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THE FOOD AND FEEDING HABITS OF THE AFRICAN CATFISH, *CLARIAS GARIEPINUS* (BURCHELL, 1822) (PISCES: CLARIIDAE) IN LAKE HAWASSA AND SHALLO SWAMP, ETHIOPIA

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ABSTRACT: Feeding habits of the African catfish *Clarias gariepinus* (Burchell, 1822) was studied based on 252 and 211 fish specimen collected from Lake Hawassa and Shallo swamp during dry and wet months of 2011. *C. gariepinus* in Lake Hawassa consumed insects (21% by volume), fish eggs (18.3%), fish (18.1%), gastropods (14.4%), macrophytes (13.6%), detritus (8.4%), zooplankton (2.6%), phytoplankton (1.7%), ostracods (0.7%), nematodes (0.5%) and fish scales (0.5%). In Shallo swamp, the fish mainly fed on macrophytes (31.7% by volume) and detritus (31.5%). Insects (12.2%), amphibians (9.5%), zooplankton (5.3%) and phytoplankton (4.9%) had also some contribution, while fish eggs, gastropods, ostracods, water mites and nematodes had insignificant contribution to the diet. Seasonal variation in the diet of *C. gariepinus* was slight in both habitats. Ontogenetic dietary shift was observed in Lake Hawassa. Smaller size *C. gariepinus* (<45 cm TL) in Lake Hawassa fed mainly on insects, fish and fish eggs and their importance decreased as the fish size increased while large sized *C. gariepinus* (>45 cm TL) tended to filter-feed more on zooplankton. All size groups of *C. gariepinus* in Shallo swamp mainly fed on macrophytes and detritus. Generally *C. gariepinus* in both habitats fed on food of plant and animal origin albeit in varying proportions, and the fish can be considered as omnivorous in its feeding habit.

Key words/phrases: *C. gariepinus*, Feeding habit, Lake Hawassa, Omnivorous, Shallo swamp.

INTRODUCTION

The African catfish, *C. gariepinus* is the most cultured species of the genus and it is almost Pan-African in its distribution, from the Nile to West Africa and from Algeria to Southern Africa (de Moor and Bruton, 1988). In Ethiopia *C. gariepinus* has a widespread distribution existing in almost all lakes, swamps, rivers and wetlands (Shibru Tedla, 1973). Its commercial

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importance has increased in recent years in some of the water bodies, especially after the overexploitation of Nile tilapia *Oreochromis niloticus* (Linneaus, 1758) (Elias Dadebo, 2000; Yosef Tekle-Giorgis, 2002; Zerihun Desta, 2003).

There is a good deal of information on the food and feeding habits of *C. gariepinus* in many parts of Africa and in the Middle East (Munro, 1967; Bruton, 1979; Spataru *et al*., 1987; Elias Dadebo, 1988; 2000; 2009; Lemma Abera, 2007; Zerihun Desta *et al*., 2007; Demeke Admassu *et al*., 2015). These authors described the species as opportunistic feeder that feeds on a wide variety of food items such as detritus, filamentous algae, zooplankton, macrophytes, aquatic and terrestrial insects, nematodes, mollusks, crustaceans and fish.

A few studies have been conducted on some aspects of the biology of *C. gariepinus* in Lake Hawassa (Elias Dadebo, 1988; 2000; Yosef Tekle-Giorgis, 2002; Zerihun Desta *et al*., 2007). Elias Dadebo (2000) reported that *C. gariepinus* in Lake Hawassa is piscivore, *O. niloticus* comprising the bulk of the fish prey. Zerihun Desta *et al*. (2007) emphasized the importance of the straight fin barb *Barbus paludinosus* in the diet of *C. gariepinus* in Lake Hawassa. However, no published work is available on the feeding habits of *C. gariepinus* from Shallo swamp. This work therefore, compares the feeding habits of *C. gariepinus* from Lake Hawassa and Shallo swamp. The data will form the basis for management of the species in Shallo swamp and in Lake Hawassa as well as indicate the trophic position of the species in those habitats.

MATERIALS AND METHODS

Study area

Lake Hawassa (also reported as Awassa) is located at an altitude of 1,680 m in the central part of the Ethiopian Rift Valley (6° 33'−7° 33' N and 38°22'−38°29' E) 275 km south of the capital, Addis Ababa (Fig. 1). The lake has a surface area of 90 km^2, a catchment area of 1,250 km^2, a maximum depth of 22 m and a mean depth of 11 m (Makin *et al*., 1975). The region around Lake Hawassa receives a total rainfall of about 1000 mm annually (Daniel Gamachu, 1977). The dry season begins in November and usually lasts until March, but in 2011, the months March-May received low rainfall and were dry. The wettest month was September (Fig. 2).

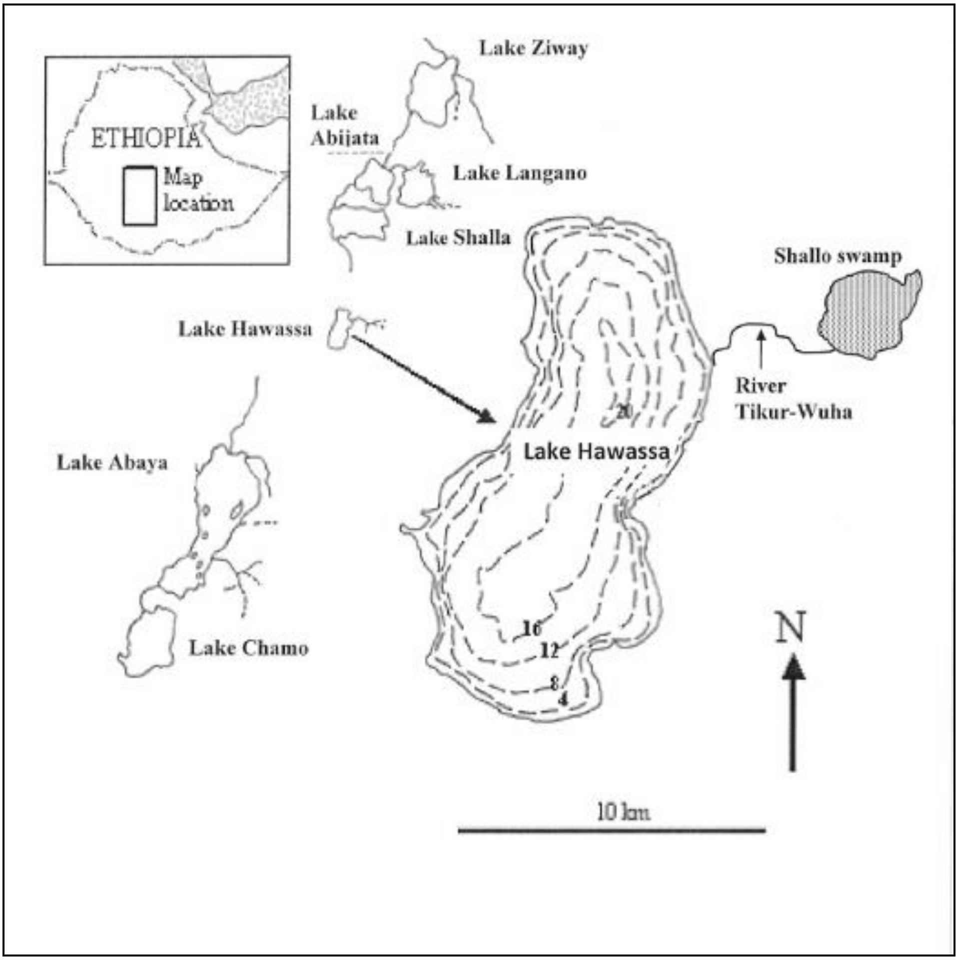

Fig. 1. Lake Hawassa in relation to other Ethiopian Rift Valley lakes, shown together with Shallo swamp. Contour lines are bathymetry at 4 m depth (Modified from Zerihun Desta *et al*., 2006).

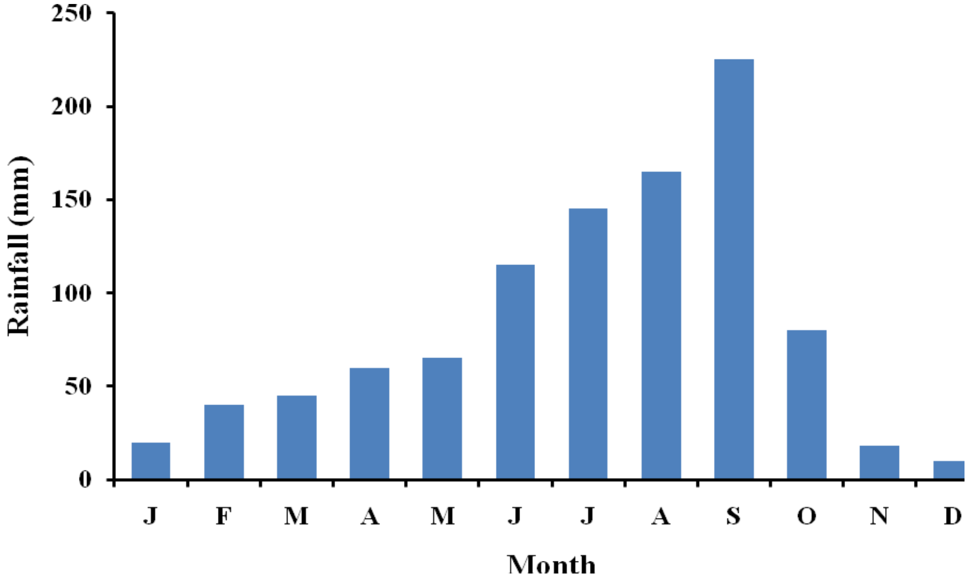

Fig. 2. Mean total monthly rainfall (mm) of the region around Lake Hawassa in 2011.

Lake Hawassa is topographically a closed basin and lacks any surface outflow. The lake is primarily fed by a small river Tikur Wuha, which originates from Shallo swamp. According to Seyoum Mengistou and Fernando (1991), the dominant zooplankton species in the lake are *Mesocyclops aequatorialis*, *Thermocyclops consimilis*, *Diaphanosoma excisum*, *Brachionus* and *Keratella*. The dominant phytoplankton species include *Lyngbya nyassae*, *Botryococcus braunii* and *Microcystis* (Elizabeth Kebede and Amha Belay, 1994). The littoral area is covered by an extensive belt of submerged and emergent rooted vegetation, which extends to about 150 m offshore and up to 4 m depth (Tudorancea *et al*., 1988). The macrophyte vegetation includes *Cyperus* sp., *Nymphea caerulea*, *Potomogeton* species, *Paspalidium geminatium*, *Typha angustifolia* and *T. latifolia*. The benthic fauna include Ostracods (dominant), Chironomids, Cyclopoids and Cladocerans (Tilahun Kibret, 1985).

The fish species found in Lake Hawassa are the Nile tilapia (*O. niloticus*), the African catfish (*C. gariepinus*), the African big barb (*Labeobarbus intermedius* R. 1836*)*, the straightfin barb (*Barbus paludinosis* P.1852), the black lampeye (*Aplocheilichthys antinorii* V. 1883) and the stone lapping minnow (*Gara quadrimaculata* R.1835) (Elias Dadebo, 2000). The former three are commercially important comprising a catch of about 500 to 600 tons per year (LFDP, 1996). The latter three species are minnow fish and are not fished due to their small size. *O. niloticus* constitutes about 90% of the total catch, while *C. gariepinus* and *L. intermedius* contribute only about 7-8% and 2-3%, respectively (Yosef Tekle-Giorgis, 2002).

The Shallo swamp used to have a surface area of 77 km^2 but currently its size has shrunk to less than 10 km^2. The water is slightly acidic (humic acid) due to large degraded biomass in the standing water and it supports diverse species of water fowl, weed bed fauna, zooplankton, phytoplankton, fungi, bacteria, amphibians, reptiles and macrophytes (Zerihun Desta, 2003). Only one fish species, *C. gariepinus* inhabits the wetland (Zerihun Desta, 2003).

Fish sampling and measurements

Fish samples were collected using experimental gillnets, hook and line as well as from fishermen's catch monthly during March to September, 2011. Total length (TL) and standard length (SL) were measured to the nearest mm using measuring board while total body weight was measured to the nearest gram using digital (for small fish <1 kg) and spring balance. Then, fish were dissected to collect stomach samples.

Stomach content analysis

Stomach contents were collected from each specimen and preserved in 5% formalin until further analysis. Larger food items were identified visually whereas dissecting microscope (Leica, MS5) and compound microscope (Leica, DME) were used to identify microscopic food items. The relative importance of each food item was determined using frequency of occurrence and volumetric analysis as described below.

Frequency of occurrence

The number of stomach samples containing one or more individuals of each food category was expressed as a percentage of all stomachs containing food (Bagenal, 1978; Bowen, 1978).

Volumetric analysis

The food items that were found in the stomach were sorted into different taxonomic categories and the water displaced by the group of items in each category was measured in a partially filled graduated cylinder. The water displaced by each category of food item was expressed as a percentage of the total volume of the stomach contents (Bagenal, 1978). In case of microscopic food items such as phytoplankton, zooplankton, ostracods and small insects, the total volume was estimated by multiplying the total number of prey organisms by the individual volume of respective organism obtained from literature (Zerihun Desta, 2007). The volumetric importance of a food category was then expressed as a percentage of the volume of all the categories of food items.

Ontogenetic dietary shift

Ontogenetic dietary shift of *C. gariepinus* from Lake Hawassa and Shallo swamp was studied based on the volumetric contribution of each food item within each length group. For studying ontogenetic dietary shift, fish were classified into three size classes. The relative importance of each food item in each size class was estimated by taking the mean percentage volume of each category of food items to the total volume in that size class.

RESULTS

The diet composition of *C. gariepinus* in Lake Hawassa

A total of 252 *C. gariepinus* were sampled from Lake Hawassa during both dry (March−May, 2011) and wet (August−September, 2011) months. The fish ranged in size from 20.1 cm to 94.8 cm TL and weighed 56.5 g to 6,800 g. Out of these, 47(18.7%) had empty stomach, while 205 (81.3%) fish specimens contained food in their stomachs. The food of *C. gariepinus* from Lake Hawassa consisted of insects, fish eggs, fish, gastropods, macrophytes, detritus, zooplankton, phytoplankton, ostracods, nematodes and fish scales (Table 1). Out of these food items, the first five constituted the bulk of the food consumed while zooplankton and phytoplankton had less importance. The remaining food items namely, ostracods, nematodes and fish scales were relatively unimportant to the diet of the fish (Table 1).

Insects occurred in 68.8% of the stomachs examined and accounted for 21.0% of the total volume of food items. Among the insect groups, Diptera, Coleoptera and Ephemeroptera were relatively important prey organisms constituting 6.9%, 5.8% and 3.7% of the total volume of ingested food items, respectively (Table 1). On the other hand, Odonata, Plecoptera and Hemiptera contributed less to the fish diet.

Table 1. Frequency of occurrence and volumetric contribution of various food items in the diet of *C. gariepinus* sampled from Lake Hawassa (n=205).

	Frequency of occurrence		Volumetric analysis	
Food items	**Number**	**Percent**	**Volume (ml)**	**Percent**
Phytoplankton	**106**	**51.7**	**9.06**	**1.7**
Diatoms	55	26.8	3.93	0.8
Green algae	54	26.3	3	0.6
Blue green algae	46	22.4	2.05	0.4
Euglenoids	2	1	0.08	0
Macrophytes	157	76.6	71.36	13.6
Detritus	158	77.1	44.08	8.4
Zooplankton	50	24.4	13.64	2.6
Copepoda	43	21	6.77	1.3
Cladocera	30	14.6	6.67	1.3
Rotifera	2	1	0.2	0.03
Ostracods	**24**	**11.7**	**3.86**	**0.7**
Nematodes	**7**	**3.4**	**2.7**	**0.5**
Insects	**141**	**68.8**	**110.2**	**21**
Diptera	104	50.7	36.35	6.9
Coleoptera	76	37.1	30.46	5.8
Ephemeroptera	48	23.4	19.12	3.7
Odonata	24	11.7	11.5	2.2
Plecoptera	36	17.6	7.46	1.4
Hemiptera	24	11.7	5.26	1
Gastropods	**64**	**31.2**	**75.54**	**14.4**
Fish eggs	**48**	**23.4**	**95.74**	**18.3**
Fish scales	**9**	**4.4**	**2.7**	**0.5**
Fish	**36**	**17.6**	**94.94**	**18.1**
O. niloticus	23	11.2	58.04	11.1
B. paludinosus	19	9.3	36.9	7

Fish eggs and fish occurred in 23.4% and 17.6% of the stomachs and comprised 18.3% and 18.1% of the total volume of food items, respectively (Table 1). Two fish species namely *B. paludinosus* and *O. niloticus*, were preyed by the fish, the latter being more important as fish prey. Gastropods were among the major food items occurring in 31.2% of the stomachs examined, accounting for 14.4% of the total volume of food ingested. Macrophytes and detritus occurred in 76.6% and 77.1% of the stomachs, respectively, and they constituted 13.6% and 8.4% of the total volume of food items, respectively (Table 1).

Zooplankton occurred in 24.4% of the stomachs and constituted 2.6% of the total volume. Among the zooplankton groups, Copepoda and Cladocera were relatively more important food items occurring in 21% and 14.6% of the stomachs, respectively, and each contributed 1.3% of the total volume. The contribution of Rotifera (0.03%) was unimportant (Table 1). Phytoplankton occurred in 51.7% of the stomachs and accounted for 1.7%

of the total volume. Among the phytoplankton, diatoms, green algae, blue green algae and euglenoids were identified. Ostracods, nematodes and fish scales were of little importance and collectively constituted 1.7% of the total volume of food items (Table 1).

Seasonal variations in the diet of *C. gariepinus* in Lake Hawassa

During the dry months, the volumetric contribution of insects (23.2%), fish (23.0%), gastropod (17.0%), fish eggs (15.7%) and macrophytes (12.4%) was relatively high. Detritus was of intermediate importance (5.7% volumetrically) while phytoplankton, ostracods and zooplankton were relatively the least in terms of volume (Table 2).

Insects occurred in 80.0% of the stomachs and volumetrically accounted for 23.2% of the total food volume during the dry months. Among the insect groups, Coleoptera and Diptera were important prey organisms occurring in 50.4% and 61.7% of the stomachs examined, respectively, and accounted for 7.8% and 6.6% of the total volume of food items, respectively (Table 2). Fish occurred in 25.2% of the stomachs and constituted 23.0% of the total volume consumed. Two fish species were preyed by *C. gariepinus*, namely *O. niloticus* and *B. paludinosis*. Gastropods, fish eggs and macrophytes occurred in 37.4%, 28.7% and 87.0% of the stomachs, and they contributed 17.0%, 15.7% and 12.4% of the total volume of food items, respectively (Table 2). Detritus occurred in 84.3% of the stomachs but its volumetric contribution was only 5.7% of the total food items during the dry months.

During the wet months, fish eggs and insects were the most important food items accounting for 21.0% and 19.0%, respectively, of the total food volume (Table 2) while macrophytes, fish, gastropods and detritus were of intermediate importance (each 11.2%−14.9% by volume). Compared to the dry months, zooplankton became relatively more important to the fish in the wet months accounting for 5.2% of the food volume, but phytoplankton and nematodes were still unimportant (Table 2). Generally, the importance of fish egg, detritus and zooplankton considerably increased while that of fish and gastropods showed marked decrease during the wet months. On the other hand, the contribution of insects and macrophytes was comparable during both dry and wet months (Table 2).

Table 2. Relative contribution of different food items in the diet of *C. gariepinus* during the dry and wet months in Lake Hawassa (n=205).

	Frequency of occurrence (%)		**Volumetric contribution (%)**	
Food items	**Dry months**	**Wet months**	**Dry months**	**Wet months**
Phytoplankton	53.9	48.9	1.51	2.02
Diatoms	33	18.9	1	0.6
Green algae	20.9	33.3	0.1	1.1
Blue green algae	27	16.7	0.4	0.3
Euglenoid	0.9	1.1	0.01	0.02
Macrophytes	87	63.3	12.4	14.9
Detritus	84.3	67.8	5.7	11.2
Zooplankton	7	46.7	0.1	5.2
Copepoda	7	38.9	0.1	2.4
Cladocera	-	33.3	-	2.6
Rotifera	-	2.2	-	0.2
Ostracods	**20.9**	-	**1.4**	-
Nematodes	-	**7.8**	-	**1**
Insects	**80**	**54.4**	**23.2**	**19**
Diptera	61.7	36.7	6.6	7.4
Coleoptera	50.4	20	7.8	3.8
Odonata	19.1	2.2	3.8	0.6
Ephemeroptera	23.5	23.3	1.1	6.3
Plecoptera	28.7	3.3	2.4	0.4
Hemiptera	17.4	4.4	1.5	0.5
Gastropods	**37.4**	**23.3**	**17**	**12.1**
Fish eggs	**28.7**	**16.7**	**15.7**	**21**
Fish	**25.2**	**7.8**	**23**	**13.4**
O. niloticus	14.8	6.7	11.4	11
B. paludinosus	15.7	1.1	11.6	2.4

Ontogenetic dietary shift of *C. gariepinus* in Lake Hawassa

The volumetric contributions of insects, fish eggs and fish were high in smaller size class and their importance decreased as the fish grew whereas in large size-class, zooplankton constituted the highest portion of the food items (Fig. 3).

C. gariepinus below 35 cm TL, mainly fed on insects (23.3%), fish eggs (19.6%) and fish (17.5%). Macrophytes (13.9%), gastropods (12.6%) and detritus (8.0%) had intermediate importance while zooplankton and phytoplankton were relatively unimportant as food items to *C. gariepinus* below 35 cm TL (Fig. 3). *C. gariepinus* between 35 and 45 cm TL also had a similar feeding behaviour as those below 35 cm TL. Insects (20.0%), fish eggs (21.1%) and fish (17.0%) composed most of the diet within this size class. Macrophytes (13.5%), gastropods (11.7%) and detritus (8.3%) were of intermediate importance while zooplankton and phytoplankton were of low importance (Fig. 3). By contrast, *C. gariepinus* larger than 45 cm mainly consumed zooplankton (30% by volume). Insects (15%), macrophytes (14.3%), detritus (13.2%), fish (12.5%) and fish eggs (9.9%) also had considerable importance to the diet of larger size classes while gastropods and phytoplankton were relatively of low significance (Fig. 3).

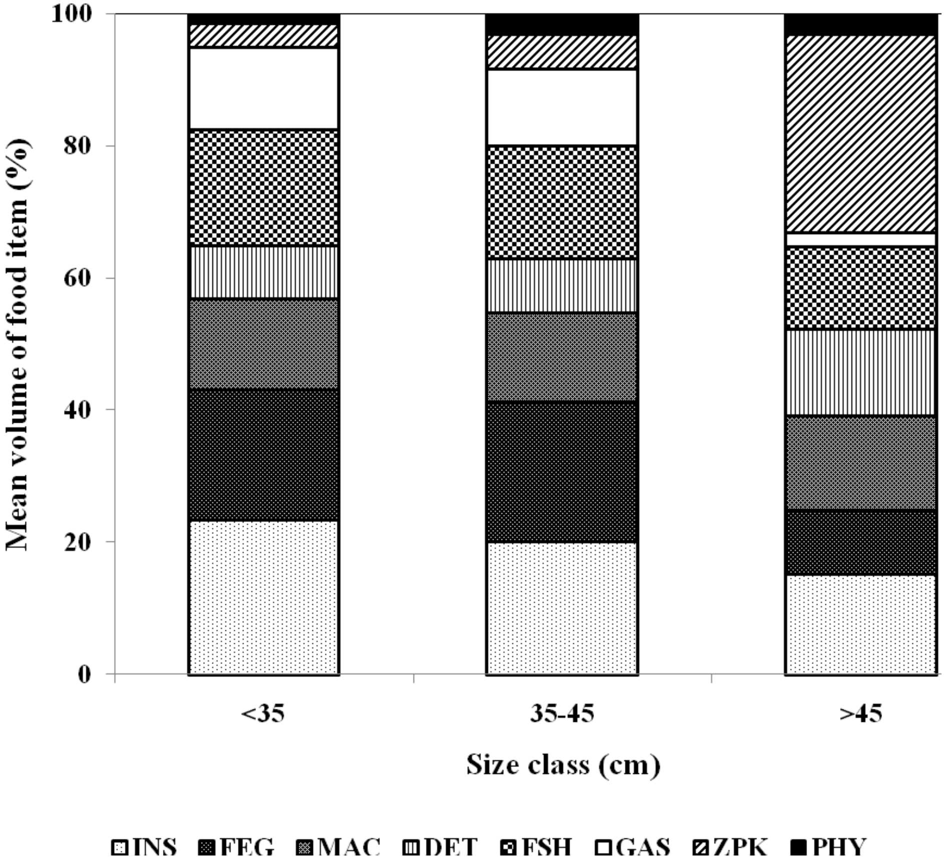

Fig. 3. The relative volume of food items consumed by different size classes of *C. gariepinus* from Lake Hawassa (INS - insects, FEG - fish egg, MAC - macrophytes, DET - detritus, FSH - fish, GAS - gastropods, ZPK - zooplankton, PHY - phytoplankton, AMP- Amphibians, OST- Ostracods).

In general, as *C. gariepinus* grew larger, the importance of zooplankton markedly increased in its diet. The detrital component also increased in the diet as the fish grew larger. By contrast, the contribution of gastropods, fish eggs, fish and insects decreased in the diets of older fish while macrophytes proportion stayed more or less the same.

The diet composition of *C. gariepinus* in Shallo swamp

Out of the 211 specimens sampled from Shallo swamp, 28(13.3%) had empty stomachs while the remaining 183(86.7%) had food in their stomachs. Overall, the fish size considered in this study ranged from 30.2 cm to 95.4 cm TL and 250 g to 5,700 g TW.

The results showed that *C. gariepinus* from Shallo swamp fed on a variety of food items including macrophytes, detritus, insects, amphibians, zooplankton, phytoplankton, fish eggs gastropods, ostracods, water mites and nematodes (Table 3). Among these, macrophytes and detritus were most frequent occurring in 94.0% and 92.3% of the stomachs, respectively, as well as they constituted the major portion of the total volume of food accounting for 31.7% and 31.5%, respectively. Insects had intermediate importance, occurring in 54.6% of the stomachs and constituting 12.2% of the total food volume. Frogs, zooplankton and phytoplankton also had considerable importance accounting for 7.9%, 5.3% and 4.9%, respectively, of the total food volume consumed (Table 3).

Table 3. Frequency of occurrence and volumetric contribution of various food items in the diet of *C. gariepinus* sampled from Shallo swamp (n=183).

Food items	**Frequency of occurrence (%)**		**Volumetric analysis**	
	Number	**Percent**	**Volume (ml)**	**Percent**
Phytoplankton	**68**	**37.2**	**46.4**	**4.9**
Diatoms	56	30.6	27.5	2.9
Green algae	35	19.1	14.6	1.5
Euglenoid	6	3.3	3	0.3
Blue green algae	6	3.3	1.4	0.1
Macrophytes	**172**	**94**	**301.8**	**31.7**
Detritus	**169**	**92.3**	**300.1**	**31.5**
Zooplankton	**43**	**23.5**	**50.4**	**5.3**
Copepoda	40	21.9	31.4	3.3
Cladocera	19	10.4	13.6	1.4
Rotifera	13	7.1	5	0.5
Water mites	**6**	**3.3**	**3.2**	**0.3**
Ostracods	**19**	**10.4**	**5.3**	**0.6**
Nematodes	**6**	**3.3**	**1.5**	**0.2**
Gastropods	**20**	**10.9**	**15.7**	**1.6**
Insects	**100**	**54.6**	**116.6**	**12.2**
Coleoptera	54	29.5	42.1	4.4
Diptera	44	24	36.1	3.8
Ephemeroptera	27	14.8	22.4	2.3
Odonata	10	5.5	7.8	0.8
Hemiptera	15	8.5	5.7	0.6
Plecoptera	4	2.2	1.5	0.2
Amphibians	**9**	**4.9**	**90.78**	**9.5**
Fish eggs	**8**	**4.4**	**21.5**	**2.3**

Seasonal variation in the diet of *C. gariepinus* in Shallo swamp

During the dry months, the volumetric contribution of macrophytes (26.4%), detritus (21%), amphibians (18.5%) and insects (15%) was relatively high (Table 4). Phytoplankton (8.6%) and zooplankton (8.3%) were of intermediate importance while gastropods, ostracods, fish eggs and nematodes were relatively unimportant. Among the insect groups, Coleoptera, Ephemeroptera and Diptera were relatively important prey organisms and constituted 5.6%, 3.4% and 3.5% of the total volume of food items, respectively, while Odonata and Hemiptera were of little importance in the diet of *C. gariepinus*. During the wet months, the importance of detritus and macrophytes increased considerably in the diet of *C. gariepinus* accounting for 94.4% and 93.3% of the stomachs examined, respectively, and constituting 42% and 37% of the total volume of food items, respectively (Table 4). Insects had an intermediate contribution (9.4%), although their significance was not as high as that in the dry season. The contribution of fish eggs (4.2%) and gastropods (2.1%) in the wet months increased compared to that in the dry months.

Table 4. Relative contribution (%) of different food items in the diet of *C. gariepinus* during the dry and wet months in Shallo swamp (n=183).

	Frequency of occurrence (%)		Volumetric analysis (%)	
Food items	**Dry month**	**Wet month**	**Dry month**	**wet month**
Phytoplankton	64.5	8.9	8.6	1.2
Diatom	60.2	-	5.7	-
Green algae	29	8.9	2.1	1.2
Euglenoid	6.5	-	0.6	-
Blue green algae	6.5	-	0.2	-
Macrophytes	**94.6**	**93.3**	**26.4**	**37**
Detritus	**90.3**	**94.4**	**21**	**42**
Zooplankton	**36.6**	**10**	**8.3**	**2.2**
Copepoda	35.5	7.8	5.1	1.5
Cladocera	19.3	1.1	2.3	0.6
Rotifera	12.9	1.1	0.9	0.1
Water mites		**6.7**	**-**	**0.9**
Ostracodes	**20.4**	**-**	**0.9**	**-**
Nematodes	**1.1**	**5.6**	**0.1**	**0.3**
Gastropods	**10.8**	**11.1**	**1.2**	**2.1**
Insects	**68.8**	**40**	**15**	**9.4**
Coleoptera	41.9	16.7	5.6	3.2
Diptera	26.9	21.1	3.4	4.4
Ephemeroptera	23.7	5.6	3.5	1.1
Odonata	10.8	-	1.7	-
Hemiptera	14	2.2	0.8	0.3
Plecoptera	-	4.4		0.4
Amphibians	**9.7**	**-**	**18.5**	**-**
Fish eggs	**3.2**	**5.6**	**0.1**	**4.9**

Ontogenetic dietary shift of *C. gariepinus* in Shallo swamp

The diet composition of *C. gariepinus* in Shallo swamp varied with its size although not as marked as observed in Lake Hawassa (Fig. 4). In the size class of 30−44.9 cm TL, macrophytes and detritus were the most important food items comprising 30.7% and 24.5% of the volume, respectively. Insect (12%), amphibians (11.3%), phytoplankton (9.7%) and zooplankton (8.6%) had intermediate importance while fish eggs, ostracods and gastropods had low importance to the diet. In the size class 45−59.9 cm TL, the importance of macrophytes and detritus further increased to 32.4% and 32.6% of the total volume, respectively (Fig. 4). The importance of insects (12.8%) remained more or less the same as in the smaller size groups but those of frogs (5.3%), phytoplankton (6.1%) and zooplankton (5.3%) decreased. Fish eggs, gastropods, and ostracods were relatively unimportant as food in this size group.

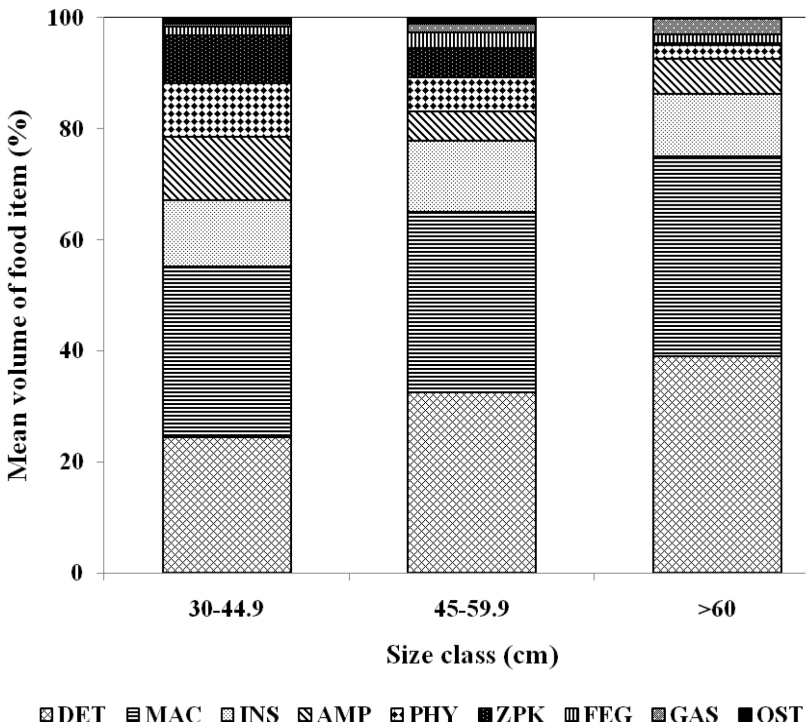

Fig. 4. The relative volume of food items consumed by different size class of *C. gariepinus* from Shallo swamp (INS - insects, FEG - fish egg, MAC - macrophytes, DET - detritus, FSH - fish, GAS - gastropods, ZPK - zooplankton, PHY - phytoplankton, AMP- Amphibians, OST- Ostracods).

In the largest size group (>60 cm), the contribution of detritus (39%) and macrophytes (36%) further increased; insects (10.1%) and frogs (6.4%) stayed more or less the same. In general as the fish grew older, the contribution of detritus and macrophytes considerably increased, while the animal component decreased in the diet.

DISCUSSION

The present study showed that *C. gariepinus* in Lake Hawassa is an omnivorous fish feeding on a wide variety of food items including insects, fish eggs, fish, gastropods, macrophytes, detritus, zooplankton, phytoplankton, ostracods, fish scales and nematodes. Earlier studies on the feeding habits of *C. gariepinus* have also reported omnivorous feeding habits of the species in Lake Hawassa (Elias Dadebo, 1988; 2000), Lake Tana (Tesfaye Wudneh, 1998), Lake Ziway (Daba Tugie and Meseret Taye, 2004), and Lake Babogaya (Demeke Admassu *et al*., 2015). Furthermore, various authors in different parts of Africa have also described the species as a slow moving and bottom living omnivore (Groenewald, 1964; Munro, 1967; Van der Waal, 1974; Willoughby and Tweddle, 1978; Clay, 1979). In order to feed on such a wide variety of food items, *C. gariepinus* is equipped with a wide array of anatomical adaptation such as a wide mouth, a broad band of chisel-like teeth, sensory organs, long gill rakers and a wide and rounded caudal fin (Bruton, 1979).

The food items consumed by *C. gariepinus* in Lake Hawassa were similar to several other populations (Munro, 1967; Bruton, 1979; Yalçin *et al*., 2001; Lemma Abera, 2007). Bruton (1979) observed that *C. gariepinus* in Lake Sibaya (South Africa) feeds on fish and aquatic as well as terrestrial insects. Munro (1967) reported that *C. gariepinus* feeds mainly on insects (Chironomidae larvae) in Mcllwaine (Zimbabwe). Also in River Asi, *C. gariepinus* was found to feed on insects among which Odonata were the main groups (Yalçin *et al*., 2001). Similarly, insects were the most important food items for the same fish in Lakes Langeno (Leul Teka, 2001), Ziway (Daba Tugie and Meseret Taye, 2004) and Babogaya (Lemma Abera, 2007) in Ethiopia. On the other hand, in some eutrophic lakes, *C. gariepinus* was found to feed on zooplankton like in Lake Barberspan, Western Transvaal, South Africa (Schoonbee, 1969) and in Lake Chamo, Ethiopia (Elias Dadebo, 2009).

Unlike in Lake Hawassa, where *C. gariepinus* consumed large proportions of animal origin food, macrophytes and detritus were found to be the most important food categories for *C. gariepinus* in Shallo swamp. This could be due to the presence of large amounts of emergent and floating water plants and partially decomposed leaves in the environment. Shallo swamp lacks fish as it is only catfish that thrives in the swamp. As a result, fish prey is totally absent in the food of *C. gariepinus* in Shallo swamp. Thus, the animal component of the diet is compensated to some extent by insects and frogs.

Seasonal variation in the diet of *C. gariepinus* was observed during the present study in Lake Hawassa. The contribution of insects, fish and gastropods was higher during the dry months than the wet months. On the other hand, the importance of fish eggs, detritus and zooplankton was higher during the wet months than the dry months. Several authors reported seasonal variations in the diet of *C. gariepinus* in different water bodies of Africa (Willoughby and Tweddle, 1978; Bruton, 1979; Yalçin *et al*., 2001; Lemma Abera, 2007). Bruton (1979) reported the importance of fish in the diet of *C. gariepinus* during autumn and winter in Lake Sibaya, South Africa, whereas during spring and summer *C. gariepinus* consumed mainly on crustaceans. Willoughby and Tweddle (1978) stated that the piscivorous role of *C. gariepinus* was significant when the water level in the marsh was low during October and November in the Shire Valley, Malawi. Yalçin *et al*. (2001) also reported that in Asi River, Turkey, food items of plant origin were important during the summer whereas zooplankton, ostracods and phytoplankton were more abundant in the stomachs in spring and winter.

There is little seasonality in the feeding activity of *C. gariepinus* in Shallo swamp. Macrophytes and detritus are most important foods for the fish during both dry and wet months, although their contribution was much more pronounced during the wet months. On the other hand, insects and frogs considerably decreased in their significance during the wet months. The most important factor affecting the availability and emergence of different food items in Shallo swamp could be the seasonal changes in water level. The high contributions of macrophytes and detritus in the diet of *C. gariepinus* during the wet months in Shallo swamp might be due to increase of nutrients during the floods that promote the growth of macrophytes. Moreover, large quantities of detritus could come from the drainage area through the floods.

There was size-based variation in the diet of *C. gariepinus* in Lake Hawassa. The contributions of zooplankton, detritus and phytoplankton increased with the size of the fish while the importance of other food items such as insects, fish, fish eggs and gastropods decreased with the size of the fish. Many investigators have reported ontogenetic dietary shift of *C. gariepinus* in different water bodies of Africa and Asia (Groenewald, 1964; Schoonbee, 1969; Willoughby and Tweddle, 1978; Bruton, 1979; Spataru *et al*., 1987; Elias Dadebo; 2000; Yalçin *et al*., 2001; Zerihun Desta *et al*., 2007; Demeke Admassu *et al*., 2015).

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