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Food and Feeding Habits of a Potential Aquaculture Candidate, the Black Nile Catfish, *Bagrus Bajad* in the Golinga Reservoir

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Abstract: A study was carried out into the food and feeding habits of *Bagrus bajad* in the Golinga reservoir in the Northern Region of Ghana to determine its various food resources and the major food items eaten and to compare food items in the stomachs of juveniles and adults as well as its feeding habits. Samples were taken in 11hr intervals (0600 and 1700 GMT – morning and evening respectively). The study revealed a wide range of both phytoplankton and zooplankton and other accessory prey items eaten by *Bagrus bajad* giving an indication that the fish is an omnivore. The juveniles exploited mostly Bacillariophyceae/Diatomophyceae (synedra, 3.68 Index of preponderance, Ip), Miscellaneous invertebrates (nematode worm, 1.26 Ip), Accessory preys (insect parts 0.43 Ip), Protozoans (lacrymaria 0.26 Ip), Miscellaneous insects (leptocella 0.18 Ip) and Chlorophyceae (botryoccoccus, 0.12 Ip) while the adults mainly fed on Bacillariophyceae/ Diatomoophyceae (synedra, 1.95 Ip), Chlorophyceae (botryoccoccus, 0.76 Ip), Miscellaneous invertebrates (nematode worm, 0.51 Ip), Accessory preys (insect parts, 0.28 Ip), Cynophyceae (rivularia, 0.12 Ip) and Desmidiaceae (netrium 0.08 Ip). Food items of juveniles and adults overlapped and percentage index of preponderance indicated diatoms to be the most preferred prey items suggesting that both juveniles and adults exploited similar food items. The ability of *Bagrus bajad* to feed on a wide range of food resources makes it promising for aquaculture especially in semi-intensive fish farming systems in the Tropics.

Key words: aquaculture, food items, index of preponderance, *Bagrus bajad*, juveniles

INTRODUCTION

The freshwaters of Ghana has fauna diversity of 28 families, 73 genera and 157 species. Out of the 157 species, 81 are of food importance (Bondad-Peantaso, 2007; Dankwa, 1999). *Bagrus* species that occur in Ghana's freshwaters are *Bagrus bajad* and *Bagrus docmac* which are of commercial and food importance. Particularly, fishes of the family Bagridae have dorsal and pectoral spines, large adipose fins with tightly forked caudal fin, long maxillary and nasal barbells, and are benthic dwellers hence benthic omnivores with strong predation ability (Dankwa, *et al*, 1999). They have broad heads which are bony (Holden, 1972). A known distribution of *Bagrus bajad* in Ghana occurs in the Volta Systems which includes the Volta Lake, the Volta River and their tributaries such as White Volta, Pru, Asukwakwa, Oti, Black Volta, Afram, Daka and Kulpawn and has been reported not in danger of extinction (Dankwa, *et al*, 1999).

For a successful culture of this species, an understanding of its dietary requirements is necessary. The understanding of fish diet is an indispensable factor to the grouping of fish with respect to their food, their method of feeding and how they feed. It also presents constructive information in placing a fish in the food web in its ecological niche and in interspecies fisheries (Boyd, 1977). According to (Bone, 1995), there are different food items exploited by fish and with various ways of feeding ranging from sieving phytoplankton or scraping algae to feeding on benthic invertebrates, and to consuming other fishes in one piece or in pieces. Some like the phytoplankton filtering menhaden feeds continuously, whilst the great white shark is said to satisfy itself on average with one large meal every six weeks, spending the rest of the period, hungrily looking for the next prey.

Aquaculture in Ghana is mostly focused on the cichlids to the detriment of catfishes which occur in most freshwater bodies especially in Northern Ghana. The only successful catfish cultured in Ghana is *Clarias*

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gariepinus. Hence, there is the need to investigate the food and feeding habits of both juveniles and adults of *Bagrus bajad* to enhance the development of the species in aquaculture development in Ghana thereby supplementing the high demand for fish and its products.

MATERIALS AND METHODS

The study was conducted in the Golinga Reservoir in the Tolon/Kumbungu District of Northern Region of Ghana and lies on latitude $9^0 25'$ N and $1^0 2'$ W. The area experiences a unimodal rainfall pattern with the mean annual precipitation and temperatures between 900 mm - 1100 mm and 24º C - 38º C respectively.

Samples of *Bagrus bajad* were collected every month from September, 2009 to May, 2010 from the catches of local fishermen with cast nets of different mesh sizes ranging from 1 inch to 3 inches. Samples were collected in 11hour intervals (0600 and 1700 GMT) and preserved with ice cubes in a plastic container to prevent the samples from deteriorating and stomach contents digesting.

Fish samples were divided into two categories based on their maturity size (Kone, 2003). Fish samples with the standard lengths below 20 mm were grouped as juveniles whiles those above 20 mm were grouped as adults. Fish samples collected were measured for their total and standard lengths with a meter rule to the nearest 0.1 mm and weighed with Sartarious TE612 (610 g capacity) scale to the nearest 0.1 g and dissected for stomach contents using a set of dissecting kits. The stomach contents were also weighed with Sartarious TE612 (610 g capacity) scale to the nearest 0.01 g and were examined under a Leica DM LS2 light microscope for taxonomic classification and food items identified to the genera level using identification keys provided by (Marshall, 1997).

The stomach contents were analyzed by calculating the Percentage Composition by Number (%Cn) (Hureau, 1970), Percentage Frequency of Occurrence (%FO) (Hyslop, 1980), Percentage Composition by weight (%Cw) and Index of Preponderance (Ip) (Needham, 1962) for individual prey items as follows:

$$\%Cn = \frac{\text{number of a particular prey item in all stomachs examined}}{\text{total number of all prey items in all stomachs}} \times 100$$

$$\%Cw = \frac{\text{weight of a particular prey item in all stomachs examined}}{\text{total weight of all prey items in all stomachs}} \times 100$$

$$\%FO = \frac{\text{number of stomachs containing a particular prey item}}{\text{total number of stomachs examined}} \times 100$$

$$Ip = \frac{(\%Cw \times \%FO)}{\sum (\%Cw \times \%FO)}$$

RESULTS AND DISCUSSION

The study showed that *Bagrus bajad* is a benthic omnivorous feeder as examination of the stomach contents revealed a wide range of zooplankton, phytoplankton, bottom deposit, fish and insect parts (Tables 1 & 2). The diets of juveniles were generally Bacillariophyceae/Diatomophyceae (synedra, 3.68 Index of preponderance, Ip), Miscellaneous invertebrates (nematode worm, 1.26 Ip), Accessory preys (insect parts 0.43 Ip), Protozoans (lacrymaria 0.26 Ip), Miscellaneous insects (leptocella 0.18 Ip) and Chlorophyceae (botryoccoccus, 0.12 Ip) (Table 1). The adults mainly fed on Bacillariophyceae/Diatomoophyceae (synedra, 1.95 Ip), Chlorophyceae (botryoccoccus, 0.76 Ip), Miscellaneous invertebrates (nematode worm, 0.51 Ip), Accessory preys (insect parts, 0.28 Ip), Cynophyceae (rivularia, 0.12 Ip) and Desmidiaceae (netrium 0.08 Ip) (Table 2).

The total well being of fish could be determined partly by the quality and quantity of food it takes. According to Le Cren (1965), the maximum size that a fish can reach may possibly be affected by the various food resources and their availability in its environment. The research revealed that *Bagrus bajad* is an omnivorous feeder because examination of the stomach contents presented a wide collection of zooplankton and phytoplankton as well as detritus (bottom deposit) and insect parts as in the findings of (Bailey, 1994). The diversity of food organisms found in the stomachs of *Bagrus bajad* also suggests that they are euryphagous and therefore, exploit a wide range of organisms in the reservoir.

Table 1: Food items in the stomachs of juvenile *Bagrus bajad* in the Golinga reservoir

Food items	Quantity (n)	Frequency (f)	Weight (w)/g	%Cn	%Cw	%FO	Ip
Bacillariophyceae (Diatomophyceae)							
Nitzschia	86	15	0.08	5.43	2.88	14.42	0.18
Synedra	654	36	0.65	41.36	23.34	34.60	3.68
Stauroneis	11	1	0.02	0.69	0.72	0.96	0.003
Cyclotella	15	11	0.03	0.94	1.08	10.57	0.05
Navicula	49	9	0.09	3.09	3.24	8.56	0.12
Frustulia	39	8	0.39	2.46	1.44	7.69	0.05
Cocconeis	1	1	0.003	0.06	0.10	0.96	0.0004
Tabellaria	2	2	0.004	0.12	0.14	1.92	0.001
Surirella	1	1	0.01	0.66	0.36	0.96	0.001
Pinnularia	1	1	0.002	0.06	0.07	0.96	0.0003
Total	859	85					
Rotifera							
Trichocerca	1	1	0.003	0.06	0.10	0.96	0.0004
Total	1	1					
Chlorophyceae							
Botryoccoccus	135	6	0.13	8.53	4.69	5.76	0.12
Oedogonium	3	1	0.006	0.18	0.21	0.96	0.0009
Scenedesmus	1	1	0.002	0.06	0.07	0.96	0.0003
Ophiocytium	5	3	0.01	0.31	0.36	2.88	0.004
Mougeotia	1	1	0.003	0.06	0.10	0.96	0.0004
Tetraspora	2	2	0.006	0.12	0.21	1.92	0.001
Pediastrum	1	1	0.003	0.06	0.10	0.96	0.0004
Total	148	15					
Cynophyceae							
Rivularia	6	2	0.01	0.36	0.42	1.92	0.005
Coelosphaerium	2	1	0.006	0.21	0.21	0.96	0.0009
Polycystis	2	2	0.004	0.14	0.14	1.92	0.001
Anabaena	1	1	0.001	0.03	0.03	0.96	0.0001
Total	11	6					
Desmidiaceae							
Gonatozygon	4	1	0.02	0.25	0.72	0.96	0.003
Netrium	8	4	0.03	0.50	1.08	3.84	0.01
Closterium	7	6	0.01	0.44	0.49	5.76	0.01
Cosmarium	1	1	0.003	0.06	0.10	0.96	0.004
Total	20	12					
Miscellaneous insects							
Halesus	1	1	0.01	0.06	0.42	0.96	0.001
Nymphula	1	1	0.004	0.06	0.14	0.96	0.0006
Leptocella	45	13	0.09	2.84	3.24	12.50	0.18
Hexperaphylax	1	1	0.004	0.06	0.14	0.96	0.0006
Arcynopteryx	1	1	0.01	0.06	0.35	0.96	0.001
Enochrus	1	1	0.008	0.06	0.28	0.96	0.001
Peltodytes	1	1	0.009	0.06	0.32	0.96	0.001
Total	51	19					
Protozoans							
Naegleria	3	1	0.003	0.18	0.10	0.96	0.0004
Paramecium	1	1	0.003	0.06	0.10	0.96	0.0004
Loxodes	1	1	0.003	0.06	0.10	0.96	0.0004
Spirostonum	1	1	0.004	0.06	0.14	0.96	0.0006
Volvox	1	1	0.004	0.06	0.14	0.96	0.0006
Didinium	1	1	0.02	0.37	0.72	0.96	0.003
Pleodorina	38	5	0.07	2.40	2.52	4.80	0.05
Polytoma	1	1	0.001	0.06	0.03	0.96	0.0001
Synura	71	3	0.21	4.49	7.58	2.88	0.09
Gonium	1	1	0.002	0.06	0.07	0.96	0.0003
Euglypha	8	1	0.01	0.50	0.57	0.96	0.002
Lacrymaria	99	6	0.29	6.25	10.46	5.76	0.26
Urostyla	1	1	0.002	0.06	0.07	0.96	0.0003
Total	227	23					
Miscellaneous invertebrates							
Nematode worm	42	19	0.42	2.65	15.16	18.26	1.26
Plecobdella	4	2	0.16	0.25	5.77	1.92	0.05
Hydrachnid	1	1	0.005	0.06	0.18	0.96	0.0007
Total	47	22					
Strongyloidae/Ancylostomatidae							
Strongyloides	4	3	0.01	0.25	0.42	2.88	0.0005
Hook worms	36	6	0.06	2.02	2.16	5.76	0.05
Total	40	9					

Table 1: Continue

Accessory preys							
Insect parts	161	17	0.16	10.17	5.77	16.34	0.43
Fish parts	7	6	0.02	0.44	0.72	5.76	0.01
Fish scales	2	2	0.002	0.12	0.07	1.92	0.0006
Detritus	7	15	0.007	0.44	0.25	6.73	0.007
Total	171	40					

Table 2: Food items in the stomachs of adult *Bagrus bajad* in the Golinga reservoir

Food items	Quantity (n)	Frequency (f)	Weight (w)/g	%Cn	%Cw	%FO	Ip
Bacillariophyceae (Diatomophyceae)							
Nitzschia	33	13	0.03	2.11	1.24	12.50	0.06
Synedra	423	26	0.42	27.15	17.42	25.00	1.95
Stauroneis	3	2	0.006	0.19	0.24	1.92	0.002
Cyclotella	80	11	0.16	5.13	6.63	10.57	0.31
Navicula	8	6	0.01	0.51	0.41	5.76	0.01
Frustulia	32	8	0.03	2.05	1.24	7.69	0.04
Diatoma	47	3	0.04	3.01	1.65	2.88	0.02
Cocconeis	1	1	0.03	0.06	0.12	0.96	0.0004
Tabellaria	1	1	0.02	0.06	0.08	0.96	0.0003
Total	628	71					
Rotifera							
Synchaeta	1	1	0.004	0.06	0.16	0.96	0.0006
Ploesoma	1	1	0.005	0.06	0.20	0.96	0.0008
Total	2	2					
Chlorophyceae							
Botryoccoccus	395	11	0.39	25.35	16.18	10.57	0.76
Cladophora	1	1	0.005	0.06	0.20	0.96	0.0008
Microspora	3	2	0.009	0.19	0.37	1.92	0.003
Oedogonium	2	2	0.004	0.12	0.16	1.92	0.0006
Ulothrix	3	1	0.006	0.19	0.24	0.96	0.003
Scenedesmus	7	4	0.01	0.44	0.41	3.84	0.007
Tetraspora	11	3	0.03	0.70	1.24	8.88	0.01
Pediastrum	7	4	0.02	0.44	0.82	3.84	0.01
Crucigenia	1	1	0.001	0.06	0.04	0.96	0.0001
Total	429	29					
Cynophyceae							
Rivularia	48	8	0.09	3.08	3.73	7.69	0.12
Merismopedia	6	1	0.01	0.38	0.47	0.96	0.001
Coelosphaerium	118	1	0.35	7.57	14.52	0.96	0.06
Polycystis	1	1	0.002	0.06	0.08	0.96	0.0003
Oscillatoria	6	3	0.01	0.38	0.41	2.88	0.005
Total	179	14					
Desmidiaceae							
Genicularia	1	1	0.01	0.06	0.41	0.96	0.0001
Gonatozygon	21	5	1.10	1.34	4.14	4.80	0.08
Netrium	22	6	0.08	1.41	3.31	5.76	0.08
Closterium	3	2	0.006	0.09	0.24	1.92	0.002
Spirotaenia	2	2	0.004	0.12	0.16	1.92	0.0006
Pleurotaenium	1	1	0.002	0.06	0.08	0.96	0.0003
Total	50	17					
Miscellaneous insects							
Leptocella	9	5	0.01	0.57	0.41	4.80	0.008
Phryganea	2	1	0.01	0.12	0.41	0.96	0.0001
Dytiscid	1	1	0.04	0.06	1.65	0.96	0.007
Berosus	1	1	0.01	0.06	0.41	0.96	0.0001
Antocha	2	1	0.02	0.12	0.82	0.96	0.003
Haliplus	1	1	0.003	0.06	0.12	0.96	0.0005
Cordulegaster	1	1	0.007	0.06	0.29	0.96	0.001
Dryopid	1	1	0.003	0.06	0.12	0.96	0.0005
Total	18	12					
Protozoans							
Naegleria	4	3	0.004	0.25	0.16	2.88	0.002
Paramecium	1	1	0.003	0.06	0.12	0.96	0.0005
Frontania	2	1	0.006	0.12	0.24	0.96	0.001
Spirostonum	2	1	0.006	0.12	0.24	0.96	0.001
Epistylis	1	1	0.002	0.06	0.08	0.96	0.003
Didinium	1	1	0.004	0.06	0.16	0.96	0.0006
Pleodorina	17	5	0.03	1.09	1.24	4.80	0.02
Blepharisma	1	1	0.002	0.06	0.08	0.96	0.0003
Mallomonas	4	1	0.008	0.25	0.33	0.96	0.001
Total	33	15					

Table 2: Continue

Miscellaneous invertebrates							
Nematode worm	24	12	0.24	1.54	9.95	11.53	0.51
Total	24	12					
Strongyloidae/Ancylostomatidae							
Strongyloides	12	6	0.03	0.77	1.24	5.76	0.03
Hook worms	38	5	0.07	2.43	2.90	4.80	0.05
Total	50	11					
Accessory preys							
Insect parts	106	16	1.10	6.80	4.14	15.38	0.28
Fish parts	4	4	0.01	0.25	0.41	3.84	0.007
Fish scales	22	4	0.02	1.41	0.82	3.84	0.01
Detritus	12	19	0.01	0.77	0.41	18.26	0.03
Total	156	43					

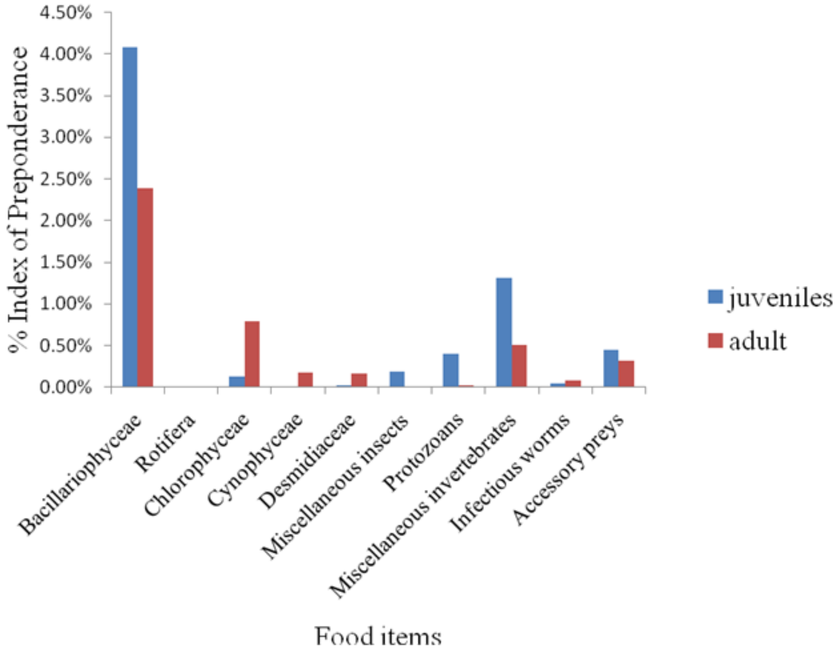

Fig. 1: Comparison of food items in the stomachs of juvenile and adult *Bagrus bajad* in the Golinga reservoir.

Juveniles and adult *Bagrus bajad* in the Golinga reservoir showed a diet overlap. They fed on about eight families of related dietary components (aside infectious worms and accessory prey items). Whilst the juveniles exploited mostly Bacillariophyceae/Diatomophyceae, Miscellaneous invertebrates, Accessory preys, Protozoans, Miscellaneous insects and Chlorophyceae, the adults also mainly fed on Bacillariophyceae/Diatomophyceae, Chlorophyceae, Miscellaneous invertebrates, Accessory preys, Cynophyceae and Desmidiaceae. The diet overlap could be due to the fact that those that were considered as juveniles had fairly developed gill rakers.

Also, the minor difference in the prey items of juveniles and adults indicates that there was a size- specific preference in order to reduce both intra and inter-specific competition for food and this confirms the findings of (Pious, 2002). Juveniles however, showed a higher percentage index of preponderance of prey items than the adults which suggest that adults, with their well developed digestive system might have sped up digestion before they were caught or they might have fed on other food items which were already digested by the time of capture. The change in diet with growth appears to offer a wide range of food resources to the species, whilst reducing possible competition between the adults and juveniles. However, there was no significant difference in the stomach contents of the two length classes (Levene's test of Equality of Variances, $p< 0.05$) over the study period in the reservoir. The presence of infectious worms (strongyloides and hookworms which usually infest the intestines of humans and livestock) in the stomachs of both juveniles and adults is an indication that, infested faecal materials were deposited at the catchments of the reservoir either by humans or livestock and are subsequently washed into the reservoir through run-off. The presence of bottom deposits (detritus) in the stomach of *Bagrus bajad* is also in line with (Ferraris, 2007) that the fish is a demersal species, that is it lives and feeds on or near the bottom of water suggesting that it is an omnivorous detritivore.

Conclusion:

In the Golinga reservoir, both juvenile and adults Bagrus bajad showed a diet overlap indicating that the fed on the same dietary components. However, there was a size-specific preference since juveniles showed a higher index of preponderance of prey items. The species in the reservoir fed on a wide range of food items and also on bottom deposits and therefore makes it a good candidate for aquaculture since feeding is a major component of any successful aquaculture system. Defecation along the catchments' of the reservoir should be prohibited to prevent worm infestation in the fishes which may eventually get to man; the last on the food chain.

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