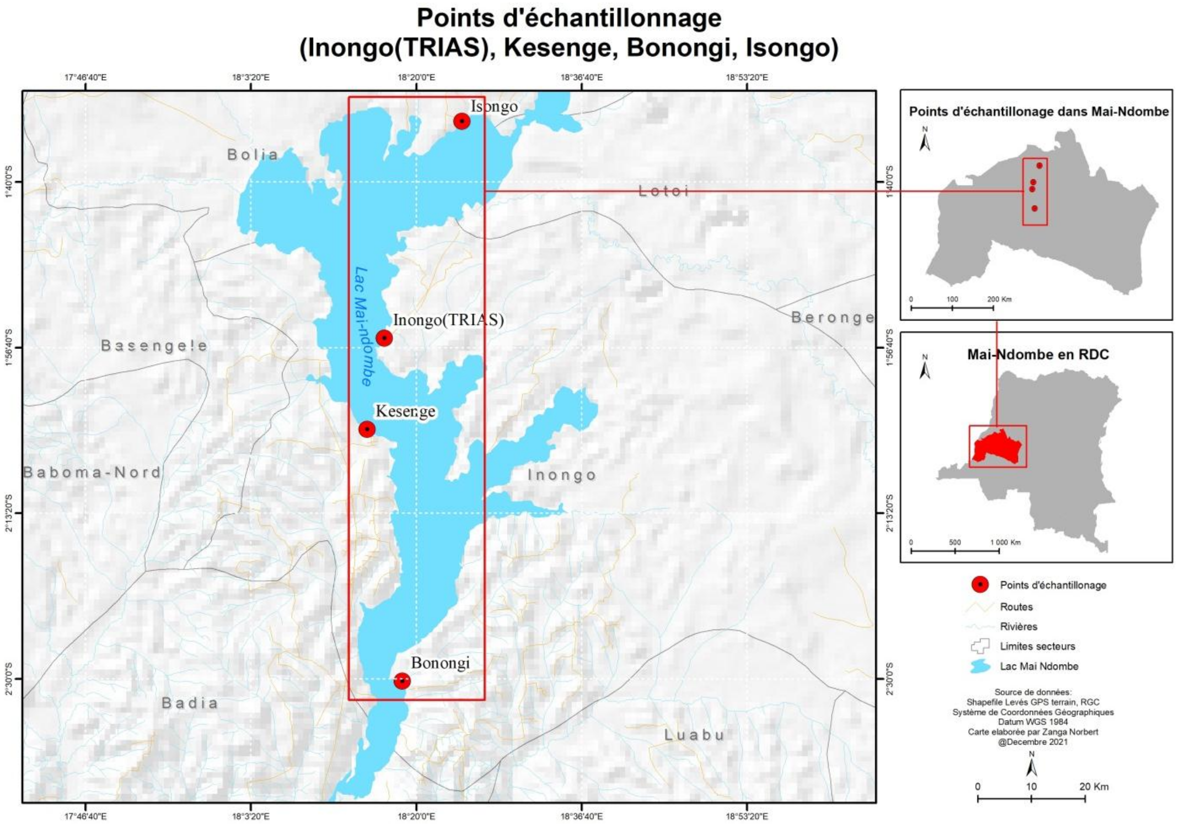

Figure 1. Map of sampling sites at Lake Mai-Ndombe (red dots).
Source: Ebengo (2022).

percentage of the total number of stomachs. Empty stomachs havebeen set aside because it can significantly change the results. It is calculated by the following relationship (Rosecchi and Nouaze, 1987; Manko, 2016; Zacharia, 2016; Mahesh et al., 2019):

$\%Ffi = (N_{fi} / N_f) \times 100$

where $\%F_{fi}$ is the frequency of occurrence of a given item i, N_{fi} is the number of stomachs in which an item i is found, and Nf is the total number of stomachs examined.

Rate of feeding activity

The filling state (replenishment) has been defined as follows: stage 0, empty stomach; stage 1, 25% full stomach; stage 2, 50% full stomach; stage 3, 75% full stomach; and stage 4, 100% full stomach (Garrido et al., 2008).

Volumetric index (Point method)

The percentages of volumes in each subsample were calculated as follows (Bertran and Calvez, 1988; Manko, 2016; Mahesh et al., 2019):

α = (Number of points assigned to the α component / Total points allocated to the subsample) × 100

where α is the volume percentage of the prey component α.

Preponderance Index

The preponderance index developed by Natarajan and Jhingran (1961) gives a unique value for each attribute. It is based on the frequency of occurrence and volume of different foods. It is calculated using the following formula (Lauzanne, 1976; Baker et al., 2014; Mahesh et al., 2019):

$IPi = (Vi\ Ffi / \Sigma Vi\ Ffi) \times 100$

where Vi is the percentage of volume of food item i, F_{fi} is the percentage of occurrence of a given food i.

By comparing the values obtained, the foods are ranked in order of dominance. This index varies from 0 to 100. Thus, prey can be classified into 4 categories according to the value of their food indices: IA< 10: prey of secondary importance; 10< IA< 25: important prey; 25< IA< 50 essential prey; IA> 50: largely dominant prey.

Relative importance index (IRI)

The IRI is used to describe fish diets and determine the relative importance of common food categories (Diaha et al., 2018). The IRI is calculated as follows:

$IRI = (\%\ Ni + \%\ Vi)\ \%\ Ffi$; and $\%\ IRIi = (IRIi / \Sigma IRIi) \times 100$

where % Ni is the percentage of the specific food category by number, % Vi is the percentage by volume, $\%\ F_{fi}$ is the frequency of

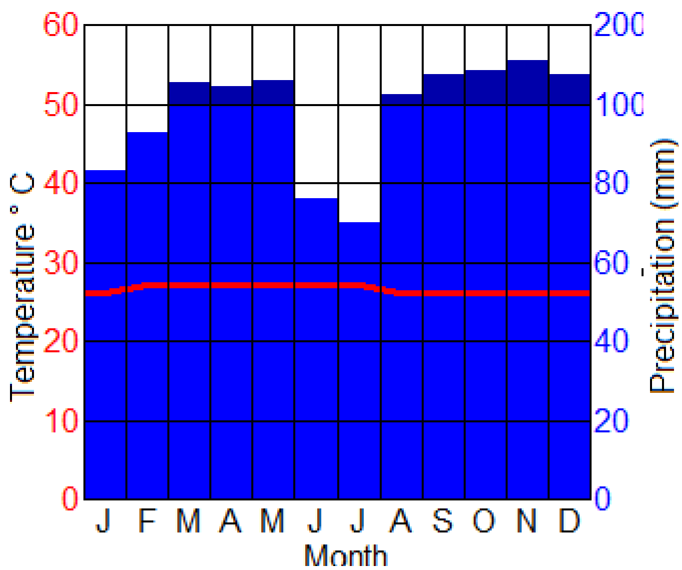

Figure 2. Umbrothermal diagram of the Lake Mai-Ndombe region. Source: Analysis of 41 years data from meteorological station Centre de Recherche en Ecologie et Foresterie (CREF) Mabali.

occurrence, % IRIi is the percentage of relative importance index, IRIi is the relative importance index for each prey category, ΣIRIi is the sum of relative importance index for each prey category.

Statistical analyses

Multi-variate and correlation statistical analyses were performed using Past 4.03 and Statistica 7.1 software, respectively (Scherrer, 1984). Trophic similarities were assessed by subjecting these data to a cluster analysis in order to eventually group size classes with similar diets.

Spearman's rank correlation coefficient (rs) analysis was used to indicate the degree of relationship between male and female diets. If rs = 1, the diets are strictly identical. If rs = -1, the diets are strictly inverse. Finally, if rs = 0, the diets are independent (Scherrer, 1984).

RESULTS

Size frequencies

The size frequencies of *N. stewarti* specimens were determined from Sturge's rule as shown in Figure 4.

Ten size classes of *N. stewarti* were determined with 3.95 mm interval based on Sturge's rule. Size classes 8, 9 and 10 were merged into one class because of the low number of specimens in each. Thus, 8 size classes were established (Figure 3).

Class interval frequency

Diet of N. stewarti

The aspects of diet addressed in this work were the vacuity coefficient (CV), feeding activity rate, intestinal coefficient (IC), numerical index (% IN), occurrence (or frequency) index (%Ffi), volumetric index (% IV), preponderance index (% IP), and relative importance index (% IRI).

Coefficient of vacuity (CV)

For all individuals examined, the calculated vacuity coefficient was 38.71%.

Feeding activity rhythm

Figure 4 visualizes the evolution of the degree of replenishment of *N. stewarti* in Lake Mai-Ndombe. *N. stewarti* had begun its trophic activity early in the morning at 5:00 am where the stomach begins to fill to peak at 1:00 pm and begins to empty to cancel at 1:00 am.

Intestinal coefficient (IC)

The calculated intestinal coefficient for 667 specimens of *N. stewarti* ranged from 0.5 to 1.0 (mean 0.69 ± 0.03). The relationship between total fish length and gut length is as shown in Figure 5.

Gut length ranged from 0.7 to 24.22 mm with an average of 15 ± 3.78 mm. The relationship between total length and fish gut length demonstrated the simultaneous increase between the two variables (r = 0.98; SD = 0.73; N = 667).

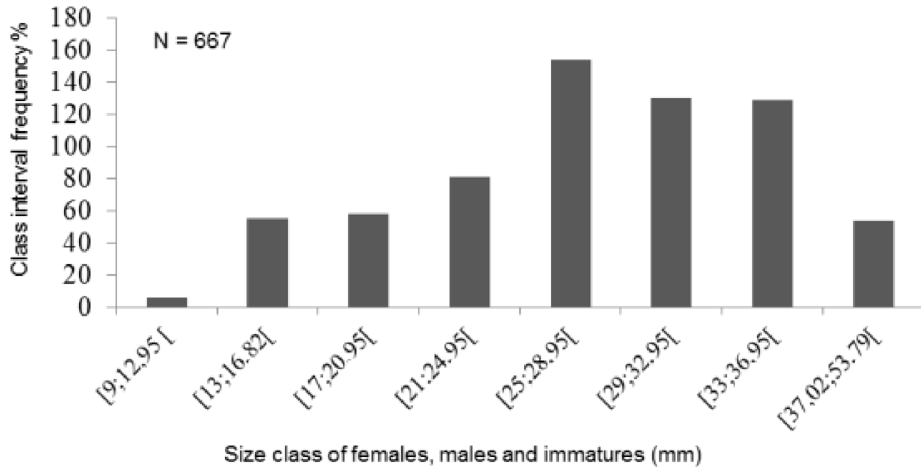

Figure 3. Histogram of size class frequencies of *N. stewarti* determined in Lake Mai-Ndombe.
Source: Analysis of *N. stewarti* length from 667 specimens

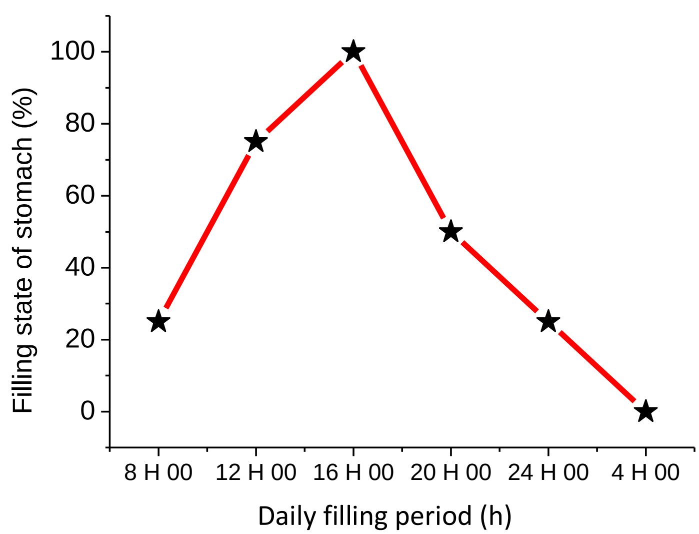

Figure 4. Nycthemeral variation in replication of *N. stewarti*.
Source: Analysis from 667 stomachs diet of *N. stewarti*

General diet composition of *N. stewarti*

Table 1 presents the general diet of *N. stewarti* in Lake Mai-Ndombe. Qualitative analysis of 667 stomachs containing prey items identified 19 food types, grouped into 4 categories: zooplankton, phytoplankton, insects, and worms. Zooplankton were the most consumed prey (%IRI=90.8). Phytoplankton (%IRI = 9.18), insects (%IRI = 0.003) and worms (%IRI = 0.000) are less observed or sometimes absent in the food bowl of this fish.

The preponderance index thus calculated had allowed us to classify the food according to the following order: zooplankton (PI > 50) is the dominant prey, phytoplankton 10< PI< 25: important prey, the remains (insect and worms) (PI < 10) are secondary prey.

Diet by sex of individuals

Table 2 presents the diet of *N. stewarti* according to sex except immatures. Table 2 indicates that female and male *N. stewarti* had consumed the same prey categories, so there is no significant difference in diet with respect to sex (t = 0.42566, p value = 0.68157 at the 0.05 significance level). Spearman's rank correlation coefficient (rs), calculated on the basis of the index

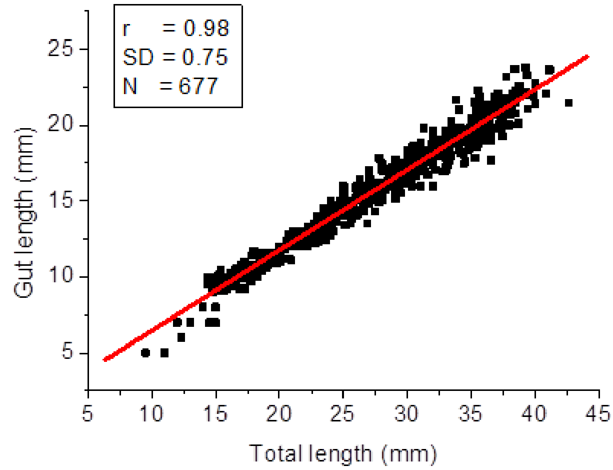

Figure 5. Relationship between total length and intestine length (mm). r = Coefficient of correlation, SD= standard deviation, N = number.
Source: Analysis from 667 guts and length of *N. stewarti*

percentages of food consumed by females and males, shows a significant correlation (N = 552; rs = 0.83; p = 0.01).

Diet as a function of individual size

The size classes determined by Sturge's rule are presented in Table 3. The diet of individuals in each size class is presented in (Figures 6a, b, c, d, e, f, g, h). Individuals in all size classes feed on plankton and composed of Cladocerans, Copepods, Rotifers, Daphnia, Diatoms, and Euglenophyceae.

Individuals in the size class [9; 12.95], consisting mainly of larvae, feed on copepods (*Nauplius*), with the relative importance index (%RI = 91.66).

Individuals belonging to the size class [13; 16.82[, consisting of juveniles, feed at the expense of zooplankton (Copepods (% IRI = 81.92) and Cladoceras (% IRI = 16.76)).

Fish belonging to the size class [17; 20.95], especially sub-adults feed on Cladocerans including (% IRI = 66.56), Copepods (% IRI = 22.35), Rotifers (% IRI = 6.89) and Diatoms (% IRI = 4.15)

Fish in the size classes [21; 24.95] and [37.042; 53.79] were considered as adults feed mainly on Cladocerans (% IRI 51.76 and 83.03%), Rotifers (% IRI 11.47 and 21.93%), Diatoms (% IRI 2.71 and 16.64) and Copepods (% IRI 1.73 and 11.62).

Dietary similarity between individuals belonging to the different size classes

The dendrogram (Figure 7) visualizes the grouping of size classes of *N. stewarti* based on prey consumed.

The food similarity dendrogram (correlation coefficient 0.97) based on the food items consumed by individuals of each size class of *N. stewarti* established from the Relative Importance Index (RI) highlighted two main trophic groups. The first group (1) is distant from the second by 73. The first one, made up of individuals belonging to classes I and II. These individuals feed at the expense of copepods (IRI = 81.92 - 91.66%) and cladocerans (8.33 - 16.76%) composed of *Nauplius* and *Diaphonosoma* species, respectively. Other prey such as Daphinia, Eglenophyceae and Rotifera are consumed in very small quantities (%IRI = 0.004 and 0.89) (Figure 7). The second group consisted of classes III, IV, V, VI, VII and VIII consuming cladocerans (IRI = 51.76 - 83.03), copepods (IRI = 1.73 - 22.35), rotifers (IRI = 6.89 - 21.93), and Diatoms (%IRI = 6.89 - 21.93). The rest of the preys are very weakly represented. This second group is subdivided into two subgroups; the first subgroup includes classes IV and V which had consumed more Cladocerans (%IRI = 57.26 - 70.27), Copepods (%IRI = 3.46 - 4.14), Rotifers (%IRI = 13.78 - 21.93) and Diatoms (%IRI = 12.47 - 16.64). The second subgroup includes classes III, VI, VII and VIII that feed on Cladocerans (%IRI = 66.56 and 83.0), Copepods (%IRI = 1.73 and 22.35), Diatoms (%IRI = 2.71 to 12.47) and Rotifers (%IRI = 6.89 to 13.78). Subgroup 2 broadens its food spectrum on prey on Euglenophyceae, insects and worms.

DISCUSSION

The average vacuity coefficient determined in the *N. stewarti* fish specimens studied was 38.71%. These

Table 1. General diet composition of *N. stewarti*

Group/taxons	IN (%)	F_{fi} (%)	IV	IP	IRI
Zooplanktons	75.2	88.8	69.4	90.0	90.8
COPEPODA					
Tropodiaptomus spp. *Thermocyclops* spp. *Nauplius*	7.0	16.9	13.9	7.9	5.9
CLADOCERIANS					
Bosminopsis spp. *Bosmina* spp. *Diaphanosoma* spp. *Alona* spp.	40.1	50.5	42.2	72.5	70.0
ROTIFERA					
Keratela cochlearis *Keratela serulata* *Keratela tecta* *Trichocera marina*	28.0	21.2	13.1	9.5	14.7
DAPHNIDAE	0.0015	0.07	0.08	0.0002	0.0001
Daphnia spp.					
Phytoplanktons	24.7	10.7	29.7	9.9	9.1
DIATOMS					
Phacus spp. *Pinnularia* spp. *Plectonema* spp.	24.7	10.1	28.8	9.9	9.1
EUGLENOPHYCAE					
Oscillatoria spp.	0.02	0.5	0.9	0.018	0.009
Insects	0.007	0.3	0.5	0.007	0.003
Chaoborus larvea	0.007	0.3	0.6	0.007	0.003
Worm	0.003	0.15	0.16	0.0009	0.0004
Nemathelminthe	0.003	0.15	0.16	0.0009	0.0004
Σ	100	100	100	100	100

%IN: Numerical index; % F_{fi}: occurrence index; %IV: volumetric index; %IP: index of preponderance; %IRI: index of relative importance.
Source: Analyse from 667 stomachs diet of *N. stewarti*

results are similar to those obtained by Ouattara et al. (2014) (CV = 42.22% in flood season) and (CV = 15.03% in flood periods) in *Engraulis encrasicolus* (Linneaus, 1758) from the Ivory Coast. The trophic activity of *N. stewarti* starts early at 5 am where the stomach starts to fill up to reach the peak around 1 pm and starts to empty to cancel at 1 am. Similar results were obtained by Kaningini (2003) in Lake Kivu who observed empty stomachs in *Limnothrissa miodon* (Boulanger, 1906) larvae fished between 22:00 and 06:00 h.

In many vertebrates, a positive relationship has been demonstrated between the length of the gut and the nature of the food they consume (Grassé and Devillers, 1965; Kramer and Bryant, 1965; Paugy, 1994). Thus, the intestine appears to be longer in herbivores, shorter in carnivores and of intermediate length in omnivores. Paugy (1994) had classified fish as follows: ichthyophagous (CI) less than 0.85, invertivorous, CI between 0.32 and 2.18, omnivorous, CI between 0.8 and 3.01 and phytophagous, CI between 4.71 and 6.78.

Table 2. General diet composition of male (n=193) and female (n=359) of *N. stewarti*.

Group/taxons	IN (%)	IN (%)	F_{fi} (%)	F_{fi} (%)	IV	IV	IP	IP	IRI	IRI
Sex	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**
Zooplanktons	**72.7**	**95.3**	**87.0**	**98.3**	**67.3**	**94.0**	**87.7**	**99.7**	**88.5**	**99.7**
Cladoceras	39.1	49.5	51.7	55.0	43.0	51.1	73.3	73.4	69.8	73.0
Copepodas	3.7	27.6	13.3	25.0	10.9	32.7	4.8	21.4	3.2	19.9
Rotiferas	29.8	18.1	21.8	18.3	13.3	10.1	9.5	4.8	15.4	6.8
Daphnidae	0.002	-	0.083	-						
Phytoplanktons	**27.2**	**4.6**	**12.5**	**1.6**	**32.0**	**5.9**	**12.2**	**0.2**	**11.4**	**0.2**
Cyanophyceae	0.02	-	0.6	-	0.8	-	0.01	-	0.009	-
Diatomés	27.2	4.6	11.8	1.6	31.2	5.9	12.2	0.2	11.4	0.2
Euglénophyceae (*Oscillatoria spp.*)					0.2					
Insects	**0.008**		**0.4**		**0.3**		**0.004**		**0.002**	
Chaoborus larvae	0.008	-	0.4	-	0.3	-	0.004	-	0.002	-
Σ	100	100	100	100	100	100	100	100	100	100

%IN: Numerical index; % Ffi: occurrence index; %IV: volumetric index; %IP: index of preponderance; %IRI: index of relative importance.
Source: Analysis from 667 stomachs diet of *N. stewarti*

Table 3. Size classes of *N. stewarti* determined from the Sturge rule.

Class	Limit of size (mm)	n	Group
I	[9 ; 12.95]	6	1
II	[13 ; 16.82]	55	
III	[17 ; 20.95]	58	2b
IV	[21 ; 24.95]	81	2a
V	[25 ; 28.95]	154	
VI	[29 ; 32.95]	130	2b
VII	[33 ; 36.95]	129	
VIII	[37.02 ; 53.79]	54	

n = Number of individuals in each size class.
Source: Scherrer (1984).

During the present investigation, the intestinal coefficient of *N. stewarti* specimens ranged from 0.5 to 1.0 with an average of 0.69 ± 0.03, which classifies it as an invertivore species.

In Lake Mai-Ndombe, *N. sterwarti* feeds on plankton (zooplankton and phytoplankton), insects, and worms. Of the 19 food items inventoried, we find copepods (Calanoides, *Tropodiaptomus* species, Cyclopoide, *Thermocyclops* species, *Nauplis*), Cladocerans (*Bosminopsis*, *Bosmina*, *Diaphanosoma*, *Alona*, and *Daphnia* species), Rotifera (*Keratela cochlearis, Keratela serulata, Keratela tecta, Trichocera marina*), Phytoplankton (Diatoms, *Phacus*, *Pinnularia*, *Plectonema* species), (*Oscillatoria* species, Euglenophyceae), insects (Grasshopper, *Chaoborus larva*), and worms (Nemathelminthe). Indeed, Paulsen (1993), Mandima (1999), Isumbisho et al. (2004), Isumbisho et al. (2006), and Mandima (2017) reported that in the stomach contents of clupeidae a microplankton slurry based on copepods and insects is observed. Variations in air temperature, rainfall and the presence of mineral salts in the water are factors that cause the proliferation of plankton that are prey to this fish in Lake Mai-Ndombe. The present results are in line with those of Otobo (1977)

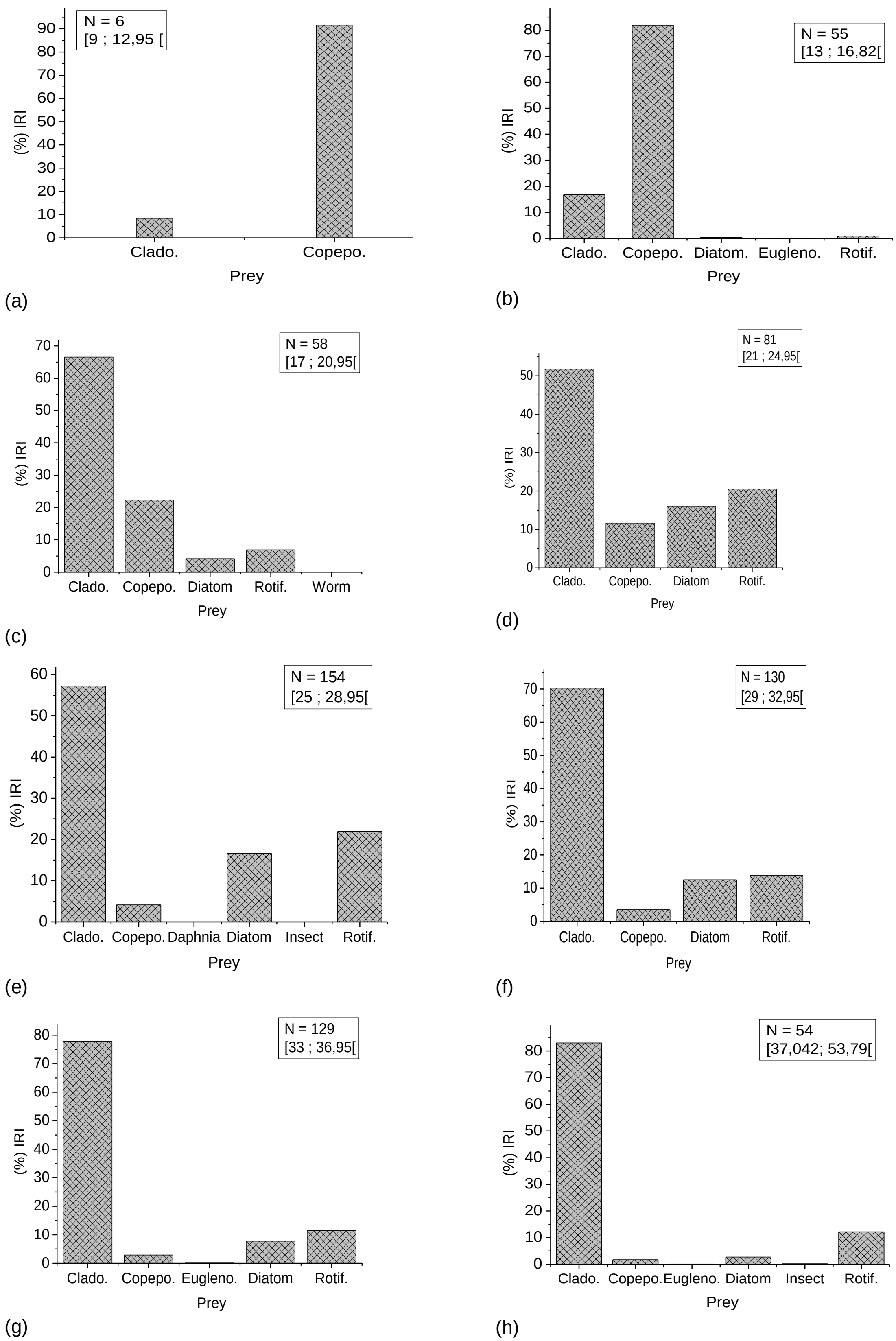

Figure 6. Diet by size class. Clado = Cladocera, Copepo = Copepoda, Daphnia = Daphnia, Diatom = Diatom, Eugleno. = Euglenophyceae, Insect = Insect, Rotif = Rotifera, Worm = Worm.
Source: Analysis from 667 stomachs diet of *N. stewarti*

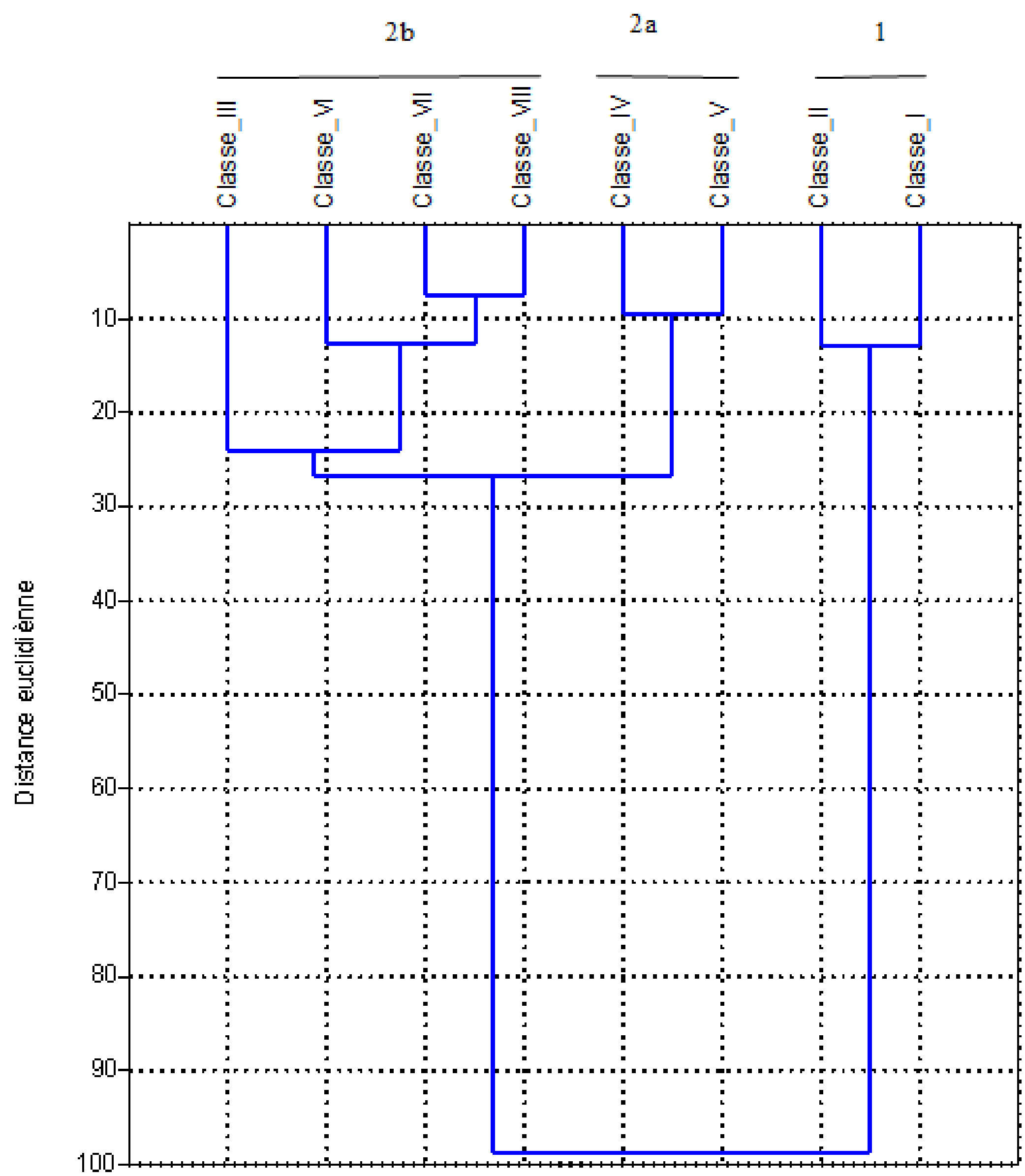

Figure 7. Dietary similarity dendrogram of *N. stewarti* by size classes.
Source: Analysis from 667 stomachs diet of *N. stewarti*

and Kolding et al. (2019) who report that the clupeidae *Stolothrissa tanganicae* feeds mainly on Copepods zooplankton, Cladocerans and some phytoplankton for reproductive activities (Mulimbwa et al., 2022).

No qualitative diet differences were observed between male and female *N. stewarti* specimens studied in Lake Mai-Ndombe. Spearman's rank correlation coefficient (rs) indicates that there is similarity in diet between the two sexes (rs = 0.83; p = 0.01).

Cladocerans and copepods were the preferred foods of individuals regardless of size. Larvae and juveniles feed on Copepods (Nauplius) and some Cladocerans while sub-adults add Rotifers, Diatoms and worms to their food bowl (Števove and Kováč, 2016).

According to Matthes (1968), Otobo (1977) and Muvengwi et al. (2012), a number of genera of Clupeidae have adapted to African fresh waters and some species can really be considered pelagic. This is the case for example of *Stolothrissa tanganicae* and *Limnothrissa miodon* from Lake Tanganyika. *S. tanganicae* is a planktivorous species feeding on tiny pelagic shrimps (*Limnocaridina*), copepods, cladocerans and some phytoplankton. *L. miodon* also consumes shrimps and zooplankton but also young stages of *Stolothrissa*. Some genera like *Pellonula, Cynothrissa,* and *Sierrathrissa* are fluviatile forms whose diet is mainly formed by insects (aquatic and terrestrial). However, they seem to adapt very well in dam lakes such as Lake Volta or Lake Kainji where they find an abundant food supply based on insects (Ephemera, Chaoborids) and zooplankton. The present results did not reveal the presence of shrimps.

Conclusion

The diet of the fish *N. stewarti* from Lake Mai-Ndombe was determined from the food indices calculated on 667 specimens fished according to a 24 h cycle.

This fish starts its feeding activity at dawn from 5 am where its stomach starts to fill and reaches the maximum around 1 pm to empty at 1 am. Its diet consists of plankton composed of Cladocerans, Copepods, Rotifers, Daphnia, Diatoms and Euglenophyceae.

No difference in qualitative diet was observed according to sex. Larvae consume especially copepods (*Nauplius*) while adults are both zooplanktonophagous (cladophagous, copepophagous, rotiphagous) and phytophagous. Insects are an accessory food.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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