Studies on Feeding Ecology of fresh water fish *(Barbus arabicus)*Dwelling in "Beesh Dam", Jazan, saudi Arabia.

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Abstract: A study was conducted to examine the feeding ecology of *Barbus arabicus*, a fish species endemic to Saudi Arabia. The specimens of *B. arabicus* were collected from Beesh Dam, Jazan region. The various types of food recovered from the stomach of fishes indicated that it is an omnivorous fish. The results obtained indicated that this fish species prefer to feed on phytoplankton mostly on the members of *bacillariophyceae*. There were insignificant differences in the quality of food consumed by the fishes of different size groups. The frequency of occurrence of various food items in the diet of *B. arabicus* of various sizes was high. The higher values of diet overlap index showed the sharing of various food items by *B. arabicus* of different sizes. The highest overlap index (0.98) was recorded in winter between group1 and group3 whereas the lowest (0.67) in fall between group2 and group3. The diet breadth index for all size groups were between 0.30-0.588 and showed little variation among the fishes of various sizes in different seasons.

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Key words: Freshwater fish, diet overlapping, diet breadth index, frequency of occurrence.

1. Introduction

Feeding studies are made to examine the diet of a fish population with a view to assess the species' nutritional status in the context of the fish community. Such studies may consider seasonal variations in the diet and or dietary comparison either between the different subgroups of the same species or between different species living in the same habitat. Studies related to feeding of fishes in their natural environments are of prime importance for the management of their fishery and also for the environment (Al-Kahem *et al.,* 1988, 1990). This also helps in understanding the role of fish in environments and its relation with other species of fish inhabiting in the same environment. A considerable number of literatures are available on this aspect (Ikomi & Odum, 1998; Cabral, 2000; Xie *et al*., 2000; Morte *et al.,* 2001, 2002; Friedlander *et al.,* 2002; Luckstadt & Reiti, 2002; Kavadias *et al.,* 2003; Rikardsen *et al*., 2003; Sever *et al*., 2005). Because of their biological diversity and productivity the wadis and meadows are fundamental in the synergistic framework of associated ecosystem.

The freshwater key biological sites in the arid landscapes of Saudi Arabia are the natural freshwater wetlands that include ponds, streams and springs as well as artificial wetlands such as reservoirs and effluent streams outside urban areas and agricultural developments. These freshwater wetlands attract and support a diverse assemblage of plants and animals and are important centers of endemism. The distribution of freshwater fish in Saudi Arabia is related to the availability of freshwater dispersal routes. Indigenous species of freshwater fish, of which there are a number in the western mountains, are represented by three genera.

The *Cyprinian* are of Asiatic origin, the *Garra* of European origin, while the *Barbus* is of a European and Afro-Indian origin. Interestingly there is not a single species of freshwater fish common to the eastern and western drainages of the Asir (Abuzinada *et al*., 2005). In the present study an attempt was made to examine the different types of food consumed by *Barbus arabicus* collected from Beesh dam, Jazan. The various indices such as a diet breadth index , diet overlap index and the selection of food displaced by this species were determined.

2. Materials and methods

Water samples for the phytoplankton and zooplankton were collected from the same region from where the fish specimens were collected. For the zooplankton 100 L of water was filtered through a plankton net made with cloths with a mesh size of 50 µm in a sampling bottle of 50 ml capacity. Preserved in 10% formaldehyde and kept for further investigations. For the phytoplankton 1 L of water from the surface was collected in a bottle and 10 ml of Lugols' solution was added for preservation. Qualitative and quantitative analysis of the Phyto-and zooplankton were done under the microscope and expressed as their relative percentage. The specimens of *Barbus arabicus*, (total length from 12-53 cm and total weight 20 -1350 g) were collected from Beesh Dam, Jazan at a fixed time (07.00 am+30. 00 min) between 25 to 28 of each month. Immediately after catch fishes were weighed for the total weight and measured for total length. They were divided into three groups on basis of their total lengths (I group from 12-20 cm, II group from 20.1-33 cm and III group from 33.1 to 53cm). The food canals of the fish specimens were removed weighed and preserved in 10% formaldehyde and kept for further analysis. The food contents of the gut of various fishes were analyzed according to the methods used by Jafri & Mustafa (1977) and Al-Kahem *et al*. (1990). The relative abundance of different food items in the gut of fishes of various size groups and in the environment was expressed on a percentage basis. Vacuity index (V) was measured by following Formula :

$$V = \frac{\text{Number of empty stomach}}{\text{Total number of stomach examined}} \times 100$$

Frequency of occurrence (F) of the food items was calculated on the basis of the presence of a particular food item in the gut of the fishes of different size groups.

$$F = \frac{\text{Number of stomach with food}}{\text{Number of stomachs examine}} \times 100$$

Food preference (selection) by the specimens of different size groups in different seasons were calculated by the method described by Lazzaro (1987) which is as follows:

$$E = [ri/pi] \Big/ \left|\sum_{i=1}^{n} ri/pi\right|$$

E = Food selection index, ri and pi are the proportion of food type I in the fish's ration and in the environment, respectively. Diet overlapping between size classes in different seasons is based on the overlap coefficient of Schoener (1970) and was calculated with the formula used by Morte et al. (2002) which is as follows:

$$a = 1 - 0.5\left(\sum_{i=1}^{n} |Pxi - Pyi|\right)$$

a = diet overlap co-efficient, n = types (no.) of food organisms, pxi and pyi are the numerical composition indices of prey (I) in the diet of size group x and y, respectively.

The diet breadth index was measured with Lavin's standardized index that was calculated by the formula.

$$Bi = (n-1)^{-1}[(\sum JPij^2)^{-1} - 1]$$

Bi = Lavin's standardized index for predator I,

Pij = proportion of diet of predator I that is made up for prey j

n = number of prey categories.

3. Results and discussion

3.1 Vacuity index (Emptiness index)

Variation in the values of this index was registered. Maximum value (5.71%) was noted in November and the index was zero in May, June and July (Fig. 1). Vacuity index values seemed to be low in summer season showing the index value higher than autumn, winter and spring seasons. The values of the index for this fish agree with the finding of various researchers on other species of fish from different areas. (Biagi *et al.,* 1992; Politou & Papaconstantinou, 1994; Gramitto, 1999; Morte *et al.,* 2002; Alkahem *et al.;* 2007). The fast gastric evacuation may also be the other factor for high values of the vacuity index (Cabral, 2000). The fact that sexual maturation commonly interfere with feeding activity among fishes may also partly explain the empty stomachs observed in mature fish in the present study. Morphological and dietary specialization may be other contributing factors (Malmquist, 1992; Amundsen *et al.,* 1995; Wainwright & Richard, 1995).

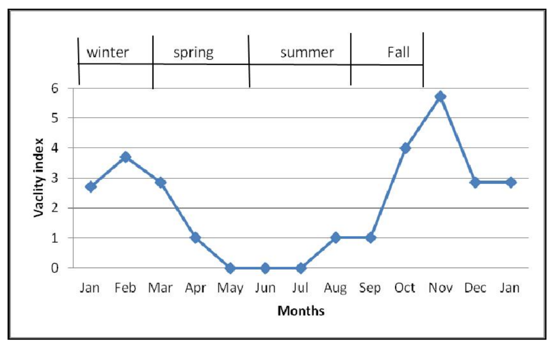

Fig. 1: Seasonal variations in the vacuity index of *B. arabicus*

3.2 Diet composition and Food selection

The results of the present study indicate that the different groups of *Barbus arabicus* feed on the same trophic level. It is a surface dwelling and its diet consists of primarily of seven major groups (Table 1). Bacillariophyceae, chlorophyceae and Myxophyceae constituted the major part of the stomach contents of the fishes of all size groups in all seasons. The other five groups Desmidiaceae, Crustaceans, Protozoa and rotifers were also consumed but in less quantity. The percentage composition of the food items in the diet of fish of different size groups was almost same. The frequency of occurrence of these food items in various groups also did not display much variation (Table 3). *B. arabicus* is a native species and was flourishing well in the different freshwater environments of the southwestern part of the Arabian Peninsula. It is omnivorous and prefers to feed mainly on Bacillariophyceae as reflected from the food selection index (Table 2). The values more than 0.018 (1/m) indicate the positive selection and less than this value showed negative selection of that particular food item. Food items from animal origin encountered were very few and most of them were negatively selected. It can be concluded that the fishes of different size groups feed mostly on common food; hence, competition for food resources among them is possible. Feeding activity of a fish is affected in a number of ways i.e. accessibility of fish to the food, its tastefulness, availability of food in the environment and lastly the cost of capture of food (Mustafa, 1976; Jafri & Mustafa, 1977; Strauss, 1979; Lazzaro, 1987; Al-Akel *et al.,* 1987; Al-Kahem *et al.,* 1988; Mills *et al.,* 1989; Shamsi *et al.,* 1995; Al-Akel, 2003; Ahmad *et al.,* 2013). It is suggested that the fish is forced to feed and thrive on some available food sources if the scarcity of certain preferred food item goes down to a critical level (Al-Akel, 2003). Most of the fish display ontogenic shift in feeding like smaller fish feeds either on zooplankton or on smaller aquatic animals and switch over on fishes and other large aquatic animals as adult. The fish B*arabus arabicus* did not show such changes or switching over from one category of food to the other for all groups in this study. Variations in food ingestion may be related to fluctuations in the density of food items in the environment (Morte *et al.,* 2002). The variation in the feeding of fish also depends upon the range depth at which fish prefer to live.

Table 1: Occurrence of different food items (percent) in the stomach of *B. arabicus* in various seasons

	seasons											
	Winter (ri)			Spring (ri)			Summer (ri)			Fall (ri)		
	Size groups			Size groups			Size groups			Size groups		
	I	II	III	I	II	III	I	II	III	I	II	III
Myxophyceae	9.46	4.075	11.3	7.79	4.005	11.9	8.45	8.22	16.3	14.8	5.9	13.6
Chlorophycea	35.08	43.7	25.2	18.2	42.97	15.9	33.1	17.9	18.7	20	21.7	27.9
Desmidiaceae	1.34	1.54	3.5	2.61	1.49	10.3	4.26	6.3	3.22	4.2	4.2	5.34
Bacillariophyceae	49.3	45.6	55	58.9	46	57.8	48.3	60.3	55.7	50.9	63.4	46.7
Rotifers	0.24	0.32	0.42	0.46	0.3	0.5	0.41	0.59	0.34	0.2	0.9	0.22
Protozoans	1.70	1.46	1.9	2.02	2.0	2.2	1.6	3.37	3.35	1.6	1.7	2.8
Crustaceans	3.09	3.62	3.0	5.79	3.5	1.92	4.25	4.01	3.19	8.5	3.0	3.6

Table 2: Food selection index of different size groups of *Barabus arabicus* in different seasons

	Seasons											
	Winter			Spring			Summer			Fall		
Food items	Size groups			Size groups			Size groups			Size groups		
	G1	G2	G3	G1	G2	G3	G1	G2	G3	G1	G2	G3
Myxophyceae	**0.015**	**0.006**	**0.012**	**0.01**	**0.006**	**0.015**	**0.006**	**0.007**	**0.013**	**0.025**	**0.008**	**0.019**
Phormidium	0.008	0.004	0.1	0.002	0.003	0.078	0.002	0.001	0.014	0.004	0.004	0.028
Polycystis	0.032	0.007	0.016	0.021	0.007	0.02	0.023	0.028	0.009	0.014	0.01	0.005
Rivularia	0.019	0.016	0.016	0.018	0.013	0.007	0.022	0.026	0.007	0.007	0.002	0.001
Spirulina	0.009	0.004	0.002	0.009	0.004	0.004	0.016	0.008	0.011	0.026	0.015	0.019
Tetrapedia	0.002	0.001	0.001	0.002	0.001	0.001	0.009	0.007	0.017	0.002	0.001	0.003
Anabaena	0.008	0.003	0.004	0.006	0.004	0.001	0.009	0.01	0.014	0.009	0.006	0.013
Oscillatoria	0.005	0.027	0.02	0.015	0.049	0.019	0.023	0.012	0.012	0.009	0.009	0.004
Coelosphaerium	0.001	0.002	0.003	0.003	0.003	0.006	0.001	0	0.01	0.004	0.005	0.043
Merismopedia	0.027	0.003	0.004	0.012	0.003	0.011	0.011	0.016	0.018	0.125	0.026	0.04
Chlorophycea	**0.02**	**0.024**	**0.01**	**0.01**	**0.028**	**0.009**	**0.013**	**0.008**	**0.008**	**0.016**	**0.014**	**0.019**
Characium	0.011	0.011	0.006	0.011	0.01	0.01	0.004	0.006	0.004	0.006	0.006	0.004
Pediastrum	0	0	0	0	0	0	0	0	0	0	0	0
Coelastrum	0.008	0.006	0.006	0.009	0.007	0.01	0.004	0.002	0.002	0.01	0.008	0.008
Kirchneriella	0	0	0	0	0	0	0	0	0	0	0	0
Tetraspora	0.013	0.016	0.009	0.013	0.014	0.01	0.007	0.007	0.006	0.008	0.001	0.008
Ankistrodesmus	0.009	0.007	0.003	0.028	0.01	0.007	0.272	0.056	0.019	0.017	0.01	0.014
Ophiocytium	0.007	0.005	0.016	0.003	0.002	0.007	0.011	0.022	0.009	0.014	0.002	0.01
Scenedesmus	0	0	0.001	0.001	0.001	0.002	0.01	0.01	0.04	0.007	0.012	0.028
Protococcus	0.066	0.016	0.004	0.004	0.018	0.013	0.07	0.049	0.013	0.033	0.031	0.032
Crucigenia	0.002	0.113	0.043	0.006	0.109	0.012	0.003	0.001	0.001	0.02	0.02	0.038
Mougeotia	0.006	0.006	0.02	0.012	0.009	0.021	0.003	0.003	0.002	0.003	0.001	0.015
Microspora	0.003	0.04	0.008	0.004	0.031	0.002	0.025	0.006	0.011	0.019	0.013	0.005
Botryococcus	0.005	0.003	0.006	0.007	0.002	0.006	0.016	0.021	0.014	0.006	0.008	0.005

Dictyosphaer	0.043	0.01	0.004	0.041	0.012	0.002	0.056	0.128	0.009	0.016	0.028	0.005
Ulothrix	0.01	0.013	0.012	0.005	0.015	0.009	0.044	0.05	0.014	0.015	0.009	0.015
Cladophora	0.004	0.003	0.004	0.005	0.006	0.007	0.01	0.013	0.34	0.036	0.064	0.056
Desmidiaceae	**0.005**	**0.006**	**0.009**	**0.01**	**0.006**	**0.038**	**0.004**	**0.006**	**0.003**	**0.009**	**0.008**	**0.01**
Gonatozygon	0.008	0.009	0.01	0.007	0.007	0.055	0.06	0.107	0.068	0.007	0.021	0.019
Genicularia	0.004	0.005	0.003	0.013	0.006	0.027	0.002	0.007	0.002	0.034	0.021	0.03
Cosmarium	0.017	0.004	0.087	0.132	0.002	0.026	0.006	0.007	0.007	0.004	0.003	0.007
Docidium	0	0	0	0	0	0	0	0	0	0	0	0
Pleurotaenium	0.009	0.008	0.019	0.003	0.002	0.01	0.016	0.003	0.003	0.007	0.002	0.002
Netrium	0.006	0.011	0.01	0.024	0.021	0.026	0.008	0.01	0.008	0.005	0.002	0.009
Staurastrum	0	0	0	0	0	0	0	0	0	0	0	0
Closterium	0	0	0	0	0	0	0	0	0	0	0	0
Bacillariophyceae	**0.062**	**0.055**	**0.049**	**0.044**	**0.041**	**0.043**	**0.011**	**0.015**	**0.014**	**0.054**	**0.055**	**0.042**
Stephanodiscus	0.169	0.098	0.047	0.058	0.012	0.024	0.038	0.051	0.006	0.068	0.209	0.013
Cyclotella	0.018	0.021	0.02	0.009	0.013	0.011	0.009	0.009	0.003	0.005	0.046	0.007
Eunotia	0.004	0.007	0.029	0.01	0.01	0.009	0.001	0.001	0.013	0.004	0.015	0.039
Diatoma	0.035	0.023	0.018	0.017	0.011	0.022	0.007	0.022	0.012	0.019	0.031	0.011
Synedra	0.07	0.038	0.013	0.078	0.04	0.023	0.012	0.015	0.009	0.071	0.07	0.03
Asterionella	0.127	0.144	0.172	0.119	0.175	0.26	0.058	0.074	0.059	0.112	0.057	0.075
Tabellaria	0.062	0.155	0.078	0.047	0.114	0.005	0.015	0.002	0.002	0.026	0.046	0.006
Nitzschia	0.002	0.041	0.007	0.003	0.047	0.013	0.003	0.004	0.013	0.032	0.037	0.023
Navicula	0.006	0.009	0.058	0.005	0.021	0.052	0.003	0.004	0.001	0.005	0.017	0.005
Frustulia	0	0	0	0	0	0	0	0	0	0	0	0
Surirella	0.056	0.018	0.036	0.015	0.011	0.018	0	0	0.012	0.005	0.014	0.183
Total phyto	**0.028**	**0.027**	**0.019**	**0.02**	**0.027**	**0.023**	**0.01**	**0.011**	**0.011**	**0.028**	**0.024**	**0.025**
Rotifers	**0.004**	**0.006**	**0.006**	**0.009**	**0.007**	**0.01**	**0.006**	**0.01**	**0.006**	**0.003**	**0.009**	**0.002**
Keratella	0.007	0.008	0.008	0.036	0.029	0.039	0.015	0.023	0.013	0.01	0.03	0.008
Chromogaster	0	0	0	0	0	0	0	0	0	0	0	0
Dicanophous	0	0	0	0	0	0	0	0	0	0	0	0
Protozoans	**0.004**	**0.004**	**0.003**	**0.005**	**0.006**	**0.006**	**0.004**	**0.01**	**0.01**	**0.005**	**0.004**	**0.008**
Chlamydomonas	0	0	0	0	0	0	0	0	0	0	0	0
Eudorina	0.01	0.009	0.003	0.007	0.013	0.017	0.008	0.03	0.006	0.009	0.016	0.009
Euglena	0.005	0.001	0.003	0.009	0.002	0.01	0.001	0.002	0.002	0.012	0.001	0.007
Monas	0.002	0.002	0.003	0.004	0.004	0.002	0.004	0.008	0.007	0.001	0.005	0.007
Peridinium	0.001	0.002	0.002	0.002	0.003	0.005	0.001	0.004	0.003	0.003	0.005	0.008
Frontonia	0.007	0.007	0.006	0.003	0.015	0.002	0.014	0.021	0.014	0.005	0.004	0.006
Polytoma	0.006	0.005	0.008	0.003	0.005	0.011	0.005	0.017	0.013	0.015	0.011	0.015
Uroglena	0	0	0	0	0	0	0	0	0	0	0	0
Paramecium	0.004	0.004	0.003	0.006	0.005	0.006	0.007	0.01	0.011	0.006	0.004	0.008
Crustaceans	**0.007**	**0.008**	**0.005**	**0.019**	**0.014**	**0.006**	**0.006**	**0.006**	**0.005**	**0.01**	**0.003**	**0.004**
Daphnia	0.007	0.005	0.006	0.024	0.021	0.017	0.005	0.007	0.005	0.003	0.003	0.004
Sida	0.006	0.003	0.002	0.012	0.006	0.002	0.005	0.003	0.001	0.02	0.001	0.003
Macrothrix	0	0	0	0	0	0	0	0	0	0	0	0
Limnocalanus	0.005	0.002	0.004	0.015	0.004	0.01	0.003	0.003	0.003	0.06	0.013	0.017
Diaptomus	0.006	0.008	0.004	0.006	0.009	0.004	0.014	0.007	0.009	0.014	0.001	0.003
Liptodora	0.015	0.007	0.012	0.049	0.013	0.009	0.014	0.018	0.003	0.004	0.001	0.001
Cypridopsis	0.008	0.021	0.003	0.023	0.027	0.004	0.007	0.006	0.006	0.006	0.01	0.004
Camptocercus	0.01	0.004	0.012	0.007	0.004	0.009	0.001	0.002	0.014	0.005	0.004	0.019
Totalzoo	**0.005**	**0.006**	**0.004**	**0.011**	**0.01**	**0.006**	**0.005**	**0.007**	**0.006**	**0.008**	**0.003**	**0.004**
Over all Total	0.022	0.022	0.016	0.02	0.024	0.02	0.009	0.011	0.01	0.022	0.018	0.019

3.3 Frequency of occurrence:

Data embodied in Table 3 indicate that the most of the food items consumed by the *Barabus arabicus* of different size groups are common. Few genera like, *Frustulia, Kirchneriella, Surirella, Monas Peridinium* and *Uroglena* have a low frequency of occurrence. Food items belonging to bacillariophyceae group were registered in the stomach of all fishes of different size groups and most of them showed high occurrence frequency (Table 4). The authors are of the opinion that there will be a competition between the fishes of different size groups and it is due to high frequency of occurrence of food items. According to Hyslop (1980) if the frequency of occurrence is more than 25% in two or more predators, competition is likely. The high frequency of occurrence of food items can be related up to some extent to the level of feeding. Fish of different size groups live in the same range depth and feed on the same level, hence, show a very high frequency of groups of occurrence of different food items in all the fishes. The frequency of occurrence may also depend upon their abundance in the environment.

Table 3: Frequency of occurrence of different food items in the fishes of different size groups in all seasons

	Seasons											
	Winter			Spring			Summer			Fall		
	F (%)	F (%)	F (%)	F (%)	F (%)	F (%)	F (%)	F (%)	F (%)	F (%)	F (%)	F (%)
Food items	**I**	**II**	**III**	**I**	**II**	**III**	**I**	**II**	**III**	**I**	**II**	**III**
Myxophyceae	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Phormidium	70	70	60	70	66.67	71.43	71.43	66.67	66.67	57.14	46.15	66.67
Polycystis	70	60	80	57.14	57.14	57.14	85.71	57.14	66.67	50	76.92	66.67
Rivularia	40	42.86	40	42.86	42.86	40	71.43	33.33	33.33	64.28	38.46	33.33
Spirulina	90	57.14	40	42.86	14.29	28.57	71.43	42.85	33.33	57.14	76.92	33.33
Tetrapedia	30	21.43	20	14.29	28.57	14.29	57.14	28.57	33.33	50	7.69	33.33
Anabaena	60	50	40	57.14	42.86	14.29	28.57	42.85	66.67	42.85	61.53	66.67
Oscillatoria	60	64.29	80	57.14	71.43	42.86	85.71	57.14	66.67	64.28	76.92	50
Coelosphaerium	20	28.57	40	28.57	42.86	28.57	57.14	28.57	100	50	84.61	100
Merismopedia	80	80	100	100	100	100	85.71	85.71	100	85.71	100	100
Chlorophycea	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Characium	30	50	40	33.33	42.86	42.86	57.14	66.67	66.67	42.85	46.15	50
Coelastrum	60	50	40	57.14	28.57	28.57	71.43	42.85	33.33	57.14	76.92	16.67
Tetraspora	30	42.86	40	42.86	57.14	28.57	71.43	57.14	33.33	42.85	15.38	33.33
Ankistrodesmus	90	100	100	100	57.14	71.43	100	100	100	85.71	100	100
Ophiocytium	30	35.71	60	71.43	100	57.14	71.43	71.42	66.67	85.71	30.77	66.67
Scenedesmus	30	14.29	40	28.57	14.29	28.57	71.43	57.14	100	50	92.31	100
Protococcus	100	100	100	85.71	100	100	100	100	100	92.85	100	100
Crucigenia	70	92.86	100	85.71	71.43	100	100	71.42	100	100	100	100
Mougeotia	50	21.43	80	42.86	42.86	28.57	57.14	57.14	33.33	42.85	30.77	66.67
Microspora	20	85.71	60	28.57	71.43	14.29	57.14	28.57	66.67	71.42	92.31	50
Botryoccoccus	70	28.57	40	71.43	100	57.14	71.43	85.71	66.67	64.28	92.31	66.67
Dictyosphaer	70	71.43	40	71.43	42.86	14.29	71.43	85.71	33.33	50	84.62	33.33
Ulothrix	50	78.57	60	42.86	42.86	42.86	42.86	57.14	66.67	42.85	69.23	66.67
Cladophora	20	21.43	40	28.57	42.86	28.57	42.86	42.85	66.67	21.42	61.54	66.67
Desmidiaceae	**90**	**92.86**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**85.71**	**100**	**100**
Gonatozygon	90	92.86	90	85.71	100	85.71	71.43	100	100	85.71	84.62	100
Genicularia	70	42.86	60	85.71	42.86	100	57.14	100	66.67	42.86	100	66.67
Cosmarium	20	7.14	20	42.86	42.86	28.57	57.14	57.14	33.33	42.86	30.76	50
Pleurotaenium	40	42.86	40	57.14	42.86	28.57	57.14	14.28	66.67	57.14	46.15	33.33
Netrium	30	50	40	57.14	57.14	42.86	42.86	57.14	66.67	57.14	38.46	33.33
Bacillariophyceae	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Stephanodiscus	70	78.57	60	71.43	57.14	42.86	100	85.71	66.67	100	100	66.67
Cyclotella	60	57.14	80	42.86	57.14	57.14	42.86	57.14	33.33	14.2	61.53	33.33
Eunotia	20	28.57	40	28.57	42.86	14.29	28.57	28.57	66.66	21.42	46.15	50
Diatoma	100	92.86	100	100	100	100	71.43	100	100	100	100	100
Synedra	100	100	80	100	100	100	100	100	100	100	100	100
Asterionella	90	100	100	71.43	71.43	85	85.71	100	100	100	100	100
Tabellaria	30	71.43	100	28.57	85.71	28.57	85.71	42.85	66.67	71.42	38.46	66.67
Nitzschia	10	57.14	40	14.29	71.43	42.86	28.57	42.85	100	0	61.53	100
Navicula	40	28.57	60	28.57	28.57	42.86	42.86	42.85	33.33	28.57	53.84	50
Surirella	0	0	0	0	0	0	14.29	28.57	0	21.42	38.46	100
Total phyto	100	100	100	100	100	100	100	100	100	100	100	100
Rotifers	**30**	**21.43**	**40**	**28.57**	**28.57**	**28.57**	**28.57**	**71.42**	**33.33**	**28.57**	**69.23**	**33.33**
Keratella	30	21.43	40	28.57	28.57	28.57	28.57	71.42	33.33	28.57	69.23	33.33
Protozoans	80	71.43	80	71.43	28.57	71.43	85.71	100	66.67	71.42	100	100
Eudorina	0	35.71	20	28.57	28.57	0	28.57	57.14	33.33	35.71	61.53	33.33
Euglena	20	21.43	40	14.29	0	57.14	14.29	28.57	33.33	0	15.3	50
Monas	0	0	0	0	0	14.29	0	28.57	0	14.28	53.84	50
Peridinium	0	0	0	0	14.29	0	14.29	0	33.33	14.28	30.76	50
Frontonia	50	64.29	20	28.57	0	14.29		42.85	33.33	28.57	53.84	50
Polytoma	0	28.57	60	28.57	0	28.57	28.57	42.85	0	0	38.47	0
Paramecium	0	21.43	20	0	0	14.29	0	42.85	66.67	0	38.47	66.67
Volvox	50	35.71	20	28.57	28.57	28.57	42.86	57.14	66.67	35.71	53.85	66.67
Crustaceans	**100**	**100**	**100**	**85.71**	**71.43**	**85.71**	**85.71**	**100**	**66.67**	**92.85**	**92.31**	**100**
Daphnia	50	28.57	60	57.14	28.57	42.86	57.14	71.42	66.67	50	84.62	66.67
Sida	60	28.57	40	57.14	14.29	28.57	57.14	28.57	33.33	42.85	46.15	50
Limnocalanus	30	35.72	40	71.43	14.29	42.86	28.57	42.85	33.33	50	61.54	0
Diaptomus	60	71.43	40	71.43	42.86	28.57	71.43	28.57	33.33	71.42	46.15	0
Liptodora	80	14.29	40	71.43	57.14	42.86	71.43	57.14	33.33	42.85	61.54	50
Cypridopsis	70	85.71	60	85.71	42.86	28.57	71.43	42.85	33.33	57.14	61.54	33.33
Camptocercus	30	21.43	40	28.57	28.57	14.29	14.29	0	0	28.57	0	33.33
Totalzoo	100	100	100	85.71	71.43	85.71	100	100	100	100	100	100

3.4 Diet overlapping:

The diet overlap index has a minimum value of 0 when no food items are shared and a maximum value of 1 when all the food items are shared. Wallace (1981) has reported that the diet overlap is considered significant when its value exceeded in 60% (0.60). The dietary similarity of *B. arabicus* among different size groups in various seasons was quantified by index of diet overlap. It was observed that high dietary overlap index existed between close size groups than non-consecutive groups (Table 4). The index values registered in winter, spring, fall and summer for all groups exceeded until 0.60. It has been observed that the fishes of different size school together and feed at the same water level, hence, similarity in feeding habit are obvious and competition would be expected. Investigation into demersal fish communities have shown an increased food overlap due to the opportunistic utilization of superabundant food resources (Macpherson, 1981; Targett, 1981; Delbeck & Williams, 1987; Morte *et al.,* 1999a, b; Pelicice & Agostinho, 2006; Alkahem *et al.,* 2007; Polacik &Rechard, 2010).

Table 4: Changes in diet overlap index among different size groups of fishes in different seasons.

Diet overlap index				
Size grops	**Winter**	**Spring**	**Summer**	**Fall**
Group1 X Group2	0.96	0.80	0.95	0.68
Group1 X Group3	0.90	0.93	0.90	0.98
Group2 X Group3	0.94	0.87	0.95	0.67

3.5 Diet breadth:

Diet breath index varied from 0.3 to 0.58 in different seasons and different size groups of *B. arabicus* (Table 5). The lowest value was recorded in summer and highest in spring. In fall and winter the index value did not change remarkably. The low index value in summer indicate that the fish's diet dominated by few food items and high values in spring show generalist diet. This line of reasoning was also given in the past (Gibson & Ezzi, 198; Krebs, 1989). Ahmad *et al.* (2013) have reported similar values of diet breadth for *Cyprinion mhalensis* and extend a considerable support to present investigation.

Table 5: Seasonal variations in the Levins' index of diet breadth of *B. arabicus*

Diet breath index			
months	**Group-1**	**Group-2**	**Group-3**
Winter	0. 33	0. 4	0. 417
Spring	0. 4	0. 417	0. 588
Summer	0. 303	0. 312	0. 345
Fall	0. 323	0. 33	0. 476

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