International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

Scatophagus argus diet, feeding habits and biochemical composition

Dr.Shireenbanu Maqbullahamed Chandrageri [1], Dr.J.L.Rathod [2]

[1]*Research Scholar, Marine Biology, Karnatak University, Karnataka, India*
[2]*Professor, Marine Biology, Karnatak University, Karnataka, India*

Abstract - *In the Indo-Pacific region, the spotted scat (Scatophagus argus) is extensively dispersed. In some areas of its distribution, this species is a desirable brackish water aquarium fish and a significant food fish. An investigation into eating patterns, physical condition, and the metabolic makeup of muscles was conducted. According to the current study on diet and feeding, the majority of the fish's gut contents were made up of algae and debris. The ecology of spotted cats' feeding was adaptable, and they chose their prey based on relative abundance. The lengthening of the stomach contents indicated an ontogenetic change in nutrition. According to the findings, an omnivorous fish's relative gut length is 3.1 (with a range of 2.14 to 3.96), which is generally regarded as normal. The biochemical makeup of the fish S. argus's muscles was investigated. Its proximate composition showed seasonal fluctuation.*

Key Words: Scatophagus, condition factor, spotted scat, omnivorous

Introduction

The spotted scat, also known as Scatophagus argus (Bardach et al., According to Barry and Fast (1988), the mudflats, mangrove swamps, harbors, upstream swamps, estuaries, and marine habitats of the Indo Pacific, the Malay Archipelago, the Philippines, Australia, and South and South East Asia, particularly India, are home to numerous species of butterfish, Argus fish, spade fish, and spotted spade fish. Variations in salinity, temperature, dissolved oxygen, tidal movements, river runoff, turbidity, and turbulence characterize the scats' habits. According to Barry and Fast (1988), these adaptations to living in such constantly shifting environments confer on them numerous biological characteristics that are highly desired in cultured finfish. The fish's flavor and quality make it an edible fish, and its spotted rhombic body makes it an intriguing aquarium fish. According to Gandhi, 2002, Barry and Fast, 1988, large-sized fish are transported to inland markets, where they are sold for the same price as other table fish. There is a lot of interest in developing methods for the propagation and culture of the spotted scat due to their advantageous biological characteristics and economic significance. In this region, brackish water aquaculture with this species has a lot of potential.

Despite its palatability and popularity among consumers, there is a lack of information regarding the biology of spotted scat. Mookerji et al. conducted research on the diet and feeding habits of S. argus in Bengali estuaries (1949), Datta et al. discovered in fresh and brackish water (1984), Thailand's mangrove forests by Monkolprasit et al. 1994) and Gandhi's 2002 study of the marine environment in and around Mandapam have all investigated the qualitative aspects. The purpose of this study is to provide some basic biological information regarding the food and feeding habits of S. argus as well as the feeding indices in light of the lack of information on the biology of spotted scat. The importance of spotted scat's season-specific changes in muscle biochemical composition in terms of nutrient value and physiological condition is investigated.

Material and Methods

Specimen Collection

The fish landing centers in and around the Cochin Estuary were the locations where the specimens for the study of food and feeding habits were collected every two weeks for a year, from January 2007 to December 2007. 764 specimens' gut contents were dissected, weighed, and preserved in 5% formalin. Both quantitative and qualitative methods were used to examine the contents of the stomach (Hynes, 1950; 1961, Natarajan and Jhingran). Each stomach's volume (displacement method) and the presence of various foods were recorded. According to Kow's (1950) suggestion, monthly variations in the feeding index were obtained based on stomach fullness to evaluate feeding intensity. Fish were categorized as gorged, full, 34 percent full, and 12 percent full as actively fed, whereas those with 14 percent full, trace, and empty were poorly fed. This classification was based on the relative fullness of the food and the space occupied by the food contents. Fish were divided into two groups based on length—under 70 mm and above 70 mm—for the purpose of analyzing the contents of their guts. The shape of their heads could distinguish the sexes of Spotted Scat. Males have a concave curvature of the head above the eye, whereas females have a head profile that ascends at a constant slope. When compared to the darker males, females typically have a lighter olive green color.

From January 2007 to December 2007, specimens were collected from the Cochin estuary using a Chinese net. The fish were brought to the laboratory in ice-cold conditions, where their body weight and length (Standard Length) were measured to the nearest 0.01 grams and centimeters, respectively. They were then kept in liquid nitrogen at -80 degrees Celsius until the results were analyzed. Their flesh was weighed to the nearest mg, their fins and spines were removed, and biochemical analysis was performed. Six experiments were carried out in triplets.

International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

Relativegut Index (RGI)
The values of relative gut indices of S. argus in the size range of <70 mm (juvenile) and >70 mm(adult) were studied by the method of Hynes, (1950) using the formula,
R.G.I. = Length of gut (mm) x 100 Total length (mm)

Condition Factor
The relative condition factor (Kn) was computed using LeCren's (1951) modified formula,
$Kn = W/aL^n$

Muscle Biochemical Analysis
Protein content was determined by Lowry's (1951) method using BSA (Bovine serum albumin) as standard. To determine the moisture content known amount of fish sample was dried in an oven at 50– 60°C for 8–10 hours. Finally the moisture content was calculated and reported in percentage (AOAC, 1988). The percentage composition of fat and carbohydrates of collected samples were analyzed according to AOAC (1988) methods.

Statistical Analysis
The SPSS® statistical software for windows, version 13.0 (SPSS Inc., Chicago, USA) was used in all data analysis. Analysis of variance method was employed to determine the statistical significance of the changes in muscle biochemical composition and the variations were compared using Duncan's Multiple Range Test. In all cases statistical significance is indicated by P<0.05

Result
The diet pattern of the various length groups revealed a gradual shift from smaller (70 mm) to larger (>70 mm) fish. Stomach is extended and U formed with maximum usage of food. Diverse species of unicellular algae and debris were the smaller specimens' primary sources of nutrition. Mud, sand, tiny mollusk shell fragments, and other inorganic matter made up detritus. Diatoms, copepods, fish scales, and fish eggs were also found. Figure 1a shows that algae (58.2–88.1 percent) and detritus (12.3%–32.4%) were more common than diatoms (7.2–19.3 percent), copepods (0.8–28.3 percent), fish scales (1.2–9.1 percent), and fish eggs (0.7–5.3 percent).

The variety of foods available to larger fish is the greatest. Throughout the observation period, adult fish (>70 mm) primarily consumed multicellular algae. Figure 1b shows that the gut contents contained algae (48.4–86.3%), detritus (12.4–46.9%), diatoms (8.9–28.3%), fish scales (2.8–15.9%), crustaceans (1.2–13.6%), fish eggs (0.2–11.3%), bivalves (1.1–8.2), copepods (0.7–16.3%), rotifers (0.4–5.2%), sea anemones (0.2–4.9%), sponges The post-monsoon months saw the greatest concentration of algae in the stomach contents. Crustaceans were present twice throughout the year, once in February and March and once in September and November. Zoea was prevalent among crustacean larvae, peaking between January and March and September and October. Prawn hatchlings were available in strength during Spring May. Additionally, the most fish eggs were discovered in November and December.
Scats' diets were found to be strongly influenced by food availability. The study clearly demonstrates that the scats take in food that they happen to encounter, despite the fact that larger fish showed a special preference for filamentous algae. Depending on the size of the prey, the fish might have swallowed entire organisms at times. Sponge, copepod, and small prawns were consumed as whole organisms. Molluscan shells and undigested chitinous remains were observed. Extended filamentous green growth have been snacked or perused by bigger fish. Anemones, fish eggs, bivalves, detritus, and fish scales have all been swallowed. Scats are bottom feeders, as debris was also observed.The feeding intensity of scats did not follow a regular pattern. During the months of January–April majority of the fishes had actively fed. May showed decreased feeding. July–August active feeding was observed, followed by decrease in feeding during September. October–December again the number of actively fed was more (Figure 1).
The values of relative gut indices ranged from 2.14 to 3.96 for fish >70 mm. The average RGI was
3.1. There existed a significant correlation between gut length and total body length ($r = 0.7427$, $p<0.05$) (Figure 2).The values of relative condition factor (Kn), (LeCren, 1951) ranged from 0.91 to 1.3 (Figure 3).

Muscle Biochemical Composition
The profile of proximate composition of S. argus muscle was assessed from January 2007–December 2007. The moisture content, protein, fat and ash content were evaluated. Moisture content in the fish ranged from 72.89–76.03%. One way analysis of variation showed significant variation ($P<0.05$) (Figure 4a). The protein content showed a minimum of 15.13% during November while a maximum of 17.47% was recorded during August. Significant monthly variation was observed ($P<0.05$) (Figure 4b). The fat content evaluated showed significant variation (Figure 4c) ranging from 5.16 to 7.92%. One way ANOVA showed significant variation ($P<0.05$). The ash content ranged from 2.15 to 2.86%. One way ANOVA did not show any significant variation in ash content with season (Figure 4d).

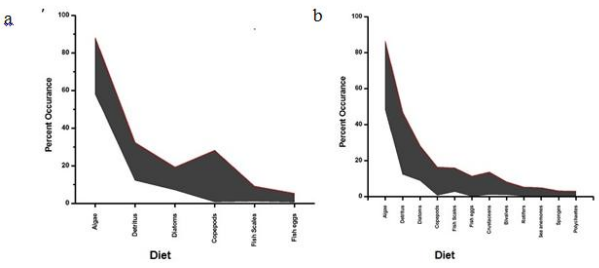

Figure 1. a and b shows the different diet pattern in fish between the length group of <70 mm and >70 mm respectively.

International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

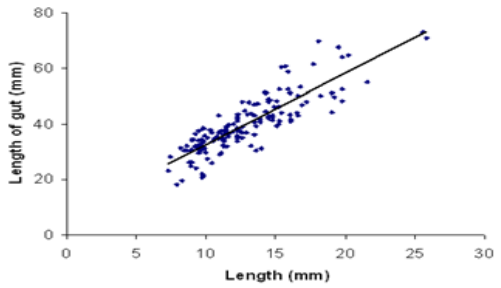

Figure 2. Changes in gut length with total length. r2 is =0.7427.

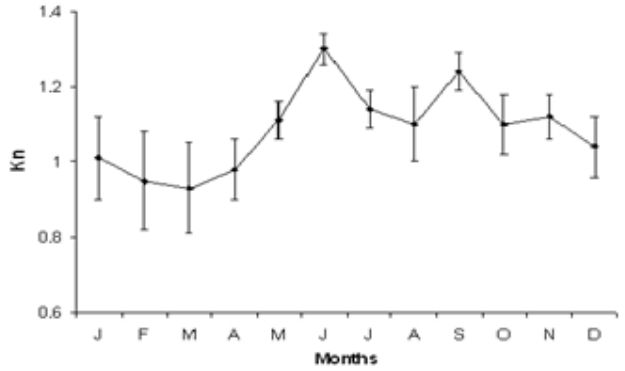

Figure 3. Monthly variations in relative condition factor of S.argus. Data are represented as mean ±SD.

Discussion

Knowledge on the food and feeding habits is essential to have knowledge on growth, distribution and general ecology of the fish. Changes in the food spectrum during different seasons help us to study the migratory patterns of the fish. Studies on the S. argus from different places in the estuaries of Bengal by Mookerji et al. (1949) reported the presence of unicellular algae, higher plants, protozoa, sponges, crustaceans, fish scales, sand and mud in the gut. Datta et al. (1984) studied the food of scats inhabiting both fresh and brackish water ponds and reported that the food comprised of aquatic macrophytes, phytoplankons, zooplanktons and macrobenthos. Gandhi (2002) studied the food and feeding of scats from the marine environment in and around Mandapam and reported that in addition to those observed by Mookerji et al. (1949) coral polyps, bivalves, Lepas, prawns, sea anemones and alphaeids were present. The present findings were also in agreement with their findings. The food items included algae, diatoms, sponges, crustaceans, fish scales, fish eggs, sea anemones, rotifers, polycheates, copepods, bivalves and detritus. The present study clearly indicated that the spotted scat feeding was related to diet availability. It was found that detritus in the gut contents of scats were always associated with algae leading us to conclude that the scats preferred algae and the fish actually consume detritus while feeding on algae attached with detritus. In estuaries, detritivory: herbivory ratios are often high compared to other waters (Lin et al., 2001), with the high efficiency of fish yields leading to the assumption that most estuarine fishes are detritivores, including the spotted scat in Taiwan (Lin et al., 2007).

Monkolprasit (1994) studied the composition and food habits of fish collected from the mangrove forests of Phanang and Ban Don Bay of Thailand. He indicated that S. argus feeds on diatoms, nematodes, rotifers, polycheates, insects and protozoa. During the present study also diatoms, rotifers and polychaetes were observed. It was also observed that adult fed on detritus, unicellular algae, copepods and protozoa which were consistent with the findings of Mookerji et al. (1949) and Gandhi (2002).Adult fish preferred multicellular algae, diatoms and detritus. Spotted scats showed reasonable flexibility in their feeding ecology. The feeding selectivity was based on the availability of the food items. Maximum occurrence of algae in the stomach contents were found during post monsoon months. Prawn larvae were present in dominance during March–May. Fish eggs were also found in maximum occurrence in November and December.

The presence of different species of multicellular filamentous algae in the gut contents during the course of this study indicated that the scats nibbled/ browsed and swallowed them. Attached organisms such as sea anemones, sponges and bivalves were scrapped by the fish and swallowed. The presence of detritus and fish scales showed that the scats are bottom feeders. Planktons present in the gut content of young fish indicated that the scats are pelagic feeders at their juvenile stage. The development of rows of small rasp like teeth and elongated intestines are well suited for scrapping and shredding and digestion of plant materials. Both animal and plant food items were recorded in the gut content, though a preference for algae could be observed indicating that the fish is omnivorous. The omnivorous nature of the fish has been revealed by Mookerji et al. (1949), Datta et al. (1984), Gandhi (2002) and Phuong et al. (2004). The present study also confirms scats to be omnivorous. However Barry and Fast (1988) have reported that adult spotted scats are primarily herbivorous in nature. The diverse food items with feeding preference supported that spotted scats showed a likely ontogenic niche shift. The smaller fish predominantly consume unicellular algae present in the water column. The prey diversity consumed by fish broadens as the length increases. Larger fish feed on substrata taking the whole prey items including the multicellular algae, benthos and detritus. Although unicellular algae remained the dominant food of smaller fish, the larger fish shifted to multicellular algae. Percent detritus content increased from 12.3-32.4% in juvenile to 12.4-46.9% in adult group. Likewise diatoms were 7.2-19.3% in juveniles increasing to 8.9-28.3% in adults. The fish scale increased from 1.2-9.1% in juveniles to 2.8-15.9% in adults.

The feeding intensity monitored monthly showed active feeding during January–April. Peak feeding intensity was observed during June-August. The female fish that fed actively during this period had shed their eggs and after spawning the fish needed to feed actively for revitalizing and rematuring of ova to spawn (Barry and Fast, 1988) during October-November (data not shown). It was noted that during the final stages of maturity of egg the fish had fed poorly. Wongchinawit and Paphavasit (2009) reports that

International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

scats have the ability to take advantage of the most profitable food source at a particular time and select food items that maximize fitness and energy gain.

The values of relative gut indices ranged from 2.14 to 3.96 for fish >70 mm (adult). The average RGI was 3.1 which are normal for an omnivorous fish. Based upon the relative intestine lengths of 0.5- 2.4 for carnivores, 2-21 for herbivores 0.8-5 for omnivores (Rust, 2002) this ratio for spotted scats suggest the omnivorous nature of the fish. The RGI which is within the observed average of 3.1 is well in conformity with the average of 2.88 (range 2.59–2.93) in detritus feeding scats found in Vietnam (Phuang et al., 2004) and 3.0 for herbivorous adult scat in the Philippines (Barry and Fast, 1998). The absence of appreciable differences in this index in juveniles and adult fish indicated that growth does not involve any major shift in the basically omnivorous habits of this fish. There existed a significant correlation between gut length and total body length ($r = 0.7427$, $P<0.05$).

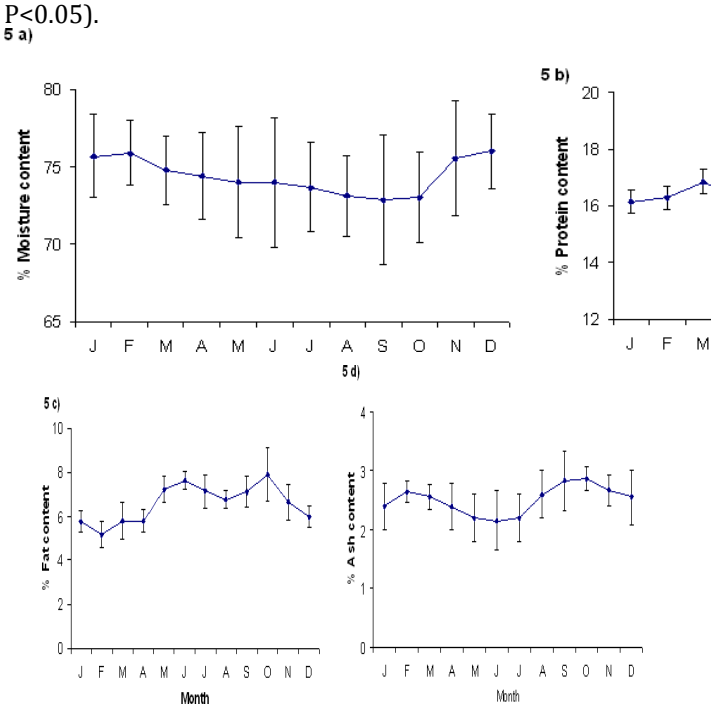

Figure 4. Changes in muscle biochemical composition of S. Argus in different months. A) Moisture b) Protein c) Fat d) Ash. Data are represented as mean ±SD

The values of relative condition factor (Kn), reflects through its variations, information on the physiological state of the fish in relation to its welfare (LeCren, 1951) ranged in this study from 0.91 to 1.3. The Kn value depends on the physiological factors like maturity and spawning as well as food availability. The Kn values did not show marked variations except peaks in June and September corresponding to the periods of maturity and spawning. These peaks are not prominent probably due to the close breeding period and releasing of eggs in batches.

As fish exhibit a wide array of diversity in their shapes, modes of life, habitat etc it is to be expected that they will also show diversity in their composition. Variations in the monthly proximate composition of S. argus was observed. The moisture content was high during the winter season (November–February) and low during the summer (February–May) and spawning season. With the onset of spawning season fat content was found to be high. Fat content was low during the refractory period of the fish from December–April and high during spawning season. Ash content did not show much variation except for the spawning season when it was low. Protein content of the fish was high during the spawning season and the minimum values were recorded in the post spawning period. High fat and protein content during spawning season has been reported for other fishes (Bhuyan, 2003; Shamsan and Ansari, 2010).

In conclusion, in the present study though the scats show a preference for algae the omnivorous nature of S. argus is well documented. Studies on the proximate composition of the fish shows the potent nutrient value of S. argus. Monthly variations in the muscle biochemical composition were observed.

Even though there exists a huge demand for this fish, culture of spotted scats is largely in its primary stages. Virtually all scat for the food market and aquaria trades are captured from the wild. The scope for the culture of the spotted scat is promising field. The present study would definitely add some basic information on the food and feeding habits as well as the nutrient value of the fish opening new vistas for brackish water culture of the spotted scat.

References

[1] Weber, S. ,&Traunspurger, W. (2015). The effects of predation by juvenile fish on the meiobenthic community structure in a natural pond. Freshwater Biology, 60(11), 2392–2409. 10.1111/fwb.12665

[2] Robert, D. , Levesque, K. , Gagne, J. A. , & Fortier, L. (2011). Change in prey selectivity during the larval life of Atlantic cod in the southern Gulf of St Lawrence. Journal of Plankton Research, 33(1), 195–200. 10.1093/plankt/fbq095

[3] Gupta, S. (2016). An overview on morphology, biology, and culture of Spotted scat *Scatophagus argus* (Linnaeus, 1766). Reviews in Fisheries Science and Aquaculture, 24(2), 203–212. 10.1080/23308249.2015.1119800

[4] Marina Hashima , Diana Atiqah Zainal Abidina , Simon K. Dasb and MazlanAbd. Ghaffara, "Food Consumption and Digestion Time Estimation of Spotted Scat, *Scatophagus argus*, Using X-Radiography Technique", AIP Conf. Proc. 1614, 745-749 (2014)

[5] Kottelat M., 2001 Scatophagidae. Scats. In: FAO species identification guide for fishery purposes. The living marine resources of the Western Central Pacific. Vol. 6. Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles. Carpenter K. E., Niem V. (eds), Food and Agriculture Organisation, Rome, pp. 3623-3626.

[6] Simon K. D., Mazlan A. G., Cob Z. C., Samat A., Arshad A., 2008 Age determination of archer fishes (Toxotesjaculatrix and Toxoteschatareus) inhabiting Malaysian estuaries. Journal of Biological Sciences 8(6):1096-1099.

[7] Marina Hashim,Diana A. Zainal Abidin,Simon K. Das,A. GhaffarMazlan, "Length-weight relationship, condition factor andTROPH of *Scatophagus argus* in Malaysian coastalWaters"

[8] Lin X, Hu S, Liu S, Huang H. Unexpected prey of juvenile spotted scat (*Scatophagus argus*) near a wharf: The prevalence of fouling organisms in stomach contents. EcolEvol. 2018 Jul 30;8(16):8547-8554. doi: 10.1002/ece3.4380. PMID: 30250722; PMCID: PMC6145014.