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Bushra Khalil
Prof. Dr. Bushra Khalil
Department of Zoology
Jinnah University for Women
V-C, Nazimabad Karachi- 74600.
Pakistan.

Farzana Ibrahim
Department of Zoology
Jinnah University for Women
V-C, Nazimabad Karachi- 74600.
Pakistan.

Food and feeding habits of *Cynoglossus arel* (Family: Cynoglossidae) from Karachi Coast, Pakistan

Bushra Khalil, Farzana Ibrahim

Abstract

The pattern of food and feeding habits *Cynoglossus arel* was studied during the period from June 2012 to June 2013, using point's methods. The composition of food of different size groups and seasons was calculated. Analysis of fullness of stomach revealed gorged – full constituted 0.67%, 3/4- full 0.90%, 1/2 - full 7.18%, 1/4- full 13.68%, barely full 70.85% and empty 6.73% in a year. Analysis of stomach contents showed the occurrence (in percentage) of polychaetes 8.12%, crustaceans 17.56%, molluscs 9.31%, fish 0.84%, sand-mud 10.39% and miscellaneous items 53.76%. Total points of fish were determined to be 4.45% for polychaetes, 21.52% for crustaceans, 7.93% for molluscs, 0.73% for fish, 7.88% for sand-mud and 57.50% for miscellaneous items.

Keywords: food analysis, stomach, carnivore, flat fish, Karachi coast.

1. Introduction

Flat fishes are excellent food fishes and these are marketed mostly fresh, frozen and also dried salts. Flat fishes are abundant in the open continental shelf and are fished on a commercial scale Munro [1]. *Cynoglossus* sp. mainly inhabit the soft muddy bottom, but some inhabit the areas of gravel and sand. They are considered one of the most important predators in benthic communities.

Flatfish serve as a major energy pathway for conservation of benthic production into a form suitable for human consumption.

De-Groot [2] found that flatfish tend to be of different feeding groups; fish-feeders, crustacean-feeders, polychaete/mollusks-feeders, thereby minimizing competition for food (Lande [3], Stickney *et al.* [4], Kravitz *et al.* [5], Percy and Hancock [6], Steinarsson [7].

Livingston [8] showed that flatfish primarily consume benthic invertebrates, with some larger, wider-gaped species being almost entirely piscivorous.

Studies on the feeding habits of flatfishes that have been conducted all over the world and been studied by a number of workers included Khan [9] and Hoda [31], Shaikat [10], Arndt and Nehils [11], Braber and De-Groot [12, 13], De-Groot [2], Kruuk [14], Lande [3], Moiser [15], Ochiai [16], El-mor and Ahamed [17] and Bayhan *et al.* [18]. Only a few studies were made on the food and feeding habits of *Cynoglossus* sp.; notably among them are Rao [19, 20], Seshappa and Bhimachar [21], Kuthlingham [22], Rajaguru [23], Jayaprakash [24] and Atabak [25].

However, taxonomical studies of this species have been carried out by Day [26], Fisher & Bianchi [27], Ramanathan [28], Qureshi [29], Ahmad and Niazi [30], Hoda [31] and Munro [1]. This paper present information on the feeding intensity and food habits of *C. arel* in the months of season and at different size groups.

2. Material and methods

A total of 446 specimens of *Cynoglossus arel* were collected from commercial landing at Karachi fish Harbor during June 2012 to June 2013. Each fish in the sample were measured from the tip of the snout to the end of the caudal fin. Stomachs were removed and opened to determine the degree of fullness and examined qualitatively. Food contents were grouped into five categories such as polychaetes, molluscs, crustaceans, fishes and miscellaneous food materials.

The stomach contents were the weighed and preserved in 70% alcohol for further analysis based on the occurrence method and points method of Hynes [32] which was adopted with slight modification allotting the points for fullness of stomach according to an arbitrary 6 points scale: 75, 50, 25, 12, 6, 0 points awarded for gorged-full, ¾ full, ½ full, ¼ full, little

Correspondence
Bushra Khalil
Prof. Dr. Bushra Khalil
Department of Zoology
Jinnah University for Women
V-C, Nazimabad Karachi- 74600.
Pakistan.

and empty stomach respectively based on inspection and estimation. The points assigned to food categories were ascertained by subdividing the total points allocated to stomach. All the points gained by each food categories were summed up and scaled down to give a percentage composition of food of all fish examined. In the "occurrence" method the number of fish in which each food item occurs is listed as percentage of total number of fish examined and calculated by ratio of number of fish feeding on particular food and number of fish examined multiplied by 100.

3. Results

Food in relation to seasons

The data on the stomach contents of 446 specimens of *C. arel* are show in Table 1 and 2. From Table 1 it is evident that the intensity of food out of 446 stomach 416 (93.27%) were with food and 30 (6.73%) without food. Among these 3 (0.67%) stomach were gorged full with food, 4 (0.90%) were 3/4 full, 32 (7.18%) were 1/2 full, 61 (13.68%) were 1/4 full, 316 (70.85%) were barely full. Fish with the highest percentage of intensity of feeding in 6 categories was marked during spring – summer i.e. February – May and minimum feeding in winter i.e. September – December while in other months feeding appeared normal as judged by the barely full and empty stomachs. The intensity of feeding did not vary during June – August and January. The type of the amount of different food group taken by fish is shown in Table 2 & 3.

Full (gorged-full) stomachs were found in December-January (2012-2013) and June (2013), but June 2012, the *C. arel* fed had 7.14% 1/2 full and 92.86% barely full and empty together. Barely full and empty stomachs combined together formed 57.14-61.54% during Feb-April 2013, which dropped to 40.00 - 46.15% in May – June, 2013. 1/4-full to 1/2-full stomachs were generally seen in almost all the months except August-September when stomachs were practically free from food constituents. These seasons coincide with spawning time. Gorged-full stomachs in December –January and June forming 2.65 - 2.94% (Table 1).

Among the different food groups, miscellaneous items were the most dominant food group by percentage of total occurrence (53.76%), whereas next to miscellaneous items, crustaceans were the second most important food group (17.56%), followed by sand mud (10.40%), molluscs (9.32%), polychaetes, (8.12%) and fish (0.84%) occupied the successive positions by percentage of total occurrence.

Crustacean occurred in all the season of the year with the maximum frequencies during Spring-Summer, February-May (20.46-33.33%) and a moderate feeding during August and November-January (13.79-17.02%) and low feeding intensity during September - October (7.43-9.52%) Polychaetes occurred in all the seasons except July and October and molluscs were absent in May. Fish though in minute quantity occurred in June 2012 (2.86%), July (1.41%), September (0.68%) and October (9.52%), Sand –mud occurred frequently in all months except January 2013 when the miscellaneous items constituted the major food constituents i.e. 62.07%. Miscellaneous items occurred in all seasons with more than 50% during August 2012 to March 2013. Percentage total points fish are shown in table 3.

Food in relation to fish size

The variation of food items with length was illustrated in Table (4-6) The intensity of feeding was least during young groups, 141-240 mm, where the barely –full and empty stomachs were very high (except 181-190 mm TL). Barely – full and empty stomachs together formed 77.27 - 85.72 from 231 mm to 330 mm TL, after which low percentages 60.00 - 66.67% were marked. 1/2-full and 1/2-full stomachs (1.43 - 2.27%) in 261-310 mm size groups, and full stomach (gorged-full) constituting 5.263 - 6.06% were observed in 311 - 330 mm size (Table 4).

Both polychaetes and crustaceans or either occurred till 230 mm TL after which molluscs joined them to form the food contents from 231- 300 mm and 341-350 mm TL. Fish if available occurred in large groups above 241-250 mm (Table 5).

Miscellaneous items formed the major condition of intensity of food contents in all size groups and sand–mud contents appeared to be taken along with the other food substance from the bottom.

Molluscs and fish were absent in young individuals till 231 mm, after which crustateans, polychaetes, molluscs and sand-mud appeared in varying percentages. However, in large species, molluscs and fish were not found in 350 mm sample and above miscellaneous items occurred very frequently in all sizes.

Intestinal nematodes were found in some cases, but no morphological abnormalities has been found due to presence of such parasites.

Total points of fish were determined to be 4.45% for polychaetes, 21.52% for crustaceans, 7.93% for molluscs, 0.73% for fish, 7.88% for sand-mud and 57.50% for miscellaneous items (Table 6).

Food contents of *C. arel* divide into 6 categories: 1. Polychaetes, 2. Crustaceans, 3. Molluscs, 4. Fish, 5. Sand-mud, 6. Miscellaneous. The details of food contents are shown in Appendix 1.

Appendix 1

Polychaetes: Diptera sp., Polynoids sp., Orbiniids sp.

Crustaceans: *Squilla empusa*, *Philyra globbosa*, Porcellain crabs Copepods, Mysis, Parapenaeops, Isopods.

Molluscs: Gastropods shells, Bivalve shell, *Solen* sp. *Mytilus* sp., *Pholladidea* sp. *Codelia*, *Tellina* sp.

Fish: *Cynoglossus* sp.

Sand-mud: Sand grains, Pebbles, gravel and mud.

Miscellaneous: Eyes, head, appendages, chelae, carapace and antennae of crabs and shrimps (crustacean), Scales and eggs of fish, Elytra and remains of tubicolous (Polychaetes) Pieces of shells (Molluscs), Small fragment of plants Holothurians, pieces of star fish (Echinoderms), Semidigested and unidentified specimens.

Table 1: Season of the year and percentage of intensity of feeding *C. arel* in different Months.

Year	Month	Stomach Examined	Gorged-full	3/4-full	1/2-full	1/4-full	Barely -full	Empty
2012	June	14	-	-	7.14	-	85.71	7.14
	July	36	-	-	5.56	16.67	77.78	-
	August	20	-	-	-	-	100.00	-
	September	82	-	-	-	-	97.56	2.44
	October	14	-	-	-	14.29	71.43	14.29
	November	62	-	-	-	6.45	87.10	6.46
	December	37	2.70	-	2.70	16.22	75.68	2.70
2013	January	34	2.94	-	5.88	17.65	67.65	5.89
	February	21	-	-	4.76	38.10	52.38	4.76
	March	55	-	1.82	21.82	21.82	45.46	9.10
	April	26	-	-	7.69	30.77	46.15	15.39
	May	5	-	-	-	60.00	40.00	-
	June	40	2.56	7.69	28.21	15.39	25.64	20.51
% of Intensity		446	0.67	0.90	7.18	13.68	70.85	6.73

Table 2: Percentage occurrence of various groups of food items in the stomach of *C. arel* in different months

Year	Month	Stomach Examined	Polychaetes	Crustaceans	Molluscs	Fish	Sand Mud	Miscellaneous
2012	June	14	11.43	20.00	14.29	2.86	5.71	45.71
	July	36	-	25.35	2.82	1.41	21.13	49.30
	August	20	2.13	17.02	10.64	-	17.02	53.19
	September	82	2.70	7.432	15.54	0.68	12.16	61.49
	October	14	-	9.52	19.05	9.54	4.76	57.14
	November	62	11.48	16.39	13.12	-	2.46	56.56
	December	37	18.75	14.06	4.69	-	1.56	60.94
2013	January	34	8.62	13.79	15.52	-	-	62.07
	February	21	18.18	20.46	2.73	2.73	6.82	50.00
	March	55	9.80	21.57	5.88	-	10.78	51.96
	April	26	8.70	26.09	6.52	-	17.39	41.30
	May	5	20.00	33.33	-	-	20.00	26.67
	June	40	4.84	25.81	1.61	1.61	17.74	48.39
% of Occurrence		446	8.12	17.56	9.32	0.84	10.40	53.76

Table 3: Percentage of total points of food contents of *C. arel* in different months.

Year	Month	Stomach Examined	Polychaetes	Crustaceans	Molluscs	Fish	Sand Mud	Miscellaneous
2012	June	14	6.19	23.71	12.37	1.03	6.19	50.52
	July	36	-	32.41	7.93	0.34	13.10	46.21
	August	20	1.67	11.67	10.00	-	12.50	64.17
	September	82	2.92	4.38	9.79	0.21	6.25	76.46
	October	14	-	8.33	13.10	3.58	7.14	67.86
	November	62	4.30	12.90	5.91	-	1.88	70.00
	December	37	8.82	18.23	2.65	-	0.88	69.41
2013	January	34	3.88	14.63	24.78	-	-	56.72
	February	21	8.02	10.16	13.37	6.42	4.28	57.75
	March	55	6.99	21.43	6.21	-	5.90	59.47
	April	26	5.05	24.77	5.05	-	15.60	49.54
	May	5	12.50	39.59	-	-	16.67	31.75
	June	40	2.06	44.30	1.58	1.58	17.41	33.07
% of Total Points		446	4.45	21.52	7.93	0.73	7.88	57.50

Table 4: Percentage of intensity of feeding of *C. arel* in different size groups.

Size group (mm, TL)	Stomach Examined	Gorged-full	3/4-full	1/2-full	1/4-full	Barely -full	Empty
151-160	1	-	-	-	-	100.00	-
161-170	1	-	-	-	-	100.00	-
171-180	2	-	-	-	-	100.00	-
181-190	4	-	-	25.00	50.00	50.00	-
191-200	1	-	-	-	-	100.00	-
201-210	3	-	-	-	-	100.00	-
211-220	2	-	-	-	-	50.00	50.00
221-230	4	-	-	-	-	100.00	-
231-240	7	-	-	14.29	-	71.43	14.29
241-250	19	-	-	10.53	5.26	68.42	15.79

251-260	46	-	-	4.35	17.39	71.74	6.52
261-270	44	-	2.27	2.27	13.64	70.46	11.36
271-280	66	-	-	9.09	13.64	66.67	10.61
281-290	70	-	1.43	4.29	14.29	78.57	1.43
291-300	48	-	2.08	8.33	8.33	75.00	6.25
301-310	50	-	2.00	14.00	10.00	72.00	2.00
311-320	33	6.06	-	3.03	15.15	72.73	3.03
321-330	19	5.26	-	-	15.79	73.68	5.26
331-340	10	-	-	30.00	10.00	50.00	10.00
341-350	9	-	-	22.22	44.44	33.33	-
351-360	4	-	-	-	75.00	25.00	-
361-370	3	-	-	-	33.33	66.67	-
% of Intensity	446	0.67	0.90	7.18	13.68	70.85	6.73

Table 5: Percentage of occurrence of various groups of food items of *C. arel* in different size groups.

Size group (mm, TL)	Stomach Examined	Polychaetes	Crustaceans	Molluscs	Fish	Sand Mud	Miscellaneous
151-160	1	-	-	-	-	-	100.00
161-170	1	33.33	33.33	-	-	-	33.33
171-180	2	-	-	-	-	-	100.00
181-190	4	42.86	14.29	-	-	-	42.86
191-200	3	25.00	-	-	-	-	75.00
201-210	2	-	-	-	-	-	100.00
211-220	4	-	-	-	-	-	100.00
221-230	7	9.09	9.09	9.09	-	18.18	54.55
231-240	19	5.88	17.65	17.65	2.94	5.88	50.00
241-250	46	10.53	18.95	9.47	2.11	12.63	46.32
251-260	44	5.33	16.00	2.67	1.33	17.33	57.33
261-270	66	4.13	15.70	13.22	-	11.57	55.37
271-280	70	8.89	19.26	6.67	0.74	14.82	49.63
281-290	48	6.59	20.88	7.69	1.10	9.89	54.39
291-300	50	9.57	20.21	8.51	-	5.32	56.38
301-310	33	6.06	15.15	10.61	-	10.61	57.58
311-320	19	10.53	13.16	23.68	-	-	52.63
321-330	10	23.53	11.77	11.77	-	-	52.94
331-340	9	-	27.27	9.09	4.56	9.09	50.00
341-350	4	11.11	11.11	-	-	-	77.78
351-360	3	14.29	14.29	-	-	14.29	57.14
% of Occurrence	446	8.12	17.56	9.31	0.84	10.40	53.76

Table 6: Percentage total points of food contents of *C. arel* in different size groups.

Size group (mm, TL)	Stomach Examined	Polychaetes	Crustaceans	Molluscs	Fish	Sand Mud	Miscellaneous
151-160	1	-	-	-	-	-	100.00
161-170	1	33.33	33.33	-	-	-	33.33
171-180	2	-	-	-	-	-	100.00
181-190	4	41.67	4.17	-	-	-	54.17
191-200	3	16.67	-	-	-	-	83.33
201-210	2	-	-	-	-	-	100.00
211-220	4	-	-	-	-	-	100.00
221-230	7	1.82	7.27	18.18	-	7.27	65.46
231-240	19	2.14	7.14	34.29	0.71	4.29	51.43
241-250	46	8.56	20.93	5.52	3.78	13.08	49.13
251-260	44	4.20	26.13	1.80	0.60	8.71	58.56
261-270	66	1.03	19.16	7.09	-	8.62	62.26
271-280	70	5.91	19.65	7.13	0.17	12.52	54.61
281-290	48	4.83	31.88	3.14	0.24	6.28	53.62
291-300	50	4.19	22.75	4.79	-	3.39	64.87
301-310	33	1.32	23.75	4.75	-	13.46	56.73
311-320	19	3.590	16.92	30.26	-	-	49.23
321-330	10	6.84	14.53	21.37	-	-	57.27
331-340	9	-	41.38	4.31	8.62	6.03	39.66
341-350	4	2.38	2.38	-	-	-	95.24
351-360	3	4.17	16.67	-	-	4.17	75.00
% of Total Points	446	4.45	21.52	7.93	0.73	7.88	57.50

4. Discussions

Present study indicates that *C. arel* is a carnivorous in nature, fish which mainly feed upon crustaceans, molluscs, polychaetes, and fishes. Crustaceans and mollusc are the most favored diet of *C. arel*. Seasonal variations in feeding habits are marked considerably. That the intensity of food out of 446 stomach 416 (93.27%) were with food and 30 (6.73%) without food. Among these 3 (0.67%) stomach were gorged full with food, 4 (0.90%) were 3/4 full, 32 (7.18%) were 1/2 full, 61 (13.68%) were 1/4 full, 316 (70.85%) were barely full. Fish with the highest percentage of intensity of feeding in 6 categories was marked during spring – summer i.e. February – May and minimum feeding in winter i.e. September – December while in other months feeding appeared normal as judged by the barely full and empty stomachs. The intensity of feeding did not vary during June – August and January. Similar observations have also been made by Rao^[20], Khan^[9], Shaukat^[10], De-Groot^[2], Lande^[3], Bayhan *et al.*^[18].

Seshappa and Bhimachar^[21] and Rajaguru^[23] reported the same observation on Malabar sole and the tongue fishes in Indian water. *Cynoglossus* species on the other hand feed mainly on polychaetes with crustaceans as a close second. Seshappa and Bhimachar^[21] observed that polychaetes formed the main constituent of the food of Malabar sole *C. semifasciatus*.

Similar observation have been reported by De-Groot^[2] that in food of species of *Cynoglossus* the crustaceans formed the main constituents and concluded that the species of the genus are crustacean feeders. Studies on the food of *Cynoglossus lingua* by Kuthalingam^[22] indicated that the large growing flatfishes are voracious carnivores feeding on crustaceans and fishes. In Malabar sole the visual factor is not involved when feeding detritus, but this is an important factor while feeding on polychaetes.

5. Conclusions

In the current work, although the primary diets of this demersal flatfish consisted of benthic prey, such as crustaceans, molluscs and polychaetes

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