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# Diet of largemouth Bass reared in earthen ponds in polyculture system with Nile Tilapia and Chinese carps in a semi-arid environment at Deroua Fisheries Station (Fkih Ben Saleh, Morocco)

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**Abstract**

Diet is an important part of the biology of the largemouth Bass (*Micropterus salmoides*. Lacépède, 1802). The behavior and interactions that occur in a fish population in an aquatic environment are the basis of any fish management action to be taken. In this work the largemouth Bass's diet, reared in polyculture with Nile tilapia, Chinese carps, common carp, blue gill and mosquito fish was studied in fish ponds at Deroua fisheries station (Ben Fquih Salah- Morocco) between June and December 2013. One Hundred largemouth Bass with a total length between 16 and 42 cm were captured, dissected and their stomach contents analyzed. The results showed that largemouth Bass's diet consists of six categories of prey with varying occurrence indices: Tilapia (66.1%), insects (25%), Mosquito fish (3.9%), Blue gill (2.8%), Common Carp (1.1%) and mollusks (1.1%). It was found that largemouth Bass 'stend to consume prey of small sizes and weight even if its size allows it to swallow larger preys.

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## Introduction

Largemouth Bass (*Micropterus salmoides* L. acépède, 1802) is a fish native to the southeast of the North American continent. It is a carnivorous fish that has a very varied diet *(N. Mary; Flouhr 2002*). It is used among other carnivorous fish such as African catfish, catfish in the biological control of excessive breeding of some reared species including tilapia (*Lazerd, 1995; Williams et al., 1985*). It has become one of the most widespread fish in the world thanks to introductions made in several countries from the late nineteenth and early twentieth century (Bruslé *et al*., 2001). It was introduced in Morocco in 1934 and acclimatized in the lakes of the Middle atlas of Morocco (Mouslih, 1987).

Largemouth Bass seed production has begun in Morocco at the Deroua fisheries station in 1997 in order to enhance largemouth Bass population in natural lakes and reservoirs. It was noted that the introduction of Tilapia recently in various reservoirs has improved Black bass yields. But no studies have been done to confirm these results scientifically.

The main goal of this work is the study of the diet of this species in aquatic habitats with a similar ichtyologique composition to that existing in the selected Moroccan dams.

As well, it is to understand the different trophic interactions that develops in its environment and these effects on other species and aquatic ecosystems.

## Material and methods

*Area of study*

The Deroua Fisheries station is located in a semi-arid region with mild winters, 25km to the west of the city of Beni Mellal (central Morocco). It is based on clay and limestone formations of Mio-Pliocene-Quaternary (Emberger, 1930).

Its mission is the production of warm-water fish seed to be stocked in Moroccan aquatic environments in order to improve fish productivity and alleviate eutrophication phenomena in reservoirs.

*Experimental Design*

This study was conducted on a largemouth bass population reared in a semi intensive system in ear then ponds in polyculture with tilapia, Chinese carps, common carp, blue gill and mosquito fish from June to December 2013. Eighteen ponds with a unit area of 2000m2 and depth of 1.5m were used in this study. The water supply of the ponds was assured by a deep well and the water flowing from Bine Elouidane dam. The following table presents the repartition of fish population used in this study.

**Table 1.** Total biomass, species biomass of the fish stocked in the ponds.

| Pond | Total Biomass kg | Tilapia | Largemouthbass | Silvercarp | Grass carp | Common carp | Blue gill* | Mosquito fish * |
|---|---|---|---|---|---|---|---|---|
| $A_1$ | 20 | 5 | 5 | 3 | 3 | 2 | -- | -- |
| B2 | 20 | 5 | 5 | 3 | 3 | 2 | -- | -- |
| C2 | 40 | 10 | 10 | 8 | 7 | 5 | -- | -- |
| C4 | 40 | 10 | 10 | 8 | 7 | 5 | -- | -- |
| F4 | 60 | 20 | 20 | 7 | 9 | 4 | -- | -- |
| F5 | 60 | 20 | 20 | 8 | 8 | 4 | -- | -- |
| B1 | 64 | 13,5 | 0,8 | 22 | 20 | 7,7 | -- | -- |
| C1 | 76,5 | 13,5 | 0,8 | 27 | 27 | 9 | -- | -- |
| B3 | 68 | 17 | 0,8 | 27 | 19 | 4,8 | -- | -- |
| B5 | 74 | 17 | 0,8 | 34 | 16 | 6 | -- | -- |
| A4 | 91 | 26 | 0,8 | 26 | 33 | 5,7 | -- | -- |
| F2 | 99 | 26 | 0,8 | 37 | 24 | 11 | -- | -- |
| B4 | 94 | 25,6 | 0,8 | 30 | 31,5 | 6 | -- | -- |
| A5 | 92 | 25,6 | 0,8 | 30 | 27,6 | 8,8 | -- | -- |
| A2 | 85,4 | 25,6 | 1,6 | 20 | 33,1 | 6,6 | -- | -- |
| A3 | 90,5 | 25,6 | 1,6 | 30 | 28 | 6,7 | -- | -- |
| F1 | 95,4 | 33 | 2,4 | 30 | 19 | 11 | -- | -- |
| E3 | 101,6 | 33 | 2,4 | 30 | 25,2 | 11 | -- | -- |

*Blue gill and mosquito fish were carried in the ponds via the flowing water.

To study the food habit, one hundred largemouth Bass have been caught twice a month the first two months and then every week the rest of the trial period. The weight and size of the fish were measured before dissecting. Similarly, the nature, weight and size of prey found in the stomachs of the black bass were determined.

*Expression of results*

To determine diet and food habit of largemouth Bass during this period, we calculated the following food indices:

- The Occurrence Index (Io), which provides information on food preferences were expressed according to Lauzanne (1976) relationship:

$$Io\ (\%) = \frac{\text{Number of stomachs containing a category prey}}{\text{Total stomachs examined}} \times 100$$

- Volumetric Index: We adopted the weighing (W) and volumetric methods (V) to sort and determine the weight or volume of each prey category for all of the sample according to expression:

$$Iv\ (\%) = \frac{\text{Total volume of a prey category (Vi)}}{\text{Total volume of prey (Vt)}} \times 100$$

$$Iw\ (\%) = \frac{\text{Total weight of a prey category (wi)}}{\text{Total weight of prey (tw)}} \times 100$$

- Digital index or index of abundance (IN or lab) (Lauzanne 1976). :Abundance index (lab) = $\frac{\text{Number of individuals of each category of prey}}{\text{Total prey}} \times 100$

- Food Index (FI): This composite index ranging from 0 to 100, is useful for comparing the relative importance of different prey in the diet (Paugy, D'Leveque, 1999). It is also used to compare the importance of prey category in the diet, and minimize potential biases associated with the use of occurrence and volume indices:

Food Index (FI) = $\frac{OI \times VI}{}$ (Lauzane, 1975)

The prey are classified according to their food index value:

- Secondary prey if 0 <SP <10
- Important prey if 10 <IP <25
- Essential prey if 25 <EP <50
- Dominant prey if DP> 50

To obtain freshly ingested stomach contents and not too attacked by digestive enzymes, fish has been selected based on the swelling of the abdomen.

**Results**

The table below shows fish yields harvested in ponds at the end of the rearing period. These yields are significally different from ponds to ponds. All species exist and they are represented different percentages in the ponds.

It should be noted that carps are represented by large specimens except at the beginning of the experiment when batches of fingerlings were present in some ponds. The other species are represented by different sizes and ages.

**Table 2.** Species and biomass (kg) composition harvested from the ponds at end of the rearing period.

| | StockedBiomass | Harveste biomass | Tilapia | Largemouthbass | Silvercarp | Grass carp | Common carp | Blue Gill | Mosquito fish |
|---|---|---|---|---|---|---|---|---|---|
| $A_1$ | 20 | 226 | 177 | 11 | 6,6 | 14,4 | 16,4 | ND | ND |
| B2 | 20 | 176,6 | 129,4 | 7,8 | 9,8 | 9 | 20,6 | ND | ND |
| C2 | 40 | 122,4 | 61,6 | 18,4 | 11,4 | 18,4 | 12,4 | ND | ND |
| C4 | 40 | 279,5 | 217 | 22 | 18,3 | 11,8 | 10,4 | ND | ND |
| F4 | 60 | 122,4 | 29 | 40 | 12 | 18,1 | 21,9 | ND | ND |
| F5 | 60 | 152 | 129 | 19 | 9,4 | 9,2 | 6,4 | ND | ND |
| B1 | 64 | 179,5 | 64 | 19 | 28,2 | 34,1 | 29,3 | ND | ND |
| C1 | 76,5 | 192,2 | 59,1 | 14 | 38,8 | 36 | 31,7 | ND | ND |
| B5 | 68 | 265 | 113,6 | 15,3 | 52,5 | 29 | 13,2 | ND | ND |
| B3 | 74 | 224 | 101,2 | 30,4 | 63,2 | 46,6 | 33,1 | ND | ND |
| F2 | 91 | 293 | 139,2 | 14,1 | 69,4 | 32,8 | 37,2 | ND | ND |
| A4 | 99 | 252 | 105 | 12,2 | 61,8 | 40,9 | 32,3 | ND | ND |
| B4 | 94 | 207 | 81,8 | 11,6 | 60,3 | 34,6 | 26,6 | ND | ND |
| A5 | 92 | 184 | 67,4 | 3 | 50,7 | 36,2 | 26,6 | ND | ND |
| A2 | 85,4 | 201 | 74,3 | 2,9 | 68 | 21,4 | 34,4 | ND | ND |
| A3 | 90,5 | 119,1 | 119,1 | 13,7 | 65 | 37,1 | 24,9 | ND | ND |
| F1 | 95,4 | 322 | 174 | 4,4 | 83,2 | 25,8 | 34,2 | ND | ND |
| E3 | 101,6 | 261 | 84,1 | 2 | 80,6 | 35,8 | 58,6 | ND | ND |

*not determined

From June to December 2013, a total of 100 largemouth Bass of total length between 16 and 42 cm and weigh ranging from 27 to 1239g were captured, dissected and their stomach contents analyzed. The results (Table 3) showed that 31 specimens have an empty stomach, a vacuity index of 31% of stomachs examined.

In the guts of 69 remaining specimens, we identified 180 preys with variability in size and weight with an average of 2.6 prey per stomach and 0.93 g per prey.

Table 3 shows the different food categories found in the stomachs of specimens of the largemouth Bass examined.

**Table 3.** Index of occurrence, numeric index, volume index, food index of largemouth Bass in the studied ponds.

| Prey | Occurrence Index | NumericIndex | volumetricIndex | Food Index |
|---|---|---|---|---|
| Tilapia | 72,5 | 66,1 | 60,4 | 43,79 |
| Blue gill | 2,9 | 2,8 | 1,36 | 0,04 |
| Gambusia | 7,2 | 3,9 | 3,61 | 0,26 |
| Common carp | 1,4 | 1,1 | 14,23 | 0,2 |
| Mollusc | 2,9 | 1,1 | 2,37 | 0,07 |
| Insects | 29 | 25 | 2,6 | 0,75 |

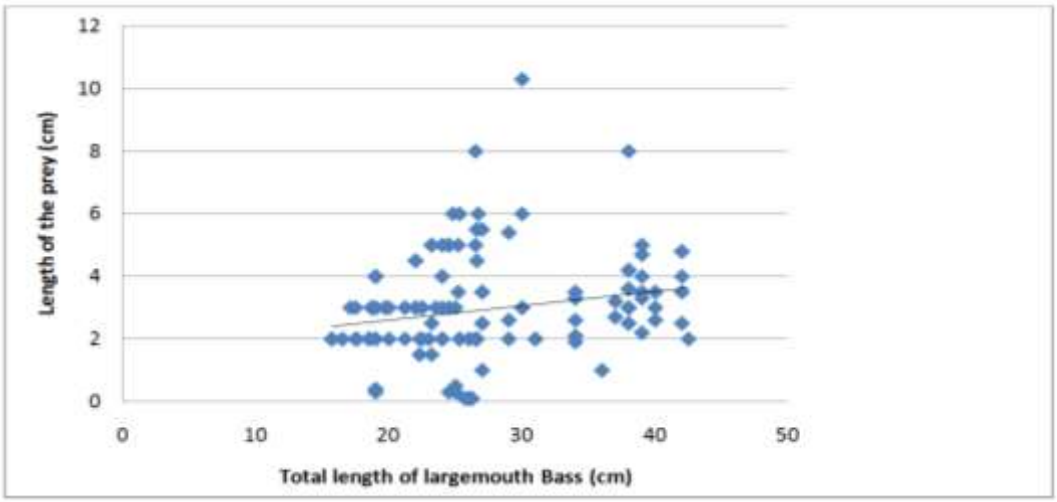


**Fig. 1**. Relationship between the total length of the largemouth Bass and the length of its prey.

Largemouth Bass's diet consists of six categories of prey (Tilapia, Blue gill, Gambusia, Common Carp, mollusk and insects). The preferred prey is composed of Tilapia (oI = 72.5%; NI = 66.1%; VI = 60.4%; FI = 43.79) and insects (oI = 29%; NI = 25%; VI = 2.6%; FI = 0.75). The food spectrum of the six categories of prey shows a dominance of Tilapia (IA = 43.79). Other preys are accidental.

*Relationship between size and weight of the predator and those of its prey*

Prey size does not depend on the size of the largemouth Bass (predator).

However, we noted that the size of the preferred prey varies for the range of the size of the largemouth Bass studied (160-450mm). Thus, 82% of the prey have a size less than or equal to 40 mm, 17% between 50 mm and 80 mm and only 1% of the prey which have a size above 80 mm. It should be mentioned that the maximum size of prey found in the stomachs analyzed reached 103 mm corresponding to one third of the size of the predator (300mm). Fig. 1 illustrates the relationship between prey size and the sizes of predators.

Fig. 2 shows the relationship between the weight of black Bass and weight of prey. The results show a dominance of small items in the stomach contents of captured largemouth Bass.

Indeed, more than 80% consume less than 5g whatever their weight per day, 15% ingest between 5g and 10g and only 5% ingest more then 10g which is equivalent to an average of 64.5mg of prey per gram fish, even if their sizes allow them to consume more than 20% of their body weight.

These results show that the stomach contents of the largemouth Bass vary widely with respect to their fresh weight, with a minimum of 0.1mg of prey per g of fresh weight ,a maximum of 79,4mg of prey per g of fresh weight and an average of 10.2mg / g of fresh weight.

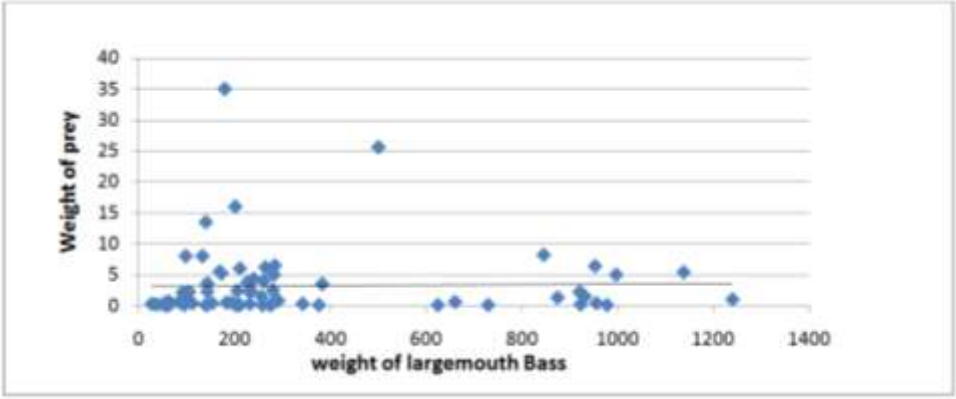


**Fig. 2.** Relationship between the weight of largemouth Bass and that of its prey.

**Discussion**

The diet of the largemouth Bass in the ponds of Deroua Fisheries Station (Fquih Ben Saleh Morocco) is composed of six categories of prey (tilapia, carp, perch sun, Gambusia, insects and mollusks) with a dominance of Tilapia (66, 1%) followed by insects (25%). The Other preys represent less than 10%. This is a regime less diversified compared to that reported by Hickley*et al* (1994) in Lake Naivasha in Kenya, Garcia (2002) in Lake Banyoles in Spain and Marinelli *et al*. (2007) in Lake Bracciano in Italy who found that the food regime of largemouth Bass consists of a wide range of prey represented by insects, worms, molluscs, crustaceans, amphibians, reptiles, and crawfish.

The study conducted between 1983 and 2004 in Lake Paul by Hodgson and Hansen (2005) found that terrestrial animals are also part of the prey consumed by the largemouth Bass. Godinho *et al.* (1997) demonstrated that the largemouth Bass are opportunistic predators, feeding on the most abundant prey in its biotope. This behavior explains the results found in this study where Tilapia was the most abundant prey in the ponds. The multiple reproductions of Tilapia during the study period have yielded a dominance of a size class between 10 and 40 mm of the juveniles of this species.

Although the rearing ponds have a diverse population of prey species (tilapia, blue gill, mosquito fish, insects, tadpoles, etc.) in different sizes, stomach contents largemouth Basswere mainly dominated by tilapia seeds (82 %) with a size less than 40mm. These results are similar to those reported by Mary (2010) who found that the largemouth Bass prefer small and medium size preys. However Hickley *et al.* (1994) and Garcia (2002) found that prey size increases with the size of the largemouth Bass. This study also revealed that in the absence of Tilapia seeds in the beginning of the experiment, the largemouth Bass could swallow other prey whose size is equivalent to 1/3 of its total length. The larger prey ingested by a largemouth Bass with a total length of 300mm was a common carp of 103mm.

Food habit of the largemouth Bass in the ponds of the Deroua Fisheries Station may be influenced by to the limited mobility of small prey and anti-predator behavior developed by larger preys which makes them less vulnerable. The results also show that the largemouth Bass can ingest up to 79,4mg / g / day of its fresh weight. This value is much higher than that found by Cochran and Adelman in their study in Lake Rebecca (1982).

These authors found that the maximum total weight of the stomach contents of the Black Bass is 11,4mg /g/day of its fresh weight.

The largemouth Bass is a predator with a well-developed digestive truck having an individualized stomach. Like any predator, he stops eating when his stomach is full. It was observed that the digestion of a prey follows a daily rhythm. In other words the largemouth Bass digests its prey in a day and comes back fill his stomach the next day. These findings confirm those reported by Hiedinger (1971) who found that the largemouth Bass is a predator which does not eat continuously.

The results reported in this study have shown that tilapia fingerlings are the most preferred prey by the largemouth Bass. The introduction of tilapia in Moroccan reservoirs would allow to boost largemouth Bass yields in these aquatic systems. Further studies to be conducted within the reservoirs will explain the relationship between the largemouth Bass as a major predator and tilapia as a major prey.

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