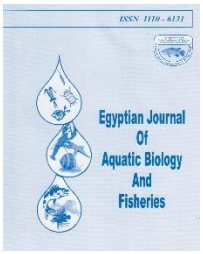
Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 25 (1): 47- 59 (2021)
www.ejabf.journals.ekb.eg



Feeding ecology and stomach content analysis of the kingsoldier bream, *Argyrops spinifer* (Forsskal 1775) (Perciformes: Sparidae) from the offshore waters (Northern Arabian Sea) of Pakistan.

Saba Ayub[1,*], Ghazala Siddiqui[1], Habib Ul Hassan [2,3], Khalid Mahmood[3], Mohamed F. A. Abdel-Aziz[4], Ghulam Abbas[1], Muneer Hussain[3], Zarieen Ayub[1] and Md. Yeamin Hossain[5]

[1]Center of Excellence in Marine Biology, University of Karachi, Karachi 75270, Pakistan
[2]Department of Zoology (MRCC), University of Karachi, Karachi-75270, Pakistan
[3]Fisheries Development Board, Ministry of National Food Security & Research, Pakistan
[4]Aquculture Division, National Institute of Oceanography and fisheries (NIOF), EGYPT
[5]Department of Fisheries, University of Rajshahi, Rajshahi-6205, Bangladesh
*Corresponding author: sabaayub.wwf@gmail.com

ARTICLE INFO
Article History:
Received: Sept. 30, 2020
Accepted: Dec. 28, 2020
Online: Jan. 16, 2021

Keywords:
Feeding ecology,
Stomach contents,
kingsoldier bream,
Argyrops spinifer,
Arabian Sea.

ABSTRACT

The present study was conducted to examine the feeding habits of the kingsoldier bream, *Argyrops spinifer* (Sparidae) from the offshore waters of Pakistan. Total of 629 specimens was collected using bottom trawlers from the offshore waters (North Arabian Sea) of Pakistan on monthly basis. Samples were taken from the landing center to the laboratory to analyze the variability in the choice of foods. Examination of gut contents of *A. spinifer* revealed that this fish is carnivore feeding habit on variable food items representing six different groups dominated by Crustacea (46.3%), Cephalopoda (27.1%), Teleostei (15.3%), Digested food (6.3%), Gastropod (4.3%) and Echinoderm (0.8%). Seasonal variance in the stomach contents of *A. spinifer* suggested that crustaceans were the dominant food in the stomach in post-monsoon 2013 (63.8%). During pre-monsoon season 2014, this fish preferred cephalopods (42.0%) followed by crustaceans (39.5%). During monsoon 2014, nearly 50% of the food constituted the crustaceans while in post-monsoon 2014, the preferred food was cephalopods (47.6%). During pre-monsoon and monsoon 2015, the fish fed mainly on crustaceans (40.0 and 46.2%, respectively) followed by fish (25.0 and 34.6%, respectively) instead of cephalopods. This studɇ provided basic information on feed diets of *A. spinifer*, which would be helpful in its fisheries management.

INTRODUCTION

Fish need food to get the energy required for the movement, growth, development, reproduction and spawning behavior, survival and existence(**Wootton, 1990; Peyami, 2018; Mohammad and Abood, 2019; Islam *et al.*, 2020; Khalid *et al.*,**

2020). It has been reported that fish utilize large portion of its energy searching for food **(Qasim, 1970; Rahman *et al.*, 2008)**. The quality and quantity of food directly affect the growth of fish while the maturation and survival are affected indirectly **(Sourinejad *et al.*, 2015)**. Awarness of the feeding behavior of marine fish is important for the evaluation of both fish stocks **(Pauly and Christensen, 2002)** and the role of fishes within an ecosystem **(Hajisamaea *et al.*, 2003; Bachok, 2004; Salavatian *et al.*, 2011; Mohanraj and Prabhu, 2012)**. Assessment of feeding is an important aspect to find out how a species interacts with its surrounding environment, their distribution of feeding habits with latitude **(Rahman *et al.*, 2009; Hassan *et al.*, 2020c; Pauly, 2000)** and habitat selection **(Labropoulou Smith, 1999)**. Data on fish feeding habits shed light on the range of prey **(Stergiou and Fourtouni, 1991)** and the relationship between predator-prey size **(Scharf *et al.*, 2000; Mohanraj and Prabhu, 2012; Priyadharsini *et al.*, 2012; Hassan *et al.*, 2020b).** A large number of fish species belonging to various taxonomic groups have the ability to adapt to a variety of food source, as well as to switch their feeding habits according to the seasonal, diurnal and temporal changes in food availability **(Gerking, 1994; Shah *et al.*, 2008)**. Information on the feeding habits of fish in their natural habitat is very important for the selection of suitable species for aquaculture and the production of their effective farming practices **(Manon and Hossain, 2011; Mondol *et al.*, 2013a)**. Sparids were observed to consume a wide range of benthic prey and a substantial amount of plant materials **(Nasir, 2000; Sarre *et al.*, 2000; Mariani *et al.*, 2002)**. Literature studies on the feeding habits of sparid fish is available, e.g., *Lithognathus mormyrus* in Central Adriatic **(Froglia, 1977; Jardas, 1996)**, *Sparus auratus* in Meditteranean lagoon system **(Tancioni *et al.*, 2003)**, *Acanthopagrus latus* from the West coast of Australia **(Platell *et al.*, 2007),** *Lithognathus mormyrus* in Souse coast, Eastern Libya **(Ali, 2008)**, *Diplodus noct* in southern Sinai, Gulf of Suez, Red Sea Egypt **(El-Mor and El- Maremie, 2008)**, and *Acanthopagrus berda* in Calicut waters, Southwest coast of India. They all reported that these fishes feed on a wide variety of prey types: crustacean, polychaetes, molluscs and echinoderms, copepods, fish parts. algae and sea grasses.

The marine sparid, *Argyrops spinifer*, is a demersal species inhabiting various types of sea bottoms at depth from 3 to 100 metres. Though this species is found in many countries, yet information is not available on its feeding habits and living environment. Studies on food and feeding habit of *A. spinifer* conducted in the Gulf of Carpentaria, Australia **(Salini *et al.*, 1994)** and Persian Gulf of Iran **(Ghanbarzadeh *et al.*, 2014)** reported that the diet included nekton, molluscs and other benthic invertebrates. Though this species has landed on the coast of Pakistan since 1980s, no information is available on the feeding biology of this fish. It is not only an essential prerequisite for fisheries management to understand the feeding ecology of a fish species, but also useful for its captive breeding and its adult-stage cultivation. The present study was therefore undertaken to investigate the dietary composition of *A. spinifer* in the coastal waters of

Arabian Sea, Pakistan, so that the results could be applicable to the fisheries management and aquaculture production of the species.

MATERIALS AND METHODS

Procurement of samples

Monthly samplings were collected from the coastal waters of Sindh and Baluchistan, Arabian Sea, and Pakistan for consecutive two years from 2013-2015 using a registred wooden ship (No.18511-B). Fishing was done during late night with the help of professional local fishers. In the current study, fishes were caught with several types of fishing gears namely trawls, gill nets, trammels nets, long-line, traps, hook and hand net **(Whitehead *et al.*, 1986; Ahmad *et al* ., 2020; Hasan *et al.*, 2020; Sabbir *et al.*, 2020)**. A formalin solution of 10% was injected with the syringe in the stomach to stop the digestion process. Fish samples were kept immediately in ice until taken to the laboratory, then preserved in 10% buffer formalin for taxonomic and morphometric studies.

Laboratory analysis

A total of 629 individuals of king soldier bream *Argyrops spinifer* were collected during the study period and they were used for gut contents analysis. After measurement of total length and weight of each individual to the nearest 0.1 cm and 0.01 g, respectively, a scissor was used to open the abdomen of fish. The sex and degree of fullness of stomach were determined. Out of 629 individuals, 435 had empty stomach while 194 specimens (79 males, 89 females and 26 unsexed) were further analyzed for the stomach contents. The stomachs were visually inspected to assess the amount of food in it and numerically allocated as 100%,75%, 50%, 25%, 10% and 0% **(Khan and Hoda, 1993)**. The stomach was preserved and the composition of the stomach content was analyzed and identified based on the relevant literature. Variation in diet composition in relation to fish size was also studied and for this purpose the fishes were classified into 5.0 cm size-classes.

RESULTS

Seasonal variations in diet composition

Different types of food items were observed in the diet of *A. spinifer*, however the major group was Crustaceans (46.3%) which was represented by crabs and shrimps followed by Cephalopods (27.1%) represented by squid and octopus (Table 1). The other food items included the fish (15.3%), the species of fish found as food item in the stomach of *A. spinifer* were identified as *Lepturacanthus savala, Ostorhinchus fasciatus, Acropoma japonicus* and fish belonging to family Cynoglossidae. The other food item was the digested food, in which the identification of the item was not possible and it amounted to 6.3% of total food items. The sea urchins and gastropods amounted to 0.8 and 0.4%, respectively (Table 1).

Table 1: The groups found in the feed contents of the stomach of *Argyrops spinifer* at Sindh and Baluchistan, Arabian Sea, Pakistan

Month	Food contents										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Nov-13	18.2	13.6	36.4	9.1	18.2	-	-	-	-	4.5	-
Dec-13	-	11.1	30.6	-	19.4	11.1	5.6	2.8	19.4	-	-
Jan-14	13.3	13.3	26.7	-	20.0	6.7	6.7	-	6.7	6.7	-
Feb-14	-	50.0	-	50.0	-	-	-	-	-	-	-
Mar-14	37.5	-	21.9	-	-	15.6	-	-	25.0	-	-
Apr-14	6.3	21.9	31.3	-	3.1	-	-	-	28.1	6.3	3.1
May-14	9.1	18.2	18.2	9.1	-	9.1	-	-	27.3	-	9.1
Jun-14	-	6.3	31.3	-	-	25.0	6.3	-	6.3	25.0	-
Jul-14	-	30.0	40.0	10.0	-	-	-	-	-	20.0	-
Aug-14	-	-	71.4	-	-	-	14.3	-	14.3	-	-
Sep-14	100.0	-	-	-	-	-	-	-	-	-	-
Oct-14	-	-	-	-	-	-	-	-	-	-	-
Nov-14	41.2	5.9	11.8	-	11.8	-	-	-	5.9	23.5	-
Dec-14	50.0	25.0	-	-	-	-	-	-	-	25.0	-
Jan-15	-	-	-	-	-	-	-	-	-	-	-
Feb-15	-	28.6	14.3	14.3	14.3	14.3	14.3	-	-	-	-
Mar-15	37.5	37.5	25.0	-	-	-	-	-	-	-	-
Apr-15	-	-	20.0	-	-	20.0	60.0	-	-	-	-
May-15	-	14.3	42.9	14.3	-	14.3	14.3	-	-	-	-
Jun-15	-	-	-	-	-	-	-	-	-	-	-
Jul-15	-	-	-	-	-	-	-	-	-	-	-
Aug-15	22.2	44.4	11.1	22.2	-	-	-	-	-	-	-
Sep-15	-	-	-	100.0	-	-	-	-	-	-	-
Oct-15	-	-	25.0	25.0	-	-	25.0	-	-	25.0	-
Total	14.9	15.3	26.7	5.1	7.1	7.1	4.3	0.4	12.2	6.3	0.8

Squids, A; Fish, B; Brachyuran Crabs, C; Squilla, D; Sergestid shrimps, E; Penaeid shrimps, F; Gastropods, G; Hermit crabs, H; Octopus, I; Digested food, J; Sea urchin, K

Table 2. Shows the monthly variations in diet composition for *A. spinifer* on the coast of Pakistan during the study period, on the whole the fish preferred brachyuran crabs followed by either fish or squid in most of the months. It was in October 2014, January 2015 and June-July 2015 that all the fish were found with no food item, that is, empty stomach. It was in September 2014 and September 2015 that the food consisted of only squids (100%) and Squilla (100%), respectively (Table 2). It was in the month of February 2014 that only two food items, fish and Squilla (50% each) were found in the stomach of *A. spinifer*, while in January 2014, and the fish stomach was found to contain 8 food items Table 2.s

Table 2: Monthly variations in the food contents of Argyrops spinifer during the study period from November 2013 to October 2015 at Sindh and Baluchistan, Arabian Sea, Pakistan

Group	Ingredients	Percent (%)
Teleostei	Fish and fish parts	15.3
Echinoderm	Sea urchin	0.8
Crustacea	Brachyuran crab, hermit crab, penaeid shrimp, sergestid shrimp, Squilla (mantis shrimp)	46.3
Cephalopoda	Squid, Octopus	27.1
Gastropod	Shells	4.3
Digested food	Food which cannot be identified	6.3

Seasonal variations in the stomach contents of *A. spinifer* showed that in post-monsoon 2013, the dominant food in the stomach was crustaceans (63.8%) . During pre-monsoon season 2014, the fish preferred cephalopods (42.0%) followed by crustaceans (39.5%). During monsoon 2014, nearly 50% of the food constituted the crustaceans while in post-monsoon 2014, the preferred food was cephalopods (47.6%). During pre-monsoon and monsoon 2015, the fish fed mainly on crustaceans (40.0 and 46.2%, respectively) followed by fish (25.0 and 34.6%, respectively) instead of cephalopods (Table 3).

Table 3: Seasonal variations in the food contents of *Argyrops spinifer* during the study period at Sindh and Baluchistan, Arabian Sea Pakistan

Seasons	Cephalopods	Crustaceans	Fish	Gastropods	Sea urchin	Digested food
Post monsoon 2013	19.0	63.8	12.1	3.4	0.0	1.7
Pre-monsoon 2014	42.0	39.5	12.3	1.2	1.2	3.7
Monsoon 2014	15.6	51.1	13.3	4.4	2.2	13.3
Post monsoon 2014	47.6	19.0	9.5	0.0	0.0	23.8
Pre-monsoon 2015	15.0	40.0	25.0	20.0	0.0	0.0
Monsoon 2015	15.4	46.2	34.6	3.8	0.0	0.0

Variations in diet composition in relation to fish size

In the smallest size-class of 11.0-15.9 cm only one specimen of *A. spinifer* was found with food in its stomach, therefore, it has not been included in the study of size-classes. The fish of size-class, 16.0-20.9 cm mainly consumed brachyuran crabs (28.4%) followed by squid (20.3%) and octopus (16.2%). In this size-class the consumption of fish was less (8.1%), however the consumption of other crustaceans was also found (Table 4.). The fish belonging to size-classes, 21.0-25.9 and 26.0-30.9 cm were found to consume diverse range of prey species, comprising brachyuran crabs as the primary food followed by fish as secondary food (Table 4.). The fish belonging to the largest size-class, 31.0-35.9 cm were found to feed on brachyuran crabs, fish and squids (Table 4.).

Table 4: Variations in food items in the stomach of *Argyrops spinifer* in various size classes during the study period.

Size-class (cm)	Food items										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
16-20.9	20.3	8.1	28.4	2.7	5.4	8.1	4.1	0.0	16.2	5.4	1.4
21-25.9	10.4	17.2	26.9	6.0	10.4	6.7	5.2	0.7	9.7	6.7	0.0
26-30.9	16.7	21.4	23.8	7.1	0.0	7.1	2.4	0.0	14.3	4.8	2.4
31-35.9	25.0	25.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0	0.0

Squids, A; Fish, B; Brachyuran Crabs, C ; Squilla, D; Sergestid shrimps, E; Penaeid shrimps, F; Gastropods, G; Hermit crabs, H; Octopus, I; Digested food, J; Sea urchin, K.

Feeding intensity

Of all 629 stomach of fish *A. spinifer* examined, it was found that 68.7% were with empty stomach while the remaining 31.3% contained food items in their stomach. The 100% fullness of stomach was represented by 7.9% of the fish, whereas 75% and 50% fullness of stomach was represented by 6.0 and 8.8% of the fish (Table 5.). Fish with the highest intensity of feed (100% fullness) was observed in November 2013, March and April 2014 when more than 25% of the examined fish had stomach fully occupied with the feed items (Table 5.). There were four occasions, October 2014, January 2015 and June-July 2015 when all the fish examined had empty stomach.

Table 5: Percent of numerical fullness of stomach of *Argyrops spinifer* during 2013-2015.

Months	Stomach examined	100% fullness	75% fullness	50% fullness	25% fullness	10% fullness	0% empty
Nov-13	18	27.8	5.6	38.9	11.1	0.0	16.7
Dec-13	31	16.1	25.8	9.7	9.7	9.7	29.0
Jan-14	31	3.2	3.2	19.4	12.9	3.2	58.1
Feb-14	30	3.3	0.0	3.3	0.0	0.0	93.3
Mar-14	30	36.7	20.0	20.0	3.3	3.3	16.7
Apr-14	31	25.8	9.7	19.4	29.0	6.5	9.7
May-14	31	9.7	9.7	12.9	3.2	0.0	64.5
Jun-14	31	6.5	12.9	19.4	6.5	3.2	51.6
Jul-14	24	8.0	8.0	16.0	4.0	4.0	60.0
Aug-14	42	2.4	4.9	2.4	4.9	2.4	82.9
Sep-14	38	0.0	0.0	2.6	0.0	0.0	97.4
Oct-14	45	0.0	0.0	0.0	0.0	0.0	100.0
Nov-14	24	17.4	13.0	13.0	8.7	4.3	43.5
Dec-14	28	3.6	3.6	0.0	3.6	0.0	89.3
Jan-15	13	0.0	0.0	0.0	0.0	0.0	100.0
Feb-15	35	0.0	5.7	2.9	2.9	0.0	88.6
Mar-15	31	0.0	3.2	0.0	6.5	9.7	80.6
Apr-15	21	4.8	0.0	4.8	4.8	0.0	85.7
May-15	12	16.7	0.0	0.0	8.3	8.3	66.7
Jun-15	21	0.0	0.0	0.0	0.0	0.0	100.0
Jul-15	11	0.0	0.0	0.0	0.0	0.0	100.0
Aug-15	12	16.7	0.0	33.3	0.0	16.7	33.3
Sep-15	18	5.6	0.0	0.0	0.0	0.0	94.4
Oct-15	21	0.0	0.0	4.8	4.8	4.8	85.7
Total	629	7.9	6.0	8.8	5.7	2.8	68.7

DISCUSSION

The present study observed that the feed composition of the sparid fish, *A. spinifer* consisted mainly of crustaceans, fish and cephalopods which is similar to the study of **Ghanbarzadeh *et al.*, (2014)** from the northern Persian Gulf who revealed that Mollusca, Arthropoda and Teleostei are the most common feed in the stomachs of *A. spinifer*. Similarly, **Salini *et al.*, (1994)** from the Gulf of Carpentaria, Australia reported that *A. spinifer* feeds on nekton, Mollusca and other benthic invertebrates. It appears that the king soldier bream is a generalist carnivorous fish which feeds on the food items available in their habitat. The findings of other workers on other species of sparid in different parts of the world are also similar to the afore- mentioned results. For example, the Sparid fish *Lithognathus mormyrus* in Central Adriatic was reported to prey on variety of feeds, including crustaceans, polychaetes, molluscs, echinoderms, fish parts and Seagrasses **(Froglia, 1977; Ahmed, 1999)**. Another Sparid fish, *Pagrus pagrus* in the Souse coast, eastern Libya was found to feed on crustacean, polychaetes, molluscs,

echinoderms, fish parts, Seagrasses and foraminifera **(Ali, 2008)**. **El-Mor and El-Maremie (2008)** while studying the feeding habits of sparid, *Diplodus noct* in southern Sinai, Gulf of Suez, Red Sea Egypt, stated that it feeds on crustaceans, fish parts, molluscs, copepods seagrasses and algae. Sparid fish *Dentex dentex* from Benghazi coast, eastern Libya was reported to feed mainly on crustaceans, cephalopods and fish **(El-Fargani and El-Mor. 2014)** Another sparid, *Boops boops* inhabiting Benghazi Mediterranean coast, were found feeding on Crustacean, Porifera, Coelenterate, Seagrasses and Mollusca **(El-Maremie and El-Mor, 2015)**. Although some authors reported the presence of plant material in the feed of sparid fishes, the present study determined that the fish *A. spinifer* did not show the presence of plant material in their feed composition. There are certain sparids which feed on only animal material an example of which is silver seabream, *Pagrus auratus* feeding on crustaceans, teleosts, echinoderms and molluscs **(Ang, 2003; French *et al*., 2012)** and Gilt-head seabream *Sparus aurata* (Linnaeus, 1758) feeding on molluscs, teleosts and crustaceans **(Hadj Taieb *et al*., 2013).**

In the present study the crustaceans, cephalopods and fish were consumed by all size classes in the fish *A. spinifer* which is similar in the consumption of Bivalvia, Malacostraca and Teleostei by all size-classes in the same species in the waters of northern Persian Gulf (**Ghanbarzadeh *et al*., 2014**). It has been reported in several other sparid fish species that dietary composition changes with increasing body size, such as, *Diplodus vulgaris* **(Pallaoro *et al*., 2006; Osman and Mahmoud, 2009),** *D. annularis* **(Derbal *et al*., 2007; Osman and Mahmoud, 2009),** *Pagellus acarne* **(Fehri-Bedoui *et al*., 2009),** and *Acanthopagrus berda* **(Thomas *et al*., 2018).**

The change in diet composition with change in size of fish has been attributed to an increase in the size and strength of jaws of fish **(Sarre *et al*., 2000; Tancioni *et al*., 2003),** while others have suggested that the increase in mean prey size with increasing predator size is to optimize the energy gain per unit effort **(Stoner and Livingstone, 1984; Dubiaski and Mansunari, 2006).**

It was reported that diets of some fish species differed with seasons **(Schafer *et al*., 2002; Hourston *et al*., 2004; Mondol *et al*., *2013*b),** however, the data available on some sparid fish suggested there was minimal changes in diet according to seasons **(Dia *et al*., 2000; Pallaoro *et al*., 2004)**. The results of the present study are in accordance with the above statement as no seasonal variations in the stomach of *A. spinifer* was observed in the main diet groups. A similar finding that no significant seasonal variations in occurrence and abundance of five main prey groups in *A. spinifer* were reported **(Ghanbarzadeh *et al*., 2014)**.

The present study provided basic information on feed diets of *A. spinifer*, which would be of great help in fisheries' management. Further study on food intake and feeding habits of this species in the coastal waters of Pakistan is required in order to understand the trophic role of *A. spinifer* in relation to other species in this ecosystem.

REFERENCES

Ahmad, A.; Khan, W.; Das, *S.N.;* Pahanwar, *W.A.;* Khalid, *S.;* Mehmood, *S.A.*, Ahmed, S.; Kamal, M.; Ahmed, M.S.; Hassan, U.H.; Zahoori, *S.* and Maqbool, A. (2020). Assessment of ecto and endo parasites of *Schizothorax*

plagiostomus inhabiting river Panjkora, Khyber Pakhtunkhwa, Pakistan. Braz. J Biol., 1678-4375. 1678-4375.

Ahmed, A. I. (1999). "Biological and Ecological Studies on Some Sparidae Fishes from Southern Sinai Coasts (Red Sea)." Ph.D. Thesis, Faculty of Sci. Suez canal Univ.,

Ang, H.P. (2003). Comparisons of the diets of four species of sparid on the central and lower west coast of Australia (Honours Thesis). School of Biological Sciences, Murdoch University, Perth, Western Australia.

Bachok, Z.; Mansor, M.I. and Noordin, R.M. (2004). Diet composition and food habits of demersal and pelagic marine fishes from Terengganu waters, east coast of Peninsular Malaysia. NAGA, World Fish Center Quarterly, 27(3):41-47.

Derbal, F.; Nouacer, S. and Kara, M. H. (2007).Composition et variaions du regime alimentaire du sparillon Diplodus annularis (Sparidae) du golfed'Annaba (Est del'Algerie). Cybium, 31:443–450.

Dia, M.; Ghorbel, M.; Bouain, A. and Kone, Y. (2000).Diet of Pagrus caeruleostictus (Sparidae) of *Nouakchott coasts* (Mauritania).Cybium, 1: 81–88.

Dubiaski-Silva, J. and. Masunari, S. (2006).Ontogenetic and seasonal variation in the diet of marimbá, *Diplodus argenteus* (Valenciennes, 1830) (Pisces, Sparidae) associated with the beds of Sargassumcymosum C. Agardh, 1820 (Phaeophyta) at Ponta das Garoupas, Bombinhas, Santa Catarina. J. Coast. Res., 1:1190-1192.

El-Fergani, E.S. and El-Mor and Fentex. M. (2014). Feeding habots of the common Dentex, *Dentex dentex* (LINNAEUS, 1758)(TELEOSTEI: SPARIDAE) from Benghazi Coast, Eastern Libya. Int. J. Bioassays., 3 (11), 3517-3522

El-Maremie, H. and El-Mor, M. (2015). Feeding Habits of the Bogue, Boops boops (Linnaeus, 1758)(Teleostei: Sparidae) in Benghazi Coast, Eastern Libya. J. Life Sci. Res., 9:189-196.

El-Mor M and E-Maremie, H.A. (2008). Feeding Habits of the Nokt Diplodus noct, from Southern Sinai, Gulf of Suez, Red Sea, Egypt. J. Aquacult. Soc., 3:1.

Fletcher, N.; Batjakas, I.E. and Pierce, G.J. (2013). Diet of the A tlantic bonito S ardasarda (B loch, 1793) in the Northeast Aegean Sea. J. Appl. Ichthyol., 29: 1030-1035.

French, B.; Platell, M.E.; Clarke, K.R. and Potter, I.C. (2012). Ranking of length-class, seasonal and regional effects on dietary compositions of the co-occurring Pagrusauratus (Sparidae) and *Pseudocaranx georgianus* (Carangidae). Estuar. Coast. Shelf Sci., 115:309-325.

Froglia, C. (1977). Feeding of *Lithognathus mormyrus* (L.) in central Adriatic Sea (Pisces, Sparidae). Rapp Commun. Intern. Mer. Medit., 24:95-97.

Fehri-Bedoui, R.; Mokrani, E. and Hassine, B. O. (2009). Feeding habits of *Pagellusa carne* (Sparidae) in the Gulf of Tunis, central Mediterranean. Scientia Marina, 73: 667-678.

Gerking, S.D. (1994). Feeding ecology of fish Academic Press. San Diego, California. 399-416. https://doi.org/10.1016/C2009-0-03283-8

Ghanbarzadeh, H. M.; Soofiani N. M.; Keivany Y.; Motlagh, S. A. T. (2014). Feeding habits of the King soldier bream, *Argyrops Spinifer* (Forsskal, 1775) (Perciformes: Sparidae), in the northern Persian Gulf. J. Appl. Ichthyol., 30: 485-489.

Khalid, S.; Khanb, W.; Das, S.N.; Ahmad, A.; . Mehmood , S.A.; Pahanwar , W.A.; Ahmed, S.; Kamal, M.; Waqas, M.; Waqas, R.M.;Hassan, U.H.; Zahoor, S. and Maqbool, A. (2020)**.** Evaluation of ecto and endo parasitic fauna of *Schizothorax plagiostomus* inhabitants of river Swat, Khyber Pakhtun Khwa, Pakistan. Braz. J. Biol. 81: 1678-4375

Hajisamae, S.; Chou,L. M. and Ibrahim, S. (2003). Feeding habits and trophic organization of the fish community in shallow waters of an impacted tropical habitat. Estuarine Estuar. Coast. Shelf Sci., 58: 89-98.

Hassan, H. U.; Ali, Q. M.; Rahman, M. A.; Kamal, M.; Tanjin, S.; Farooq, U.; Mawa, Z.; Badshah, N.; Mahmood, K.; Hasan, M. R.; Gabool, K.; Rima, F. A.; Islam, M. A.; Rahman, O. and Hossain, M. Y. (2020a). Growth pattern, condition and prey-predator status of 9 fish species from the Arabian Sea (Baluchistan and Sindh), Pakistan. Egypt. J. Aquat. Biol., 24: 281 – 292.

Hassan, H.U.; Ali, Q. M.; Ahmad, N.; Attaullah, M.; Chatta, A.M.;Farooq, U. and Ali, A. (2020b). Study of vertebrate diversity and associated threats in selected habitats of Sindh and Baluchistan, Pakistan. Int .J .Biol. Biotechnol., 17 (1): 163-175, 2020.

Hassan, H.U.; Ali, Q.M.;Ahmad, N.; Masood, Z.; Hossain, M.Y.; Gabol, K.; Khan, W.; Hussain, M.; Ali, A.; Attaullah, M. and Kamal, M. (2020c). Assessment of growth characteristics, the survival rate and body composition of Asian Sea bass *Lates calcarifer* (Bloch, 1790) under different feeding rates in closed aquaculture system. Saudi .J. Biol. Sci., https://doi.org/10.1016/j.sjbs.2020.11.056

Hasan, M.R.; Mawa, Z.; Hassan, H.U.; Rahman, M.A.; Tanjin, S.; Abro, N.A.; Gabol, K.; Bashar, M.A.; Rahman, M.A.; Jasmine**, S.; Tanjin, S.; Bashar, M.A.; Ohtomi, J.** and **Hossain, M. Y. (2020).** Impact of eco-hydrological factors on growth of Asian stinging catfish Heteropneustes fossilis (Bloch, 1794) in Wetland Ecosystem. Egypt. J. Aquat. Biol., 24(5): 77-94.

Hecht, T.; Irish, A. and Sales, J. (2003). Effect of protein level and varying protein-lipid. Afr. J. Mar., 25(1): 283-288.

Hourston, M.; Platell, M.E.; Valesini F. J. and Potter I.C. (2004). Factors influencing the diets of four morphologically divergent fish species in nearshore marine waters. J. Mar. Biol. Assoc. U.K. 84: 805-817.

Islam, M.A.; Mawa, Z.; Hossain, M.Y.; Hasan, M.R.; Khatun, D.; Chowdhury, A.A.; Rahman, o.; Rahman, M.A.; Tanjin, S.; Hassan, H.U. and Ohtomi, J. (2020). Morphometric and meristic characteristics of Spotted snakehead *Channa punctata* (Bloch, 1793) in a wetland ecosystem (NW Bangladesh) using multi-linear dimensions. Indian J. Mar. Sci., 49 (08):1442-1446

Jardas, I. (1996). Ichthyofauna of the Adriatic Sea. Zagreb, 533: 416-417.

Labropoulou, M. and Papadopoulou-Smith, K.N. (1999). Foraging behaviour patterns of four sympatric demersal fishes. Estuarine, Coast. Shelf Sci., 49:99-108.

Manon, M.R. and Hossain, M.D. (2011). Food and feeding habit of *Cyprinus carpio* var. specularis. Journal of the National Science. J. Sci. Found., 9(2):163-169.

Marian, S.; Maccaroni, A.; Massa, F.; Rampacci, M. and Tancioni, L. (2002). Lack of consistency between the trophic interrelationships of five sparid species in two adjacent central Mediterranean coastal lagoons. J. Fish Biol., 61:138-147.

Mohamed, A.R.M. and Abood, A.N. (2019). Feeding ecology of two sciaenid species (*Johnius belangerii* and *Johnius dussumieri*) in the Shatt Al-Arab River, Iraq. Int. J. Fish. Aquat. Stud., 2019; 7(5): 08-13

Mohanraj, T. and Prabhu, K. (2012). Food habits and diet composition of demersal marine fishes from Gulf of Mannar, southeast coast of India. Adv. Biol. Res., 6(4):159-164.

Mondol, M. M. R.; Dewan, S.; Rahman, M. M.; Jasmine, S. and Hossain, M. Y. (2013b). Food and feeding habits of the mola carplet *Amblypharyngodon mola* (Hamilton, 1822) in rice field ecosystem with consideration of water quality parameters. Our Nature, 11(1): 61-75.

Mondol, M. M. R., Rahman, M. M., Ahamed, F., Sarker, M. A. A., Subba, B. R., & Hossain, M. Y. (2013a). Diet and feeding habits of *Cyprinus carpio* in relation with water quality of integrated rice-fish farming ecosystem. Our Nature, *11*(2): 138-151.

Nasir, N.A. (2000). The food and feeding relationships of the fish communities in the inshore waters of Khor Al-Zubair, northwest Arabian Gulf. CYBIUM, 24: 89-99.

Osman, A. M. and Mahmoud. H. H. (2009). Feeding biology of *Diplodus sargus* and *Diplodus vulagaris* (Teleostei, Sparidae) in Egyptian Mediterranean waters. W. J.F. M. S., 1(4): 290-296.

Pallaoro, A.; Šantić, M. and Jardas, I. (2004). Diet composition of young- of- the-year saddled bream, *Obladamelanura* (Linnaeus, 1758) from the eastern central Adriatic Sea. J. Appl. Ichthyol., 20: 228-230.

Pallaoro, A.; Šantić, M. and Jardas, I. (2006). Feeding habits of the common two-banded sea bream, *Diplodus vulgaris* (Sparidae), in the eastern Adriatic Sea. Cybium: J.Ichthyol., 30: 19-25.

Pauly, D. and Christensen, V. (2000). Trophic levels of fish. In: Concept design and Data source: ICLARM, Philippines. 182-188

Pauly, D. (2000). Herbivory as a low-latitude phenomenon. Fish Base, pp.179.

Peyami F.Y. (2018). Food and feeding habit of a Teleostean fish *Salmostoma bacaila* (Ham.) at Partapur dam, Makhdumpur Jehanabad, Bihar. Int. J. Fish. Aquat., 6(4):388-391

Platell, M.E.; Ang, H.P.; Hesp, S.A. and Potter, I.C. (2007). Comparisons between the influences of habitat, body size and season on the dietary composition of the sparid *Acanthopagrus latus* in a large marine Embayment. Estuarine, Estuar. Coast. Shelf Sci., 2(4):626-634.

Priyadharsini, S.; Manoharan, J.; Varadharajan, D. and Subramaniyan, A. (2012). Interpretation on the food and feeding habits of *Dascyllus trimaculatus* (Ruppell, 1829) from Gulf of Mannar, South East coast of India. Arch. Appl. Sci. Res., 4(4):1758-1762.

Qasim, S. Z. (1972). The dynamics of food and feeding habits of some marine fishes. Indian J. Fish.,19: 11-28.

Rahman, M. M.; Jo, Q.; Gong, Y. G.; Miller, S. A. & Hossain, M. Y. (2008). A comparative study of common carp (*Cyprinus carpio* L.) and calbasu (*Labeo calbasu* Hamilton) on bottom soil resuspension, water quality, nutrient accumulations, food intake and growth of fish in simulated rohu (*Labeo rohita* Hamilton) ponds. Aquaculture, 285(1-4):78-83.

Rahman, M. M., Hossain, M. Y., Jo, Q., Kim, S. K., Ohtomi, J., & Meyer, C. (2009). Ontogenetic shift in dietary preference and low dietary overlap in rohu (*Labeo rohita*) and common carp (*Cyprinus carpio*) in semi-intensive polyculture ponds. Ichthyol. Res., 56(1):28.

Salavatian, M.; Gholiev, Z.; Aliev, A. and Abassi, K. (2011). Feeding behavior of brown trout, *Salmo trutta fario*, during spawning season in four rivers of Lar National Park, Iran. Casp. J. Environ. Sci., 9(2):223-233

Salini, J. P.; Blaber,S. J. M. and Brewer, D. T. (1994). Diets of trawled predatory fish of the Gulf of Carpentaria, Australia, with particular reference to predation on prawns. Mar. Freshwater Res., 45: 397-411.

Sarre, G. A. Platell, M. E. and Potter, I. C. (2000). Do the dietary compositions of *Acanthopagrus butcheri* in four estuaries and a coastal lake vary with body size and season and within and amongst these water bodies. J. Fish Biol, 56: 103-122.

Sarre, G.A. Platell, M.E. and Potter, I.C. (2000). Do the dietary compositions of *Acanthopagrus butcheri* in four estuaries and a coastal lake vary with body size and season and within and amongst these water bodies. J. Fish Biol., 56(1):103-122.

Sabbir, W.; Md. Hossain, M. Y.; Rahman, M. A.; Hasan, M. R.; Mawa, Z.; Tanjin, S.; Habib- Ul, H. and Ohtomi, J. (2020). First report on condition factor of *Panna heterolepis* (Trewavas, 1977) in the Bay of Bengal (southwestern Bangladesh) in relation to eco-climatic factors. Egypt. J. Aquat. Biol., 24: 591–608.

Scharf, F.S.; Juanes, F. and Rountree, R.A. (2000). Predator size-prey size relationships of marine fish predators: interspecific variation and effects of ontogeny and body size on trophic-niche breadth. Mar. Ecol. Prog. Ser., 208:229-248.

Sourinejad, I.; Nikkhah K. A. S.; Kamrani, E. and Ghodrati Shojaei, M. (2015). Feeding habits of Yellowfin Seabream (*Acanthopagrus latus*) in the northern region of the Persian Gulf.Casp. J. Environ. Sci., 13(1):31-39.

Shah, M. M. R., Hossain, M. Y., Begum, M., Ahmed, Z. F., Ohtomi, J., Rahman, M. M., ... & Fulanda, B. (2008). Seasonal variations of phytoplanktonic community structure and production in relation to environmental factors of the southwest coastal waters of Bangladesh. J .Fish. Aquat .Sci., 3 (2):102-113DOI: 10.3923/jfas.2008.102.113

Stergiou, K.I. and Fourtouni, H. (1991). Food habits, ontogenetic diet shift and selectivity in *Zeus faber* Linnaeus, 1758. J. Fish Biol., 39(4):589-603.

Stoner, A. W. and Livingstone, R. J. (1984). Ontogenetic patterns in diet and feeding morphology in sympatric sparid fishes from seagrass meadows. Copeia, 1984:174–187.

Tancioni, L.; Mariani, S.; Maccaroni, A.; Mariani, A.; Massa, F.; Scardi, M. and Cataudella, S. (2003). Locality-specific variation in the feeding of *Sparus auratus* evidence from two Mediterranean lagoon systems. Estuar. Coast. Shelf Sci., 57: 469-474.http://doi/10.1016/S0272-7714(02)00376-1

Thomas, S.M.; Chadha, N.K.; Purayil, S.B.P.; Kandiyil, A.P.; Kavungal, V.; Joseph, I.; Sawant, P.B. and Abhijith, R. (2019). The Food and Feeding Habits of

Goldsilk Seabream, *Acanthopagrus berda* (Forsskal, 1775). Turk. J.FISH Aquat. Sci., 19(7):605-614.

Verdiell-Cubedo, D.; Oliva-Patern, F. J.; Andreu-Soler. A. and Torralva, M. (2007). Characteristaion of the nursery areas for YOY Sparidae fish species in a Mediterranean coastal lagoon (SE Iberian Peninsula). An.De Biol., 29: 3-11.

Wootton, R.J. (1990). Ecology of teleost fishes. Chapman and Hall, London, pp404.

Whitehead, P.J.P.; Bauchot, M.L.; Hureau, J.-C.; Nielsen, J. and Tortonese, E. (Eds.) (1986). *Fishes of the Northeastern Atlantic and the Mediterranean*, Vols. I–III. UNESCO, Paris, 1473 pp.