

**Length-weight relationship, condition factor and feeding habit of the Silurid Catfish
Bagrus docmak (Forsksskal, 1775) in Lake Victoria, Kenya**

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Abstract

Bagrus docmak is a species of the Bagrid catfishes that is indigenous to Lake Victoria, and is an important source of livelihood to communities around the lake. Fish samples were caught using gillnets of mesh sizes 50 mm and 10 mm. The length and weight of individual fish was measured in the field, while stomachs were preserved in 5% formalin and taken to the laboratory for gut content analysis. The overall sex ratio (male: female) was 1.0:1.26 which did not deviate significantly from 1:1 ($p > 0.05$). The length of fish ranged from 12.0-55.0 cm TL and weighed between 20.0 g and 1650.0 g, with mean length and weight of 32.7 cm TL and 351.2 g, respectively. The relative condition factor was 0.97, 1.01 and 1.00 for male, female and combined sexes, respectively. The condition factor was not significantly different in relation to sex of fish and size classes ($p > .05$). The slope b of the length-weight relationship was 2.94, 2.94 and 2.90 for females, males and combined sexes, respectively. Analysis of stomach fullness revealed that most of the stomachs were $\frac{1}{4}$ full (44.6%), while (29.7%) were empty. Non-empty guts had variety of food items with *Caridina*, insects and fish remains each contributing the highest (21%) proportions. Most stomachs in each size class were $\frac{1}{4}$ full, and empty stomachs notably reduced with increased fish size. Juveniles of less than 30 cm TL fed exclusively on *Caridina*; otherwise with increased size the fish ingested insects, and different fish species such as *Barbus*, bivalve, Haps, crabs and detritus in variable quantities. This study provides information on the length weight relationship and condition factor of *B. docmak* useful for its management. Knowledge of its food requirements in the wild can be used to inform feed formulation for its successful culture.

Keywords: *Bagrus docmak*, food, length-weight, sex ratio

Introduction

Bagrus is a genus of Bagrid catfishes. They are relatively large catfishes found in freshwater habitats in Africa. *Bagrus docmak* is an indigenous piscivorous fish native to Lakes; Victoria, Albert, Edward, George and the Rivers; Nile and Kagera in Uganda. The natural stocks of *B. docmak* in Lake Victoria waters have declined drastically since the introduction of Nile perch (Yongo *et al.*, 2017; Balirwa *et al.* 2003), and concomitant ecological changes with the *B. docmak* currently restricted to refugia in rocky habitats). Competition with Nile Perch has largely displaced the species from the inshore and open waters of Lakes Victoria, Kyoga and Nabugabo.

In Lake Victoria the fish is now largely restricted to mouths of large rivers. *Bagrus docmak* is an important source of livelihood to communities around the lake. It is also a species of high aquaculture potential, largely because of its attractive attributes including size, taste, flesh quality, and overall commercial importance (Mwanja *et al.* 2014). Being a carnivorous fish, it could also be used in polyculture with *Oreochromis niloticus* as a measure to check the latter's populations in culture systems (Mwanja *et al.*, 2014). Studies on length–weight relationships and condition factor are well documented for some freshwater fishes in Lake Victoria (Yongo *et al.* 2017; Njiru *et al.* 2006; Yongo *et al.* 2019). However there are limited studies on the length weight relationship and condition factor of *Bagrus docmak* in the lake. The Condition factor is a quantitative parameter of the state of the wellbeing of the fish that determine present and future success by its influence on growth, reproduction and survival (Le Cren, 1951).

The food and feeding habit of *Bagrus* species in Lake Victoria were reported by several workers many years ago till now (Corbet, 1961; Ogari and Asila, 1992; Seegers, 2008). Understanding the feeding habit of fish is very useful in guiding towards formulation of artificial diets in its culture practices. Fish exploit food items in nature according to the possessed adaptations such as their mouth, gill rakers, dentition and gut system which are related to feeding. *Bagrus docmak* feeds mainly on fish, but also on insects, crustaceans and molluscs (Seegers, 2008). In young fish invertebrates are the principal food source, while adult fish are primarily piscivorous feeding on *Haplochromis* (Corbet, 1961) which has since disappeared in the lake. It is noted that ecological changes in Lake Victoria has altered the feeding habit of various species such as Nile perch (Agembe *et al.* 2018), tilapia (Njiru *et al.* 2004) and *R. argentea* (Yongo *et al.* 2016). Possibly these changes could have also altered the feeding habits of *B. docmak* in the lake. Thus, the study investigated on length-weight relationship, condition factor and feeding of *Bagrus docmak* with emphasis on its food and ontogenetic diet shift.

Materials & methods

The experimental survey was conducted using a canoe mounted with an outboard engine. Fishing was conducted on quarterly basis from sampling sites between 34°13' and 34°52'E and 0°4' and 0°32'S, representing the Kenyan waters of Lake Victoria from September 2015 to July 2016. Fish samples were caught using gillnets of mesh sizes 50 mm and 10 mm in the wings and codend respectively. The nets were set overnight from 7.00 pm to 6.30 am. Immediately after

their capture, the fish were sorted for *B. docmak* caught (127). The total length (0.1 cm) and weight (0.01g) for each individual fish was measured in the field. The fish were then dissected and sex determined according to Bagenal and Tesch (1978). In the field, each stomach was awarded an index of fullness from 0 to 20 using a point method by Hyslop (1980). An empty stomach scored 0, while stomachs that were a quarter, half, three-quarters and completely full scoring 5, 10, 15 and 20, respectively.

Non-empty stomachs were preserved in 5% formalin and then transported to Kenya Marine and Fisheries Research Institute laboratory in Kisumu (Kenya) for gut content analysis. In the laboratory food items were emptied into a petri dish and examined under dissecting binocular microscope (x50). Food items were sorted into categories and identified. Each category was assigned a number of points proportional to the estimated contribution. The percentage frequency of occurrence was calculated as numbers of stomach with particular food item expressed as percentage. The gut contents were assessed separately for the different length class categories; < 30, 31-35, 36-40, 41-45, 46-50 and 51-55 cm to compare the contribution of each food item in each length class.

The length-weight relationship was estimated using the formula:

$$W = a \times TL^b$$

The relative condition factor was calculated according to Le Cren (1951) as follows:

$$K = \frac{W}{a \times TL^b}$$

Where K = condition factor, W = weight of fish (g), TL = total length of fish (cm) a (intercept) and b (slope) are constants of regression equation.

Likelihood ratio chi-square test (χ^2 test) was used to test for the difference in population sex ratio. One-way analysis of variance (ANOVA) was used to test for variation in mean total length and body weight between females and males, whereas, variation in condition factor was tested using the Kruskal-Wallis test.

Results

The overall sex ratio (male: female) was 1.0:1.26 which did not deviate significantly from the hypothetical distribution of 1:1 ($\chi^2 = 1.27$, $p = 0.26$). The length of fish ranged from 12.0-55.0 cm TL and weighed between 20.0 g and 1650.0 g, with mean (\pm SE) length and weight of 32.7 \pm 1.1 cm TL and 351.2 \pm 32.3 g, respectively. The mean length was 33.6 \pm 1.3 cm for females and 33.0 \pm 1.8 cm for males; whereas, female and male had mean weight of 359.6 \pm 38.9 and 363.6 \pm 56.2 g, respectively. There was no significant difference in mean length ($F=0.09$, $p = 0.759$) and weight ($F=0.00$, $p = 0.953$) between males and females. The relative condition factor was 0.97, 1.01 and 1.00 for male, female and combined sexes, respectively. The condition factor was not significantly different between males and females ($H = 2.21$, $p = 0.137$). Similarly, there was no significant variation in condition factor in relation to size classes ($H = 2.54$, $p = 0.771$, Table 1). The slope b of the length-weight relationship was 2.94, 2.94 and 2.90 for females, males and combined sexes, respectively (Fig. 1). Analysis of stomach fullness revealed that most of the stomachs were $\frac{1}{4}$ full (44.6%), while (29.7%) were empty (Fig. 2a). The non-empty guts had variety of food items with *Caridina*, insects and fish remains each contributing the highest (21%) proportions (Fig. 2b). Relationship between stomach fullness and size class showed that most stomachs in each size class were $\frac{1}{4}$ full, and empty stomachs notably reduced with increased fish size (Fig. 3). Gut content analysis showed that fish of less than 30 cm TL fed exclusively on *Caridina*; otherwise with increased size the fish ingested insects, and different fish species such as *Barbus*, bivalve, Haps, crabs and detritus in variable quantities (Fig. 4).

Table 1: Relative condition factor of *B. docmak* in relation to size classes.

TL	n	Mean	SE	95% CI
<30	42	1.009	0.038	(0.821, 1.113)
31-35	23	0.966	0.043	(0.872, 1.075)
36-40	19	0.969	0.029	(0.875, 1.026)
41-45	10	0.981	0.019	(0.951, 1.010)
46-50	17	1.062	0.068	(0.950, 1.186)
51-55	16	1.071	0.068	(0.947, 1.223)
Total	127	1.000	0.019	(0.889, 1.072)

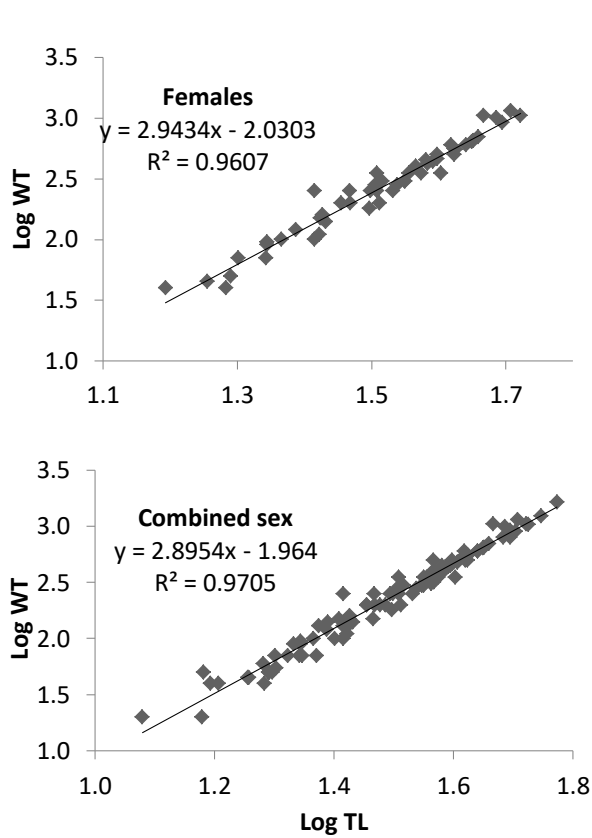


Figure 1: Log TL-Log WT relationship of *B. docmak* from Lake Victoria, Kenya.

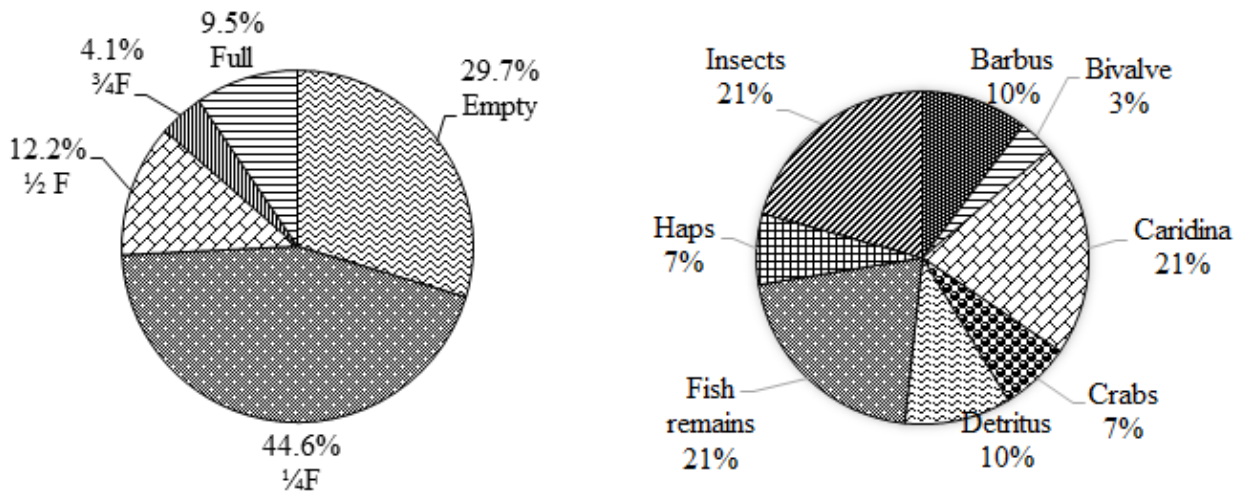


Figure 2: a) Stomach fullness, b) diet composition.

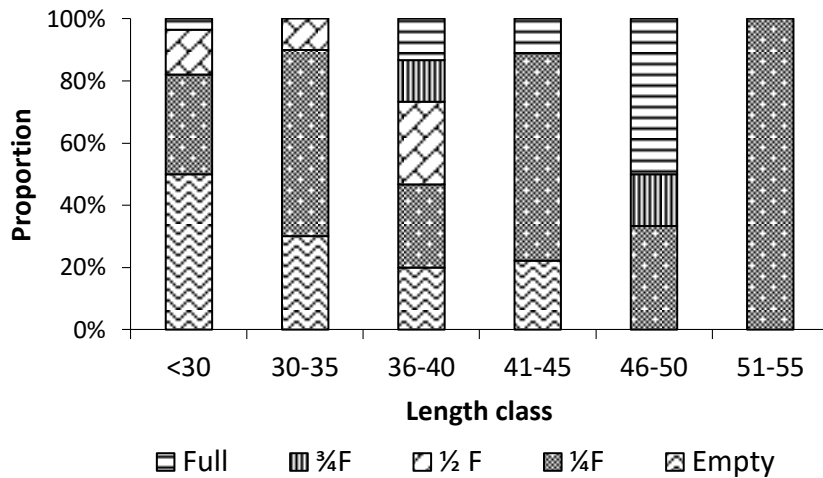


Figure 3: Stomach fullness in relation to size classes.

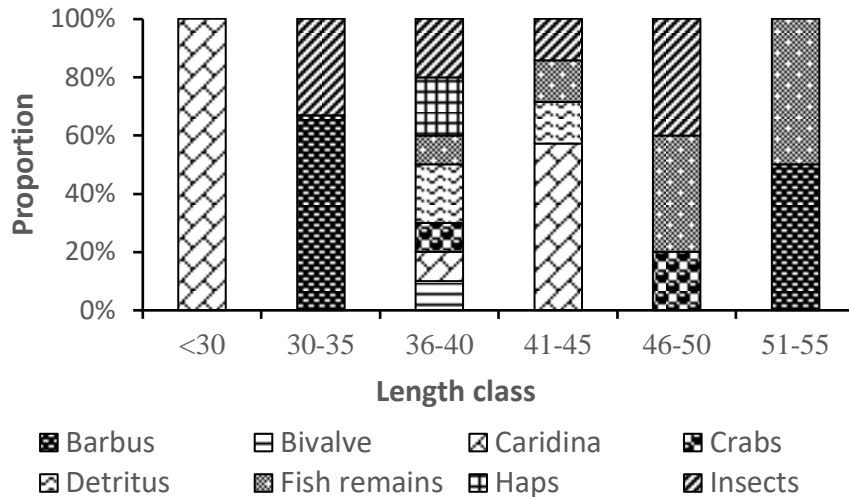


Figure 4: Percentage contribution of different food items consumed at different size classes of *B. docmak* from Lake Victoria, Kenya.

Discussion

The reported sex ratio of 1.0: 1.26 (male: female) for *B. docmak* was not different from the expected 1:1. These results are comparable with the findings of Aruho *et al.* 2013 who found a sex ratio of 1.0: 0.96 for the same fish in the Victoria Nile. Similar findings on sex ratio have also been found in other related catfishes such as *Schilbe intermedius* and *Synodontis victoriae* in the Nyanza gulf of Lake Victoria (Table 2). Studies on *B. docmak* in other lakes have also reported similar results of proportionate sex ratio (Ikongbeh. *et al* 2012; Hailu Anja *et al.* 2009). It is

therefore evident that the catfishes tend to have nearly equal population of males and females unlike in cyprinids where males predominate (Yongo *et al.* 2018; Njiru *et al.* 2006). It is observed that values of the slope b and the condition K do not vary significantly for the three catfishes (*B. docmak*, *S. intermedius* and *S. victoriae*) in Lake Victoria (Table 2). This observation may be attributable to the fishes occupying same trophic level and having almost similar feeding behaviour as reported in other studies (Okatch and Dadzie, 1988; Wanyanga *et al.* 2016). *Clarius gariepinus* in Lake Naivasha, however, showed a slightly higher b value with very low K (Table 2). The b value of fish varies depending on the prevailing environmental conditions and food availability. It can therefore be used as an indicator of food intake to assess health status.

Table 2: The regression slope (b), sex ratio and condition factor (K) of some catfishes.

Catfishes	Lake	Sex ratio male: female	b females	b males	b both sex	K	Source
<i>Bagrus docmak</i>	Victoria	1.0: 1.26	2.94	2.94	2.90	1.00	This study
<i>Schilbe intermedius</i>	Victoria	1.0: 1.23	3.10	3.00	3.20	1.00	Mutethya <i>et al</i> 2020
<i>Synodontis victoriae</i>	Victoria	1.0: 2.70	2.97	2.59	2.91	1.01	Yongo & Wairimu 2018
<i>Bagrus docmak</i>	Akata	1.0: 1.08	2.61	2.84	2.79	1.62	Ikongbeh <i>et al</i> 2012
<i>Clarius gariepinus</i>	Naivasha	-	3.30	3.16	3.23	0.55	Keyombe <i>et al.</i> 2015

The diet composition of *B. docmak* in this study varied with its size with the juveniles of less than 30 cm TL feeding exclusively on *Caridina nilotica*, while the adult fish ingesting various food items including insects, Barbus, bivalve, Haps, crabs and detritus. According to Okach and Dadzie (1988), adult *B. docmak* in the Nyanza gulf of Lake Victoria fed mostly on fish-Haplochromis spp. and *Engraulicypris argenteus* (Pelligrin), whereas, juveniles preferred aquatic benthic invertebrates including *Phyllogomphus aethiops*, *Phanostoma senegalense*, *Chironomus spp*, *Caridina nilotica* and *Chaoborus spp* among others. In Lake Chamo (Ethiopia), juvenile *B. docmak* (<40 cm FL) ingested more insects than fish while older fish were largely piscivores, with fish constituting 98% of their diet by weight (Anja and Mengistou, 2001). Review by Yongo *et al.* (2019) on the feeding habits of various *Synodontis* catfishes in African freshwaters also reported a similar ontogenetic diet shift. *Bagrus* species are predatory bottom-dwellers and feed on invertebrates or other fish. They feed predominantly on invertebrates when young and shift to piscivorous feeding habit when adult as reported by Chilvers and Gee (1974).

Ontogenetic changes in fish diet are guided by development of the fish morphological and physiological features as it grows (Njiru *et al.* 2004; Agembe *et al.* 2018; Yongo *et al.* 2016). This study provides information on the length weight relationship and condition factor of *B. docmak* useful for its management. Knowledge of its food requirements in the natural habitats can be used to inform feed formulation for its successful culture.

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