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FEEDING BEHAVIOR AND FECUNDITY RATE OF SHRIMP SCAD *ALEPES DJEDABA* ALONG BALOCHISTAN COAST, PAKISTAN

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ABSTRACT

Shrimp scad *Alepes djedaba* is widespread in tropical waters and commercially important fish species of Pakistan. Feeding habits and fecundity rate were studied for *A. djedaba* from Balochistan, Pakistan. Total of 111 specimens were examined to perceive the feeding habits and 102 specimens for fecundity rate. Total of 16 ovaries were taken from stage four for estimation of fecundity rate. Frequency occurrence and numerical abundance were used to evaluate the feeding behavior. In frequency occurrence method different food items was observed. Fishes were found at 46% in guts, digested food at 34%, shrimp at 14% and shrimp larvae were found at 6%. While, fishes were observed at 48.74%, digested food at 33.17%, shrimps at 13.32% and shrimp larvae at 4.77% according to numerical abundance. These results show that *A. djedaba* is carnivorous in nature. The lowest fecundity rate was 8693 and highest rate was 73246, the average of fecundity rate of *A. djedaba* was found to be at 37220. Based on present findings it is evident that the fish has an extended spawning period throughout the year with a peak in July and August. The positive correlation (R^2= 0.976) was observed between fish (weight) and fecundity rate during present study.

Keywords: *Alepes djedaba*, frequency occurrence, preponderance index, Gonadosomatic index

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INTRODUCTION

Carangids belong to order Perciformes, suborder Percoidei, and superfamily Percoidea. Family Carangidae includes group of fishes generally called jacks, trevallies, amberjacks, pompanos, scads, kingfish, pilotfish, rainbow runners and others. The carangid fishes occupy marine and estuarine waters in tropical, subtropical and temperate areas (Bannikov, 1987). Most of the Carangidae species are vital for the profitable, recreational and aquaculture fisheries (Katsuragawa and Matsuura, 1992; Psomadakis *et al*., 2015). As a fish species in family carangidae, Shrimp scad *Alepes djedaba* (Forsskål, 1775) is a pelagic fish and forms inhabitants near rock reefs, often in turbid waters (Carpenter *et al*., 1997). *A. djedaba* is one of the most commercially important fish species from Pakistani waters mainly exported to different countries of the world.

The presence of maturing and mature females of *A. djedaba* specimens in most of the months indicated a prolonged spawning period. The fecundity of this fish ranges from 621600 to 806386 (Raje, 1993). According to Shuaib and Ayub (2011) *A. djedaba* ranging in weight between 181 to 413 g and fecundity rate 8981 to 75075 eggs (average 26649.3 ± 17747.4). Feeding behaviors of fish significantly affects growth, existence reproduction and mortality (Wootton, 1990; Fagberno *et al*., 2001), and having trophic connection in an ecosystem (Pauly and Christensen, 2000). This species feed on two types of animals i.e., juvenile fishes and crustacean larvae depending on the availability of these food items.

Numerous studies are available from Pakistani waters on stock evaluation and biological reference point of Carangidae family and other important species of Pakistan (Panhwar *et al*., 2014; Qamar *et al*., 2015, 2016; Kalhoro *et al*., 2017; Razzaq *et al*., 2019; Baloch *et al*., 2020; Abdul *et al*., 2021). While, study on biological parameters were reported from Pakistan (Shuaib and Ayub, 2011; Qamar *et al*., 2015), and from other parts of the world like Porto Novo (Venkataramani *et al.,* 1984), Cochin India (Sivakami, 1990), Verayal coast India (Raje, 1993), and from Egypt (Attia, 2018). However, to the best of our knowledge there is limited information available on feeding habits and fecundity rate of *A. djedaba* from Pakistani waters. This is because present study on feeding habits to know diet composition and tropic level of fish species. Fecundity rate of *A. djedaba* was conducted, which would contribute in basic biological study. Present findings will help for fishery management to set the fishing and ban season for this species from Balochistan coast, Pakistan.

MATERIALS AND METHODS

Data collection: Total of 111 specimens of *A. djedaba* was examined to observe the feeding habits and 102 specimens for fecundity rate. Samples were collected during research survey program along Sonmiani Bay Daam, Kundmalir, Ormara, Pasni, Gwadar and Jiwani during March 2019 to February 2020 along Balochistan, Pakistan. The fork length (FL) was measured in centimeters (cm) on measuring board and weight was measured using digital balance in grams (g). The minimum and maximum length and weight was measured at 17 to 31.5 cm and 55 to 252 g, respectively. However, total of 16 ovary samples were taken from stage four to estimate fecundity rate of *A. djedaba* during present study. The length and weight to examine fecundity rate of fish ranging from 20 to 37 cm and 89 to 279 g, respectively.

Fecundity rate: Fecundity is considered to be the number of eggs hatched by females before they are born young ones (Bagenal and Braum, 1978). The gravimetric technique or weight technique (Lagler, 1956) was used to assess the fecundity of *A. djedaba*. The gravimetric method offers the greatest opportunity of error reduction and easy sampling method. The gravimetric technique is more effective than any other process. The gravimetric or weight process has been effectively used by Doha and Hye (1970), Shafi *et al.* (1978), and Dewan and Doha (1979). The eggs of sub-samples of ovaries were preserved in buffer solution for 24 hours. Due to preservation in solution the eggs was easily counted by microscopic colony counter.

The values were relative to ovary weight; quantity of eggs for sub-sample calculated by applying follows formula:

$$Facundity = \frac{\text{No. of eggs in sub} - \text{sample} * \text{Gonadal weight}}{\text{Weight of sub} - \text{sample}}$$

Gonadosomatic Index: Gonadosomatic Index (GSI) is a percent (%) of total weight of fish. The GSI of fish samples were estimated for all of the female individually by following method:

$$GSI = \frac{\text{Weight of Ovary} * 100}{\text{Weight of fish}}$$

Feeding habits: Sample lengths and weights were measured after that abdomen of fishes were split open to determine the sex and then guts were removed carefully, weighted (g) together with its contents. Gut contents were removed and preserved in 70 % formalin. All food items in stomach were recognized to the achievable taxon with the help of standard identification keys. The feeding habits and different prey in the diet of fish quantified using frequency occurrence (*Co*) and numerical abundance (*Cn*). Frequency occurrence and numerical abundance was calculated using Hureau (1970) following formula:

$$Co = 100 \times \frac{\text{No. of stomach containing certain food item}}{\text{No. of examined full stomachs}}$$

$$Cn = 100 \times \frac{\text{No. of food items concerned}}{\text{Total no. of food items observed}}$$

Index of relative importance: The present great quantity (% N), percentage weight (% Wt), and percentage frequency (% F) of every prey group were estimated by Hyslop (1980). The knowledge were used to estimate an index of relative Importance (IRI) that together all three food estimates (Pinkas *et al.,* 1971). $\boldsymbol{IRI} = (\%\,\mathbf{N} + \%\,\mathbf{Wt}) * \%\,\mathbf{F}$, where, index of relative importance (IRI) were further calculate and show as % IRI (Cortes, 1997).

RESULTS

Fecundity rate: The fecundity rate ranged from 8693 to 73246. The average of fecundity of *A. djedaba* was 37220. The positive correlation (R^2= 0.976) between fish weight and fecundity rate was observed during present study (Figure 1).

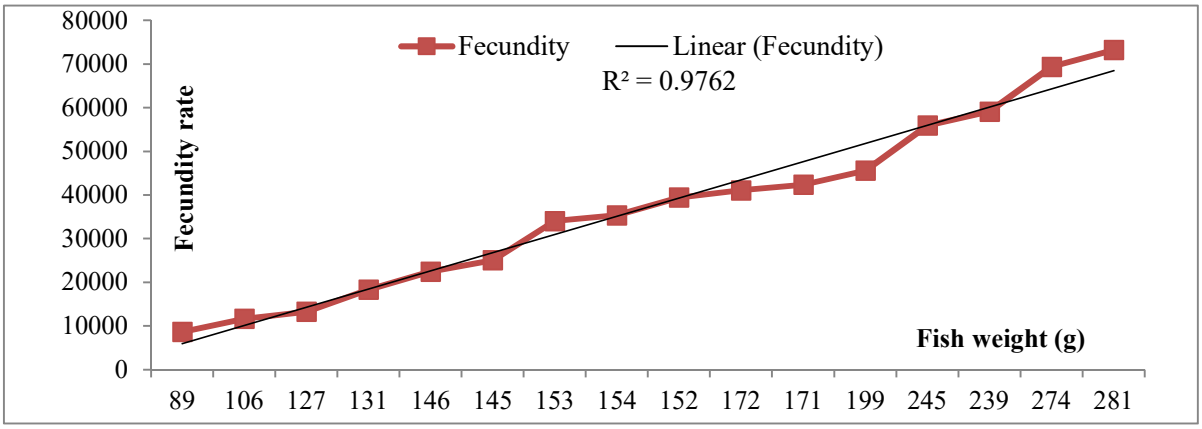

Figure 1. Fecundity rate (weight relation to fecundity) of *A. djedaba* fish along Balochistan coast, Pakistan

Different fecundity rate was observed from different length size classes of fish. The high fecundity rate in length class size (23 to 25 cm) was 31%, (20 to 22 cm) 23.32 %,(26 to 28 cm) 22.23 %, (29 to 31 cm) 17.91 %, (35 to 37 cm) 2.83 % and the low fecundity rate was observed as (32 to 34) 2.71% (Table 1). The highest rate was observed in 23-25 length class (cm) of fish species along Balocistan coast, Pakistan.

Table 1. Fecundity rate (%) of *A.djedaba* based on length class during the study 2019-2020

Length class (cm)	Number	Fecundity rate %
20-22	29	23.32
23-25	33	31.0
26-28	21	22.23
29-31	15	17.91
32-34	2	2.71
35-37	2	2.83

Maturity stages of male and female gonads of *A. djedaba*:

1. Stage 1st (Immature): In the stage 1st, the ovary was clear, eggs invisible and colour was observed pink. Ovary size was small, while the testes were observed white and thin.
2. Stage 2nd (Maturing): In 2nd stage the ovary was observed with small ova and developing the yolk. light yellowish in colour. While testes was found few big as compared to normal size with white colour.
3. Stage 3rd (Mature): In stage 3rd, the ovary was observed with normal in size and yellowish in colour .While testes size was also normal.
4. Stage 4th (Ripe): In stage 4th, the ovary was full with ova and large in size .While both ovaries and testes were found releasing liquid material.
5. Stage 5th (Spent): In stage 5th, the ovary was with light reddish in colour, and testes were in white colour. While the size of testes and ovary found to be reduced

While, higher percentages about 60% maturing and mature female ovaries were found during July and August. However, ripe ovaries about 40.5% were observed during June. Whereas, spent fish percentage was found during October, November and December at 45.5%, 55.5% and 50.5 % respectively. While, immature fishes were found during February at about 75% (Table 2). However, greater number of maturing and mature male fish tests was detected during February with 62% and July 45 % and ripe fish during September 35.5 %. The spent fish found in the months of April 50.2 %, June 55.5 %, October 60% and December 52%. However, male immature fish was found during February about 62% (Table 3). It was observed that male and female mature and ripe fishes almost present in different month. The present findings indicate that *A. djedaba* breeds throughout the year but the favorable season was observed during July and August.

Table 2. Distribution of female ovaries (%) percentage of *A. djedaba.*

Months	immature	maturing	mature	ripe	spent
March	45	10	-	-	45
April	50.5	14	0.5	-	35
May	30.5	14	10	0.5	45
June	-	19	40.5	40.5	-
July	-	60	30	10	-
Aug	-	-	60	30	10
Sep	-	29.5	35	35.5	-
Oct	35	15.5	4	-	45.5
Nov	25	10.5	-	9	55.5
Dec	34	5.5	-	10	50.5
Jan	45	10	7	7	31
Feb	75	4.5	-	-	20.5

Table 3. Distribution of male tests (%) percentage of *A. djedaba.*

Months	immature	maturing	mature	ripe	spent
March	37	10	12.5	-	40.5
April	25.3	-	10.5	14	50.2
May	18	8	16	20.5	37.5
June	35.5	-	-	9	55.5
July	-	45	30	25	-
Aug	15.3	-	44.2	30	10.5
Sep	-	29.5	35	35.5	-
Oct	24.5	-	-	15.5	60
Nov	35	4.5	-	15	45.5
Dec	39	-	-	9	52
Jan	45	-	24	-	31
Feb	62	6	-	-	32

Gonadsomatic index: The GSI, as the weight of ovary ratio for body weight, was used as an indicator of the gonad state and the maturity index of the fish. After measuring the length and weight of the fish, the ovaries were separated. The weight ratio of gonads and fish was calculated for each individual.

The low calculated value was 2.24% and high GSI value estimated as 4.402%. Length vary in the relative weight of ovaries was expressed as GSI. The GSI values between length sizes were significantly different (Table 4).

Feeding habits: In current study frequency occurrence for different food items was estimated as fish 46%, shrimp larvae 6%, shrimp 14% and digested food is 34% (Figure 2).

The numerical abundance value of different food items of *A. djedaba* is shown in Table 5. The most abundant food item was fish (48.74%), shrimp larvae (4.77%), shrimp (13.32%) and digested matter (33.17%). The fish was found as abundance food items in the fish gut content.

Index of relative importance: The present great quantity of numeric abundance was 48.74%, percentage weight 41.66 % and percentage frequency 46%. This knowledge is use to estimate an index of relative importance (IRI %) that together all three food estimates. The index of relative importance (IRI %) was recorded about 0.09% during present study.

Table 4. Gonadosomatic index of *A. djedaba* along Balochistan coast, Pakistan.

Length (cm)	Number of fish examined	GSI %
20	1	2.247
21	5	2.35
21.5	7	2.461
22	7	3.484
22.5	9	3.079
23	5	3.554
23.5	7	4.072
24	8	3.568
24.5	6	3.941
25	4	3.727
25.5	3	4.068
26	3	4.402
26.5	4	4.148
27	4	3.89
27.5	3	3.723
28	4	3.746
28.5	3	3.691
29	3	3.357
29.5	2	3.211
30	3	3.278
30.5	3	3.074
31	2	3.313
31.5	2	3.036
32	2	3.153
35.5	2	3.035

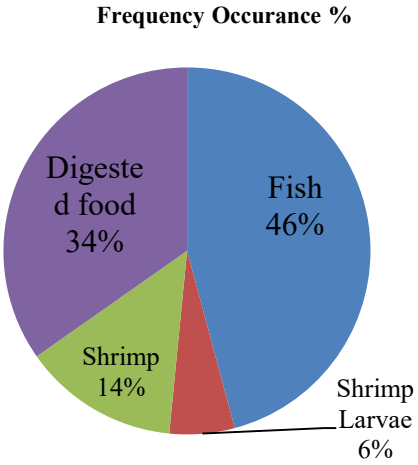

Figure 2. Frequency occurrence (% *Co*) for food items of *A. djedaba* from Pakistan

Table 5: Numeric abundance (% *Cn*) of different food items of *A. djedaba* along Balochistan coast, Pakistan.

Food organism	Total food item	Numeric abundant (*Cn*)
Fish	194	48.74
Shrimp larvae	19	4.77
Shrimp	53	13.32
Digested matter	132	33.17

Feeding intensity: Intensity of feeding of *A. djedaba* was calculated from gastro-somatic index (GaSI) (Desai, 1970). The high percentage of empty stomach were found as 33.09 (%) in 17 – 19 cm size class and small value found as 13.62% in length class 29-31 cm. The empty stomach contains ¼ while full stomach consists on 3/4 full and ½ full stomachs respectively. High percentage value of fullness of stomach were found in current study as 21.33% in length class 29-31 (cm) and lowest percentage value of full stomach was observed as 17.26% in length class 17-19 (cm) (Table 6).

Table 6: Feeding intensity of *A. djedaba* for different size class based on percentage of emptiness and fullness.

Length class (cm)	Empty	Emptiness %	Full	Fullness %
17 – 19	28.57	33.09	71.43	17.26
20 – 22	12.5	14.47	87.5	21.15
23 – 25	19.23	22.27	80.76	19.52
26 – 28	14.28	16.53	85.71	20.72
29 – 31	11.76	13.62	88.23	21.33

Emptiness includes ¼ full and empty stomachs; Fullness includes full, 3/4 full and ½ full stomachs.

Table 7: Index of preponderance of different length classes of different food items *A djedaba.*

Length class (FL-cm)	Fish	Shrimp larvae	Shrimp	Digested matter
17-19	33.33	8.34	16.67	41.66
20-22	16.19	0	19.04	64.77
23-25	37.04	13.58	9.87	39.51
26-28	64.59	0	12.5	22.91
29-31	77.88	6.73	10.58	4.81

Index of preponderance: Analysis of stomach diet of *A. djedaba* consists of fishes, shrimp larvae, shrimp and digested materiel. Food items are classified into different length (cm) classes. Index of preponderance indicates that fishes were major food items consumed by fish. Food varies in different length class. The high value of fish food was observed as 77.88% found in class 20-31 (cm),

shrimp larvae high value was 13.58% found in class 23 - 25 (cm), shrimp highest value present 19.04 % and digested matter 64.77 % in the class 20-22 (cm) (Table 7).

DISCUSSION

Fecundity rate: Information about total quantity of eggs produced by a fish during a year is significant to determine the spawning potential of fish (Jadhav and Mohite, 2014). In previous studies from India the fecundity of this fish was ranged from 621600 to 806386 (Raje, 1993), and from Pakistan fecundity rate ranged from 8981 to 75075 eggs (Shuaib and Ayub, 2011). The fecundity increased with increasing length and weight (Jadhav and Mohite, 2014). During present study it was also detected that there is highly positive correlation (R^2=0.976) was found between fish weight and fecundity rate. It was observed that present study findings are close with previous study from Pakistan (Shuaib and Ayub, 2011). But values are different from other parts of the world. Difference in the values may be because of size of fish, and time of sample collection and different locations. Fecundity rate could also depend on the catching methods used in the area, which impact on the study findings. The result showed, *A. djedaba* will provide valuable information to the fish biologists and fisheries management authorities on this species.

GSI is one of the most popular and simple instantaneous measure for estimating reproductive effort. Generally, GSI in female is higher than in males (Helfman *et al*., 2009). In present study, the low calculated value was 2.24% and high GSI value estimated that as 4.402%. But this is contrary to the report of Sivakami (1990) that lower GSI values were found for female. The values of GSI between length sizes were meaningfully dissimilar.

The appearance and the relative size of gonads over time are most often used in fisheries studies to understand the reproductive cycles and time of spawning of marine fishes (King, 1995). Different environmental factors particularly temperature, day length and food supply directly influences the initiation of gonadal maturation and fecundity. The survival of a fish species by reproducing in a fluctuating environment determines its success (Moyle and Czech, 2000). Ovaries are usually examined to understand the various developmental stages. Our results indicate that *A. djedaba* has reproduced thought the year. Based on present findings it was evident that the fish has an extended spawning period with a peak in July and August. Similar study of the species has been reported earlier (Reuben *et al.,* 1992; Raje, 1993; Shuaib and Ayub, 2011).

Feeding habits: During present study, it was observed that *A. djedaba* mostly feeds on fishes (46 %) and crustaceans (20 %) which indicate that this species is highly carnivorous in nature. According to Sivakami (1990) *A. djedaba* feeds on a variety of food items including fish juveniles, crustaceans such as ostracods, decapods, *Lucifer* spp., amphipods, cladocerans, stomatopods, insects and algae. Similar findings were also observed in pelagic region by Raje (1993). A review on the food habits of carangid fishesrevealed that food habits of fishes is one of the factors interconnected with reproductive periodicities (Sivakami, 1996). An earlier work by Kuthalingam (1955) reported that *A. djedaba* fed less during immature stages than when they are mature. However, Sivakami (1990) observed lower food volume during breeding season. While, present study observed that fish was basic food items with percentage of 46% and shrimp larvae at 6%, shrimp 14 % as well as digested food is 34%. Current findings indicate that this fish species is mainly carnivores which are close or similar with previous studies conducted from different regions. Qamar *et al*. (2015) also found that *A. djedaba* is also carnivore in nature. Little difference of the feeding habits is maybe because of sample size and time of data collection and also highly effected by the catching methods used in that region. The results of present study contribute valuable information about the feeding and reproductive behavior of the species which will help to plan effective strategies for its sustainable exploitation.

Conclusion: *A. djedaba* is carnivorous fish and mostly feeds on fish food items. It has prolonged spawning season with peak in July and August. This study has provided some basic information on feeding habits and reproductive biology for *A. djedaba,* which will be helpful to evaluate reproductive potential of individual fish species. Present study will also help to managers who are interested in culturing this fish to know the feeding and fecundity time for this species. It may also be suggested to avoid fishing activities for this commercial fish species during the spawning season. Further, current study should also be useful for fishery biologist and government fishery regularity departments to impose adequate regulation for sustainable fishery management.

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