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Studies on the food and feeding habits of cultivable butterfish *Scatophagus argus* (Cuv. and Val.)

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Abstract

The present study on the food and feeding habits of the butterfish *Scatophagus argus* revealed that unicellular algae and detritus dominated the gut contents of young fish of size <50mm compared to the occurrence of *Enteromorpha compressa* and detritus in fishes of size above 50 to 100 mm in total length. *Ulva* spp. was recorded in lesser quantities in fishes <100 mm compared to other size groups. Unicellular algae were represented by *Chaetoceros* spp., *Skeletonema* spp., *Thalossiosira* spp., *Tetraselmis* spp. and *Chlorella* spp. Fish scales, protozoans, shells of bivalves, sponges, sea anemones, *Lepas* spp. penaeid prawns, *Alphid* spp. and copepods were also present in the gut contents. It was also observed that fish measuring 50 mm and below fed on phytoplankton, protozoa, detritus and copepods. Presence of both animal and plant food items revealed that *S. argus* is an omnivorous fish.

Introduction

The spotted butterfish *Scatophagus argus* is also known as leopard pomfret (Mookerjee *et al.*, 1949), butterfish, Argus fish, spadefish, spotted spade fish (Barry and Fast, 1988) and spotted scat (Bardach *et al.*, 1972). It is abundant in the coastal waters of India. This fish was not exploited properly during the early part of this century due to the lack of demand, which was attributed to its feeding behaviour. They are largely consumed by the economically backward fishermen and also by others because, it is not an expensive fish but at the same time the flesh is of good quality and taste. Large size fishes are transported to inland markets, where they fetch price just like any other table fish.

Butterfishes are abundant in near shore waters of South and Southeast Asia where they inhabit estuaries, coastal mudflats, mangrove swamps, harbours and upstream rivers. These habits are characterized by extreme fluctuations in salinity, dissolved oxygen, temperature, tidal movements, river runoff, turbidity and turbulence. The adaptations which allow the butterfishes to live in such ever changing environments endow them with many biological attributes highly desired in a cultured finfish (Barry and Fast, 1988). Mookerjee *et al.*, (1949) collected various sizes of *S. argus* during the years 1945 to 1946 from different places in estuaries of Bengal. They reported that the gut contents revealed the presence of unicellular algae, higher plants (*Nitella* spp. and *Chara* spp.), protozoa, sponges, crustaceans, fish scales, sand and mud. Datta *et al.*, (1948) studied the food of *S.argus* inhibiting both fresh and brack-

ish water ponds and reported that it comprised of aquatic macrophytes, phytoplankton, zooplankton and other macrobenthos. Monkolprasit (1994) reported that gut content of *S. argus* caught in Thailand showed the presence of diatoms, nematodes, rotifers, polychaetes, insects and foraminifera.

The earlier workers have made only qualitative analysis of the gut content of *S.argus*. Therefore, the aim of the present investigation is to gain more knowlege and offer a comprehensive account of food and feeding habits. The analysis of gut content was carried out qualitatively and quantitatively.

Material and methods

Samples of butterfishes were collected from the fish landing centers in and around Mandapam twice a week during August 1995 to July 1997. Since the body is compressed, dissection was done on the lateral side of the fish to remove the gut contents. Considering the occurrence as well as the quantity of food items the gut content analysis of *S.argus* was carried out by the "Index of preponderance" method (Natarajan and Jhingran, 1961). The volume (displacement method) and occurrence of various food items in each stomach were recorded. The precentage occurrence of different items of food in different months was determined by summing the total number of occurrence of all items. Since butterfishes are omnivorous, determination of volume of each item of food was easily made by displacement method.

The food components were identified as far as possible up to the species level. Whenever the food items were found in mutilated condition, it was possible to identify them only up to genus level. The percentage volume of each food item was determined from the total volume of all the gut contents. The percentage occurrence of each food item also was worked out. The "Index of preponderance" was calculated from these values. In order to investigate the order of preference of food items taken by different size groups the fish were grouped into<50mm, 50 to 100mm, 100 to 200 mm and >200 mm.

To ascertain the condition of feed during different months, the degree of fullness of the each stomach was recorded. From this the feeding intensity during different months was calculated. Depending on the relative fullness and the space occupied by the food contents in each stomach, they were classified as full, 3/4 full, 1/2 full, 1/4 full, little and empty. From the total number of fish examined in a month, the percentage occurrence of the different categories was estimated. Fishes with stomachs classified as full, 3/4 full and 1/2 full were considered as actively fed, whereas those with 1/4 full and little as poorly fed.

Results

Qualitative analysis

The main food of the fish consisted of multicellular algae and detritus. The multicellular algae were represented by *Enteromorpha compressa* and *Ulva* spp. The components of detritus were mud, sand, minute broken shells of molluscs, protozoa and other inorganic matter. Unicellular algae were represented by *Chaetoceros*

spp., *Skeletonema* spp., *Thalassiosira* spp., *Tetraselmis* and *Chlorella* spp. . Small fish scales were also found in most of the guts of small and big size fishes. Protozoa occurred occasionally in some guts. Other items noticed include shells of bivalves, sponges, sea anemones and *Lepas spp.* Penaeid prawns were represented by young ones of *Penaeus indicus, P. semisulcatus and Metapenaeus* spp. Other crustaceans observed were carridean prawns of the family Alphaeidae and copepods.

Quantitative analysis

Unicellular algae and detritus were found predominantly in the gut contents of young fish of size <50 mm. Their percentage occurrence was high (algae 7.3-74.7%, detritus 28.6-87.3%) during the entire study period. Fish scales, protozoa and copepods were also recorded in the same size group of fishes. The percentage occurrence of copepods (1.2-5.4%) was lesser than protozoa (2.2-11.8%).Unicellular algae were found in fishes of size 50 to 100 mm. *E. compressa* and detritus were the dominant items in fishes of size 50 to 100 mm, 100 to 200 mm and > 200 mm. Their percentage occurrence was high (*E.compressa* 16.1-63.0% and detritus 10.8%-58.4%) in all the size groups. *Ulva* spp. was recorded in fishes of size < 100 mm but to a lesser extent compared to *E.compressa*..

Sea anemones (0.1-5.4%), coral polyps (0.1-6.1%), prawns (0.2-2.9%), bivalves (0.04-0.9%), foraminifera (0.04-0.99%), other crustaceans (0.4--5.8%), copepods (0.2-1.8%) and *Lepas* spp. (0.07-1.7%) were also found in the gut contents of fish of size above 50 above mm throughout the observation period. The percentage occurrence of sponges (1.3-16.9%), sea anemones, fish scales (1.3-16.9%) and coral polyps was higher than that of the other food items such as copepods, alphaeids and protozoa. Copepods were recorded to a lesser extent during the whole period of observation. Alphaeids occurred only on two occasions during the observation period and that too in the size group >200 mm. Protozoans were totally absent in all the size groups except in the smallest size group of <50mm.

Selectivity in feeding

From regular observations, it was understood that the diet of *S.argus* appeared to depend largely on the availability of food items. During the present study, presence of *E.compressa* attached on dead corals, on immersed hard substrate, and on jetties constructed in the sea was recorded. *Ulva* spp. was also recorded from the area of survey. Sponges, sea anemones, bivalves and *Lepas* were found attached to the above-mentioned structures. Food items such as unicellular algae, phytoplankton, copepods and small protozoans were also encountered in the gut contents of juvenile fishes. Pieces of coral polyps of small size, small prawns, other crustaceans, foraminifera and Alphaeids were also observed. The study clearly indicated that butterfishes did not exhibit any specific selection of food items or area. Instead they feed on the available food items, where the school of butterfishes happens to go.

Condition of stomach

During August 1995, majority of the fish had fed actively (full, 3/4 full and 1/2 full), whereas during September, fish which had fed actively and poorly (1/4 and little) were more or less equal. In October, November 1995 and March 1996, the percentage of fish that had fed actively showed a rise, whereas a steep rise was observed during December 1995, February and May 1996. In January and July 1996, majority of fish were in the category of poorly fed whereas in April and June 1996 good feeding activity was noticed.

During August 1996 and March 1997, the fish had fed actively, whereas during September, October 1996 and February 1997, fish, which had fed actively and poorly, occurred equally. There was a rise in fish, which had fed actively during November 1996 and January 1997. Feeding was poor in December 1996 and in July 1997. During May 1997, the fish had fed actively, whereas in April and June, the fish had fed more actively. The present study indicated that there was no regular pattern in feeding activity (Figure 1).

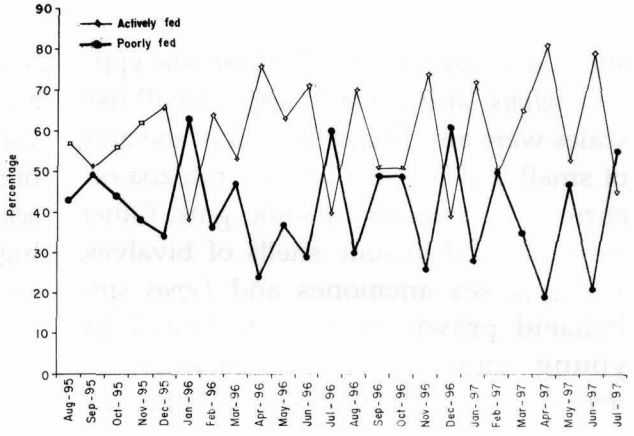

Fig. 1. *Percentage of fish actively and poorly fed*

Feeding habits

The fishes were sometimes observed to have eaten whole organisms. This was obviously governed by the size of the prey. The common food items that were found to have been fed in whole were small prawns, copepods, some phytoplankton, sponges, *E.compressa* and *Ulva* spp. Coral polyps, *Lepas,* sea anemones and alphaeids were found as undigested chitinous remains.

Lengthy filamentous algae *E.compressa* were found to have been browsed by big fish. Attached organisms such as sea anemones, small *Lepas,* bivalves and sponges were seen to have been scrapped and swallowed by big fish. Coral polyps were found to have been nibbled by big fish. Prawns, other crustaceans and alphaeids were seen to have been bitten and swallowed. Detritus, fish scales and foraminiferan shells were found to have been swallowed by big fishs.

Protozoa, phytoplankton and copepods were found in small fish, which indicated that young fish fed on the surface. Since detritus was also recorded from the gut contents of young fish, it could be inferred that young fish also would have fed at the bottom.

Discussion

Like many other factors, the distribution and fluctuation in abundance of organisms, which form the main food of a species, also affect the shoaling behaviour, migration for food, spawning, growth con-

dition and also the fishery. Therefore, many workers have given considerable attention to this subject of food and feeding habits. Method of "Index of preponderance (Natarajan and Jhingran, 1961) was a standard method which was followed by a number of workers (Gandhi, 1982; Appanna Sastry, 1993; Sivakami, 1995, 1996).

Mookerji *et al.*, (1949) collected various sizes of *Scatophagus argus* from different place in the estuaries of Bengal and reported the presence of univellular algae, higher plants, protozoa, sponges, crustaceans, fish scales, sand and mud in the gut. During the present study also, presence of the above mentioned food components were observed in addition to coral polyps, bivalves, *Lepas*, prawns, sea-anemones and alphaeids. The presence of additional food components was probably because of the different types of habitats from which the fish were collected. Mookerji *et al.*, (1949) collected fish from the estuaries whereas for the present study fish were collected from the marine environment.

Datta *et al.*, (1984) studied the food of butter fish inhabiting both fresh and brackish water ponds and reported that the food comprised of aquatic macrophytes, phytoplankton, zooplankton and other macro benthos. The present findings were also in agreement with their findings. But, the only difference was that they collected specimens of butterfish from fresh and brackish water ponds.

Monkolprasit (1994) studied the composition and food habits of fishes collected from the mangrove forests of Phan-NGA and Ban Don Bay of Thailand. He indicated that *S. argus* feeds on diatoms, nematodes, rotifers, polychaetes, insects and protozoa. During the present investigation also, phytoplankton, crustacean and protozoa were recorded.

The present study clearly indicated that the butterfishes fed on whatever food items were available. Thus phytoplankton, filamentous algae, detritus, *Ulva* spp., sponges, coral polyps, sea-anemones, bivalves, *Lepas*, prawns, other crustaceans, protozoa, copepods, fish scales and Alphaeids were consumed by them. It was also observed that fish measuring 50mm and below fed on phytoplankton, protozoa, detritus and copepods which was consistent with the finding of Mookerji *et al.*, (1949). Fish measuring more than 100 mm in length fed mainly on filamentous algae and detritus. Sometimes, *Ulva* spp., also constituted the main food item of the same size fish. Fish below 100 mm in length, fed on phytoplankton in addition to the components explained earlier. Mookerji *et al.*, (1949) stated that fish measuring 136 mm fed on unicellular and multicellular algae, higher plants, protozoa, sponges, crustaceans, fish scales, sand and mud. From the present investigation it could be inferred that large size butterfishes preferred algae and detritus whereas juvenile fish preferred phytoplankton as well as detritus. It was also observed that even though peak appearance of food items such as *E.compressa*, during May, detritus during July, *Ulva* spp., during August and September '96 and sponges during May' 97 in the gut content

of fish above 50mm, they also appeared with other food items throughout the observation period of August 1995 to July 1997. This showed that there was no seasonal or annual variation and selection of food in the feeding habits of this fish.

Observation on selectivity of feeding indicated that the diet of *S.argus* depended on the availability of food organisms in the environment where they were found commonly. However, butterfishes took filamentous algae and detritus more than the other food items. Mookerji *et al.*, (1949) have also stated that butterfishes preferred more vegetable food than animal food. Fish measuring 50 mm and below preferred only phytoplankton. Large fish preferred filamentous algae. Thus the present findings also were consistent with the observations of Mookerji *et al.*, (1949).

Various state of condition of stomachs such as 3/4 full, 1/2 full, 1/4 full and little were found in all the size groups. However, no variation in feeding habits could be observed irrespective of the status of the fish as to whether they fed actively or poorly.

The presence of filamentous algae in the gut contents during the course of this study indicated that the butterfishes browsed and swallowed them. Attached organisms such as sea anemones, *Lepas*, bivalves and sponges are scrapped by the fish and swallowed. This indicated that they could also nibble and swallow coral polyps. The presence of detritus, fish scales and foraminiferan shells showed that these fish consumed these items also. From these observations, it was clear that the fish had the habit of browsing, scrapping, nibbling and swallowing the prey. As many of the above mentioned food items were available at the bottom of the sea, these fish could be called a bottom feeder as well. Since plankton was recorded in the gut content of young fish, they could be called in their juvenile stage a surface feeder.

Both animal and plant food items were recorded in the gut content. Therefore, *S.argus* is an omnivorous fish. Mookerji *et al.*, (1949) have also suggested the same. However, they also indicated that they preferred more vegetable food than animal food. Datta *et al.*, (1984) stated the qualitative and quantitiative analysis of the diet clearly revealed its omnivorous nature. Monkolprasit (1994) also suggested that *S.argus* was an omnivorous fish. However, Barry and Fast (1988) have reported that adult spotted butterfishes were primarily herbivorous in nature.

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