SENRA Academic Publishers, British Columbia
Vol. 7, No. 3, pp. 2499-2504, October 2013
Online ISSN: 1920-3853; Print ISSN: 1715-9997

Canadian Journal of pure & applied sciences

STUDIES ON FOOD AND FEEDING HABITS OF *MUGIL CEPHALUS* (LINNAEUS, 1758) EAST COAST OFF ANDHRA PRADESH, INDIA

R Kurma Rao and *K Ramesh Babu
Department of Marine Living Resources, College of Science and Technology
Andhra University, Visakhapatnam-530 003, India

ABSTRACT

The present study was aimed to focus on the food and feeding habits of the grey mullet at east coast of Andhra Pradesh, India. Total 558 specimens in length range 113 to 370 mm were subjected into analysis for the period of September 2010 to August 2011. In adult fish the analysis of the gut revealed that the Chlorophyceae, Myxophyceae, Bacillariophyceae, Dino-flagellates, copepods and polycheatae worms along with sand and mud were the prominent representatives of the species *Mugil cephalus*. Where as in Juveniles the volume of the gut varied according to season the Bacillariophyceae (Diatoms) and micro algae, *cladophora* (Green algae) and Myxophyceae were prominent. The volume of the gut in Juveniles maximum in the months of October and September, low in the month of April was observed.

Keywords: *Mugil cephalus*, Chlorophyceae, Myxophyceae, Bacillariophyceae and *cladophora*,

INTRODUCTION

Food and feeding habits of a species of fish is intimately associated with the ecological niche that they occupy in the natural environment. In order to understand the type of food consumed and the feeding habits, the analysis of the gut contents of the individuals collected from their habitats is carried out (Oren, 1981). In general, mullets are known to be benthic feeders. They move about in the benthic region of the habitat and feed on the benthic organisms. Flathead grey mullet, *Mugil cephalus* is known to be a diurnal feeder (FIGIS, 2006). The present study is carried out on the food and feeding habits of the flathead mullet *M. cephalus* from the Interu mangrove swamp in Krishna estuarine region. The overall share of Aquaculture was 2.6% in the total production of Marine fishes and it was contributed substantially by striped/flathead grey mullet as one of the species (FAO, 2010).

It is an economically important euryhaline and eurythermal species contributing to sizable fisheries of estuarine and coastal regions in many countries including China (Chang *et al*., 2004), Egypt (Saleh, 2008), India (Barman *et al*., 2005; Jana *et al*., 2004), Israel (Lupatsch *et al*., 2003), Italy (Luzzana *et al*., 2005), New Zealand (Wells, 1984), Nigeria (Anyanwu *et al*., 2007), Sri Lanka (De Silva and Silva, 1979), Taiwan (Chang *et al*., 2000), Tunisia (Khériji *et al*., 2003). Studies on the food and feeding habits of mullets inhabiting the coastal waters and the coastal lakes in India were studied earlier in the following species of mullets: *Mugil tade* and *Mugil cunnesius* (Pillay, 1953, 1954, 1958), *Mugil cunnesius* (Sarojini, 1958) from coastal waters of Bengal; *Liza macrolepis* (Luther, 1963) from Mandapam in Tamilnadu; mullets from Chilka Lake, (Rajan, 1964), *Mugil parsia* (Sarojini, 1954, 1957; Ghosh *et al*., 1974), *Mugil macrolepis* (Prasadam, 1970), *Mugil cephalus* (Rangaswamy, 1973) from lake Pulicat.

MATERIALS AND METHODS

Present study is based on the analysis of gut contents of 558 specimens in the length range 113 to 370mm TL collected at fortnight intervals from September 2010 to August 2011 from the fish market at Bantumilli. These specimens include both juveniles and adult fish. After recording the length, weight, sex, stages of maturity of the fish, the guts were removed and preserved in 10% formalin for analysis in the laboratory.

Initially the volume of contents in the gut was measured in a measuring cylinder. Later, the food organisms present in the gut contents of each individual were separated in to different taxonomic groups and were identified with help of the keys, up to the level of the genus. Seasonal changes in the occurrence and abundance of major groups of food organisms in the guts were recorded.

Description of the alimentary canal (Fig. 1)
The alimentary canal in *Mugil cephalus* starts with an oesophagus which leads into stomach. The stomach has thick-walled gizzard-like segments and leads into the gastrointestinal tract. 2-6 pyloric caecae are present in the form of whorl at the junction between stomach and duodenum (the anterior part of the intestine). Alimentary canal measures nearly three times the body length. The

*Corresponding author email: krameshmlr@gmail.com

mullets are known to feed on the benthic algal formations by sucking (Odum, 1968). Sand and mud also enters the gut along with the food.

Fig.1. Alimentary canal

RESULTS

The analysis shows that the guts of mullets collected in the present the study, consisted of encrusted algal matter including the representatives of Chlorophyceae, Myxophyceae, diatoms belonging to Bacillariophyceae, dino-flagellates, harpacticoid copepods, polycheate worms and sand and mud. In certain seasons the presence of sand and mud along with decaying organic matter is high. The percentage of decaying organic matter along with sand and mud is noticed to be higher in the guts of the adult fish. Feeding by sucking the top layers of sediments, flathead grey mullets eat the detritus and the microorganisms. Mullets constitute an ecologically important link in the energy flow within estuarine communities

Table 1. Mean value of the gut contents (in ml) during the different months of the study period in juveniles and adults.

Months		Juveniles	Adults
September	2010	5.1	6.7
October	2010	7.7	8.2
November	2010	--	1.6
December	2010	1.8	3.7
January	2011	1.6	2.8
February	2011	4.1	5.3
March	2011	3.2	5.6
April	2011	1.5	2.5
May	2011	--	2.7
June	2011	2.3	4.5
July	2011	2.3	2.6
August	2011	3.9	6.9

Juveniles of mullets are known to feed selectively on zooplankton, while the adults feed on the organisms associated with encrusted benthic algae belonging to the family Bacillariophyceae, Chlorophyceae and Myxophyceae. In Juveniles, volume of food present in the guts varied during different months (Table 1 and Fig. 2). The results show that the volume of gut contents is maxim in the month of October followed by September, February and August. Juvenile fish are not represented in the samples collected during the months of May and November. The volume of gut contents is low in the month of April (Fig. 4).

Studies on the gut contents during different months indicate that in juvenile fish sand, mud and silt formed 30% and planktonic organisms formed 70% of the gut contents (Fig. 2). The gut contents were mostly represented by the Bacillariophyceae (diatoms) and micro algae followed by the *cladophora* (green algae) and Myxophyceae. In the guts of juvenile fishes, the following groups of organisms were recorded:

Bacillariophyceae
This group is represented by the organisms belonging to following genera; *Skeletonema, Thalassionema, Chaetoceros, Coscinodiscus, Rhizosolenia, Stephanodiscus.*

Myxophyceae
This group is represented by the organisms belonging to the following genera; *Lyngbya, Oscillatoria, Phoromidium,* Spirulina.

Chlorophyceae
This group is represented by the organisms belonging to the following genera; *Chaetomorpha,* Cladophora, Spirogyra.

Dino-flagellates
This group is represented by the organisms belonging to the genus; *Gymnodinium.*

Among the adults the volume of food in the guts was maxim in the month of October followed by August and September and the volumes of gut contents are also relatively higher in the months of February and March (Table 1 and Fig. 3). This shows that there are two peaks in a year i.e. one during February and March and another during August to October months (Fig. 5). In the adults the sand and detritus occur in large quantities indicating a bottom feeding habit. The active feeding during the above months may due to the availability and abundance of the benthic food organisms in the inshore region and in the Mangrove swamp area. No earlier studies on feeding intensity of the flathead grey mullet are available in literature for comparison.

In the present study it was observed that the gut contents of adult individuals during majority of months are mostly represented by the decaying organic matter and the benthic organisms present at the bottom layers of the habitat. Sand and mud formed the dominant component. Decaying organic matter formed approximately 45% of

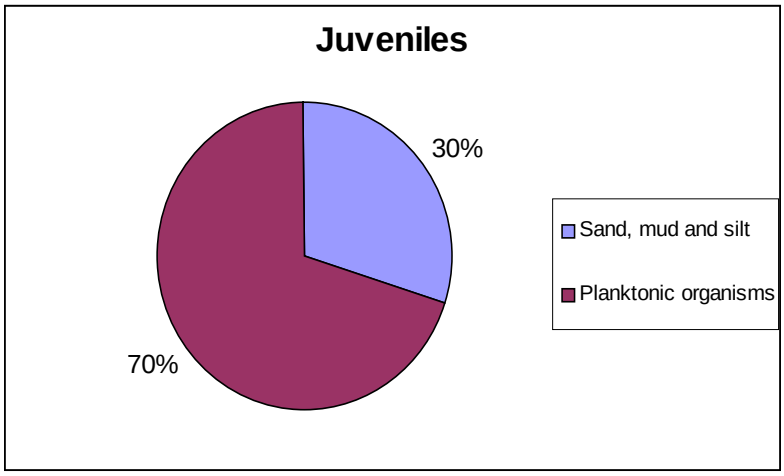

Fig. 2. Food preferences in Juveniles.

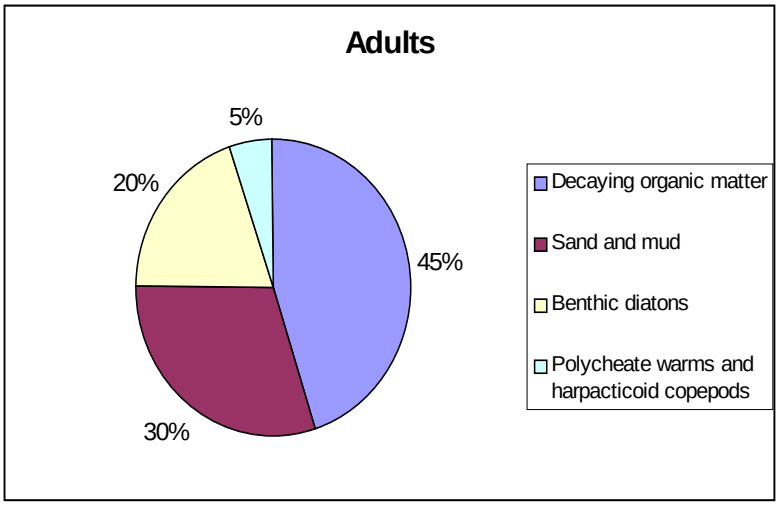

Fig. 3. Food preferences in adults.

the volume of the gut contents and benthic organisms including the polycheate worms, harpacticoid copepods formed 5%. The Sand and the mud formed 30 % and benthic diatoms formed 20% of the diet (Fig. 3).

DISCUSSION

Mullets are primarily benthic feeders. In view of the presence of relatively large quantities of the dead and decaying organic matter settled at the bottom layers of the habitat and algae consisting of Bacillariophyceae, Chlorophyceae and Myxophyceae along with other benthic organisms in the guts of adults, they were considered as benthic feeders by earlier workers (Egusa, 1950; Yashouv and Ben Schacher, 1967; De Silva and Wijeyaratyne, 1977).

Several earlier studies indicated that juveniles and adults feed on different items of food. Juveniles feed selectively on zooplankton organisms developing in to a mixture food feeder, finally a plant feeder (Pillay, 1972; Blaber and Whitfield, 1977). The diet of young mullets consisted predominantly the diatoms (Bachllariophyceae) followed by the green algae and blue-green algae (De Silva and Wijeyaratyne, 1977; Wells, 1984; Sanchez Rueda, 2002).

Earlier studies on the analysis of gut contents show the presence of sedimented algae. This algal encrustation formed the dominant component of the feed in adult fish. Earlier workers (Sarojini, 1954; Thomson, 1963 and 1966; Ghosh *et al*., 1974; Blaber, 1976, 1977) made similar observations in their studies on the feeding of mullets.

In the adults the sand and detritus occur in large quantities indicating the bottom feeding habit. This clearly indicates that there is a gradual transition from a planktonic feeding

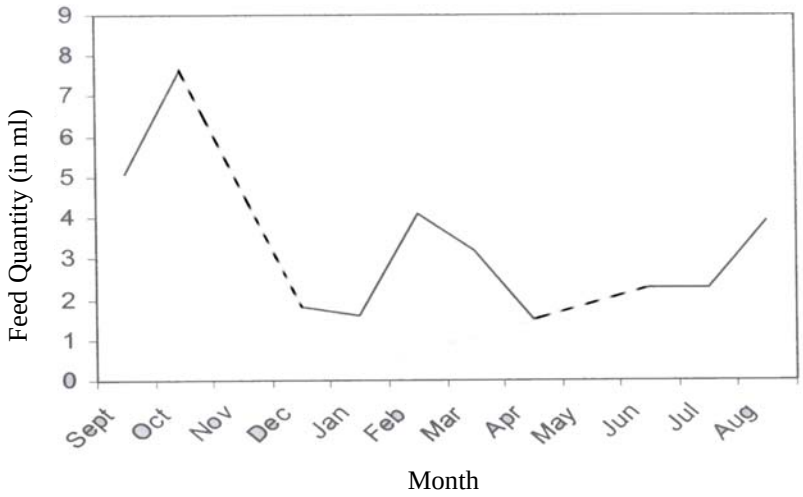

Fig. 4. Monthly average value of gut contents in juveniles during the study period.

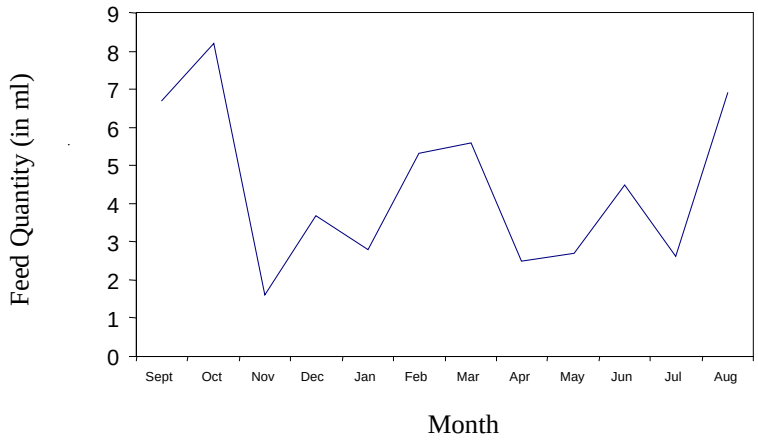

Fig. 5. Monthly average value of gut contents in adults during the study period.

habit in the juvenile (Blaber and Whitfield, 1977) to a benthic feeding habit as the fish grows in size and becomes the adult. Earlier, similar changes in the feeding of *M. cephalus* have been observed in the coastal lagoons in Israel (Zismann *et al*., 1974). Wells (1984) also studied the food and feeding of flathead grey mullet, *M. cephalus* from the freshwater habitats, Lake Waahi and Waikato River in New Zealand and reported that *M. cephalus* is detritus feeder feeding mostly on algal species and detritus of macrophytic origin. Sanchez Rueda (2002) studied stomach contents of *M. cephalus* of Mexican waters. He observed that the sediments formed the basic food of *M. cephalus* in these waters.

Studies of Rangaswamy (1973) from Lake Pulicat in India have shown that mullets feed on a variety of benthic organisms consisting of diatoms, dino-flagellates, foraminifera and copepods. This species was considered as iliophagous due to the presence of large quantities of sand in the guts which enter along with the benthos, while feeding.

The results of the present study reveals that adults of *M. cephalus* feed mostly on dead and decaying organic matter, benthic algae along with benthic organisms such as harpacticoid copepod and polychaete worms. The juveniles feed mostly on planktonic organisms

(phytoplankton and zooplankton) and sand and mud containing detritus.

CONCLUSION

The findings of the present study suggest that the gut analysis in both Juveniles and Adults contains different taxonomic groups of organisms but the representatives of the taxonomic groups (planktonic and encrusted algae) differs along with seasonal variations along with sand and mud.

ACKNOWLEDGEMENT

The author Thanks the Head, Department of Marine Living Resources, Andhra University, Visakhapatnam, for permitting to carry out this Research work

REFERENCES

Anyanwu, PE., Gabriel, UU., Akinrotimi, OA., Bekibele, DO. and Onunkwo, DN. 2007. Brackish water aquaculture: a veritable tool for the empowerment of Niger Delta communities. Scientific Research and Essays. 2:295-301.

Barman, UK., Jana, SN., Garg, SK., Bhatnagar, A. and Arasu, ART. 2005. Effect of inland water salinity on growth, feed conversion efficiency and intestinal enzyme activity in growing grey mullet, Mugil cephalus (Linn.): field and laboratory studies. Aquaculture International. 13:241-256.

Blaber, SJM. 1976. The food and feeding ecology of Mugilidae in the St. Lucia lake system. Biol. J. Linn. Soc. 8:267-77.

Blaber, SJM. 1977. The feeding ecology and relative abundance of mullet (Mugilidae) in Natal and pondland estuaries. Biol. J. Linn. Soc. 9:259-275.

Blaber, SJM. and Whitfield, AK. 1977. The Feeding ecology of juvenile mullet (Mugilidae) in South-east African estuaries. Biol. J. Linn. Soc. 9:277-84.

Chang, CW., Iizuka, Y. and Tzeng, WN. 2004. Migratory environmental history of the grey mullet *Mugil cephalus* as revealed by otolith Sr:Ca ratios. Marine Ecology Progress Series. 269:277-288.

Chang, CW., Tzeng, WN. and Lee, YC. 2000. Recruitment and hatching dates of grey mullet (Mugil cephalus L.) juveniles in the Tanshui Estuary of Northwest Taiwan. Zoological Studies. 39:99-106.

De Silva, SS. and Wijeyaratyne, MJS. 1977. Studies on the biology of young grey mullet, *Mugil cephalus* Linnaeus II. Food and Feeding. Aquaculture. 12:157-167.

De Silva, SS. and Silva, EIL. 1979. Biology of young greymullet *Mugil cephalus* L., populations of a coastal lagoon in Sri Lanka. Journal of Fish Biology. 15:9-20.

Egusa, S. 1950. Some notes on the feeding habit of the young of *Mugil cephalus* L. Bull. Jap. Soc. Sci. Fish. 5(11):715-720.

FAO, 2010. The State of the World Fisheries and Aquaculture. Food and Agricultural Organization of the United Nations, Rome, Italy.

FIGIS, 2006. FIGIS Servlet FIRI Water Resources and Aquaculture service CASIP. 1-8.

Ghosh, AN., Das, PR. and Das, LK. 1974. Expermental observations on the food requirement of fry of *Mugil parsia* (Hamilton). In: Coastal Aquaculture in the Indo-Pacific Region. Ed. Pillay, TVR. 429-37.

Jana, SN., Garg, SK. and Patra, BC. 2004. Effect of periphyton on growth performance of grey mullet, *Mugil cephalus* (Linn.), in inland saline groundwater ponds. Journal of Applied Ichthyology. 20:110-117.

Khériji, S., El Cafsi, M., Masmoudi, W., Castell, JD. and Romdhane, MS. 2003. Salinity and temperature effects on the lipid composition of mullet sea fry (*Mugil cephalus*, Linne, 1758). Aquaculture International. 11:571-582.

Luther, G. 1963. Some observations on the biology of *Liza macrolepis* (Smith) and *Mugil cephalus* Linnaeus (Mugilidae) with notes on the fishery of grey mullets near Mandapam. Indian J. Fish. 10 B (2): 642 – 66.

Lupatsch, I., Katz, T. and Angel, DL. 2003. Assessment of the removal efficiency of fish farm effluents by greymullets: a nutritional approach. Aquaculture Research. 34:1367-1377.

Luzzana, U., Valfré, F., Mangiarotti, M., Domeneghini, C., Radaelli, G., Moretti, VM. and Scolari, M. 2005. Evaluation of different protein sources in fingerling grey mullet *Mugil cephalus* practical diets. Aquaculture International. 13:291-303.

Odum, WE. 1968. The ecological significance of fine particle selection by the striped mullet *Mugil ephalus*. In: Proceedings of the symposium on marine food chains. Ed. Steele, JH. London, Oliver and Boyd. 222-240.

Oren, OH. 1981. Aquaculture of Grey mullets (International Biological program No. 26). Cambridge University press, Cambridge, England. pp507.

Pillay, SR. 1972. A bibliography of the grey mullets, family Mugilidae FAO. Fisheries Technical paper no. 109. Rome.

Pillay, TVR. 1953. Studies on the food and feeding habits and alimentary tract of the grey mullet *M. tade* Forsskal. Proc. Natu.Inst.Sci India. 19:777- 827.

Pillay, TVR. 1954. The Biology of grey mullet, *Mugil tade* Forsskal with notes on its fishery in Bengal. Proc. Nat. Inst. Sci. India. 20:187-217.

Pillay, TVR. 1958. Biology and fisheries of grey mullets of Bengal. II. Biology of *Mugil cunnesius* Valenciennes. Indian J. Fish. 5:56-76.

Prasadam, RD. 1970. Preliminary observations on the food and feeding habits of the grey mullet *Mugil macrolepis* (Smith) Auguas, from Pulicat Lake. J. Zoo. Soc. India. 22(1&2):63-67.

Rajan, S. 1964. Environmental Studies of Chilka Lake. I. Feeding Spectrum of fishes. Indian J. Fish. 11(2):521-32.

Rangaswamy, CP. 1973. Studies on the age and growth and food habits of the grey mullet *Mugil cephalus* Linnaeus of the Lake Pulicat. J. Inland Fish. Soc. India. 5:9-22.

Saleh, M. 2008. Capture-based aquaculture of mullets in Egypt. In: Capture-Based Aquaculture, Global Overview. Eds. Lovatelli, A. and Holthus, PF. FAO Fisheries Technical Paper, No. 508. FAO, Rome. 109-126.

Sanchez Rueda, P. 2002. Stomach content analysis of *Mugil cephalus* and *Mugil curema* (Mugiliformes: Mugillidae) with emphasis an diatoms in the Tamiahua Lagoon, Mexico. Revista Biologia Tropical. 50(1):245-252.

Sarojini, KK. 1954. Biology and fisheries of the grey mullets of Bengal I. Biology of *Mugil parsia* (Ham.) with notes on its fishery in Bengal. Indian J. Fish. 4(2):254-283.

Sarojini, KK. 1957. Biology and fisheries of the grey mullets of Bengal. I. biology of *Mugil parsia* Hamilton with notes on its fishery in Bengal. Ind. J. Fish. 4:160-207.

Sarojini, KK. 1958. Biology and fisheries of the grey mullet of Bengal II. Biology of *Mugil cunnesius* Valenciennes. Ind. J. Fish. 5:56-76.

Thomson, JM. 1963. Synopsis of biological data on the grey mullet *Mugil cephalus* Linnaeus 1758, Fish, Synop. Div. Fish, Oceanogr. CSIRU, Aust. (1):1-75.

Thomson, JM. 1966. The Grey Mullets. Oceanogr. Mar. Biol. Ann. Rev. 4:301-315.

Wells, RDS. 1984. The food of the grey mullet (*Mugil cephalus* L.) in Lake Waahi and the Waikato River at Huntly. New Zealand Journal of Marine and Freshwater Research. 18:13-19.

Yashouv, A. and Ben Schachar, A. 1967. Breeding and growth of Mugilidae. II. Feeding experiment under laboratory conditions with *Mugil cephalus* L. and *Mugil capito* C. Bamidgch. 19:50-66.

Zismann, L., Berdugo, Y. and Kimor, B. 1974. The food and feeding habits of early stages of grey mullets in the Haifa Bay region. In Israel Oceanographic Limnological Research, Haifa Laboratory, Annual Report. 72-73.

Received: May 3, 2013; Revised: May 31, 2013;
Accepted: June 5, 2013