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THE FOOD AND FEEDING HABITS OF THE AFRICAN CATFISH, *CLARIAS GARIEPINUS* (BURCHELL, 1822), IN LAKE LANGENO, ETHIOPIAN RIFT VALLEY

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ABSTRACT: The food and feeding habits of the African catfish (*Clarias gariepinus*) were studied in Lake Langeno, Ethiopia, from samples taken during April-October, 2000. Stomach content analysis (n=394) showed that the fish ingested a variety of items including algae, macrophyte parts, crustacean zooplankton, insects, fish and fish eggs as well as Hydracarina (water mites) and nematodes. The insects were most diverse and were sub-adult or adult stages belonging to at least eight taxa. The zooplankters were copepods (*Mesocyclops* sp), cladocerans (*Daphnia*, *Diaphanosoma*, *Ceriodaphnia*) and Ostracoda whereas the cichlid *Oreochromis niloticus* was the only fish species ingested. Frequency of occurrence was highest for insects (71.6%) followed by zooplankton (58.6%) and fish (19.8%). It was 7-10% for macrophyte parts, detritus and sand grains, and below 1% each for Hydracarina and Nematoda. Results from frequency of occurrence, numerical abundance and gravimetric contribution showed that zooplankton, insects and fish are the major food items of *C. gariepinus*. Since the items of plant origin were believed to be accidentally ingested, the studied *C. gariepinus* is considered to have a carnivorous habit. The fish consumed progressively more *O. niloticus* but less zooplankton and insects as it grew in length. The contribution of fish to the diet of *C. gariepinus* was high during the season of high water level which was attributed to increased prey abundance due to spawning. There was also a concurrent high frequency of empty stomachs (%) during this time which may be due to the fish's engagement more in spawning activity than in hunting for prey. Analysis of prey to predator length ratios suggested that most of the studied *C. gariepinus* consumed *O. niloticus* that were 5-10% of their own length.

Key words/phrases: *Clarias gariepinus*, Ethiopia, Food, Hydracarina, Lake Langeno, Omnivore.

INTRODUCTION

The African catfish, *Clarias gariepinus* (Family Clariidae), is a widespread freshwater species found in eastern, central and southern Africa, and in Turkey and the Middle East (Willoughby and Tweddle, 1978; Spataru *et al*., 1987). It inhabits natural and man-made lakes, impoundments, fishponds,

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streams, rivers, and can thrive in both deep and shallow waters (Demeke Admassu *et al*., 2015a and references cited therein). In Africa, it occurs in several river systems including the Nile, the Niger and the Okavango, and in the East African rift valley lakes (Clay, 1979; Spataru *et al*., 1987; Nyamweya *et al*., 2010; Demeke Admassu *et al*., 2015a). In Ethiopia, *C. gariepinus* is believed to occur in almost all water bodies inhabited by fish (Shibru Tedla, 1973).

The ecological success of the fish could be attributed to its indiscriminate and opportunistic feeding habits, rapid growth rate and its ability to tolerate adverse environmental conditions (Demeke Admassu *et al*., 2015a and references cited therein). The latter feature of the fish is marked by its ability to tolerate hypoxia since it is able to use aerial oxygen via its accessory breathing organs (Willoughby and Tweddle, 1978; Viveen *et al*., 1986). The aforementioned features of *C. gariepinus* make it one of the species suitable for aquaculture (Viveen *et al*., 1986). *C. gariepinus* is also one of the most important species in the fisheries of east, central and southern Africa (Willoughby and Tweddle, 1978; Nyamweya *et al*., 2010) including Ethiopia (LFDP, 1998; Reyntjens and Tesfaye Wudneh, 1998; Tesfaye Wudneh, 1998; Demeke Admassu *et al*., 2015a).

The African catfish is an indiscriminate and opportunistic feeder ingesting a wide variety of items such as algae, macrophyte tissues, crustaceans (especially zooplankton), insects, other fish, detritus and sand grains (Fryer, 1959; Groenewald, 1964; Clay, 1979; Willoughby and Tweddle, 1978; Elias Dadebo, 2000; Demeke Admassu *et al*., 2015a). Therefore, the fish is considered as omnivorous by some authors (Jubb, 1967; Willoughby and Tweddle, 1978), but an indiscriminate carnivore accidentally ingesting plant materials and sand grains by some others (Groenewald, 1964; Kirk, 1967; Demeke Admassu *et al*., 2015a). In addition, size-based as well as seasonal differences in the food habit of *C. gariepinus* has also been reported (Demeke Admassu *et al*., 2015a).

A study on the food and feeding habits of such ecologically and economically important species as *C. gariepinus* is an important development. The knowledge is needed, for instance, to protect the natural food of the fish, and for proper exploitation of its stocks as well as to understand its feed requirements in culture systems. However, such knowledge is lacking for *C. gariepinus* in Lake Langeno. Therefore, the present study is an attempt to fill that knowledge gap by reporting on the food and feeding habits of the fish in this lake.

MATERIALS AND METHODS

Description of Lake Langeno

Lake Langeno (7°36′ N; 38°45′E) is found in the Ethiopian Rift Valley about 190 km south of the capital, Addis Ababa. It is situated at altitude of 1582 m, and has an area of 241 km^2 and a mean depth of 17 m (Wood and Talling, 1988; Tudorancea *et al*., 1989). Lake Langeno is fed by a number of small streams draining the highlands in the east and the south, and discharges into the nearby Lake Abijata through the Horakello River. A portion of its inflow may also be derived from hot spring waters (Kassahun Wodajo and Amha Belay, 1984). The lake has a light reddish-brown color mainly due to a high colloidal suspension of inorganic silt which is also responsible for 94-98% of total light attenuation (Wood *et al*., 1978).

Lake Langeno lies in the sub-humid region of Ethiopia (Daniel Gamachu, 1977) characterized by having two rainy seasons a year, viz., the "little rains" ("short rains") usually during March-May, and the "heavy rains" usually during June-September (Daniel Gamachu, 1977; Kassahun Wodajo, 1982; Kassahun Wodajo and Amha Belay, 1984). During the year of the present study, the little rains occurred during March-June (Fig. 1). Although rainfall data are not available for the period July-December 2000 (except November), we observed heavy rains during July-September. The level of the lake water begun to rise following the beginning of the heavy rains, and it was high during July-October, but low during April-June (Personal observation).

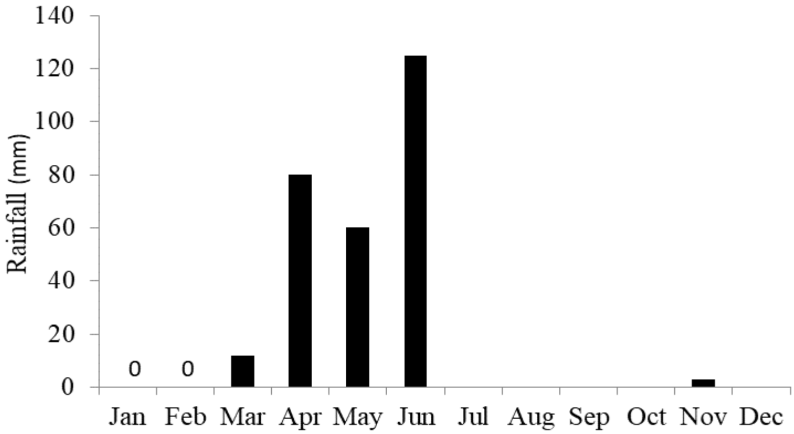

Fig. 1. Monthly total rainfall (mm) in the Lake Langeno area during January-June and in November 2000. Data (unavailable for the period July-October and December) obtained from the Ethiopian Meteorological Authority.

Surface water temperature of Lake Langeno is moderately warm with a mean of above 20°C all year round (Kassahun Wodajo, 1982; Demeke Admassu, 1998). The chemistry of its water is similar to the other Ethiopian rift valley lakes in that Na^{+} and HCO_3- + CO_3^{2-} are the dominant ions (Talling, 1965; Kassahun Wodajo, 1982; Von Damm and Edmon, 1984). According to Elizabeth Kebede *et al*. (1994), phytoplankton biomass of the lake is low (Chl *a* = 2 μgl^{-1}) with *Microcystis*, *Oocystis* and *Cyclotella* being major members of its phytoplankton community. Zooplankton community of the lake is composed of *Lovenula* (*Paradiaptomus*), *Mesocyclops*, *Daphnia*, *Ceriodaphnia* and *Brachionus* species (Kassahun Wodajo and Amha Belay, 1984).

The fish community of Lake Langeno is composed of *Oreochromis niloticus*, *C. gariepinus*, *Barbus* (*Labeobarbus*) sp., *Tilapia zillii* and *Cyprinus carpio* of which the latter two are introduced species. According to LFDP (1998), potential fish yield is about 1,000-1,500 tons per year, but the annual landing is about 500 tons, 22% of which is due to *C. gariepinus*.

Sampling and measurement

Samples of *C. gariepinus* were caught in each month (except September) between April and October, 2000. Hooks and line gear with hook numbers 5, 6 and 7 baited with pieces of tilapia (*O. niloticus*) flesh as bait were used for sampling. In addition, the catch by local fishermen was also sampled whenever possible to increase sample size and fish size range in the sample.

Immediately after capture, total length (TL) of each specimen was measured to the nearest 0.1 cm. Each specimen was then dissected and its stomach inspected. If the stomach was empty, this was recorded. Otherwise, stomach with contents was longitudinally cut and preserved in 5% formaldehyde solution for analysis in the laboratory.

Stomach content analysis

In the laboratory, stomach content was transferred into a Petri-dish, and large items in the content were identified by the unaided eye. Small-sized items were microscopically examined (6x-50x) and identified to the lowest taxon possible using descriptions, illustrations and keys in the literature (Macan, 1959; 1976; Borror and Delong, 1964; Harding and Smith, 1974; Pennak, 1978; Edington and Hildrew, 1981; Defaye, 1988). In addition, a drop of the sample was also examined at higher magnifications (100x-400x) to note whether smaller items, such as phytoplankton, were ingested.

After identification, a list of items encountered in the stomach was prepared and each item was counted when appropriate.

Estimation of relative importance of food items

The relative importance of food items was estimated using standard methods, i.e., frequency of occurrence, numerical abundance and gravimetric methods (Windell and Bowen, 1978; Hyslop, 1980). Frequency of occurrence is the number of *C. gariepinus* (stomachs) in which a given item occurred, and it was expressed in percent of the total number of fish or stomachs containing food. Numerical abundance is the total number of a food item expressed in percent of the total number of all food items. In gravimetric method, average wet weight of a food item was estimated from the weights of fresh samples taken from the natural habitat and weighed to the nearest 0.0001g using a Sartorius sensitive balance. Average weight was calculated from the weights of at least three samples each with 5 to 100 individuals of a food item type. The weight of prey fish (*O. niloticus*) was estimated from length-weight equation of the species in Lake Langeno (Demeke Admassu, unpublished). Total weight of a given food item in the stomach content was then estimated as the product of its number and average weight, which was then expressed in percent of the total weight of all food items ingested.

Results from the above three methods of relative importance were used as bases to identify major and minor food items of the fish (e.g., Demeke Admassu *et al*., 2015a).

Investigation of fish-size and food habit relationship

The relationship between the size (TL) of *C. gariepinus* and its food habit was investigated by plotting the relative importance of major food items against TL of the fish. In addition, an attempt was made to investigate the relationship between the TL of *C. gariepinus* (predator) and the TL of its prey fish. As it will be shown later, *O. niloticus* was found to be the prey fish to *C. gariepinus* in this study. The TL of the prey fish (*O. niloticus*) was measured from freshly ingested and undigested individuals in the stomach content of the predator. Data on the TL of prey fish were then scatter-plotted against the TL of the predator. The scatter plot was then compared with theoretical lines passing through prey to predator TL ratios of 1:5, 1:10, 1:20 and 1:30 (Hailu Anja, 1996 and references therein).

Estimation of feeding periodicity

Seasonal difference in the food habit of *C. gariepinus* was studied from seasonal fluctuations in the frequency of fish with empty stomach and in the relative contribution of major food items (e.g., Demeke Admassu *et al*., 2015a). Thus, the percentage frequency of empty stomachs was plotted by sampling month to investigate the time of their minimum/maximum. In addition, the frequency of occurrence, numerical abundance and gravimetric contributions of major food items were plotted by seasons of low and high lake water levels. As explained elsewhere (description of Lake Langeno), the period April-June was considered as the season of low water level whereas July-October was considered as the season of high water level.

RESULTS

Composition of stomach content

From a total of 461 *C. gariepinus* individuals caught in this study, 67 (14.5%) had empty stomachs. The stomach content of the rest of the fish (394, 85.5%) was composed of a variety of organisms as well as fish eggs, detritus and sand grains (Table 1). The organisms ingested by *C. gariepinus* in Lake Langeno, which were plant or animal origin, belonged to at least seven major taxa/groups. The items of plant origin were filamentous algae, *Microcystis* sp. and macrophyte fruits, shoots and roots. The items of animal origin ingested by the fish were quite diverse and ranged from zooplankton, particularly micro-crustaceans, to a relatively larger macro-invertebrates and vertebrate, i.e., fish, and fish eggs (Table 1). The other animals were insects, Hydracarina (water mites) and nematodes.

Table 1. A list of items identified from the stomach content of *C. gariepinus* from Lake Langeno (n = 394).

Taxon (item)
Algae: Filamentous algae, *Microcystis aeruginosa*
Macrophyta: Fruits, seeds, shoots and roots
Crustacea: Copepoda (*Mesocyclops* sp.), Cladocera (*Daphnia* sp., *Diaphanosoma* sp., *Ceriodaphnia* sp.), Ostracoda
Insecta
Trichoptera larvae
Hemiptera (Notonectidae)
Ephemeroptera nymphs
Diptera larvae and pupae (Chironomidae, Culicidae, Unidentified dipterans)
Odonata nymphs (Isoptera, Anisoptera)
Coleoptera larvae
Plecoptera nymphs
Hymenoptera
Hydracarina
Nematoda
Pisces: *Oreochromis niloticus*, Fish eggs
Detritus
Sand grains
Unidentified animal remains

Crustaceans ingested by the studied *C. gariepinus* were copepods (one genus), cladocerans (three genera) and Ostracoda. The insects ingested by the fish were most diverse and included sub-adult or adult stages of Trichoptera, Hemiptera, Ephemeroptera, Diptera, Odonata, Coleoptera, Plecoptera and Hymenoptera. Unidentified Hydracarina and nematodes were also ingested each by one individual *C. gariepinus*. The tilapia *O. niloticus* was the only fish species ingested by the studied *C. gariepinus*.

Relative importance of food items

Although the studied *C. gariepinus* ingested a variety of items, there were large differences in the relative contribution of the items. For instance, frequency of occurrence of the items ranged from below 1% to about 72% (Table 2). Likewise, numerical abundance ranged from below 0.001% to about 88%, whereas gravimetric contribution ranged from below 0.0001% to about 45% for the items for which those values were estimated (Table 2).

The frequency of occurrence method showed that insects as a group were ingested by at least 72% of the *C. gariepinus* containing food in their stomach (Table 2). Frequency of occurrence was 24-58.6% for Crustacea and 19% for fish (*O. niloticus*). Macrophytes were encountered in about 10% whereas detritus and sand grains were encountered each in about 8% of the studied *C. gariepinus*. The high frequency of insects as a group was mainly due to Diptera (about 72%) and Hemiptera (about 62%) which were also the two most frequently encountered food items. Odonata and Trichoptera occurred in comparable frequencies (about 12%) whereas each of the remaining insects occurred at frequencies ranging from about 0.8% to 8% (Table 2). Among crustaceans, copepods and cladocerans occurred in about 59% whereas Ostracoda occurred in about 24% of the studied *C. gariepinus* (Table 2).

Based on the numerical abundance method, however, crustaceans as a group were 99.3% of the total number of the enumerated food items (Table 2). The numerical dominance of crustaceans was mainly due to copepods and cladocerans. The numerical abundance of Ostracoda in the food of the fish was also much higher than that of all the non-crustacean food items put together (0.7%). Insects as a group were the second most numerous food items of *C. gariepinus*, and their numerical contribution was mainly due to Diptera (0.5%) followed by Hemiptera (0.1%) (Table 2). The numerical contribution of Odonata and Trichoptera was 0.01% each whereas that of each of the remaining insects was below 0.001%. Fish, *O. niloticus*, made up only 0.01% of the total number of enumerated food items and that was the same as the numerical contribution of Odonata or Trichoptera (Table 2).

The gravimetric method showed that insects as a group were 92.7% of the total weight of the food ingested by the studied *C. gariepinus* (Table 2). The highest gravimetric contribution of insects was mainly due to Diptera (45.5%) followed by Hemiptera (36%) and Odonata (10.7%). Gravimetric contribution was about 7% for crustaceans as a group and 0.4% for fish (Table 2).

In summary, based on the frequency of occurrence as well as the gravimetric methods, the food items of *C. gariepinus* in Lake Langeno in descending order of importance were insects, crustaceans and fish (*O. niloticus*). Numerically, crustaceans were most important food items and were followed by insects. However, all the three methods showed that, among the three food types, fish was the least important food of the studied *C. gariepinus*. Generally, insects, crustacean zooplankton and fish were considered to be major food, whereas nematodes, Hydracarina and fish eggs were minor food, of *C. gariepinus* in Lake Langeno. As explained elsewhere (Discussion section), macrophytes, algae, detritus and sand grains are not believed to be food items of the fish.

Table 2. Relative importance (%) of various items in the stomach content of *Clarias gariepinus* from Lake Langeno based on frequency of occurrence, numerical abundance and gravimetric (weight) methods. N is the number of fish in which the items were found, ND = not determined.

Food item	Frequency (%)	Number (%)	Weight (%)	N
Crustacea	**58.6**	**99.3**	**6.9**	**231**
Copepoda+ Cladocera	58.6	87.9	4.4	231
Ostracoda	23.9	11.4	2.5	94
Insecta	**71.6**	**0.624**	**92.7**	**282**
Diptera	71.6	0.5	45.5	282
Hemiptera	62.2	0.1	36.0	245
Odonata	12.2	0.01	10.7	48
Trichoptera	11.7	0.01	0.3	46
Ephemeroptera	8.1	<0.001	0.03	32
Coleoptera	5.8	<0.001	0.2	23
Hymenoptera	1.27	<0.001	<0.0001	5
Plecoptera	0.76	<0.001	<0.0001	3
Pisces (*O. niloticus*)	**19.8**	**0.01**	**0.4**	**78**
Macrophyta	10.15	ND	ND	40
Detritus	7.61	ND	ND	30
Sand grains	7.61	ND	ND	30

Size-based difference in food habit

Each of the major food items (insects, crustaceans and fish) were ingested by *C. gariepinus* belonging to each length group ranging from 25 cm to 94 cm TL (Figs. 2, 3 and 4). However, there were size-based differences in their relative importance. Thus, crustaceans were most frequent in *C. gariepinus* between 45 cm and 64 cm TL, but their frequency tended to decrease with TL being minimum for the largest length group (Fig. 2a). Frequency of occurrence of insects was maximum (90-100%) in *C. gariepinus* belonging to the two smallest length classes (<45 cm), and tended to decrease with fish length towards a minimum in the largest length group (Fig. 2b). On the other hand, the frequency of occurrence of *O. niloticus* as food of *C. gariepinus* tended to increase with the size of *C. gariepinus*, the maximum frequency being in the largest length group (Fig. 2c).

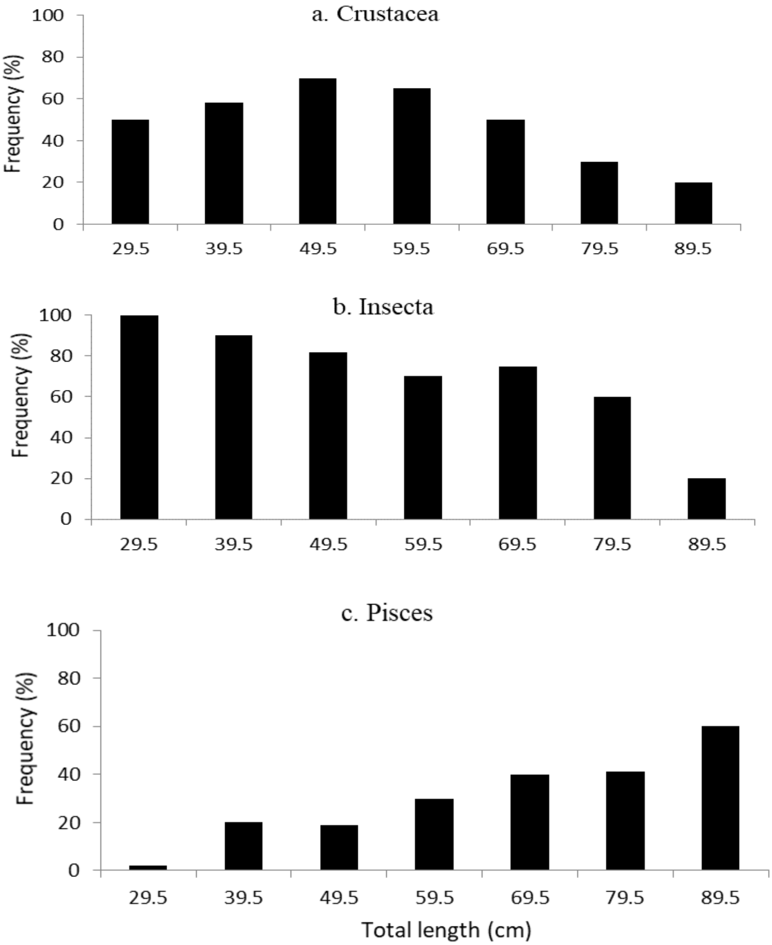

Fig. 2. Frequency of occurrence (%) of Crustacean zooplankton (a) Insecta (b) and Fish (c) in the food of different length (cm) classes of *Clarias gariepinus* from Lake Langeno. Length represented by mid-points of length classes.

Based on the numerical method, crustaceans were the most important food of the studied *C. gariepinus* of all length groups (Fig. 3a). The numerical contributions of insects and fish were prominent only in *C. gariepinus* of the largest length group (Figs. 3b and c). Gravimetrically, insects were the dominant food of *C. gariepinus* of all length groups, but there was an increase in the gravimetric contribution of crustaceans for *C. gariepinus* between 45 cm and 74 cm, and that of fish for *C. gariepinus* belonging to the largest length group (Fig. 4).

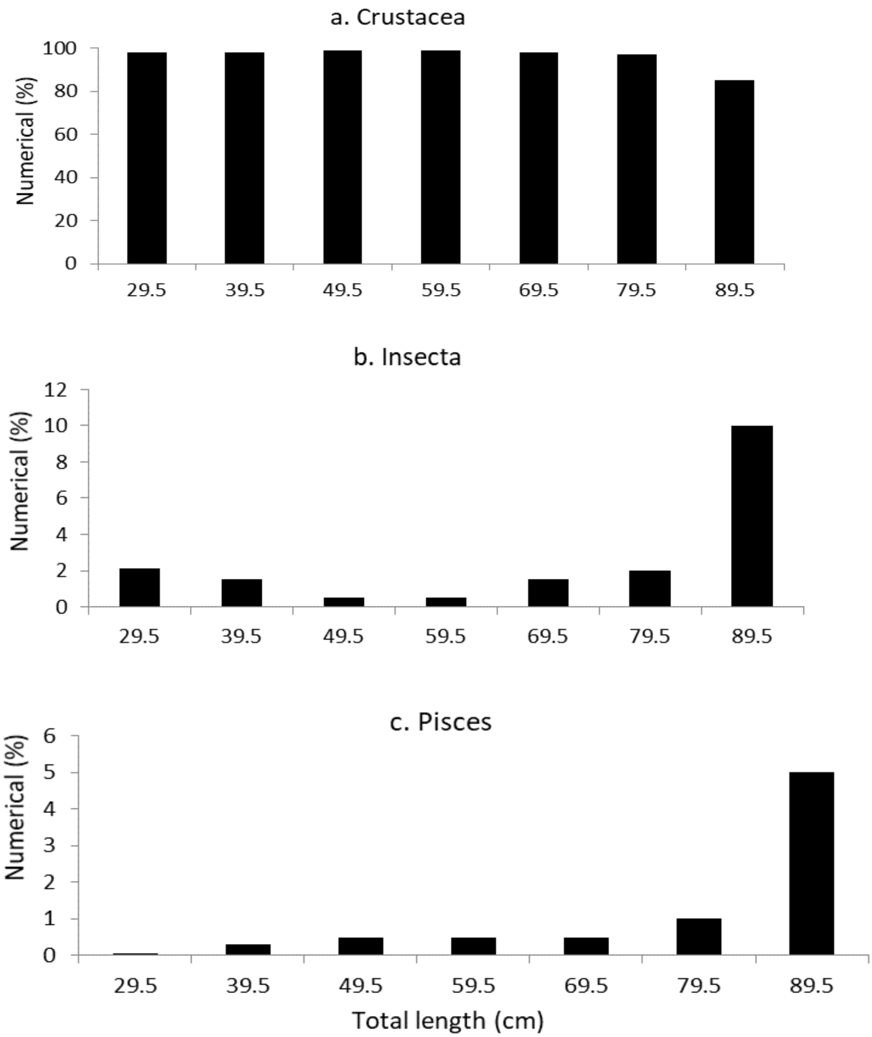

Fig. 3. Numerical abundance (%) of Crustacean zooplankton (a), Insecta (b) and Fish (c) in the food of different length (cm) classes of *Clarias gariepinus* from Lake Langeno. Length represented by mid-points of length classes.

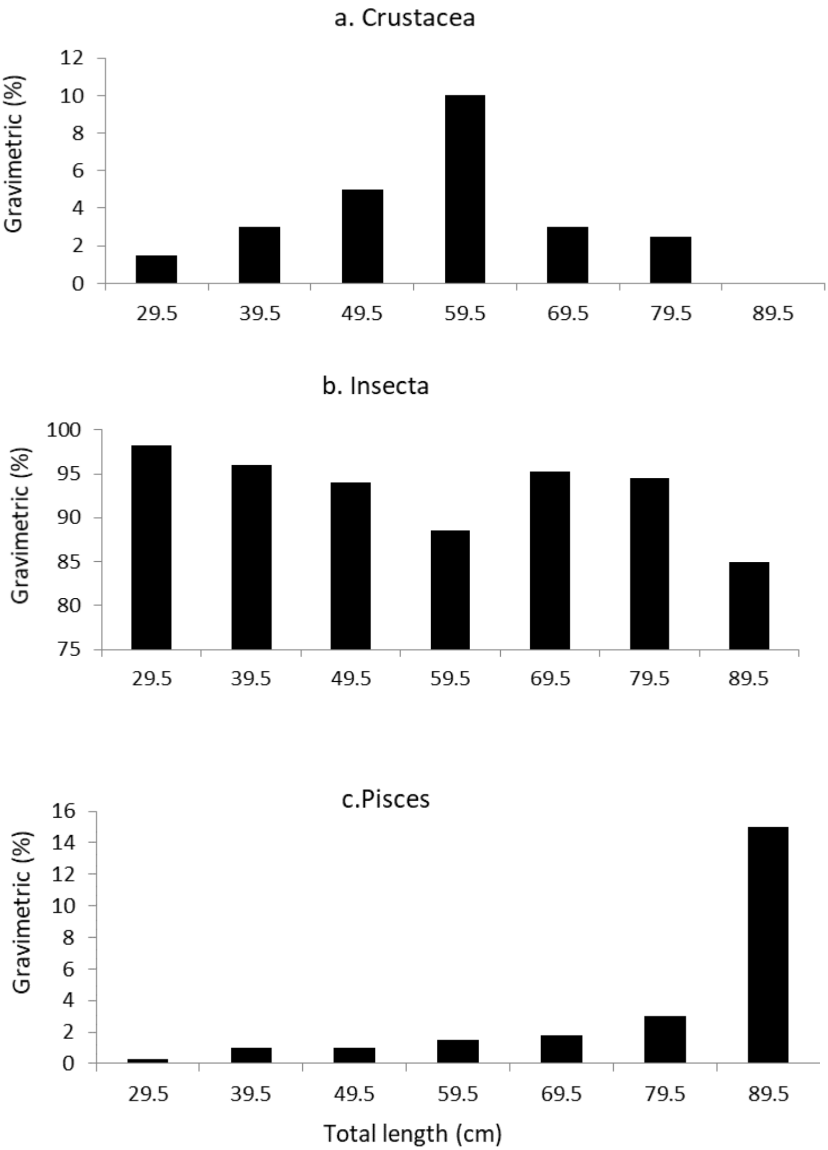

Fig. 4. Gravimetric contribution (%) of Crustacean zooplankton (a), Insecta (b) and Fish (c) in the food of different length (cm) classes of *Clarias gariepinus* from Lake Langeno. Length represented by mid-points of length classes.

Prey to predator TL ratio

The TL of *C. gariepinus* (predator) that had ingested *O. niloticus* (prey) ranged from 34 cm to 87.5 cm. The TL of the prey that was ingested by the predator ranged from 1.5 cm to 16 cm. An individual predator of 37 cm TL had ingested a prey of 16 cm TL giving a prey to predator TL ratio of 1:2.3. Another individual predator of 77 cm TL had ingested a prey of 1.5 cm TL giving a ratio of 1:51. Thus, prey to predator TL ratio in this study ranged from 1:2.3 to 1:51. A scatter plot of the data indicated no relationship between the TL of the predator and that of the prey (Fig. 5). Instead, prey to predator length ratio ranged from 1:5-1:10 for about 31% whereas from 1:10-1:20 for about 35% of the total number of the predator (Fig. 5). Thus, for the majority (about 66%) the ratio was between 1:5 and 1:20 whereas it was either below 1:5 or above 1:30 for about 8% each of the studied *C. gariepinus*.

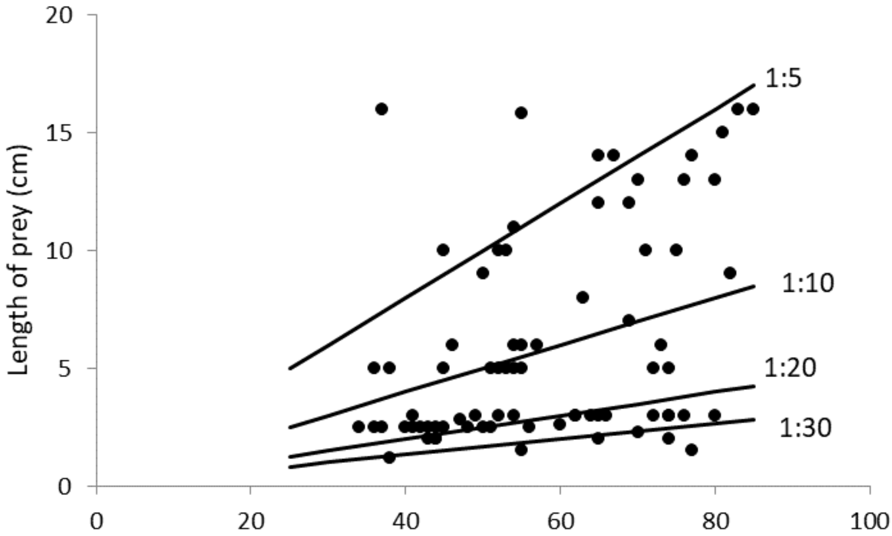

Fig. 5. A scatter plot of the length of the Lake Langeno *Clarias gariepinus* (predator) and its prey fish (*Oreochromis niloticus*). Lines are hypothetical lines passing through the indicated prey to predator length ratios.

Seasonality in food habit

Monthly frequency of *C. gariepinus* with empty stomach ranged from 0% to about 22% during the study period. Fish with empty stomach were not caught in May and in June, and their frequency was only 1.8% in April. In contrast, their frequency was high in July, August and October peaking in August (Fig. 6). Thus, the great majority of *C. gariepinus* with empty stomach were caught during the period of high lake water level.

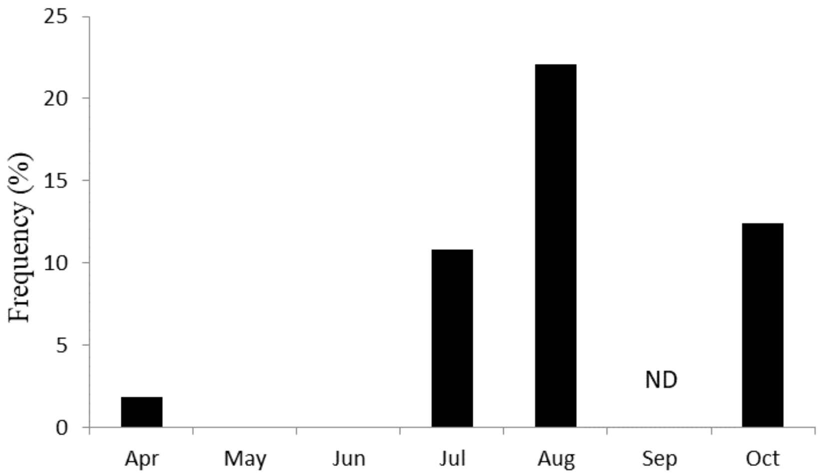

Fig. 6. Monthly frequency (%) of *Clarias gariepinus* with empty stomach in samples from Lake Langeno. ND = no data.

The relative importance of crustacean zooplankton and of insects was similar between the high and the low water level seasons based on the three methods (Figs. 7a and b). Thus, for instance, the frequency of occurrence of crustacean zooplankton was about 30% in both seasons (Fig. 7a), and that of insects was 68% in the low water level season whereas 65% in the high water level season (Fig. 7b). In contrast, all the three methods of relative importance showed that fish (*O. niloticus*) was more important food of the studied *C. gariepinus* during the season of high than low lake water level. For instance, frequency of occurrence of fish during the high water level season (10%) was twice that during the low water level season (Fig. 7). The numerical as well as the gravimetric contributions of fish during the high water level season were almost ten times the contributions during the low water level season.

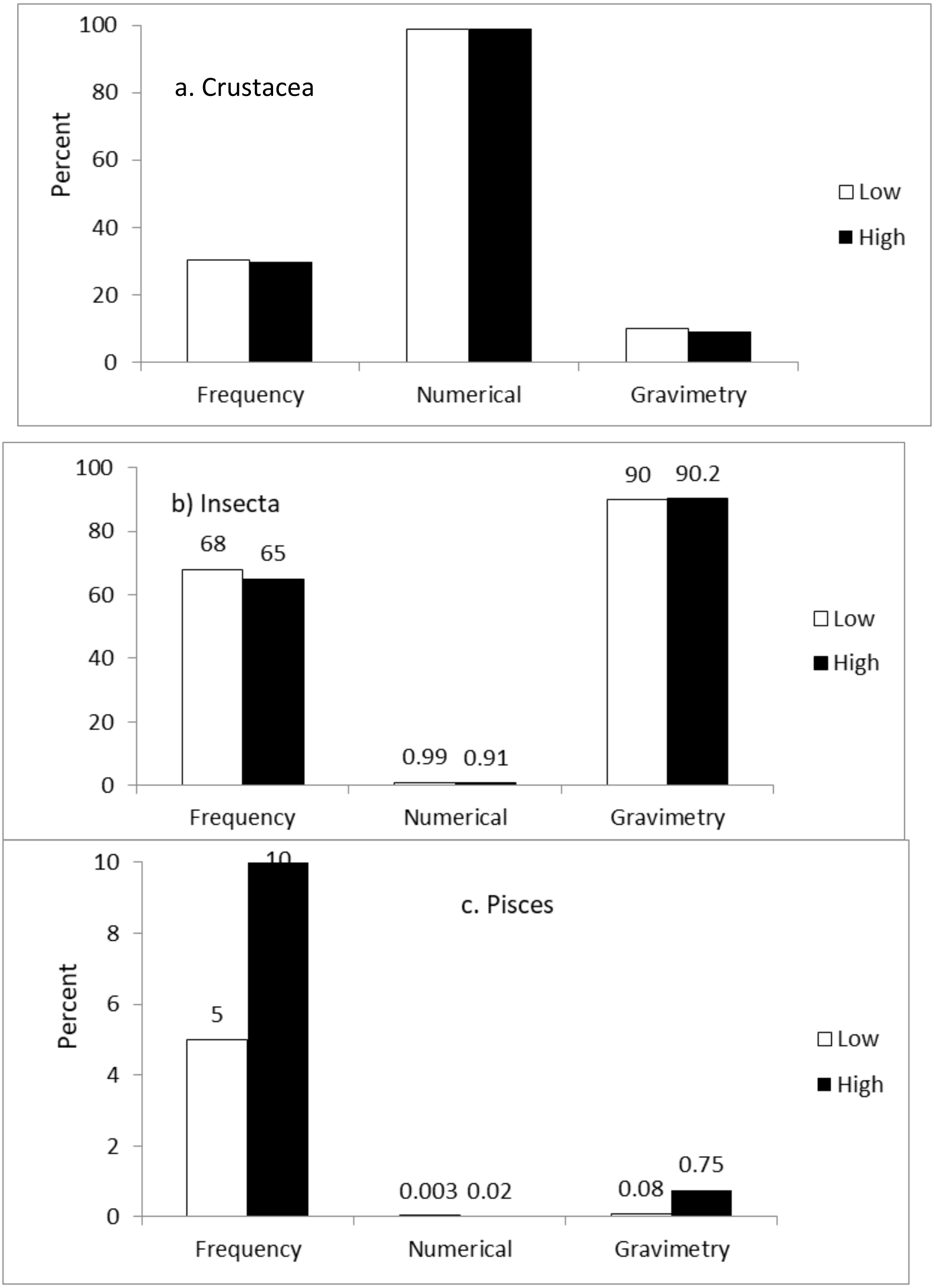

Fig. 7. Relative contribution (%) of Crustacean zooplankton (a) Insecta (b) and Pisces (c) to the diet of *Clarias gariepinus* (Lake Langeno) at low (April-June, □) and high (July, August, October, ■) water level seasons based on frequency of occurrence, numerical abundance and gravimetric methods.

DISCUSSION

C. gariepinus in Lake Langeno ingests a variety of organisms and items. The organisms ingested by the fish varied from phytolankton (e.g., *Microcyctis*) to parts of higher plants, and from micro-invertebrates (crustacean zooplankton) to a relatively higher vertebrate (*O. niloticus*). Detritus and sand grains were also ingested by the fish. Those organisms and items are also ingested by the same species in other lakes in Ethiopia (Tesfaye Wudneh, 1998; Elias Dadebo, 2000; Daba Tugie and Meseret Taye, 2004; Demeke Admassu *et al*., 2015a) and elsewhere (Bruton, 1979; Willoughby and Tweddle, 1978; Spataru *et al*., 1987). According to Demeke Admassu *et al*. (2015a), the species in Lake Babogaya ingests items varying from algae to macrophyte parts, from crustacean zooplankton and insects to fish as well as detritus and sand grains. Similar results are reported for the species in Lake Sibaya, South Africa (Bruton, 1979) and in Lake Kinneret, Israel (Spataru *et al*., 1987).

Among the items ingested by *C. gariepinus* in this study, crustacean zooplankton, insects, nematodes, Hydracarina, fish eggs and fish (*O. niloticus*) are believed to be food items to the fish. Based on their relative contribution, however, crustacean zooplankton, insects and fish are considered as the major food items of catfish in Lake Langeno. The finding agrees well with other studies on the same species in Ethiopia (Tesfaye Wudneh, 1998; Elias Dadebo, 2000; Daba Tugie and Meseret Taye, 2004; Demeke Admassu *et al*., 2015a) and elsewhere (Bruton, 1979; Willoughby and Tweddle, 1978; Spataru *et al*., 1987). Demeke Admassu *et al*. (2015a), for instance, reported that zooplankton, insects, fish (*O. niloticus*), fish eggs, mollusks and nematodes are important food of the species in Lake Babogaya among which the former three are the major food items of the fish. Daba Tugie and Meseret Taye (2004) have also reported that zooplankton and insects were the most important food of *C. gariepinus* in Lake Zwai.

The insect diet of *C. gariepinus* in this study is most diverse as it was composed of adult or sub-adult stages of at least eight taxa such as Tricoptera, Ephemeroptera, Diptera and Odonata (Tables 1 and 2). However, *O. niloticus* was the only fish species ingested by *C. gariepinus* in this study. Similarly, insects were most diverse whereas *O. niloticus* was the only fish species consumed by *C. gariepinus* in other Ethiopian lakes (Elias Dadebo, 2000; Daba Tugie and Meseret Taye, 2004; Demeke Admassu *et al.*, 2015a). Demeke Admassu *et al*. (2015a), for instance, reported that the species in Lake Babogaya feeds on sub-adult and adult stages of insects belonging to seven taxa, but *O. niloticus* is the only fish species ingested by the fish.

The algae, macrophyte parts, detritus and sand grains are believed to be accidentally ingested by the fish in this study while it was pursuing its prey organisms. Therefore, *C. gariepinus* in Lake Langeno is considered to be an indiscriminate carnivore in its feeding habit accidentally ingesting plant material. The same has been concluded for several other populations of *C. gariepinus* (Groenewald, 1964; Thomas, 1966; Kirk, 1967; Spataru *et al*., 1987; Elias Dadebo, 2000; Demeke Admassu *et al*., 2015a). Groenewald (1964) and Kirk (1967), for instance, concluded that *C. gariepinus* is a carnivorous predator which accidentally ingests algae, macrophyte fragments and detritus together with larvae/pupae of benthic organisms. Similarly, the species in the Ethiopian lakes Hawassa (Elias Dadebo, 2000) and Babogaya (Demeke Admassu *et al*., 2015a) is considered to be a carnivorous fish accidentally ingesting macrophyte parts, algae, detritus and sand grains. Some other workers (e.g., Jubb, 1967; Willoughby and Tweddle, 1978), however, have considered *C. gariepinus* to be omnivorous in its feeding habit.

There are important differences in the relative importance of the major food types of the fish in this study. In terms of frequency and gravimetrically insects and numerically crustacean zooplankton are the most important major food. All the three methods showed fish to be the least important major food. The same has been reported for other populations of *C. gariepinus* (Bruton, 1979; Spataru *et al*., 1987; Daba Tugie and Meseret Taye, 2004; Demeke Admassu *et al*., 2015a). According to Demeke Admassu *et al*. (2015a), insects, followed by crustaceans, are the most important whereas fish (*O. niloticus*) are the least important major food of the species in Lake Babogaya. Likewise, Elias Dadebo (2002) found crustacean zooplankton to be more important than fish in the diet of *C. gariepinus* in Lake Chamo, Ethiopia. In contrast, the cichlid *O. niloticus* is the most important food of the catfish in Lake Hawassa (Elias Dadebo, 2000) as are cichlid fishes to the closely related *C. senegalensis* in a man-made lake in Ghana (Thomas, 1966).

The study showed size-based as well as seasonal differences in the food habit of *C. gariepinus*. Generally, while crustacean zooplankton and insects are important diet of small-sized *Clarias*, the importance of *O. niloticus* tended to increase with the TL of *Clarias* (Figs. 2-4). This suggests that as

C. gariepinus in Lake Langeno grows in size, it feeds progressively less zooplankton and insects but progressively more *O. niloticus*. The same has been reported for other populations of *Clarias* in Ethiopian (Elias Dadebo, 2000; Demeke Admassu *et al*., 2015a) as well as in other water bodies (Corbet, 1961; Munro, 1967).

Seasonal difference in the food habit is marked by the high relative importance of fish (*O. niloticus*) in the diet of *Clarias* at the time of high than low lake water level (Fig. 7). According to hatch-dates backcalculated from daily increments in otoliths, *O. niloticus* in Lake Langeno breeds intensively during the main rainy season and at high water level (Demeke Admassu, unpublished data). Therefore, the increased importance of *O. niloticus* to the diet of *Clarias* at the time of high water level is attributable to a concurrent increased abundance of the prey fish. A similar result, as well as explanation, has been given for the *C. gariepinus* populations in lakes Babogaya (Demeke Admassu *et al*., 2015a), Zwai (Daba Tugie and Meseret Taye, 2004) and Hawassa (Elias Dadebo, 2000). In addition, as it is the case for other populations of *C. gariepinus* (e.g., Demeke Admassu *et al*. 2015a), the population in Lake Langeno can be considered as an opportunistic carnivore feeding on different food types depending on seasonal fluctuations in their abundance (Fryer and Iles, 1972; Matipe and De Silva, 1985).

The majority of *C. gariepinus* with empty stomach occurred at the time of high lake water level (Fig. 6) which is also the case for the species in Lake Babogaya (Demeke Admassu *et al*., 2015a). This may be attributed to spawning activity. The breeding season of the Lake Langeno *Clarias* was not studied. However, intensive breeding of fishes in the tropics is coincident with rainfall and rise in water level. The same is true for *C. gariepinus* populations in the nearby lakes Zwai (Daba Tugie and Meseret Taye, 2004) and Hawassa (Eias Dadebo, 2000), and in Lake Babogaya (Demeke Admassu *et al*., 2015b). *C. gariepinus* in Lake Langeno as well may breed intensively during the rainy season and at the time of high water level. Therefore, the high incidence of fish with empty stomach at that time could be due to the fish being engaged more in spawning activity than in hunting for prey. The same has been concluded for the Lake Babogaya population of *C. gariepinus* (Demeke Admassu *et al*., 2015a). Since the fish feeds more on *O. niloticus* at that time, the reduced feeding activity may be compensated for by feeding more of larger-sized prey (fish) than the smaller ones (zooplankton, insects).

The observed prey to predator TL ratio suggest that *C. gariepinus* in Lake Langeno consumes *O. niloticus* that are 1.95% to 43% of its own size. The majority (66%), however, consume 5% to 10% of their own size. The same has been found by Lemma Abera (2007) for the Lake Babogaya population of *C. gariepinus*. In addition, as it is the case for the catfish in Babogaya (Lemma Abera, 2007), there is no correlation between the TL of *C. gariepinus* in Lake Langeno and that of its prey (Fig. 5). This may be due to *C. gariepinus* being unspecialized piscivore, consuming fish when specialized piscivores are rare or absent (Nagelkerke *et al*., 1994; Tesfaye Wudneh, 1998).

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