E3 Journal of Agricultural Research and Development Vol. 3(4). pp. 049-058, June, 2013
Available online http://www.e3journals.org
ISSN: 2276-9897 © E3 Journals 2013

Full Length Research Paper

Food and feeding habits of the African big barb *Labeobarbus intermedius* (Rüppell, 1836) (Pisces: Cyprinidae) in Lake Koka, Ethiopia

Elias Dadebo[1*], Agumas Tesfahun[1] and Yosef Teklegiorgis[2]

[1]Biology Department, Hawassa University, P. O. Box 5, Hawassa, Ethiopia,
[2]Animal and Range Sciences Department, Hawassa University, P. O. Box 336, Hawassa, Ethiopia

Accepted 17 June, 2013

The food and feeding habits of the African big barb *Labeobarbus intermedius* (Rüpell, 1836) was studied based on 390 gut samples collected in April- May 2011 (dry months) and July- August 2011 (wet months) in Lake Koka, Ethiopia. Frequency of occurrence and volumetric methods of analysis were used in this study. Macrophytes, detritus and insects were the most important food items occurring in 79.1%, 80.0% and 62.5% of the guts, and accounting for 46.3%, 27.5% and 18.2% of the total volume of food, respectively. The contributions of phytoplankton, zooplankton, fish scales and ostracods were relatively low. Macrophytes and detritus were important food items during the wet months occurring in 96.2% and 60.9% of the guts, respectively and comprising 66.1% and 24.0% of the total volume of food items, respectively. The contribution of insects was low during the wet months. Detritus, macrophytes and insects were found to be the dominant food items in all size classes, whereas the contributions of ostracods, fish scales, zooplankton and phytoplankton were low. Based on the results it can be concluded that *L. intermedius* was omnivorous in its feeding habits in Lake Koka.

Keywords: *L. intermedius*, feeding habits, Lake Koka, ontogenetic diet shift.

INTRODUCTION

The African big barb *Labeobarbus intermedius* (Rüppell, 1836) is widely distributed in Northern Kenya and in most parts of Ethiopia. It is one of the commercially important fish species in Ethiopian fisheries (LFDP, 1997; Bjørkli, 2004; Desta *et al*., 2006). According to LFDP (1997), the annual yield of *L. intermedius* was about 365 tons per year from the inland water bodies of Ethiopia. However, recently the consumption of *L. intermedius* in some rift valley lakes (Lakes Hawassa and Koka) declined because it was found to be not safe for human consumption due to high mercury concentration (Mengesha, 2009).

*Corresponding authors: E-mail: edadebo@yahoo.com; Tel: +251- 911- 750307

The diet composition of fish may vary with in wide ranges on temporal and spatial conditions and environmental factors (Cabana *et al.,* 1994). According to Persson and Crowder (1998), the major factors that influence fish diet are fish size, maturity, condition, season (water level), bottom, depth, latitude, longitude and habitat types. In aquatic systems where the water levels in lakes and reservoirs have been known to

fluctuate, the quality and abundance of food items for fish vary significantly through time (Cabana *et al*., 1994). A particular characteristic of fish is that individuals increase in size during their ontogeny and this increment in size is correlated with changes in food quality and quantity in aquatic systems and growth varies according to food availability in the environment (Werner, 1988). Various authors have studied the food and feeding habits

of *L. intermedius* in Ethiopia (Admassu and Dadebo, 1997; Sibbing, 1998; De Graaf, 2003; Assaminew, 2005; Desta *et al*., 2006; Mengesha, 2009; Deribe *et al*., 2011). Admassu and Dadebo (1997) studied the diet composition, length-weight relationship and condition factor of *L. intermedius* 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 *L. intermedius* 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 *L. intermedius* in Lake Tana was composed of benthic invertebrates, mainly insect larvae and detritus. According to Assaminew (2005), the diet of *L. intermedius* was composed of macrophytes, detritus, insects, nematodes, fish, fish eggs and fish scales in Lake Koka.

Information on the biology and ecology of *L. intermedius* from Lake Koka is scanty. Assaminew (2005), Mengesha (2009) and Deribe *et al.* (2011) have studied the diet of *L. intermedius* in Lake Koka and reported the omnivorous feeding habits of the species. The type of food items consumed by *L. intermedius* depends on prey availability, season and habitat differences and size of the fish (Admassu and Dadebo, 1997; Sibbing and Nagelkerke, 2001; Desta *et al*., 2006). The available information on the biology and ecology of this species from Lake Koka is not sufficient to guide the management of the lake. Such area specific information is vital for proper management and utilization of the stock. The purpose of this study was therefore, to investigate the diet composition, seasonal variation in feeding intensity and ontogenetic dietary shifts of *L. intermedius* in Lake Koka.

MATERIALS AND METHODS

The Study Area

Lake Koka (Latitude: 8°19' - 8°28' N and Longitude: 39°01' - 39°09' E) is located in the northern part of the Main Ethiopian Rift (MER) Valley, in the Awash Basin about 100 km south east of the capital city, Addis Ababa. It is located at 1,590 m and has an area of 180 km^2 (Figure 1). The region is characterized by a semi-arid to sub-humid climate (Peder, 2009). The main rainy season starts in June and extends to the end of August/September, while the short rainy season occurs from March to May. The phytoplankton biomass was measured to be 5.9 mm^3 L^{-1} and dominated by *Microcystis* (Mesfin, 1988). The zooplankton was low in diversity but abundant, and there were large populations of benthic invertebrates (Peder, 2009). The mean annual maximum and minimum temperatures are 30.4° C and 14° C, respectively as well as the mean depth of 9 m (Kibret, 2010).

The dam is the first hydropower plant in Ethiopia by generating electricity for Addis Ababa and other urban centers. In addition to electricity generation recently the dam is also used for downstream irrigation that is accounted for 6,000 ha Wonji Sugarcane Project. The area is characterized by a wide and open plain suitable for cultivation of agricultural crops. Vegetables are grown around the reservoir in the wetland created by the receding reservoir water and using diesel water pumps to extract the shallow ground water. Sparsely distributed *Acacia* trees are common in the area (Kibret, 2010). Main habitats are the surrounding farmland and partly protected woodland beside the dam site and hot springs below it. *Eichhornia crassies* has invaded the lake and spreading very rapidly (Mesfin, 1988). The main activity in the area is farming and the widely grown crop is *Eragrostis teff.* The farmers using the alluvial soil around the lake also grow horticultural crops and pulses particularly haricot beans (Mesfin, 1988).

The fishery of Lake Koka is dominated by four fish species. These are the Nile tilapia *(Oreochromis niloticus*), the common carp (*Cyprinus carpio),* the African catfish (*Clarias gariepinus),* and *L. intermedius.* A tiny cyprinodont minnow (*Aplocheilichthyes antinorii*) also exists in the lake. According to the Ethiopian Department of Fisheries and Aquaculture, the Lake supports a fishing industry of 625 tons of fish each year. The dominant species is *O. niloticus* that contributes about 327 tons per year (59% of the total landings) (LFDP, 1997).

The lake attracts people for work and new settlement to develop extensive farming in the catchment. The floriculture farms around the Lake release their untreated effluents directly to the Lake (Mesfin, 1988). These effluents contain fertilizers and pesticides may cause pollution and contribute to eutrophication. Recently the lake has suffered from severe green algae bloom and was referred to as “the green lake” (Peder, 2009). The greatest threat to Lake Koka itself is sedimentation and recent studies show the rate of sedimentation 25 million m^3 annually.

Fish Sample Collection and Measurements

Fish samples of adult *L. intermedius* were purchased from the local fish market. Fishermen in Lake Koka use gillnets of 100-160 mm stretched mesh size. Then they set their nets late in the afternoon and collect the catch early in the morning the following day. In addition to the

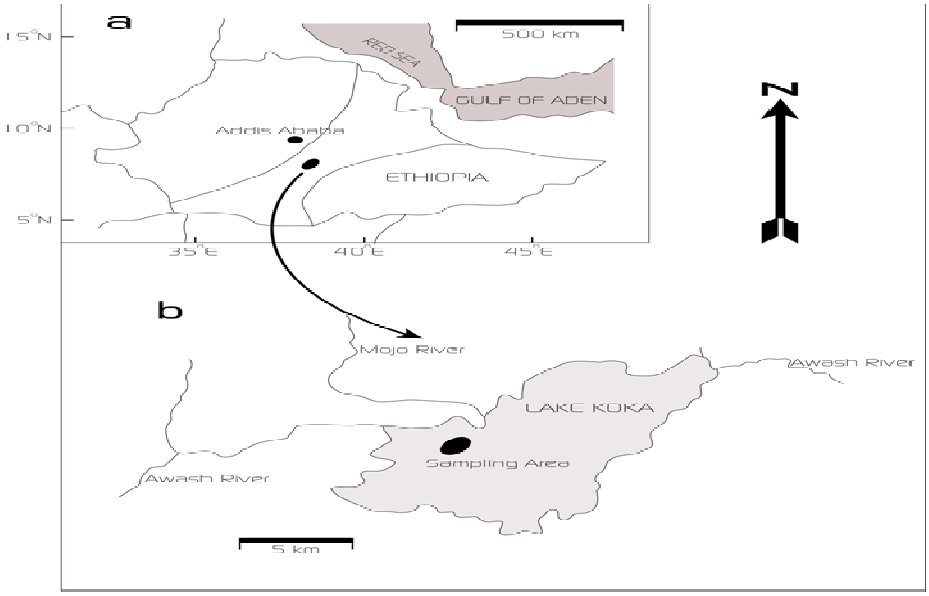

Figure 1: Map of Ethiopia with the relative position of Lake Koka indicated (a) and map of Lake Koka with the sampling area indicated

adult fish, fingerlings were sampled in the shallow littoral area using a beach seine of 6 mm mesh size. Fish samples were collected twice during the dry season (April and May) and twice during the rainy season (July and August). After collection total length (TL) was measured to the nearest millimeter and total weight (TW) was weighed to the nearest 0.1gram.

Gut Content Analysis

We preserved the contents of all non-empty guts in 5% formalin solution for further analysis in the laboratory. Since *L. intermedius* is a stomachless fish we sampled the content up to the first bend of the intestine. Visual examination was used to identify larger food items, but a dissecting microscope (LEICA MS5) and a compound microscope (LEICA DME) were used to identify microscopic food items. In order to investigate the relative importance of the different food items, we used the following methods of analysis.

Frequency Of Occurrence

The number of examined guts in which one or more of a given category of food items was found was expressed as a percentage of the total number of non-empty guts (Windel and Bowen, 1978). This method gives information on the proportion of a particular population of fish that fed on that particular food item.

Volumetric Analysis

The food items that were found in the guts were categorized into different taxonomic groups and the volume of each group was measured (Bowen, 1983). Then the volume of a given category of food items was expressed as a percentage of all the categories of food items present in the samples. The importance of different food items for different size classes was determined by dividing the fish into four size classes (I- < 20.0 cm TL, II- 20.0-29.9 cm TL, III- 30.0-39.9 cm TL and IV- > 40.0 cm TL) and determining percentage mean volume of food in each size class.

RESULTS

Diet Composition

Out of the total number of 266 adult fish samples collected 250 (94.0%) were non-empty while the remaining 16 (6.0%) were completely empty. The length and weight range of the adult fish was 23.3 cm TL to 49.0 cm TL and 95.4 g to 1,200 g TW. In addition to the adult fish, 70 fingerlings collected from the shallow littoral area of the lake were included in the gut content analysis. The size range of the fingerlings was 5.9 cm to 11.4 cm TL

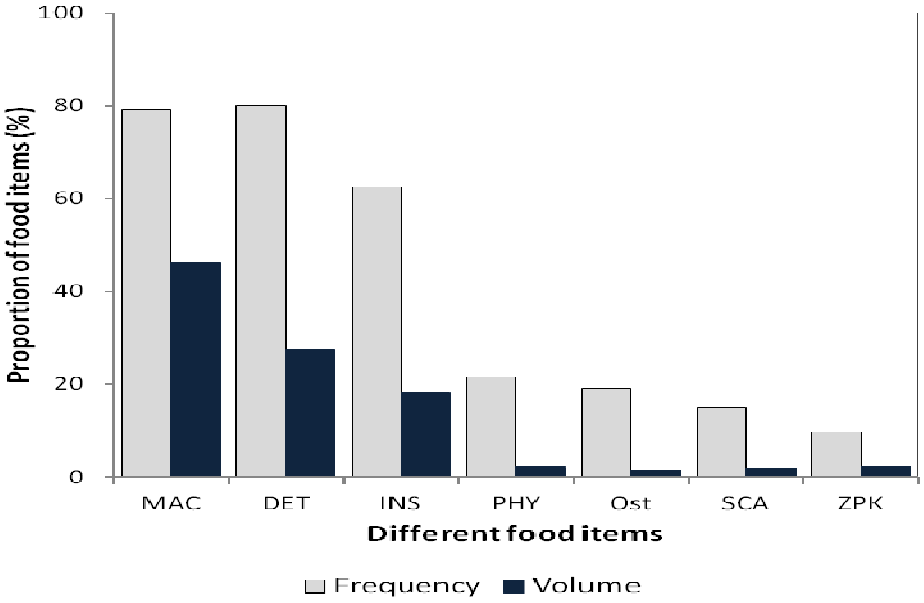

Figure 2: The Relative proportions (%) of different food items in the diet of *L. intermedius* using frequency of occurrence and volumetric analysis methods from Lake Koka (MAC-Macrophytes, DET-Detritus, INS-Insects, PHY-Phytoplankton, OST-Ostracods, SCA-Fish scales and ZPK-Zooplankton)**.**

Table1: Frequency of occurrence and volumetric contribution of different food items in the diet of 320 *L. intermedius* from Lake Koka.

Food items	Frequency	Percent	Volume(ml)	Percent
Phytoplankton	**69**	**21.6**	**22.9**	**2.1**
Blue green Algae	40	12.5	5.0	0.5
Green algae	51	15.9	10.0	0.9
Diatoms	62	19.3	8.0	0.7
Zooplankton	**31**	**9.7**	**25.4**	**2.3**
Rotifers	8	2.5	0.1	0.01
Copepods	9	2.7	1.2	0.1
Cladocerans	1	0.3	24.1	2.2
Insects	**200**	**62.5**	**198.5**	**18.2**
Diptera	155	46.1	135.2	12.4
Ephemeroptera	36	11.3	12.3	1.1
Coleoptera	49	14.6	32.6	3.0
Hemiptera	31	19.2	14.6	1.3
Plecoptera	14	4.4	3.7	0.4
Detritus	**256**	**80.0**	**300.3**	**27.5**
Macrophytes	**253**	**79.1**	**506.8**	**46.3**
Fish scale	**48**	**15.0**	**21.8**	**2.0**
Ostracods	**61**	**19.1**	**17.9**	**1.6**

and 1.6 g to 12.4 g TW. All the fingerlings were non-empty.

The food items identified from the gut contents of *L. intermedius* were macrophytes, detritus, insects, phytoplankton, zooplankton, ostracods and fish scales (Figure 2, Table 1). From these food items macrophytes, detritus and insects occurred in high number of guts and constituted the bulk (92.0%) of the food consumed by volume (Figure 2, Table 1). The remaining food items accounted for only 8.0% of the total volume of food items.

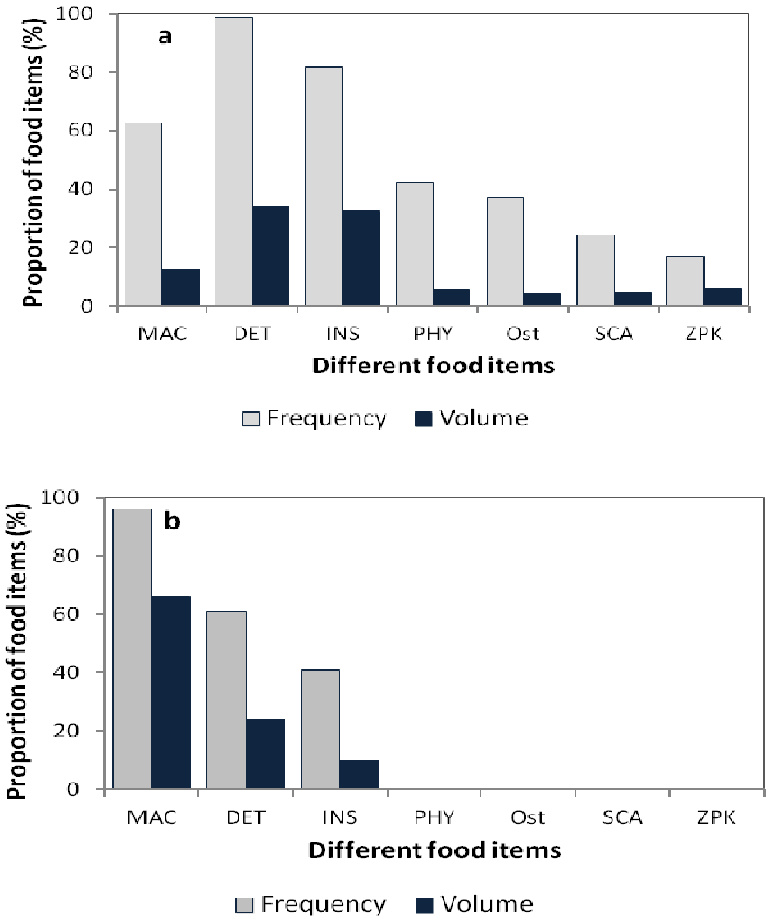

Figure 3: The relative proportion (%) of different food items in the diet of *L. intermedius* during dry month (a) and wet month (b) from Lake Koka (DET-Detritus, MAC-Macrophytes, INS-Insects, PHY-Phytoplankton, OST-Ostracods, SCA-Fish scales and ZPK-Zooplankton).

Macrophytes were the most important food items occurring in 79.1% of the guts and constituting 46.3% of the total volume of food items (Figure 2, Table 1). Detritus occurred in 80.0% of the guts and accounted for *Diptera* were by far the most important groups occurring in 46.1% of the guts and constituting 12.4% of the total volume (Table 1). The contribution of other groups of insects was low (Table 1).

The frequency of occurrence of phytoplankton was relatively high (21.6%) but their total volumetric contribution was rather low (2.1%). Blue green algae, green algae and diatoms were encountered during the present study, among which green algae had the highest contribution (Table 1). Zooplankton occurred in 9.7% of the guts and accounted for 2.3% of the total volume of food consumed (Figure 2, Table 1). Fish scales occurred in 15.0% of the guts and accounted for 2.0% of the total 27.5% of the total volume of food items (Figure 2, Table 1). Insects occurred in 62.5% of the guts and their volumetric contribution was 18.2% of the total volume of food items (Figure 2, Table 1). Among the insect groups, volume (Figure 2, Table 1). Ostracods occurred in 19.1% of the guts and constituted 1.6% of the total volume (Figure 2, Table 1).

Seasonal Variation In The Diet Of *L. Intermedius*

There was notable variation in the type of diet and the proportions consumed by *L. intermedius* in Lake Koka during the dry and wet months. Generally, the number of food items consumed during the dry month was much higher (seven) than the number of food items consumed during the wet month (three) (Figure 3a, b).

Table 2: Frequency of occurrence and volumetric contribution of different food items in the diet of 320 *L. intermedius* during dry and wet months from Lake Koka.

	Frequency	Occurrence (%)	Volumetric	Contribution (%)
Food items	**Dry Months**	**Wet Months**	**Dry Months**	**Wet Months**
Phytoplankton	**42.1**	**-**	**5.7**	-
Blue green algae	24.4	-	1.2	-
Green algae	31.1	-	2.5	-
Diatom	37.8	-	2.0	-
Zooplankton	**17.1**	-	**6.1**	-
Rotifers	2.4	-	0.02	-
Copepods	5.5	-	0.3	-
Cladocerans	15.4	-	5.8	-
Ostracods	**37.2**	-	**4.4**	-
Insects	**81.7**	**41.0**	**32.5**	**9.8**
Diptera	76.2	19.2	25.4	4.7
Hemiptera	18.9	-	3.6	-
Ephemeroptera	20.7	1.3	2.5	0.4
Coleoptera	0.6	30.8	0.2	4.7
Plecoptera	7.9	0.6	0.7	0.1
Detritus	**98.8**	**60.9**	**34.0**	**24.0**
Macrophytes	**62.8**	**96.2**	**12.7**	**66.1**
Fish scales	**24.4**	**-**	**4.6**	**-**

Detritus was the most important food item during the dry month. It occurred in 98.8% of the stomachs and volumetrically its contribution was 34.0% of the total volume of food items (Figure 3a, Table 2). Insects occurred in 81.7% of the stomachs and accounted for 32.5% of the total volume food consumed (Figure 3a, Table 2). *Diptera* were the most important food items among the insect groups. They occurred in 76.2% of the stomachs and constituted 25.4% of the total volume of food items (Figure 3a, Table 2). The contribution of other groups of insects was low because of their low frequency and volumetric contributions (Figure 3a, Table 2). Macrophytes and phytoplankton occurred in 62.8% and 42.1% of the stomachs, respectively and comprised 12.7% and 5.8% of the total volume food items, respectively. Ostracods, fish scales and zooplankton occurred in 37.2%, 24.4% and 17.1% of the stomachs, respectively. Their volumetric contributions were 4.4%, 4.6% and 6.1% of the total volume of food items, respectively (Figure 3a, Table 2).

During the wet month, macrophytes were the most important food items occurring in 96.2% of the guts and accounting for 66.1% of the total volume food items (Figure 3b, Table 2). Detritus occurred in 60.9% of the guts and comprised 24.0% of the total volume food consumed (Figure 3b, Table 2). The contribution of insects was relatively low. They occurred in 41.0% of the guts and constituted 9.8% of the total volume of food items (Figure 3b, Table 2). During the wet month the contributions of foods of plant origin was very high while the contributions of animal prey was low.

Ontogenetic Dietary Shift

Percent mean volume contribution of different food items with size of fish is given in (Figure 4). Detritus, macrophytes and insects were the dominant food items in all size classes, whereas the contribution of ostracods, fish scales, zooplankton and phytoplankton was low (Figure 4). In size class < 20.0 cm TL the dominant food items were detritus 39.7% followed by insects 36.3% (Figure 4). The contributions of macrophytes and zooplankton were 10.0% and 6.1%, respectively of the total volume of food items. The contributions of ostracods, fish scales and phytoplankton were 3.3%, 1.4% and 3.1% of the total volume of food items, respectively (Figure 4). In this size class, the most important food items were detritus and insects. These two food items constituted 76.0% of the total volume of food consumed (Figure 4). The remaining food items constituted 24% of the total volume of food items (Figure 4).

In size class 20.0-29.9 cm TL macrophytes, detritus and insects were important food items accounting for 45.0%, 34.7% and 12.8% of the total volume of food items, respectively (Figure 4). These three food items constituted 92.5% of the total volume of food items within that size class (Figure 4). The less important food items namely, ostracods 0.9%, fish scales 2.8%, zooplankton 1.0%, and phytoplankton 2.8% collectively constituted less than 10% of the volume of food consumed within the size class (Figure 4).

The dominant food items in size class 30.0-39.9 cm TL

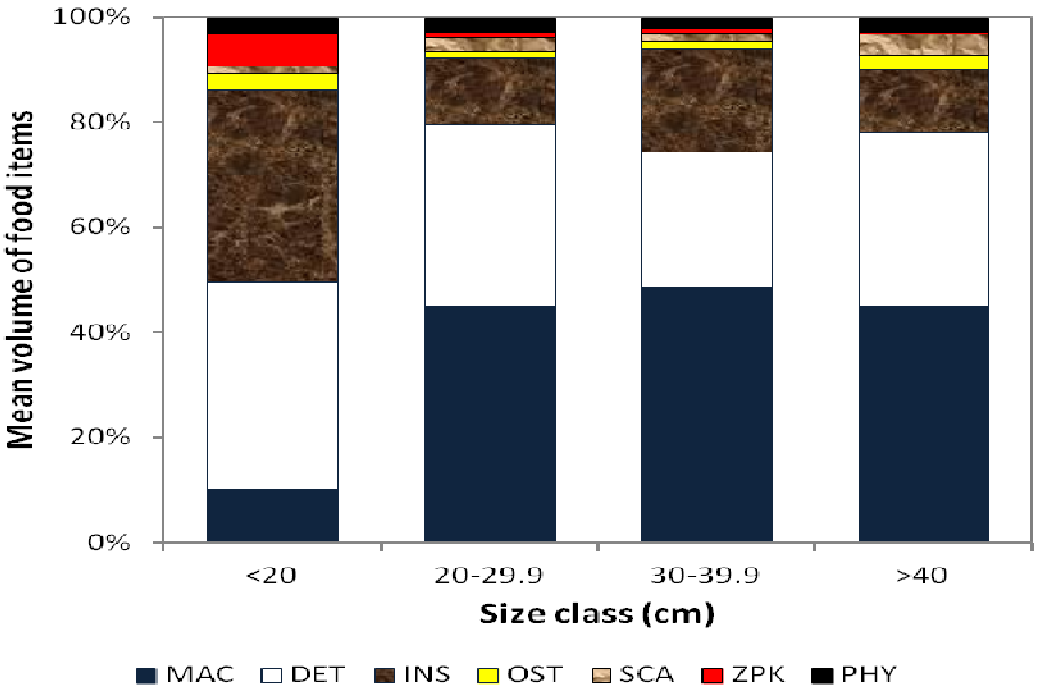

Figure 4: The relative proportion (%) of different prey items in the diet of *L. intermedius* at different size classes from Lake Koka (DET-Detritus, MAC-Macrophytes, INS-Insects, OST, Ostracods, SCA-Fish scales, ZPK-Zooplankton and PHY-Phytoplankton).

were macrophytes 48.6%, detritus 25.8%, and insects 19.6% and these three food items constituted 94% of the total volume of food items within the size class. The contributions of ostracods 1.5%, fish scales 1.4%, zooplankton 0.8% and phytoplankton 2.2% were relatively low, collectively constituted only 6% of the total volume of food consumed in that size class (Figure 4).

In size class >40 cm TL the order of the importance of dominant food items was similar. Macrophytes, detritus and insects constituted the bulk of the food items consumed. These food items accounted for 45.0%, 33.0% and 12%, respectively of the total volume of food items consumed within the size class (Figure 4). The less important food items were again ostracods 2.7%, fish scales 4.0%, zooplankton 0.3% and phytoplankton 2.9%. The dominant food items constituted about 90% of the total volume of food items while the minor food items constituted only about 10% of the total volume of food items within the size class (Figure 4).

DISCUSSION

L. intermedius fed mainly on detritus, macrophytes and insects in Lake Koka. Unlike the present study, the major food items of *L. intermedius* were mollusks, fish prey and aquatic insects in Lake Hawassa (Desta *et al*., 2006). Comparable with the present study the main food items of *L. intermedius* constituted macrophytes, detritus and aquatic insects in Lake Koka (Assaminew, 2005). Similarily, in Lake Tana the diet of *L. intermedius* was dominated by benthic prey organisms especially insect larvae and detritus (Sibbing, 1998; De Graaf, 2003). Diet studies of big barbs from other inland waters of Africa and Asia have been shown to be omnivorous and the fish is able to change its diet depending on availability of prey, seasonal and spatial differences (Admasu and Dadebo, 1997; Sibbing and Nagelkerke, 2001).

The high occurrence and volumetric contribution of detritus in guts of *L. intermedius* showed the significant contribution of this food item in their nutrition. Detritus is reported as a dominant food item of *B. bocagei*, *B. staeindachneri and B. cyclolepis* and additional food for *B. comiza* in Maritza River from Bulgaria (Losos *et al*., 1980). Dietary studies on big barbs in different lakes showed that (Corbet, 1961; Cambray, 1983; Admassu and Dadebo, 1997) the ingestion of detritus, sand particles and benthic food items indicated the ability of the species to possess benthic habitats. Detritus is considered low in nutritional value (Bagenal and Braum, 1978; Bowen, 1979). Several studies in lotic and lentic water systems have considered that an increased

consumption of detritus is a prime response to a decline of higher value primary food resources (Bowen, 1979; King *et al*., 2003).

The importance of insects mainly Dipterans in the diet of different *Barbus* species was reported by various authors (Hyslop, 1980; Losos *et al*., 1980; Piet, 1998). This was probably due to the dense stand of aquatic weeds that support significant biofilm assemblage of benthic prey production noted by Piet (1998). Nagelkerke and Sibbing (1993) reported the importance of macrophytes in the diets of *B. sukris* and *B. truttiformis* in Lake Tana, Ethiopia. The results of the present study are in agreement with the findings of other investigators in different water bodies of Africa where macrophytes, detritus and insects dominate the gut content of the species. Unlike the present study, Desta (2006) reported the dominance of gastropods in the diet of *B. intermedius* in Lake Hawassa the volumetric contributions of zooplankton, phytoplankton, ostracods and fish scales were relatively low in the diet of *L. intermedius.* These food items could probably be consumed accidentally when the fish searches other food items in the environment. According to Losos *et al*. (1980) mollusks, beetles larvae and ants were incidentally consumed in the diet of *B. cyclolepis* because of their low volumetric contributions in Maritza River, Bulgaria. In many tropical freshwater ecosystems zooplanktivorous fishes were poorly distributed (Piet, 1998). De Graaf (2003) documented three zooplanktivorous barbs, two small barbs (*B. tanapelagius* and *B. humalis*) and one big barb *B. brevicephalus* in Lake Tana. Zoopanktivory and the filter feeding habits on zooplankton are rare in tropical waters (De Graaf, 2003).

Piscivory was not observed in the diet of *L. intermedius* during the present study. This is probably due to the presence of a top predator, *C. gariepinus* which feeds on *C. carpio*, *O. niloticus*, *Barbus sp.* Piscivory is not common in Cyprinids due to the absence of oral teeth and the shortage of stomach acidity (Sibbing, 1982; Desta *et al*., 2006). However, piscivory is relatively common among the African cyprinids due to the presence of sufficient fish prey and the absence of other piscivorous fishes while in Europe some cyprinids specialized on fish even in the presence other piscivorous fish (Desta *et al*., 2006). Nagelkerke (1997) noted that in Lake Tana, Ethiopia five out of eight big barbs found to be specialized on fish and the nature of piscivory is due to the abundance of *B. humilis* in the littoral region and *B. tanapelagius* in the pelagic area. High level of piscivory was observed in the diet of *B. intermedius* in Lake Hawassa, Ethiopia (Admassu and Dadebo, 1997; Desta *et al*., 2006).

Seasonal variation was observed on the type of food and their proportion during the dry and wet periods of the Year detritus and insects were the most important food items during the dry period. Detritus was probably ingested with insects when the fish was trying to pick insects from the sediment assisted by their ventral mouth projection that is suited for benthic feeding (Adeyemi, 2009). During the wet period of the year, macrophytes and detritus were the most important food items. The source of detritus could be probably floods that introduced fragments of plant materials in the lake. Balcombe *et al*. (2004) suggested that *Barbus sp.* consumed more detritus and fewer insects during high water level in a Sri Lankan reservoir. High water levels designated as resource rich while low water levels have poor resources in trophic dynamics in lentic systems (Balcombe *et al*., 2004). The availability of food items changes throughout the year in tropical region due to seasonal changes and feeding habits of fish depend on seasonal variation (Desta *et al*., 2006; Peder, 2009).

Fingerlings mostly fed on detritus and insects in large amounts while in larger size classes macrophytes, detritus and insects were the most dominant food items. The remaining food items were of minor contribution in the diet of *L. intermedius*. An attempt was made to determine ontogenetic diet shift. There was slight ontogenetic variation in the diet of *L. intermedius* among the different size classes. The importance of macrophytes, detritus and insects was dominant in all size classes while the contributions of ostracods, phytoplankton, zooplankton and fish scales were low regardless of their size. The slight variation observed was that macrophytes were relatively unimportant in the diet of the smallest size class while they are dominant food items in larger size classes. Moreover, insects that were dominant in the smallest size class were relatively unimportant in larger size classes. Desta *et al*. (2006) studied the feeding habits of *L. intermedius* in Lake Hawassa and reported slight ontogenetic diet shift in *L. intermedius* from Lake Hawassa. They noted that insects were important food source for juvenile, but their importance declined with size of fish. The results of the present study agree well with the report of Desta *et al*. (2006). Desta *et al*. (2006) also reported that *L. intermedius* in Lake Hawassa shifted to piscivorous feeding habits as its size increases. However no fish prey was encountered in the present study. Corbet (1961) studying *B. altianalis* in Lake Victoria and Spataru and Gophen (1987) working on *B. altianalis* in Lake Kinneret, (Israel) pointed out lack of ontogenetic diet shift and therefore, small and large sized fish consumed similar food items.

CONCLUSION

The most important food items of *L. intermedius* in Lake Koka were detritus, macrophytes and insects while

zooplankton, fish scales, phytoplankton and ostracods were low in their contribution. During the dry period the food items that were identified in the diet of *L. intermedius* were detritus, insects, macrophytes, zooplankton, fish scales, phytoplankton and ostracods. Among these food items detritus, insects and macrophytes were the most important food items while the remaining food items were low in their contribution. During the wet period only three food items were identified. These were macrophytes, detritus and insects and all were important in the diet of *L. intermedius*. The dominant food items in all size classes were detritus, macrophytes and insects while the remaining food items were low in their contribution. Detritus and insects were the dominant food items of juveniles, while macrophytes, detritus and insects were the dominant food sources of adults. Generally, *L. intermedius* was found to be omnivorous in its feeding habits; macrophytes become more important in its diet as it grows older.

ACKNOWLEDGEMENTS

We thank fishermen Kecha Fiche and Abu Geleta for their assistance during the fieldwork. Yirgashewa Bekele is acknowledged for assisting us during the laboratory work. Thanks are also due to Dr. Andargachew Gedebo, the NORAD Project coordinator, for providing a vehicle for the field trips. Biology Department of Hawassa University provided us the necessary facilities and laboratory space. Ethiopian Ministry of Education provided financial assistance for the second author.

REFERENCES

Adeyemi SO (2009). Food and feeding habits of some commercially important fish species in Gbedikere Lake, Bassa, Kogi State, Nigeria. Int. J. Lak. Riv. 2(1): 31-36.

Admassu D, Dadebo E (1997). Diet composition, length-weight relationship and condition factor of *Barbus species (Rüppell, 1836) (*Pisces: Cyprinidae) in Lake Awassa, Ethiopia. SINET: Ethiop J. Sci. 20: 13-30.

Assaminew K. (2005). Distribution, abundance and feeding biology of fish species in Koka reservoir and the associated Awash River floodplain, Ethiopia. . Unpublished M.Sc Thesis. UNESCO-IHE Institute for Water Education, Delft.

Bagenal TB, Braum E (1978). Eggs and early life- history. Pages 165-201. In Methods for assessment of fish production in freshwaters. Black Well Scientific Publications, London.

Balcombe SR, Bunn SE, Davies PM, Smith FJ (2004). Variability of fish diets between dry and flood periods in an arid zone floodplain river. J Fish. Biol. 55: 609-617.

Bjørklis G (2004). The fisheries in Lake Awassa, Ethiopia; estimation of annual yield. Unpublished M. Sc Thesis. Department of Plant and Environmental Sciences, Norwegian University Life Sciences, Ås, Norway.

Bowen SH (1979). A nutritional constant in detritivory by fishes: the stunted population of *Sarotheradon mossambicus* in Lake Sibaya, South Africa. Ecol. Monog. 49: 17-31.

Bowen SH (1983). Quantitative description of the diet. pp. 325-336. In L.A. Nielsen and D. L. Johnson, eds. Fisheries Techniques. Bethesda, Maryland.

Cabana G, Tremblay A, Kalff J, Rasmussen JB (1994). Pelagic food chain structure in on *namaycush*). Can. J. Fish. Aquat. Sci. 51: 381-389.

Cambray JA (1983). The feeding habits of minnows of the genus Barbus *(Pisces, Cyprinidae)* in Africa, with special reference to *Barbus anoplus* Weber. J. Limn. Soc. South Afr. 9: 12-22.

Corbet PS (1961). The food of the non-cichlid fishes in the Lake Victoria basin with remarks on their evolution and adaptation to lacustrine conditions. Proc. Zool. Soc. Lond. 136: 1-101.

de Graaf M (2003). The piscivorous barbs of Lake Tana (Ethiopia): major questions on their evolution and exploitation. Neth. J. Zool. 50: 215-223.

Deribe E, Børgstrøm R, Rosseland BO, Salbu B, Norli HR, Elko OM, Dadebo E, Zinabu G M (2011). Bioaccumulation of persistent organic pollutants (POPS) in fish species from Lake Koka, Ethiopia: The influence of lipid content and tropic position. Sci. Total. Environ. 410-411: 136-145.

Desta Z, Børgstrøm R, Rosseland BO, Zinabu GM (2006). Major difference in mercury concentrations of the African big barb, *Barbus intermedius* (R.) due to shifts in trophic position. Ecol. Freshwat. Fish. 15: 532–543.

Hyslop EJ (1980). Stomach contents analysis - a review of methods and their application. J. Fish Biol. 17: 411-429.

Kibret T (2010). The effect of water Physical quality and water level changes on the occurrence and density of larvae of Anopheles mosquitoes around the shoreline of the Koka Reservoir, Central Ethiopia. 40 pp.

King AJ, Humphries P, Lake PS (2003). Fish recruitment on floodplains: the roles of patterns of flooding and life history characteristics. Can. J Fish. Aquat. Sci. 60: 773-86.

Lakes Fisheries Development Program (LFDP) (1997). Lake Management Plans: Phase II, Working Paper 23: MOA. 23 pp.

Losos L, Penaz M, Kuvickova J (1980). Food and growth of fishes of Jihlava River. Act. Sc. Nat. Brno. 14 (1): 1-46.

Mesfin M (1988). Some limnological observations on two Ethiopian hydroelectric reservoirs Koka (Shewa administrative district) and Fincha (Welega administrative district. Hydrobiologia 157: 47-55.

Mengesha M (2009). Heavy metal pollution in the rift valley Lakes of Awassa and Koka. Unpublished M. Sc Thesis. University of Bremen, Germany.

Nagelkerke LAJ, Sibbing FA, Osse JWM (1993). Morphological and ecological differentiation among the large barbs of Lake Tana, Ethiopia. Brackish Water Fishes, Dakar, Senegal. 45 pp.

Nagelkerke LAJ (1997). The barbs of Lake Tana, Ethiopia: morphological diversity and its implications for taxonomy, trophic resource partitioning, and fisheries. Unpublished Ph. D Thesis, Wageningen Agricultural University, Wageningen, the Netherlands.

Peder A (2009). Mercury in African sharp tooth catfish (*Clarias gariepinus*) from Lake Koka and Lake Ziway. Unpublished M.Sc. Thesis, Department of Plant and Environmental Sciences, Norwegian University Life Sciences, Ås, Norway.

Persson L, Crowder LB (1998). Fish-habitat interactions mediated via ontogenetic niche shifts. Pages 3- 23. In M. M. Caldwell, G. Helmaier, O. L., Lange, H.A. Mooney, U. Schulth, and E. Sommer, eds. The Structuring Role of Submerged Macrophytes in lakes, Vol. 131. Springer, New York:

Piet GJ (1998). Impact of environmental perturbation on a tropical fish community. *Can.* J. Fish. Aqu. Sci., 55: 1842-1853.

Sibbing FA (1982). Pharyngeal mastication and food transport in the carp (*Cyprinus carpio L.*): cineradiography and electromyography study. J. Morph. 172: 223-258.

Sibbing FA (1998). Ecomorphology as a tool in fisheries: identification and ecotyping of Lake Tana barbs (*Barbus intermedius* Complex*),* Ethiopia. Neth. J. Agri. Sci. 42: 77-85.

Sibbing FA and Nagelkerke LAJ (2001). Resource partitioning by Lake Tana barbs predicted from fish morphometrics and prey characteristics. Reviews in Fish Biology and Fisheries 10: 393-437.

Spataru P and Gophen M (1987). The food and benthophagous feeding habits of *Barbus longiceps (Cyprinidae*) in Lake Kinneret (Israel). Hydrobiol., 110: 331-337.

Werner EE (1988). Size, scaling and evolution of life cycles. Pages 60-81. In B. Ebenman and L. Persson, 2nd eds. Size structured populations: ecology and evolution. Heidelberg, Springer-Verlag.

Windel JT and Bowen SH (1978). Methods for a study of fish diets based on analysis of stomach contents. Pages 219- 226. In Methods for the assessment of fish production in freshwaters, IBP Handbook No. 3. Black Well Scientific Publications, London.