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Feeding biology and some biological Parameters of Nile tilapia (*Oreochromis niloticus)* and Bubu *(Auchenoglanis occidentalis*) (Pisces: Animalia) in Alwero Reservoir, Baro-Akobo Basin, South West Ethiopia

By:

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Abstract:

The study was conducted to assess feeding biology and some related biological parameters of Nile tilapia (Oreochromis niloticus) and Bubu (Auchenoglanis occidentalis) Longitudinal study were carried out to investigate food type, feeding biology, length-weight relationships and condition factors of the two fish species in the Reservoir. Fish samples were collected during one dry season (March, 2019) and one wet season (July, 2019). A total of 104 and 80 Nile tilapia and Bubu specimens were collected, respectively. Sampling sites were selected based on the accessibility of the reservoir. Fish specimens were collected using gillnets of 12cm, 16cm, 20cm and 24cm stretched mesh sizes. Prior to dissecting the fish samples for the collection of gut samples, morphometric (weight, standard length and total length) measurements of the fish samples were recorded. Gut contents were preserved in 10% formalin solution and transported to Zoological Sciences Laboratory, Jimma University. Frequency of occurrence and volumetric methods were used for analyzing feeding habit of the fish. An index of preponderance was used to assess overall contribution of prey items to the fish diets. Both Nile tilapia and Bubu had omnivorous way of feeding habit, the diet overlap index was 56%, indicating high dietary overlap between the two species. The diet breadth of Nile tilapia (Ba= 0.33) and Bubu (Ba = 0.40) showed that both species were apparently omnivorous utilizing various types of food resources in the reservoir. The feeding habit of Nile tilapia did not show significant difference between seasons, but that of Bubu showed significant seasonal differences on some prey items such as aquatic insects that had 84% IP and 47% IP during dry and wet seasons, respectively. The lines of best fit to $TW = {}_aTL^{b,}$ *for log transformed Weight-Total length had the equations of log TW =1.224log TL 1.68(*R^2 *= 0.9) for Nile tilapia and logTW = 122 log TL 0.624 (*R^2 *= 0.26) for Bubu. The mean values of the relative weight index for Nile tilapia and Bubu were 312.5 ± 100.39% (SD) and 1271.5 ± 204.5% (SD) respectively, were also investigated to understand their condition factor. This study is important step towards understanding the food web in Alwero Reservoir and eventually developing a trophic model for use in fisheries management.*

Keywords: Alwero Reservoir, Condition factor, Feeding Biology, Some Biological Parameter

Feeding biology and some biological parameters of Nile tilapia *(Oreochromis niloticus*) and (Bubu*) Auchenoglanis occidentalis*) (Pisces: Animalia) in Alwero Reservoir, Baro-Akobo Basin, South west Ethiopia

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Tokuma Nigesho (PhD, scholar)

February, 2020

Jimma, Ethiopia

Declaration

I, the under signed, declare that the study entitled “feeding biology and some biological parameters of Nile tilapia and Bubu in Alwero Reservoir, Baro-Akobo Basin, Southwest Ethiopia,” is my original work and has not been presented for any degree in any other university, and all the source materials used for the study were duly acknowledged.

Declared by

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Acronyms

A.S.L above Sea Level

FCF: Fulton's Condition Factors

GPNRS: Gambella People National Regional State

LFDP Lake fisheries development program

LWR: Length-Weight relationships

R^2: Regression coefficient

SD: Standard deviation

Wrel Relative weight

1. INTRODUCTION

1.1. Background

Fish distribution and abundance in different habitats are associated with availability and abundance of food in a particular habitat (Welcomme, 2011). The study of food and feeding habits of the fish in freshwater fish species is a subject of continuous research because it constitutes the basis for the development of a successful fisheries management program on fish capture and culture (Oronsaye and Nakpodia, 2005). Accurate quantification of fish diets is an important aspect of fisheries management (Quinton *et al*., 2007). Food and feeding habit of fish are important biological factors for selecting a group of fish for culture in ponds to avoid competition for food among them and live in association to utilize all the available foods (Narejo, 2006). Feeding habits of fish also provides essential information on bionomics of single species.

The determination of food and feeding habit in fish is vital need for commercial production. It varies with season, size, ecological factors and the food composition in aquatic habitat also varies throughout the year (Hynes, 1950). Fish food varies from seasons to seasons, due to seasonal changes in temperature influencing food consumption as well as available food organisms, and from species to species. Fish diet is an important factor governing fish growth, condition factor, fecundity and migration patterns (Rao, 1974; Adeyemi *et al.,* 2009). Analysis of stomach contents is a common method for investigating fish diet, and thus describing food chains and webs shared by different species. Such studies also reveal interactions among species (Kenneth *et al*., 2004).

Ethiopia is endowed with enormous freshwater resources. It includes over 20 natural lakes, pond, rivers, man-made lakes and wetlands covering an estimated surface area of 18,587 km^2 (Worie and Getahun, 2015). These water bodies have been estimated to give a shelter for more than 200 fish species (Rediet, 2012; Awoke, 2015). Nile tilapia is one of the popular species among commercial fishes of Ethiopia. The species is distributed in almost all inland waters of Ethiopia and accounts for about 60 % of the capture fishery in the country (Getahun, 2007).The feeding habits of Nile tilapia consist of a great variety of aquatic organisms depending upon availability (Canonico, 2005). The Study of primary diet of Nile tilapia has been inconsistent in much of the research papers, some studies classified Nile tilapia as omnivorous and others as herbivorous (Canonico *et al.*, 2005). For example, the species was reported as planktivorous, showing preference for phytoplankton species such as blue greens, green algae and diatoms, in Lake Chamo (Teferi *et al.*, 2000) and in crater lakes of Uganda (Bwanika *et al.*, 2004). Nile tilapia in Lake Abu-Zabal, Egypt (ShallKash and Khalifa, 2009) and in Ero Reservoir Nigeria (Oso *et al.*, 2006) has been reported as omnivorous. Moreover, many authors reported that Nile tilapia feeds on a variety of food items including phytoplankton, zooplankton, insects, detritus, macrophytes, fish parts and nematodes (Engdaw *et al.*, 2013; Negassa and Prabu, 2008; Tadesse, 1999; Tefera, 1993; Teferi *et al.*, 2000; Temesgen, 2017; Wakjira, 2013; Teame *et al.*, 2016). However, in terms of prey importance, the foods of plant origin (mainly phytoplankton) are the most consumed food types by the fish in all of the water bodies. For instance, the studies carried out in some rift valley lakes (e.g. Lake Hawassa (Tadesse, 1999), Lake Chamo (Teferi *et al*., 2000) Lake Ziway (Negassa and Prabu, 2008), Lake Langeno (Temesgen, 2017) and Koka Reservoir (Engdaw *et al*., 2013), some high land lakes (e.g. Lake Hayq (Worie and Getahun, 2015). Their feeding habits also vary with age and size. As the sizes of the fish increases, the consumption of large quantities of various phytoplankton's evidently increased (Tefera, 1987; Tadesse, 1998). Juvenile Nile tilapia in with less than 6cm total length consumes Chironomid larvae, copepods, and rotifers in Lake Ziway, and nematodes and zooplankton in Lake Hawassa (Tudorancea *et al.*, 1988). Nile tilapia can modify their feeding habits depending on the availability of natural foods as well (Njiru *et al.*, 2004).

Bubu is a prominent member of a catfish family of Claroteidae occurring in Africa (Nelson, 2006). Catfish are heavily exploited and widely cultivated. They are the fourth most widely cultivated freshwater fish after Carp, Salmon and Tilapia (Etim *et al.*, 1999*).* Distribution of Claroteidae includes the Nile River basin and most of west and central Africa south to the tropic of Capricorn, including the East African lakes. Bubu is found in Africa in the Nile, Lake Chad, West Africa, Congo-lualaba River system, East African lakes, Omo River and Giuba. Bubu in Lower Benue River feeds on a wide range of food ranging from plants and animal food items which could make it be regarded as an omnivore. Future attempts to culture this species must take cognizance of its food habits in the wild (Onimisi *et al.*, 2009).

Length-weight relationship (LWR) is very important for proper fish utilization and management of the fish population and it is possible to estimate the average weight of fishes at a given length (Lawson *et al.,* 2013). Furthermore, the length-weight relationships among the fish population indicates that their wellness (Hamid *et al.*, 2015). The difference in length-weight is obtained by the biotic and abiotic environmental factors as well as the trophic status of a given aquatic ecosystem. Condition factor is good parameter that shows the wellbeing of fishes in their natural habitat or in aquaculture and it is represented as by the coefficient of body condition. It is an indicator of different biological and ecological factors in relation to fishes feeding habits (Nehemia *et al.,* 2012). Better body condition is correlated with high values of condition factor. Similarly, poor body condition is obtained when the values of condition factor is less (Gupta and Tripathi, 2017). Although, it is influenced by stress, sex, season, availability of food and the water quality in the environment in which they live (Ighwela *et al.*, 2011).

Length-weight relationship and condition factor data on a given fish population are vital parameters for stock assessment, because they provide important information Olabode *et al. (*2007) in both wild and controlled environments. In addition, the information is vital to enhance the knowledge of the natural history of commercially important fish species like *L. nedgia*, Nile tilapia and Carp for conservation (Shalloof *et al.,* 2009). The objective of this work is, thus, aimed to providing basic information on preferred feeding biology and some biological parameters of Nile tilapia and Bubu species in the Alwero Reservoir.

1.2. Statement of the problem

Fish food is an important factor that governs fish growth, fecundity, condition and migration patterns (Rao, 1994; Adyemi *et al.,* 2009). Moreover, water temperature can influence the digestibility and feeding rate in fish, which generally increase with water temperature (Bowen, 1982). Information about the fish feeding habit has an important application in fisheries and aquaculture management. In aquaculture, for example, it helps to select species of fish for culture and produce an optimum yield by utilizing all the available potential food of the water bodies without any competition. Moreover, information on feeding habit, length-weight relationship and fish condition has important applications in fisheries management (Froese, 2006). Despite their fisheries importance, no scientific information exists on the feeding biology and some biological parameters of fish species inhabiting Alwero Reservoir, which is located in Baro-Akobo Basin, Gambella Regional State, and Southwest Ethiopia. Therefore, in this study an attempt was made to address the following research questions:

1. Which food types are frequently eaten by the two more abundant species viz. Nile tilapia and Bubu fish species in Alwero Reservoir?
2. Is there a difference in food types based on seasonal variation for the two fish species?
3. How do the dietary niche breadth vary and overlap for the two fish species?
4. What is the length-weight relationships of the two fish species look like?
5. What is the body conditions of the two fish species in the reservoir look like?

1.3. Objectives

1.3.1. General objective

- ➢ The study aimed to investigate feeding biology and some biological parameters of Nile tilapia and Bubu in Alewro Reservoir.

1.3.2. Specific objectives

- ✓ To assess the feeding biology of Nile tilapia and Bubu in Alwero Reservoir
- ✓ To assess the dietary niche breadth and overlap of Nile tilapia and Bubu in the reservoir.
- ✓ To investigate length-weight relationships of Nile tilapia and Bubu in the reservoir.
- ✓ To investigate condition factors of the Nile tilapia and Bubu in the reservoir

1.4. Significance of the Study

Results of the study would provide a baseline information on feeding biology and some biological parameters of Nile tilapia and Bubu inhabiting Alwero Reservoir, which currently is an important source of fisheries to the local community. This can be useful in the proper and sustainable exploitation of the fish resources of Alwero Reservoir in Baro Akobo Basin and this may give an insight for future large scale research. The data on fish feeding would also serve as input for any fisheries management effort in the reservoir.

2. LITERATURE REVIEW

2.1. Food and Feeding Habits

Food and feeding habit of fish are important biological factors for selecting a group of fish for culture in ponds to avoid competition for food among themselves and live in association and to utilize all the available food (Oronsaye and Nakpodia, 2005). Thorough knowledge on the food and feeding habit of fishes provide keys for the selection of culturable species and the importance of such information is necessary for successful fish farming. The food habit of different fish varies from month to month. This variation is due to changes in the composition of food organisms occurring at different seasons of the year (Oronsaye and Nakpodia, 2005).

Examining the food and feeding habits of a species is important for evaluating the ecological role and position of the species in the food web of ecosystems (Allan and Castillo, 2007). Information on their diet provides further support on practices of aquatic management, especially agriculture, aquaculture and conservation. Among many animals in aquatic ecosystem, fish are a major top predator and occupy a deterministic status in the trophic waterfall of the aquatic ecosystem. Several species of fishes play an important role in economies in many countries around the world. However, what determines the success in commercialization of fish is the food it receives for growth and nutrition (Olden *et al.*, 2006). Avoidance of competition for food or management of niche partitioning may lead to successful co-habitation of the species (Curtean and Bănădu, 2008).

Nile tilapia feed on a wide range of natural food organisms, such as phytoplankton, zooplankton Detritus, benthic detritus, fish parts, nematodes and they ingest through “filter-feeding”. Actually, they do not physically filter the water through gill rakers as the true filter feeders. The gills secrete mucus that traps plankton which is then swallowed (Popma and Masser, 1999).The fish change food and feeding habit with size, daytime, photoperiod, water depth and geographical location (El-Sayed, 2006).There are also diurnal and seasonal changes in the feeding habits. It was found that all size classes of Nile tilapia in Lake Turkana (Great Rift Valley, Kenya) followed a regular daytime feeding cycle. But the fish fries consumed invertebrates during the hours of darkness infrequently (Harbott, 1982). Also a 24hr feeding study of tilapia in Lake Victoria, Kenya, showed that the fish feed mostly during the day and only very little at night. Two peaks in the daily feeding regime can be defined: one around 11 o´clock in the morning and one around 5 o´clock in the afternoon (Njiru *et al.*, 2004).The season may also have an influence on the feeding habit. It was found that the feeding activity of Nile tilapia in Bangladeshi fish ponds was greater in summer than in winter

Various authors have reported the food and feeding habits of African big barb in Ethiopia Admassu and Dadebo (1997) reported the diet composition, length-weight relationship and condition factor of African big barb in Lake Hawassa and reported the diet composition of the species to be phytoplankton, insects, detritus, macrophytes, gastropods and fish. Desta *et al*, (2006) have also studied the feeding habits of African big barb in Lake Hawassa in connection with its mercury concentration and have reported the food items of the species as gastropods, aquatic insects, macrophytes, detritus, fish fry and fish eggs. Sibbing (1998) reported that the diet of African big barb in Lake Tana was composed of benthic invertebrates, mainly insect larvae and detritus. According to Assaminew (2005) the diet of African big barb is composed of macrophytes, detritus, insects, nematodes, fish, fish eggs and fish scales in Lake Koka.

The African catfish is widely distributed in African freshwaters in the Niger and Nile River systems, extending to southern Africa, in the Limpopo, Orange-Valley, Okavango River systems and most of the East African rift lakes (de Moor and Bruton, 1988). The species is one of the most important individual commercial freshwater fish species in many parts of Africa (Dadebo, 2000; Abera, 2007). There is considerable knowledge of the biology of the fish in other parts of Africa. However, little has been done on the basic biology of the species in Ethiopia. Such area-specific information is needed for proper management and utilization.

In tropical swamps, rivers and lakes the low solubility of oxygen at high temperatures and the decomposition of organic matter can often combine to produce low concentration of oxygen, particularly during the dry season. To increase the availability of oxygen the catfish has developed tree-like chambers on top of the gill cavity. Because of this respiratory organ, the catfish is able to live in stagnant, warm waters with very low dissolved oxygen. Due to this African catfish is able to survive in desiccated (dried) environments or even in highly polluted bodies of water. The feeding habits of African catfish are studied in some Ethiopian water bodies (Dadebo, 2000; Desta *et al*., 2007; Abera, 2007).The available information indicates that African catfish utilizes a wide variety of food items, including terrestrial and aquatic insects, snails, zooplankton and several benthic organisms and fish. In some eutrophic water bodies of Africa, African catfish was found to shift to ram-feeding mode and filters large quantities of zooplankton using its long and compact gill rakers (Murray, 1975).

In Ethiopia, the lakes and the river systems have great potential for the production African catfish. In fact it is one of the commercially important fish species in Ethiopia. It has also considerable importance in the traditional fishery.

The family Claroteidae is a group of cat fish of which Bubu is a prominent member. About 13 genera and 86 species of Claroteids in two subfamilies are known to exist. The sub families are Claroteinae and Auchcnoglanidinae. The subfamily Auehenoglanidinae is sometimes classified as a separate family Auehenoglaniclinae. This group was also often formerly placed in Bagridae (Nelson, 2006). Bubu inhabit lakes and large rivers, they occur in shallow water with muddy bottom (Eccles, 1992). They include the Nile basin in North Africa, Lake Chad in West Africa, Congo-Iualaba River system in Central Africa, East African lakes, Omo River and Giuba River. Bubu is readily abundant as from October. This family is of considerable commercial importance in Lake Akata area. Studies on the biology of some members of this family have been conducted by various scholars. Notable reports include that of Ogbe *et al.* (2003) reported Bubu in the Lower Benue River, Shinkaf and Ipinjolu (2010) reported Bubu in River Rima, North-Western, Nigeria, Ikongbeh *et al*. (2013) reported Bubu in Lake Akata, Benue State Nigeria.

2.2. Length-Weight Relationships (LWR)

Growth of an organism means a change either in length or weight or in both. With the increased age and an increase in size is due to the conversion of the food material into the body building molecules by means of nutrition, digestion and metabolism. The study of Length-weight relationship is known for its practical utility in fish management and conservation because the two variables are useful in deriving the index of condition of fish. The fish growth parameters and their applicability have been discussed by (Froese, 2006).The estimation of population size of a fish stock for the purpose of its rational exploitation often requires knowledge of individual body length-weight relationships in the population (Dulčić and Kraljević, 1996). Length-weight relationships have several applications, namely in fish biology, physiology, ecology and fisheries assessment. In biological studies, LWR enables seasonal variation in fish growth to be followed and the calculation of condition indexes. It also give us life histories and morphological comparisons between different fish species or between different fish populations from different habitats (Gonçalves *et al*., 1997; Petrakis and Santos *et al*., 2002).

2.3. Condition Factor

Condition factors are used for comparing fatness or well-being of fish, based on the assumption that heavier fish of a given length are in better condition. It is known that condition factor parameters depend on factors including biological and environmental, as well as geographical and temporal, such as fullness of gut, type of food consumed, the age and condition of the fish or the season of year when samples are collected (Ferreira *et al*., 2008). Generally, higher condition is associated with higher energy content, adequate food availability, reproductive potential and favorable environmental conditions (Pauker and Coot, 2004).

3. MATERIALS AND METHODS

3.1. Description of the Study Area

The study was carried out at Alwero Reservoir, Baro-Akobo Basin, Gambella Regional State, South west Ethiopia (Fig. 1) and the dam was constructed on Alwero and Ceri Rivers. The reservoir is located near Gambella Town, on 45 km towards the south of the Town within Abobo District of Anywaa Zone (GPNRS, 2011). It was constructed at an altitude of 455m a (a.s.l), at geographic coordinates of 07°49’0”-7°54′0” N and 34°30’0”-34°34′0” E. The construction of Alwero River dam began in 1982 and was completed in 1997 by the support obtained from government of Russia, its purpose being to provide irrigation water for 10,000 hectare of forest land cleared and prepared for planting cash crops (mainly cotton- *Gossypium*). It was not used for over 20 years, after which the Saudi Star company acquired a permit for dam water use in that area. The construction of the dam and reservoir had a number of unfortunate results, including the submergence of settlement and resettlement sites near the dam and Abobo town. The farms of the domestic investor, I4, is near the dam, on the other side of the road from the smaller plot of land that was later allocated to Saudi Star and used as their Nursery for seedlings (Deneke, 2013). The locality has temperature ranging from 18.2°c-35.5°c and receives a maximum annual rainfall of 904.6mm (Abobo meteorological station, 2010). Alwero Reservoir has a depth that ranges 3m -21m with a mean depth of about 9m and a total surface area of 74 km^2 (Hussein *et al.*, 2010; Tigabu, 2010; Tesfaye and wolf, 2014). The local communities depend on the Alwero Reservoir fishery for their livelihoods.

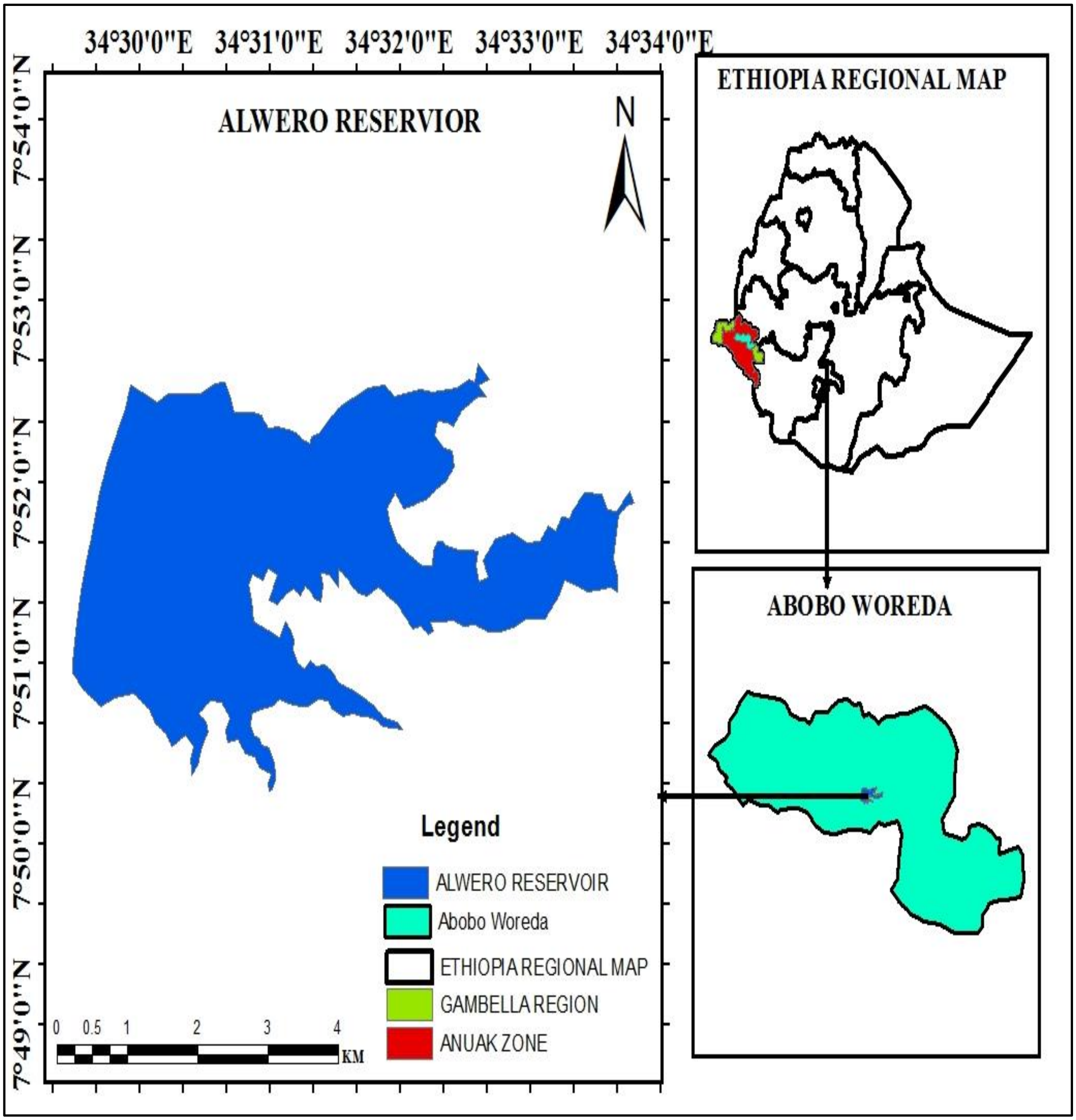

Figure 1: Map of the study Area, Alwero Reservoir, Anuak Zone

3.2. Fish and Gut Sampling

The total of 104 and 80, respectively, of Nile tilapia and Bubu gut samples were collected in dry (March, 2019) and one wet seasons (July, 2019) cross-sectionally. The fish gut samples were preserved in 10% formalin solution for subsequent analysis in Zoological Sciences Laboratory, Jimma University. A combination of monofilament and multifilament gill nets were used for sampling. The gill nets had stretched mesh sizes of 12cm, 16cm, 20cm and 24 cm a panel length of 100m and width of 1m per mesh size. Four sets of gillnets, two parallel and two perpendicular to the shore, were set at a sub-surface level at each of the two sampling sites (Kano and Gedeb). Locally available fishing gears such as Ajaabat its local name were additionally used especially in the shore areas. Each site was sampled for two days.

3.3. Length and Weight data

Total length (TL) was taken from tip of the snout to the extended tip of the caudal fins of each freshly caught fish were measured to the nearest centimeter 0.1cm using a standard fish measuring rule or measuring board. A triple beam balance (Scaltec Model, 123565, 155A) was used to measure the weight (wt) of all freshly caught fishes and to the nearest gram 0.1gr.

3.4. Gut Content Analysis

The prey items were identified microscopically to the lowest possible taxa using relevant taxonomic keys (Fernando, 2002; Bellinger and Seege, 2010; Emi and Andy, 2007)). Prey items were quantified using volume measurement with direct displacement. The volume of the water displaced by each category of food items was expressed as a percentage of the total volume of the gut contents (Bowen, 1983).

3.5. Estimation of Diet Composition

3. 5.1. Frequency of Occurrence

The number of stomachs in which prey item occurs was recorded and expressed as a percentage of the total number of stomachs examined (Winde and Bowen, 1978). This method demonstrates what organisms were being feed upon, but it gives no information on quantities or numbers and does not take in to consideration the accumulation of food organisms resistant to digestion.

$$\mathrm{Oi} = \frac{\mathrm{Ji}}{\mathrm{P}}$$

Where, Oi frequency occurrence, Ji is number of fish containing prey **i** and P is the number of fish with food in their stomach.

3.5.2. Percent Composition by Volume

The volume of a given category of food item was expressed as a percentage of all the categories of food items present in the samples. Food items that are found in the guts were grouped into different taxonomic categories and the water displaced by a group of items in each category was measured in a partially filled graduated cylinder as developed by Hyslop, (1980).

$$\%V = \frac{\text{Volume of one food item found in all specimens} \times 100}{\text{The volume of all food items in all specimens}}$$

3.5.3. Index of preponderance

An index of preponderance (IP) was used to assess the important diets in the feeding habits of the fish species according to Natarajan and Jhingran, (1961) as:

$$\mathrm{IPI} = (\%\mathrm{VI}) \times (\%\mathrm{Oi})$$

Where, %VI = percentage volume of a particular diet in the total volume of food items, %Oi = percentage frequency of occurrence of a particular diet in the total number of guts were examined.

3.5.4. Diet Breadth Index

The diversity of prey items taken by each fish species was assessed using a diet breadth (range or scope) index (B) as:

$$B = 1/ \sum_{i=1}^{n} Pi^2$$

The equation (Hurlbert, 1978) was standardized for the trophic niche measure ranging from 0 to 1, according to the equation:

$$Ba = [(\sum P^2_{ij})^{-1} - 1] / (n - 1)^{-1}$$

Where Ba= standardized trophic niche breadth, Pij= proportion of food category "i" in the diet of species "j": n = total number of food categories. Trophic niche breadth was considered low of in the range of 0 -0.39, intermediate from 0.4 - 0.6 and high from 0.61 - 1 Grossman, (1986).

3.5.5. Diet Overlap Index

The extent of diet overlap between the two fish species were assessed using Horn’s index

$$H = \frac{2\sum^{n}_{i=1} PijPi}{\left(\sum^{n}_{i=1} \frac{Pij^2}{J^2} + \sum^{n}_{i=1} \frac{Pik^2}{K^2}\right) JK}$$

- Where: Pij = volume proportion of prey i in the total preys consumed by fish species j, Pik = volume proportion of prey i in the total preys consumed by fish species k, n = the total number of prey categories J, K = total amount of all the preys consumed by fish spices j and k respectively Gelwick and Mathews (2007).

3.5.6. Length-Weight Relationship

Total length was related to weight for each fish species using the power equation according to Bagenal and Tesch, (1978) as:

$$W = aTL^b$$

Where, W = observed weight of fish (g), TL = total length of fish (cm), a, and b = parameters

3.5.7. Fish Condition

Fish condition between the two species was compared based on relative weight according to Froese (2006) as:

$$\mathrm{Wrel} = \frac{\mathrm{W}}{(\mathrm{a_m})(\mathrm{TL^b m})} \times 100$$

Where Wrel = relative weight (g), W = measured weight (g), a_m = geometric mean a, bm = mean b for each of the two fish.

3.6. Data Analysis

Significant seasonal variations in fish condition were tested using a one way ANOVA in SPSS version 20.

The mean b-values for each species were tested using the one sample t-test to verify whether it significantly varied from the isometric value at 5 % level of significance.

3.7. Ethical Considerations

Permissions to sample in the study areas were obtained from Gambella livestock and Fishery Agency and local government administrations of Abobo Wereda district.

4. RESULTS

4.1. Diet Composition of Nile tilapia and Bubu

Total length ranged from 21 to 30 cm and 35 to 51cm, and the total weight ranged from 179 to 638 g and 921 to 1831g for Nile tilapia and Bubu, respectively. The results of diet analysis for Nile tilapia and Bubu are summarized in Table 1 and Table 2, respectively. The identified diets of Nile tilapia included phytoplankton, aquatic insects, zooplankton, detritus, vegetation (plant leaves) and fish scales (Table 1). Phytoplankton, aquatic insects and detritus constituted bulk of the diet of the fish accounting for 99.14% by volume. These prey items were also the most frequent food items of the fish occurring in 39.40%, 32.49% and 27.21% of the fish specimens, respectively. In agreement with percent frequency of occurrence and prey volume, the percentage index of preponderance% showed phytoplankton 46.35% and aquatic insects (31.52%) were the most important food item in the diet of Nile tilapia followed by detritus (22.12 %).

Prey items identified in the diet composition of Bubu include phytoplankton, aquatic insects and detritus constituted 97.58 % by volume. (Table 2). Aquatic insects were the most frequent prey items that constituted more than 50% of the fish diet followed by phytoplankton and detritus, respectively. Aquatic insects, phytoplankton and detritus were the important food preys identified in the diet of Bubu with the 59.66%, 22.76% and 16.77%IP respectively.

Table 1: Diet composition of Nile tilapia in Alwero Reservoir. Percentage volume (%V), percentage frequency of occurrence (% O) and percentage index of preponderance (%IP) of the different prey items in the diet of 104 Nile tilapia

Food item	O	%O	V	%V	IP	%IP
Phytoplankton	**173.00**	**166.35**	**232.10**	**39.40**	**9145.51**	**46.35**
Green algae	56.00	53.85	70.72	12.01	849.10	4.30
Blue green algae	76.00	73.08	148.35	25.19	3736.39	18.94
Red algae	19.00	18.27	8.36	1.42	11.85	0.06
Yellow algae	14.00	13.46	0.54	0.09	0.05	0.01
Diatoms	8.00	7.69	4.13	0.70	2.90	0.01
Zooplankton	**7.00**	**6.73**	**2.55**	**0.43**	**1.10**	**0.01**
Cladocera	1.00	0.96	0.20	0.03	0.01	0.01
Copepods	6.00	5.77	2.35	0.40	0.94	0.01
Aquatic insects	**96.00**	**92.31**	**191.38**	**32.49**	**6218.27**	**31.52**
Diptera	65.00	62.50	157.40	26.72	4206.16	21.32
Trichoptera	20.00	19.23	22.58	3.83	86.52	0.44
Ephemeroptera	6.00	5.77	7.38	1.25	9.25	0.05
Odonata	5.00	4.81	4.03	0.68	2.75	0.01
Detritus	**88.00**	**84.62**	**160.32**	**27.22**	**4363.67**	**22.12**
Fish scales (parts)	**3.00**	**2.88**	**0.42**	**0.07**	**0.03**	**0.01**
Vegetation (plant leaves)	**12.00**	**11.54**	**2.25**	**0.38**	**0.86**	**0.01**
Total	**(n)104**		**589.01**	**100.00**	**19729.45**	**100.00**

NB: The bold fonts represent values for the major prey categories

Table 2: Diet composition of Bubu in Alwero Reservoir. Percentage volume (% V), percentage frequency of occurrence (% O) and percentage index of preponderance (% IP) of the different prey items in the diet of 80 Bubu

Food item	O	%O	V	%V	IP	%IP
Phytoplankton	**80.00**	**100.00**	**71.25**	**25.65**	**2565.16**	**22.76**
Blue green algae	38.00	47.50	40.90	17.30	821.88	7.29
Red green algae	5.00	6.25	1.00	0.28	1.72	0.02
Green algae	23.00	28.75	21.44	5.90	169.56	1.50
Diatoms	14.00	17.50	7.91	2.18	38.08	0.34
Aquatic insects	**106.00**	**132.50**	**182.93**	**50.32**	**6667.37**	**59.16**
Diptera	50.00	62.50	109.15	30.03	1876.59	16.65
Trichoptera	15.00	18.75	16.60	4.57	85.62	0.76
Ephemeroptera	34.00	42.50	53.58	14.74	626.35	5.56
Plecoptera	4.00	5.00	2.45	0.67	3.37	0.03
Odonata	3.00	3.75	1.15	0.32	1.19	0.01
Zooplankton	**14.00**	**17.50**	**6.16**	**1.69**	**29.63**	**2.37**
Copepods	5.00	6.25	2.38	0.65	4.09	0.04
Cladocra	9.00	11.25	3.78	1.04	11.68	0.10
Detritus	**74.00**	**92.50**	**62.70**	**21.65**	**2002.42**	**16.77**
Vegetation (plant leaves)	**4.00**	**5.00**	**1.08**	**0.30**	**1.49**	**0.01**
Fish scales (parts)	**7.00**	**8.75**	**1.42**	**0.39**	**3.42**	**0.03**
Total	**80,(n)**		**325.53**	**100.00**	**11269.48**	**100.00**

NB: The bold fonts represent values for the major prey categories

4.2. Seasonal Variation in the diet composition of Nile tilapia and Bubu

Seasonal comparison in the diet composition of Nile tilapia (Fig 2) showed that the fish had more or less comparable feeding habit both during the wet and dry seasons. Aquatic insects, phytoplankton and detritus were the most dominant prey items for Nile tilapia accounting for more than 98.56 %IP during each season. While vegetation, zooplankton and fish scales were relatively less important during the dry and wet seasons with importance index less than 1.5% (%IP). Aquatic insects with 84.86 %IP is the most important food items in the diet of Bubu durin*g* the dry season. But, their contribution declined during wet seasons to 47.22 %IP, while Bubu consumed considerable amount of phytoplankton 34.1 %IP and detritus 18.25%. However, during the wet and dry seasons, the contribution of vegetation and fish scales was insignificant, because they occurred in few numbers and their volumetric as well as IP% contribution was also very low. And very less amounts of zooplankton constituted below 1%IP during the dry and wet season (Fig 3).

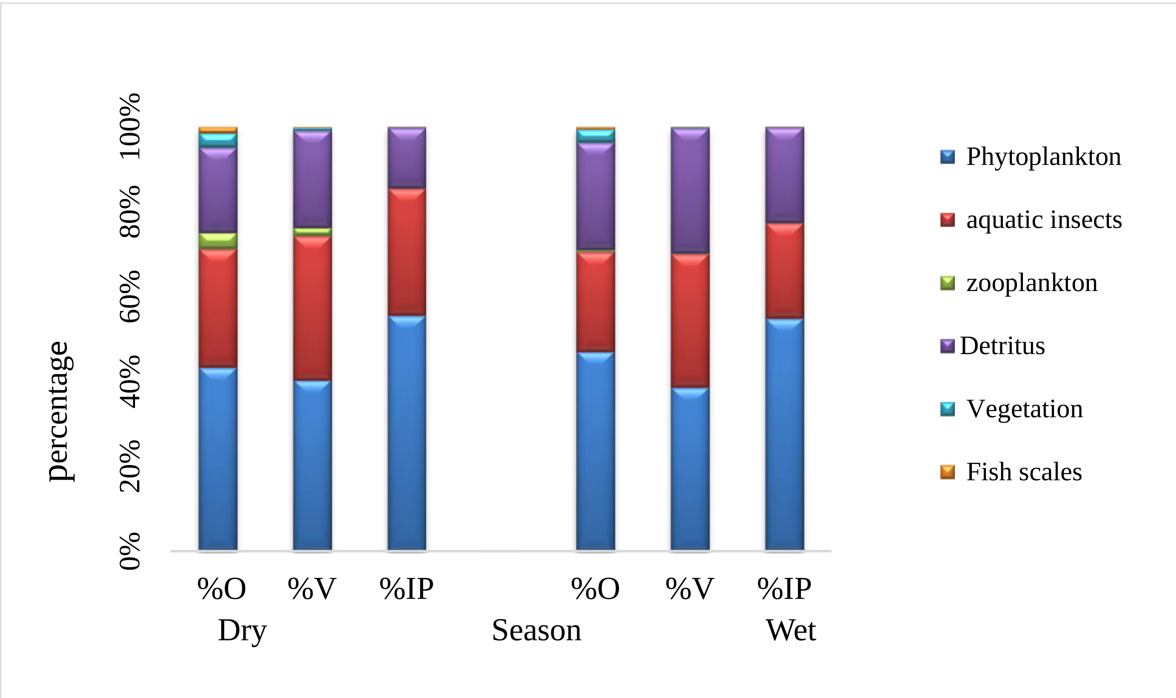

Figure 2: Seasonal comparison of Nile tilapia diet composition in Alwero Reservoir, Baro Akobo basin

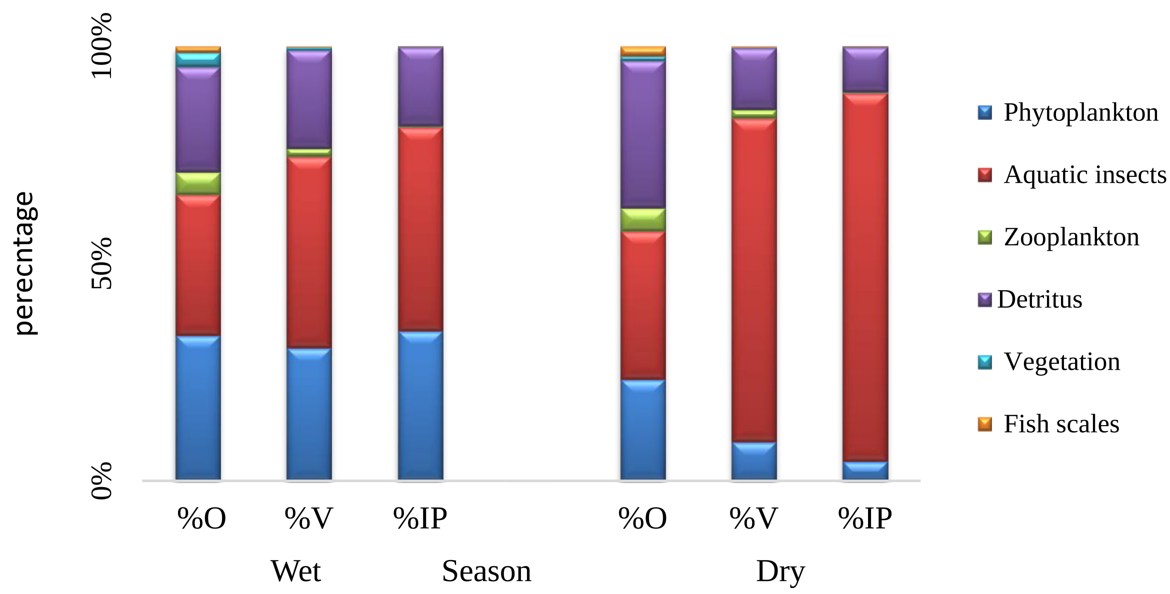

Figure 3: Seasonal comparison of Bubu diet composition in Alwero Reservoir, Baro Akobo basin

4.3. Diet breadth and Overlaps

The diet breadth index (BA), a measure of the diversity of prey items taken by each fish species, was 0.33 and 0.40 for Nile tilapia and Bubu, respectively. The Horn's (H) diet overlap index for Nile tilapia and Bubu was 0.56

4.4. Some population parameters

4.4.1. Length-weight relationships

The relationship between total length and total weight for the Nile tilapia and Bubu is best described by the power equations. Nile tilapia have the b- value TL=1.68, TW =1.22 and $R^{2=}0.9$. The length-weight relation which identified Bubu species were b-value TL 0.624, Tw=122 and R^2 =0.26 which is well described in (Fig, 4 and 5) as shown below.

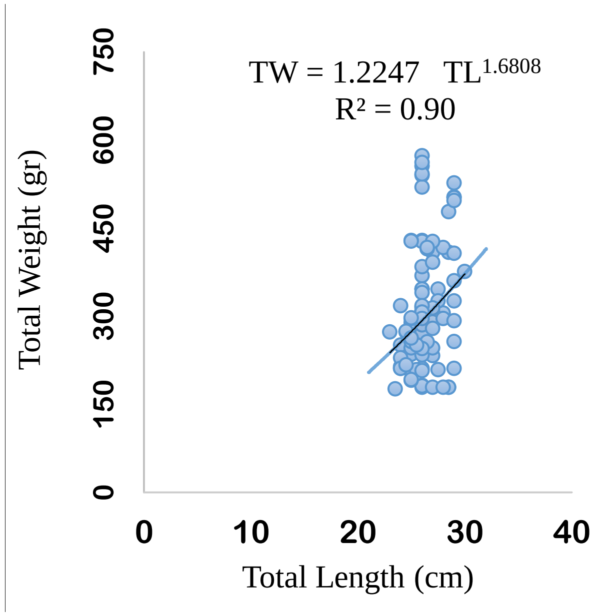

Figure 4: Total length-weight relationship of Nile tilapia in Alwero Reservoir

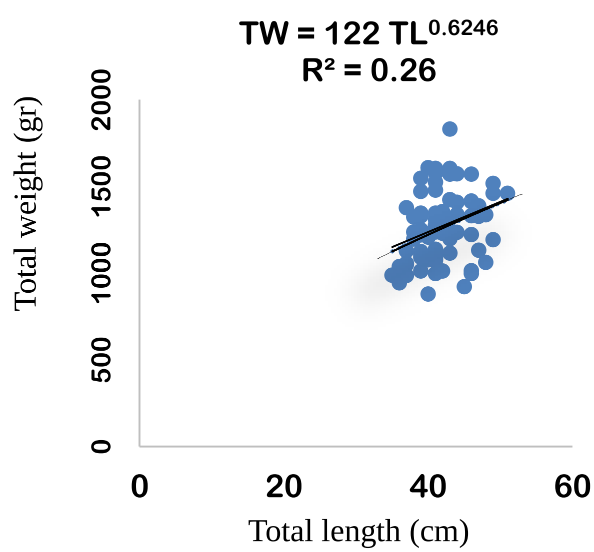

Figure 5: Total length-weight relationship of Bubu in Alwero reservoir

4.4.2. Condition Factor

The relative weight that compares with measured weight of the species was 104.63 (wrl) for Nile tilapia and the relative weight of Bubu was 101.04 (wrl). The mean values of the relative weight index for Nile tilapia and Bubu were 312.5 ± 100.39% (SD) and 1271.5 ± 204.5% (SD), respectively and The mean Fulton condition values (k) for Nile tilapia and Bubu, are summarized in Table 3.

Table 3: Some descriptive statistics of total length (TL), total Weight (TW) and mean Fulton condition factors (k ± SD) for the fish species collected from Alwero Reservoir. N = number of fish samples; SD = standard deviation and Wrel = relative weight

Species	N	TL (cm)	Wt. (gm)		
		Mean ±SD	Mean ± SD	k ± SD	Wrel
Nile tilapia	104	26.30±1.45	312.15±100.39	1.72±0.53	104.63
Bubu	80	41.9±3.37	1271.5±204.5	1.78±0.42	101.04

5. DISCUSSION

A study on stomach content analysis is important in providing useful taxonomic information of fish diets, role of fish in their environment and to draw stock assessment models and provide knowledge of maintaining (filling) more exploited species in a sense of mono-poly culture systems (Sivadas and Bhaskaran, 2009). Therefore, the examination of the feeding habit of Nile tilapia and Bubu in the reservoir *(*one of the commercially important fish species in Ethiopia) is very important for proper utilization of the stock in Alwero reservoir. The diet of Nile tilapia and Bubu in Alwero Reservoir consists of phytoplankton, zooplankton, aquatic insects, detritus, vegetation and fish scales. Nearly all the food items identified in the diet of Nile tilapia were also observed for Bubu except for some variations, Plecoptera were observed only in the gut of the Bubu. In contrast, yellow green algae were observed only from the diet of Nile tilapia. Although these food items are not equally represented in the diet, the wide choice available to the fishes suggests that when one food item is in short supply, others in abundance could be eaten (Table 1 and 2).

The type of food items found in the stomach of Nile tilapia in Alwero Reservoir is quite similar to Wakijira (2013) at Gilgel gebi Reservoir and Tefera (1987) reported from lakes Zweye and Hawassa for the some species feeds mainly on phytoplankton, zooplankton, detritus and also aquatic insects like diptera, Ephemeroptera. Apart from the major food items, they also picked a variety of other food items.

In addition, the present study fish scales contribute an appreciable amount of diets for Nile tilapia in terms of frequency of occurrence which agree with others studies conducted for the same species by Teferi *et al. (*2005) from lake Chamo, Worie and Getahun (2015) from lake Hayq Teame *et al*. (2016) from Tekeze Reservoir and Lake Hashenge.

The variation on the consummation of food items by Bubu in Alwero Reservoir is similar to reported of Onimisi *et al*. (2009) from Zaria Reservoir, which feed on Varity of food items ranging from phytoplankton, aquatic insects, detritus and vegetation, hence the species is considered as omnivorous bottom feeder.

Gut content analysis and the values for the diet breadth indices of Nile tilapia (Ba= 0.33) and Bubu (Ba= 0.40) showed that both species were apparently omnivorous utilizing various types of food resources in the reservoir. Relatively, higher value of diet breadth index for Bubu suggests the more generalist nature of the fish than Nile tilapia. More diverse types of prey items were retrieved from the diet of Bubu. However, the importance and contribution of the various prey items to the diets of both fishes varied between the two species.

Nile tilapia predominantly feed on phytoplankton, aquatic insects and detritus, which remained major components in its diet both during the wet and dry seasons (Fig 2). Vegetation, fish scales and zooplankton generally remained less abundant in the diet of Nile tilapia, however, phytoplankton was the most frequent item occurring in 45 % (O) of the specimens examined. The feeding habit of Nile tilapia in Alwero Reservoir observed in the predetermined study, is in agreement with the omnivorous nature of the Nile tilapia investigated by Wakijira (2013) at Gilgel Gebi Reservoir.

Phytoplankton, aquatic insects, detritus, zooplankton and vegetation, were the dominant food items for Bubu although there is no more variation on the diet according varied season except aquatic insects 84.86% and 47.22% IP in dry and wet season, respectively. The variation in the consumption of food items of Bubu studied in the Alwero Reservoir is relatively similar to that reported by Onimisi *et al.* (2009), they reported that Bubu from Zaria Reservoir feed on a variety of items ranging from insect, plant material and detritus, hence the Bubu in Zaria reservoir can be considered as omnivorous. Moreover, the consumption of more aquatic insects (84 %IP) and (47 %IP) by Bubu during the dry and wet season respectively were comparable with the finding of Ikongbeh *et al*. (2013) from Lake Akata, Benue State, Nigeria who found similar consumption pattern for Yellow Giraffe catfish. Phytoplankton, zooplankton, aquatic insects and detritus were common to the diets of both fish species. Vegetation and fish scales were found only in the diet of Bubu. The contribution of aquatic insects to the diet of Bubu (59.66%IP), while it was the most dominant and common component in the diet. To consider the present studies of Bubu in Ethiopia is difficult to compare and contrast the previous reports from other water bodies, while no more study was not reported before.

Interpretation of dietary niche overlap between two or more species is not clear-cut. Some associated it to competition (Schoener, 1974), while others (Abrams, 1980; Holt, 1987) held an opposing view. In the dietary niche, overlap was computed to quantify the extent to which fish species shared a set of dietary resources thereby maintaining viable population in the presence of one another (Bouillot *et al*., 2005). Nevertheless, some of these differences in the prey items, the two fish species occurring in the reservoir still had high value of diet similarity index (H'= 0.56 or 56%). This high diet similarity between the two species should be indicative of the availability of various food resources in the reservoir rather than competition. Rich occurrence of the various food items should be attributed to high trophic flow resulting from the process of decomposition of the natural vegetation overcome by water filling up the reservoir (Wetzel, 2001; Chipps and Garvey, 2007). Furthermore, the presence of both benthic prey items (e.g. aquatic insects) and pelagic prey items (e.g. phytoplankton and zooplankton) in the diets of these fish is also a clear indication of their ability to utilize resources from different habitats.

The length-weight relationship (LWR) in fish is described by the power function $W = aTL^b$, where W is weight, L is length whereas, a and b are the species-specific parameters of the function, which can be estimated by regression analysis adopted from (Bagenal and Tesch, 1978).

Fish generally passes through different stages of development which can be defined by different LWR (positive or negative allometric growth, $b > 3$ or $b < 3$, respectively), or not (isometric growth, $b = 3$) (Nehemia *et al*., 2012). Accordingly, LWR of the current study showed the negative allometric growths for the Nile tilapia and Bubu in Alwero Reservoir, where both species b-value is less than three, (b-value 1.68 for Nile tilapia and b-value 0.626 for Bubu) (Figures 4 and 5).

The b-value of 1.68 was observed for Nile tilapia in Alwero Reservoir in the present study was varied from the values (2.76) reported by Wakjira, (2013) in Gilgel Gibe Reservoir. The b- value 0.6246 was observed for Bubu in Alwero Reservoir in the present study is comparable with the value (0.869) reported by Ikongbeh *et al.(*2013) from Lake Akata, Benue State, Nigeria**.**

The relative weight index according to Froese (2006), Nile tilapia was104.63 and the relative weight of Bubu was 101.04 therefore the relative index suggests that Nile tilapia was in better condition than Bubu. Instead of the Fulton condition factor, to compare the conditions between the two species while, their mean b values were significantly lower than 3.0. Nile tilapia had the lower relative weight index value of 312.15 ± 100.39 % (SD) as compared to Bubu which had a value of 1271.50 ± 204.5 % (SD). Thus, while both species were generally in good condition, the relative weight index suggests that Bubu was in a better condition than Nile tilapia (Table, 3).

The condition factor is absolute tool for assessing the health status of the aquatic ecosystem (Ighwela *et al*., 2011). The condition factor reflects, through its variations, information on the physiological state of the fish in relation to its welfare. The condition factor (K) of species in this study ranged from 1.83-1.66 for Nile tilapia and 1.83-1.70 for Bubu. The difference in condition factor value of fish specimens collected from the Alwero Reservoir may be attributed to variation in living conditions such as feeding, habitat quality, and climatic condition. Thus, condition factor of the fish is strongly influenced by biotic and abiotic conditions. Condition factors of population may depend on not only its age and gender composition, but also environmental elements and season of the year when samples are collected as well. Moreover, higher body condition is associated with high energy content, adequate food availability, reproductive potential and favorable environmental conditions (Paukert and Rogers, 2004).

The mean FCF value for Nile tilapia presented in this study is 1.83 much similar to 1.87 FCF value from Gilgel Gibe Reservoir (Wakjira, 2013). The mean FCF obtained for Nile tilapia in this study (1.83) in (Table 3) was comparable to report of Tesfaye and Tadesse (2008) ,(1.84) in the lake Langeno, The condition factor of Nile tilapia showed variations among the populations in the Ethiopian freshwater including lakes, rivers and reservoirs as noted in the report by (Tesfahun and Temesgen, 2018).

It was observed in the present study, that mean condition factor for Bubu were greater than "1" which indicates that fish species are doing well in the Reservoir, meaning that increase in length brought about the proportional increase in weight. Magawata (2008), who reported good condition in about 10 species of fishes from River Rima. The condition factor of Bubu in this study was favorably comparable with condition factors of different tropical fish species investigated and reported by (Lizama, 2002). The condition factor of Bubu in Alwero reservoir in dry season 1.7 and 1.83 in wet season presented this study comparable to the report made 1.53 and 1.52 FCF) from Lake Akata in Nigeria (Ikongbeh *et al.,* 2013) (**Appendix, 15)**.

The main reason for the differences observed in the mean FCF between the present might relate to the variation in the extent of sampling or variations in the factors such as food quantity and quality, water level and flow rate, feeding rate, health and reproductive activity of fishes in the study areas. Statistically no significant seasonal variation was observed for Nile tilapia and Bubu.

6. CONCLUSION AND RECOMMENDATION

6.1. Conclusion

The results of the present study have clearly indicated that the most important food categories of Nile tilapia and Bubu in Alwero Reservoir were phytoplankton, aquatic insects and detritus, were major food items whereas vegetation, zooplankton and fish scales were minor food items both in dry and wet season. On the other hand, aquatic insects was the most important food category for Bubu during the dry season, but its contribution declined during wet the season, and no more seasonal variation on the food item of Nile tilapia both the dry and wet season of the present study. The gut content analysis suggested that both Nile tilapi*a* and Bubu are an omnivorous fishes in their feeding habits. The fish conditions in Alwero Reservoir implies that the optimum b values observed for the Nile tilapia and Bubu species should relatively be suggestive of a better condition.

6.2. Recommendation

Based on the above findings, the following recommendations were made, detailed studies and investigation are required on:

- ✓ The seasonal variation on phytoplankton and zooplankton composition
- ✓ The Eutrophic condition of the reservoir should be assessed
- ✓ The physical and chemical limnology of the reservoir
- ✓ The age and growth estimation of different fish species in the reservoir, etc.

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APPENDIES

Appendix: 1 Dry season diet composition of Nile tilapia in Alwero Reservoir. Percentage volume (% V), percentage frequency of occurrence (% O) and percentage index of preponderance (% IP) of the different prey items in the diet of 61 Nile tilapia

Food item	O	%O	V	%V	IP	%IP
Phytoplankton	**106**	**173.77**	**139.2**	**38.652986**	**6716.7483**	**55.0043**
Green algae	35	57.377	41.78	11.603812	665.7925	5.45226
Blue green algae	48	78.6885	91.78	25.492277	2005.9496	16.427
Red algae	17	27.8689	4.805	1.3346814	37.19604	0.3046
Yellow algae	3	4.91803	0.22	0.0611092	0.3005373	0.00246
Diatoms	3	4.91803	0.58	0.1611062	0.7923255	0.00649
Zooplankton	**1**	**1.63934**	**0.6**	**0.1666616**	**0.2732157**	**0.00224**
Copepods	1	1.63934	0.6	0.1666616	0.2732157	0.00224
Aquatic insects	**53**	**86.8852**	**113.4**	**31.485149**	**2735.5949**	**22.4021**
Diptera	38	62.2951	98.32	27.310277	1701.2959	13.9321
Trichoptera	11	18.0328	13.33	3.7012758	66.744318	0.54658
Ephemeroptera	2	3.27869	0.68	0.1888831	0.6192889	0.00507
Odonata	2	3.27869	1.025	0.2847135	0.933487	0.00764
Detritus	**57**	**93.4426**	**106.2**	**29.499099**	**2756.4732**	**22.5731**
fish scales	1	**1.63934**	0.01	**0.0027777**	**0.0045536**	**3.7E-05**
Vegetation	7	**11.4754**	0.696	**0.1933274**	**2.2185114**	**0.01817**
All total	61		360	100	**12211.313**	**100**

Appendix|:2 1Wet season diet composition of Nile tilapia in Alwero Reservoir. Percentage volume (% V), percentage frequency of occurrence (% O) and percentage index of preponderance (% IP) of the different prey items in the diet of 43 Nile tilapia

Food item	O	%O	V	%V	IP	%IP
Phytoplankton	**67**	**155.814**	**92.93**	**40.58**	**6323.33**	**55.20**
Green algae	21	48.83721	28.94	12.64	617.21	**5.39**
Blue green algae	28	65.11628	56.57	24.70	1608.64	**14.04**
Red algae	2	4.651163	3.55	1.55	7.21	**0.06**
Yellow algae	11	25.5814	0.32	0.14	3.57	**0.03**
Diatoms	5	11.62791	3.55	1.55	18.03	**0.16**
Zooplankton	**6**	**13.95**	**1.95**	**0.85**	**11.88**	**0.10**
Celadocera	1	2.325581	0.2	0.09	**0.20**	**0.00**
Copepods	5	11.62791	1.75	0.76	**8.89**	**0.08**
Aquatic insects	**43**	**100**	**78.03**	**34.08**	**3407.57**	**29.75**
Diptera	27	62.7907	59.08	25.80	**1620.02**	**14.14**
Trechoptera	9	20.93023	9.25	4.04	**84.55**	**0.74**
Ephemeroptera	4	9.302326	6.7	2.93	**27.22**	**0.24**
Odonata	3	6.976744	3	1.31	**9.14**	**0.08**
Detritus	**31**	**72.09302**	**54.12**	**23.63**	**1703.86**	**14.87**
fish scales	2	4.651163	0.41	**0.18**	**0.83**	**0.01**
Vegetation	5	11.62791	1.55	**0.68**	**7.87**	**0.07**
Total	43 (n)		**228.99**	**100.00**	**11455.35**	**100.00**

Appendix3|: Dry season diet composition of Bubu in Alwero Reservoir. Percentage volume (% V), percentage frequency of occurrence (% O) and percentage index of preponderance (% IP) of the different prey items in the diet of 33 Bubu

Food item	O	%O	V	%V	IP	%IP
Phytoplankton	**22**	**66.6667**	**11.75**	**8.97906**	**598.604**	**4.4956**
Blue green algae	12	36.3636	7.05	5.38744	195.907	1.4713
Yellow green algae	1	3.0303	0.06	0.04585	0.13894	0.001
Green algae	7	21.2121	3.34	2.55235	54.1407	0.4066
Diatoms	2	6.06061	1.3	0.99343	6.02078	0.0452
Aquatic insects	**50**	**151.515**	**97.6**	**74.5835**	**11300.5**	**84.868**
Diptera	25	75.7576	63.1	48.2195	3652.99	27.434
Trechoptera	7	21.2121	10.3	7.87101	166.961	1.2539
Ephemeroptera	15	45.4545	22.2	16.9647	771.123	5.7912
Coleptetra	3	9.09091	2	1.52835	13.8941	0.1043
Zooplankto3n	**5**	**15.1515**	**2.505**	**1.91426**	**29.0039**	**0.2178**
Copepods	1	3.0303	0.3	0.22925	0.6947	0.0052
Cladocra	4	12.1212	2.205	1.68501	20.4243	0.1534
Detritus	**32**	**96.9697**	**18.705**	**14.2939**	**1386.08**	**10.41**
Vegetation	1	**3.0303**	**0.08**	**0.06113**	**0.18525**	**0.0014**
Fish scale	2	**6.06061**	**0.22**	**0.16812**	**1.0189**	**0.0077**
TOTAL	**33**		**130.86**	**100**	**13315.4**	**100**

Appendix|4: Wet season diet composition of Bubu in Alwero Reservoir. Percentage volume (% V), percentage frequency of occurrence (% O) and percentage index of preponderance (% IP) of the different prey items in the diet of 33 Bubu

Food item	O	%O	V	%V	IP	%IP
Phytoplankton	**58**	**123.404**	**59.5**	**30.5653**	**3771.89**	**34.1054**
Blue green algae	26	55.3191	33.85	17.3888	**961.936**	8.69782
Red green algae	4	8.51064	0.94	0.48288	**4.10962**	0.03716
Green algae	16	34.0426	18.1	9.29802	**316.529**	2.86205
Diatoms	12	25.5319	6.61	3.39558	**86.6956**	0.7839
Aquatic insects	**56**	**119.149**	**85.325**	**43.8317**	**5222.5**	**47.2218**
Diptera	25	53.1915	46.05	23.656	**1258.3**	11.3775
Trechoptera	8	17.0213	6.3	3.23633	**55.0865**	0.49809
Ephemeroptera	19	40.4255	31.375	16.1174	**651.556**	5.89136
Plecoptera	1	2.12766	0.45	0.23117	**0.49184**	0.00445
Odonata	3	6.38298	1.15	0.59076	**3.7708**	0.0341
Zooplankton	**9**	**19.1489**	**3.65**	**1.87502**	**35.9046**	**0.32465**
Copepods	4	8.51064	2.08	1.0685	**9.09364**	0.08222
Cladocra	5	10.6383	1.57	0.80651	**8.57993**	0.07758
Detritus	**42**	**89.3617**	**43.99**	**22.5978**	**2019.38**	**18.2592**
Vegetation	**3**	**6.38298**	**1**	**0.5137**	**3.27896**	**0.02965**
fish scales	**5**	**10.6383**	**1.2**	**0.61644**	**6.55791**	**0.0593**
Total	47 (N)		**194.665**	**100**	**11059.5**	**100**

Appendix 5 Dry season diet overlap analysis both Nile tilapia and Bubu

	Pi		NT (J)	AO (K)				$\sum\left(\frac{\sum_{i=1}^{n} Pij^2}{J^2}+\frac{\sum_{i=1}^{n} Pik^2}{K^2}\right)JK$			H
Dry	NT	AO	Pi2	Pi2	PiJ*PiK	J2	K2		J^2	K^2	
hytoplankton	0.38	0.08	0.1444	0.0064	0.0304						
Zooplankton	0.02	0.01	0.0004	0.0001	0.0002						
Aquatic insects	0.31	0.74	0.0961	0.5476	0.2294						
Detritus	0.29	0.14	0.0841	0.0196	0.0406						
Vegetation	0.02	0.01	0.0004	0.0001	0.0002						
Fish scales	0.01	0.01	0.0001	0.0001	0.0001						
			0.3255	0.5739	0.6018	17124.34	129607.9	2E-05	4.42797E-06	1.104094435	0.545062

$2\sum_{i=1}^{n} PijPik$

Appendix: 6 Wet season diet overlap analysis both Nile tilapia and Bubu

	Pi		NT (J)	AO (K)				$\frac{\sum_{i=1}^{n} Pik^2}{K^2}$	$\left(\frac{\sum_{i=1}^{n} Pij^2}{J^2}+\frac{\sum_{i=1}^{n} Pik^2}{K^2}\right)JK$		H
Wet	NT	AO	Pi2	Pi2	PiJ*PiK	J2	K2	$\frac{\sum_{i=1}^{n} Pij^2}{J^2}$			
Phytoplankton	0.41	0.31	0.1681	0.0961	0.1271						
Zooplankton	0.01	0.01	0.000064	0.0001	0.00008						
Aquatic insects	0.34	0.44	0.1156	0.1936	0.1496						
Detritus	0.23	0.23	0.0529	0.0529	0.0529						
Vegetation	0.01	0.01	0.0001	0.0001	0.0001						
Fish scales	0.01	0.01	0.0001	0.0001	0.0001						
			0.336664	0.3427	0.65936	52436.42	37894.46	6.42042E-06	9.04E-06	0.689326749	0.956528

$2\sum_{i=1}^{n} PijPik$

Appendix: 7. the dry and wet season samples of Nile tilapia and Bubu fish species of the of Alwero Reservoir

Appendix: 8 Gut samples of Nile tilapia and Bubu of fish species both dry and wet season at Alwero Reservoir

Appendix: 9 Length-weight measurement of Nile tilapia at Alwero Reservoir at both seasons

Appendix: 10 length- weight measurement of Bubu at Alwero Reservoir at both seasons

Appendix: 11 Removal of gut from fish samples of Nile tilapia and Bubu

Appindex12: Identification of food items from the gut samples which collected from the study area in the laboratory by using identification keys

Appendix 13: T-Test: Two-Sample Assuming Unequal Variances of Nile tilapia Bubu

	DFCF	WFCF
	1.428083751	*1.547564861*
Mean	1.84040282	1.665791986
Variance	0.418183263	0.206814126
Observations	60	42
Hypothesized Mean Difference	0	
Def.	100	
t Stat	1.601067528	
P(T<=t) one-tail	0.05625823	
t Critical one-tail	1.660234326	
P(T<=t) two-tail	0.112516461	
t Critical two-tail	1.983971519	

T -TEST NT

	1.240129538	*1.827556419*
Mean	1.7150169	1.830836754
Variance	0.179167959	0.179647085
Observations	32	46
Hypothesized Mean Difference	0	
Df	67	
t Stat	-1.188013415	
P(T<=t) one-tail	0.119511242	
t Critical one-tail	1.667916114	
P(T<=t) two-tail	0.239022484	
t Critical two-tail	1.996008354	

Appendix 15: locally used gill nets (Ajaabat, its local name)

Appendix 15 Summary of Mean ± SD of Fulton Condition Factor (FCF) for Nile tilapia and Bubu fish species during two seasons in Alwero reservoir Baro Akobo basin

Fish species	Dry season		Wet season		P-value
	Mean± SD	N	Mean± SD	N	
Nile tilapia	1.83 ± 0.64	61	1.66 ± 0.45	43	0.06
Bubu	1.70 ± .42	33	1.83 ± 0.42	47	0.12