FOOD AND FEEDING HABITS OF THE DEMERSAL FISHES OFF BOMBAY

C. SUSEELAN[1] AND K. V. SOMASEKHARAN NAIR[2]
Central Marine Fisheries Research Institute; Sub-station, Bombay

ABSTRACT

The food and feeding habits of some of the common fishes landed by the trawlers at Bombay have been studied by employing the points method and the volumetric method. *Ilisha filigera* has been observed to be carnivorous, feeding chiefly on *Acetes* and teleosts, and *Thrissocles malabarica* feeds predominantly on planktonic organisms. The food of the catfishes consisted of benthic epifauna and infauna and also fishes. *Polydactylus indicus* and *Polynemus heptadactylus* were feeding at all depths in the water column. *Pomadasys hasta* was noted to be mostly a benthic feeder. *Pseudosciaena diacanthus*, *Otolithoides brunneus*, *Otolithus ruber*, *Johnius dussumieri*, *J. carutta*, *J. axillaris*, *J. aneus* and *Sciaena dussumieri* fed chiefly on prawns, *Acetes* and fishes. *Muraenesox talabonoides* has been found to be predacious mainly on fishes. The seasonal variation in the diet of the fishes as a whole was determined by finding out the 'food index'. Prawns and teleosts were the most important food items consumed by the majority of the species. The values of the 'feeding index' did not show any significant variations in the different months. However, it was slightly higher during the period July to September.

INTRODUCTION

Very little information is available on the food and feeding habits of trawl fishes in India excepting those studied by Rao (1964) from the landings by the Government of India fishing vessels operating in the Bay of Bengal. The present study, which mainly refers to the common ground fishes of the north-west coast, becomes all the more significant when considering the quantity of trawl fishes landed at Bombay, and is based on the examination of the stomach contents of 1038 specimens belonging to 17 different species.

MATERIAL AND METHODS

The samples were collected from the trawl landings at Sassoon Dock, Bombay, by the Govt. of India vessels and the New India Fisheries Company's trawlers during the years 1966-1968. Each fish was examined in the fresh state for length and stage of maturity and the stomach was preserved in 5% formalin for further studies. The total length of the specimen was measured from the tip of the snout to the longest caudal fin ray, except in the case of *Polydactylus indicus* (Shaw) where the standard

Present address: 1. Central Marine Fisheries Research Institute; Centre, Colachel.
2. Central Marine Fisheries Research Institute; Sub-station, Kozhikode.

length was recorded as the caudal fin rays were found invariably broken. The stage of maturity was noted to see whether there is any correlation between feeding intensity and maturity stage of the fish. The intensity of feeding was determined based on the degree of distension of the stomach wall and the amount of food contained in it and classified as 'gorged', 'full', '3/4 full', '½ full', '¼ full', 'trace' and 'empty'. The food items were identified as far as possible up to the species and the percentage composition of the different food elements was estimated by the points method and the volumetric displacement method (Hynes, 1950; Pillay, 1952). The digested portion of the food when mixed with high amounts of mucus of the stomach was excluded while assessing the percentage composition of the gut contents.

OBSERVATIONS

1. *Pseudosciaena diacanthus* (Lacepede)

A total number of 87 specimens of size range 17.1 - 142.0 cm was examined. Most of the juvenile 'ghol' (up to about 60 cm length) in the total landings (about 85-90%) were observed with extroverted stomachs, as was also observed by Rao (1963). Prawns appear to be the most favourite food item of the juveniles, the common species met with being *Parapenaeopsis stylifera*, *P. sculptilis*, *Penaeus* sp. and *Palaemon* sp., followed by teleosts *Otolithus ruber*, *O.* sp., *Johnius dussumieri*, *J. carutta* and *Opisthopterus tardoore*, crabs and stomatopods (Fig. 1A, B). *Acetes indicus* and some molluscs formed a small portion in the feed. Table 1 indicates that the feeding intensity is slightly higher during the period September to November. Rao (1963) noted a period of high feeding activity during September - December.

The adult fish is piscivorous, teleosts constituting more than 63% in the total food (Fig. 1 C, D). The common species were *Ilisha filigera*, *Thrissocles* sp., *Opisthopterus tardoore*, *Otolithus ruber*, *Johnius dussumieri*, *Nemipterus japonicus*, *Lactarius lactarius*, *Caranx* sp. and *Leiognathus* sp. Prawns, represented by species like *Metapenaeus affinis* and *Palaemon tenuipes*, were next in importance and other organisms recorded were stomatopods, crabs, bivalves, gastropods and cephalopods.

Bhatt *et al.* (1964) found "digested prawns and prawn remains" in the stomach of a few specimens. Rao (1963) observed prawns and fishes to be the major food items.

2. *Otolithoides brunneus* (Day)

Fifty-five specimens, mostly juveniles of size range 27 - 143 cm, were examined. The juvenile 'koth', like the juvenile 'ghol', is carnivorous, feeding mainly on prawns, *Acetes* and teleosts, with very small quantities of cephalopods and other crustaceans (Fig. 2A, B). The prawns were found to consist mostly of *Parapenaeopsis stylifera*, *P.* sp. and *Solenocera* sp. The feeding intensity of the juveniles was poor during October to February (Table 1). Analysis of the stomach contents of a few adult specimens indicated a diet consisting mainly of teleosts and a fair amount of

prawns along with some cephalopods. The fishes met with were *Coilia dussumieri*, *Trichiurus* sp. and *Harpodon nehereus*. The prawn species recorded were *Metapenaeus* sp. and *Palaemon tenuipes*.

According to Karandikar and Thakur (1951), sciaenids are carnivorous, feeding on fish, crustaceans, molluscs and annelids. Kutty (1967) has observed that 'koth' mainly feeds on fishes, prawns and other crustaceans like crabs and stomatopods and that the feeding intensity in the juveniles was least during the cold season from November to February.

3. *Otolithus ruber* (Schneider)

This is one of the commonest species that occurs among small sciaenids collectively called 'dhoma', the quantitative abundance of which is very high in the trawl catches. A total of 240 specimens of size range 9.3 - 31.5 cm was examined, of which 54 were with empty stomachs. A good number of specimens were observed with extroverted stomachs.

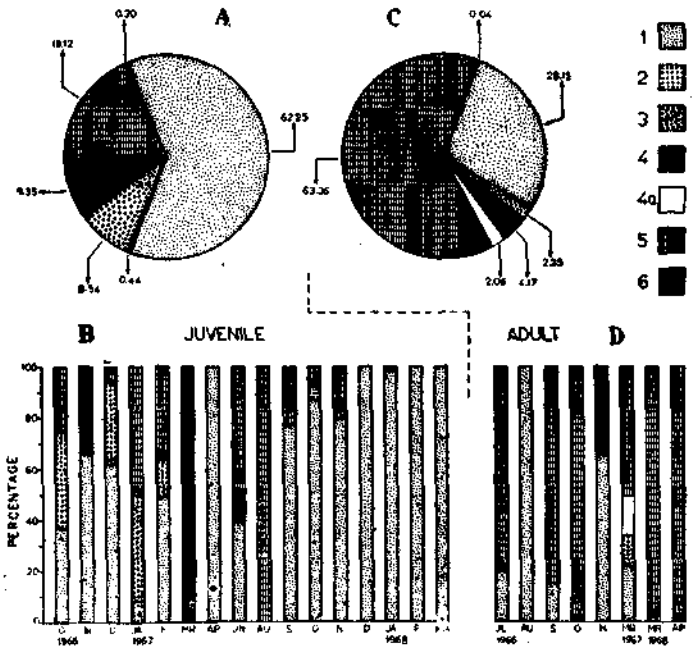

FIG. 1. Food of *Pseudosciaena diacanthus*. A and C—Percentage composition of the food items; B and D—Composition of food items in different months of observation. 1—prawns; 2—*Acetes*; 3—stomatopods; 4—crabs; 4a—cephalopods; 5—teleosts; 6—miscellaneous items, which include crustacean remains, bivalves, gastropods and teleost eggs in juveniles, and bivalves and gastropods only in adults.

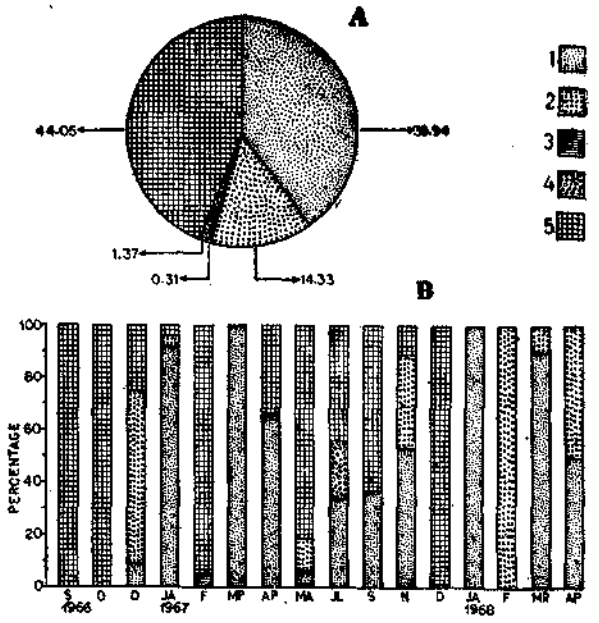

FIG. 2. Food of *Otolithoides brunneus* (juveniles). A—Percentage composition of the food items; B—Composition of food items in different months of observation. 1—prawns; 2—*Acetes;* 3—other crustacean remains; 4—cephalopods; 5—teleosts.

The fish is an active carnivore, prawns and teleosts forming the main constituent of the diet. A wide variety of other organisms like stomatopods, amphipods isopods, copepods, cephalopods and salps was also met with in the stomach (Fig. 3 A, B). The fishes encountered were *Johnius dussumieri, Johnius* sp., *Otolithus* sp., *Polynemus heptadactylus, Bregmaceros mcclellandi* and *Leiognathus* sp. The feeding intensity was considerably high, especially among mature fish, during the period from October to January (Table 1).

Jacob (1948) has observed that *O. ruber* is piscivorous in habit, feeding on fishes with the help of its conspicuous canines. Chacko (1949) has also observed this fish to be carnivorous and actively predacious at surface and midwaters. In the case of the related species *O. argenteus*, Bapat and Bal (1952) noticed a plankton feeding habit in juveniles at surface and a distinct carnivorous habit, feeding mainly on fishes, in the adults. Venkataraman (1960) also reported that *O. ruber* is mainly a carnivorous fish, teleosts forming the major item of its food. Vaidya (1960) recorded the adult to be carnivorous, feeding on crustaceans, teleosts and cephalopods, and the post-larvae and the juveniles as surface plankton feeders, feeding chiefly on crustaceans (the juveniles consuming fishes and cephalopods also in small quantities).

The present observation agrees with those of all the previous workers except for certain minor differences. Vaidya (1960) remarked *Bregmaceros mcclellandi* to be the chief item in its food, but during the present study, the juveniles of *Johnius dussumieri* and *Johnius* sp. were more frequently observed than *B. mcclellandi* in the stomach of this fish. The present investigation has also revealed that the feeding intensity is invariably related with the maturity stage of the fish, as most of the specimens examined during the spawning months were with empty stomachs or stomachs containing little food, while those examined after the spawning period had a higher percentage of full stomachs, as also observed by Vaidya (*op. cit.*).

4. *Johnius dussumieri* (Cuvier)

A total of 129 specimens of size range 12.8 - 25.5 cm was examined. This is a carnivore preferring a benthic habitat, as evidenced by the presence of polychaetes, gastropod shells, sand grains and mud in the stomach. Specimens with extroverted stomachs were observed very frequently. Prawns, *Metapenaeus* spp. and teleosts, *Bregmaceros mcclellandi* and *Leiognathus* sp. formed the major constituents of the diet with fairly high percentage of stomatopods. The other organisms that formed

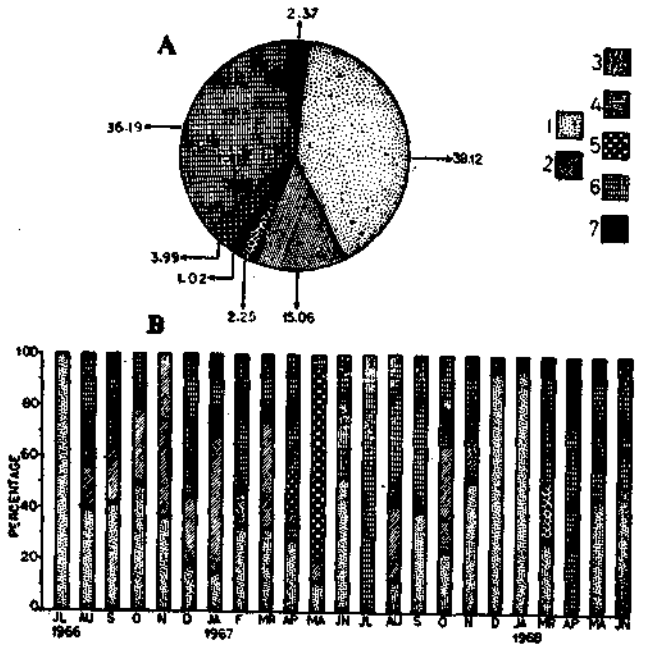

FIG. 3. Food of *Otolithus ruber*. A—Percentage composition of the food items; B—Composition of food items in different months of observation. 1—prawns; 2—*Acetes;* 3—stomatopods; 4—cephalopods; 5—salps; 6—teleosts; 7—miscellaneous items, which include amphipods, isopods, copepods, other crustacean remains and decapod larvae.

TABLE 1. *Feeding intensity and feeding index*

Species	1966 J	A	S	O	N	D	1967 J	F	M	A	M	J	J	A	S	O	N	D	1968 J	M	A	M	J
*Pseudosciaena diacanthus**	P	P	G	M	G	P	P	P	M	P	—	G	—	M	G	G	P	P	P	G	G	P	—
*Otolithoides brunneus**	—	—	G	P	E	E	P	P	G	M	P	G	G	—	M	—	P	P	P	G	—	—	—
Otolithus ruber	M	P	P	G	G	G	G	G	P	G	P	G	G	P	P	P	G	G	G	G	P	E	G
Johnius dussumieri	M	—	G	M	M	P	P	G	P	M	P	P	—	P	H	G	P	P	P	G	G	H	P
J axillaris	—	—	P	G	G	M	P	—	E	E	G	—	M	M	P	P	P	G	—	G	—	G	—
Pomadasys hasta	—	—	P	P	E	P	P	E	M	M	G	P	P	E	G	P	E	P	P	—	P	G	—
Polynemus heptadactylus	—	G	P	G	G	G	G	G	P	M	P	P	P	P	P	—	G	P	P	P	—	P	—
Muraenesox talabonoides	—	P	G	—	G	G	—	E	G	E	G	P	P	G	M	—	G	G	P	P	P	—	—
Arius thalassinus	—	M	G	G	G	—	M	P	M	—	G	—	—	P	G	P	P	P	M	—	P	M	—
Ilisha filigera	—	—	G	—	P	P	P	E	P	E	P	P	—	M	P	P	P	P	P	P	G	P	P
Feeding index	83	45	76	40	47	43	37	56	40	41	57	53	75	69	72	45	36	24	17	54	58	61	45

Data not available for February 1968. *Juveniles only. H-heavy (gorged); G-good (full or 3/4 full); M- medium (1/2 full); P-poor (very little food); E-Empty.

part of its feed were *Acetes*, crabs, amphipods, copepods (*Euchaeta* sp. and others) gastropods (*Umbonium* sp.), cephalopods and nereid polychaetes (Fig. 4 A, B). The feeding intensity was generally low except during the post-spawning periods, September to October and March to May.

Jacob (1948) has recorded prawns and white-bait as the chief food items of this species. Chacko (1949) observed this fish to be a carnivore, predacious at mid water and bottom. Bapat and Bal (1952) and Savant (1963) have noticed that the juveniles are voracious crustacean feeders with a tendency to feed at the bottom. Savant (*op. cit.*) also found prawns, *Acetes*, stomatopods, crabs, gastropods, bivalves, cephalopods and the teleosts in the food of the adult fish. An apparent correlation between feeding and maturity of the fish was also observed by Savant (*op. cit.*).

5. *Johnius carutta* Bloch

This 'small sciaenid', which is fairly common in the trawl catches, is a carnivore feeding mainly on free-living crustaceans at the bottom like penaeid prawns, *Acetes indicus*, portunid crabs and amphipods, fishes and molluscs like pteropods and gastropods (*Umbonium* sp.).

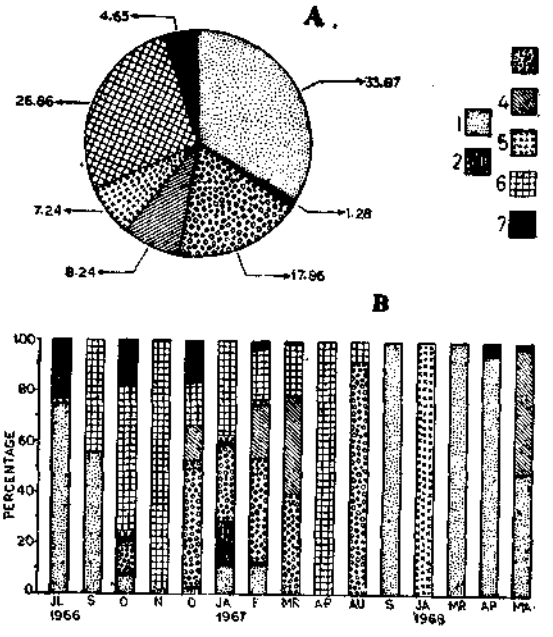

FIG. 4. Food of *Johnius dussumieri*. A—Percentage composition of the food items; B—Composition of food items in different months of observation. 1—prawns; 2—*Acetes;* 3—stomatopods; 4—crabs; 5—polychaetes; 6—teleosts; 7—miscellaneous items, which include amphipods, copepods, decapod larvae, other crustacean remains, gastropods, cephalopods, sand grains and mud.

Jacob (1948) recorded copepods (*Paracalanus* sp.), *Lucifer* sp., foraminiferans, radiolarians, larval crabs, *Gammarus*, prawns, polychaetes, *Stolephorus* spp., *Cynoglossus semifasciatus*, *Sciaena* spp., fish scales, eggs and sand grains in its stomach. He also reported one instance of cannibalism. Rao (1964) has observed that the food of this species is composed mostly of benthic fauna.

6. *Johnius axillaris* (Cuvier)

This is one of the less common species of 'small sciaenids'. Eighty-eight specimens of size range 9.9 - 27.8 cm were examined.

Like the other sciaenids, this is a carnivore feeding chiefly on fishes and invertebrates that live near the bottom. Occasionally pelagic copepods and salps were also met with in the stomach. The diet seems primarily based on teleosts and prawns supplemented by a wide variety of other organisms like *Acetes*, stomatopods, amphipods, isopods, copepods, polychaetes, cephalopods and salps (Fig. 5 A, B).

The feeding intensity was found to be slightly higher in the months of May and December (Table 1) although gorged stomachs were observed occasionally in other months also.

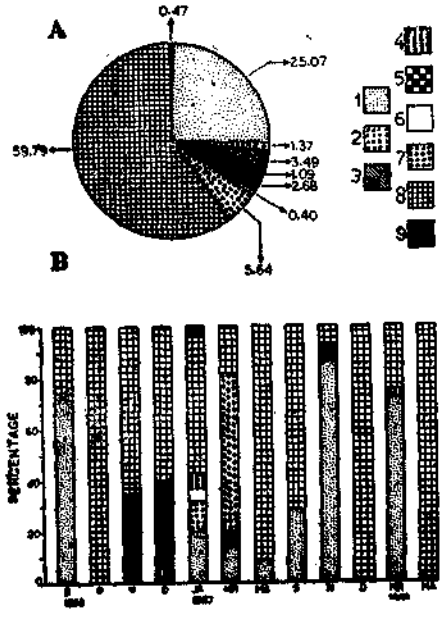

FIG. 5. Food of *Johnius axillaris*. A—Percentage composition of the food items; B—Composition of food items in different months of observation. 1—prawns; 2—*Acetes;* 3—stomatopods; 4—crabs; 5—cephalopods; 6—polychaetes; 7—salps; 8—teleosts; 9—miscellaneous items, which include amphipods, isopods, copepods and other crustacean remains.

7. *Johnius aneus* Bloch

This species, though in lesser numbers, occurs very frequently in the trawl catches. The food items found in the stomach of a few specimens examined were *Acetes indicus* and unidentifiable teleost remains.

Rao (1964) has recorded from its stomach prawns, crabs, *Squilla*, alima, *Lucifer*, mysids, isopods, amphipods, copepods, euphausiids, prawn larvae and teleosts (*Rastrelliger*).

8. *Sciaena dussumieri* (Valenciennes)

Some adult specimens were collected infrequently during September—October 1966 and April and October 1967. This is a carnivorous fish, predacious at mid water and bottom. Most of the specimens examined were with extroverted stomachs. The stomach contents of the available specimens included stomatopods, salps, molluscan remains and teleost scales.

Jacob (1948) noticed polynoid worms (*Lepidonotus* sp.), molluscan remains and hydrozoan colonies in a specimen he examined. According to Basheeruddin and Nayar (1961) the juveniles feed on polychaete worms, copepods and other crustaceans.

9. *Pomadasys hasta* (Bloch)

A total of 61 specimens of size range 17.8 - 64.0 cm was examined. This fish, 'karkara', is primarily a bottom feeder. The food comprises teleosts, *Apogon* sp. *Bregmaceros* sp. and young eels, stomatopods, portunid crabs, prawns, amphipods tubicolous polychaetes, bivalves, gastropods, cephalopods and salps (Fig. 6 A, B). A higher percentage of amphipods, stomatopods and crabs was noticed in a few juvenile specimens examined than in the adults. The feeding intensity was poor almost throughout the year.

Venkataraman (1960) noticed polychaetes, copepods and *Coscinodiscus* in a few specimens of this species he examined.

10. *Polynemus heptadactylus* (Cuvier)

The 'shende' is fairly abundant and is obtained throughout the year. A total of 111 specimens of size range 12.5 - 26.2 cm was examined.

P. heptadactylus is a predacious carnivore exhibiting a tendency to feed at the bottom, as evidenced by the occurrence of benthic organisms mixed with sand grains and mud in the diet. The gut contained a variety of organisms, with a higher percentage of prawns (*Metapenaeus affinis*, *Parapenaeopsis hardwickii*, *Parapenaeopsis* sp., *Miyadiella* sp., *Palaemon tenuipes* and *Solenocera* sp.), stomatopods (*Squilla*) and teleosts and with lesser but significant quantities of *Acetes*, crabs, amphipods, copepods (*Euchaeta* sp.), crustacean larvae (megalopa, alima etc.), other

crustaceans (ostracods, euphausiids, *Lucifer* etc.), bivalves, gastropods (*Umbonium* sp.), polychaetes and fish eggs (Fig. 7 A, B). No marked variation could be noticed in the feeding intensity of this species at different seasons or in relation to its breeding.

Chacko (1949) observed that *P. heptadactylus* is a carnivore actively predacious at surface and mid water, feeding on prawns, *Acetes* and fishes (*Stolephorus* sp. and *Sardinella* sp.). Bapat and Bal (1952) recorded that *Acetes indicus* and *Acetes* sp. form the major item of food in the early stages which is supplemented by teleosts (*Bregmaceros mcclellandi* and *Otolithus argenteus*), copepods and polychaetes in the larger stages of the young fish. Venkataraman (1960) has reported that its food mainly consists of prawns and polychaetes along with crabs, megalopa, amphipods, copepods, *Lucifer* and *Evadne*. Nayak (1965) observed the adult fish to be carnivorous, preferring a benthic habit, with a mixed diet of crustaceans ranking first, followed by fishes, polychaetes, molluscs and echinoderms, without any definite seasonal fluctuations or reference to breeding periodicity of the species.

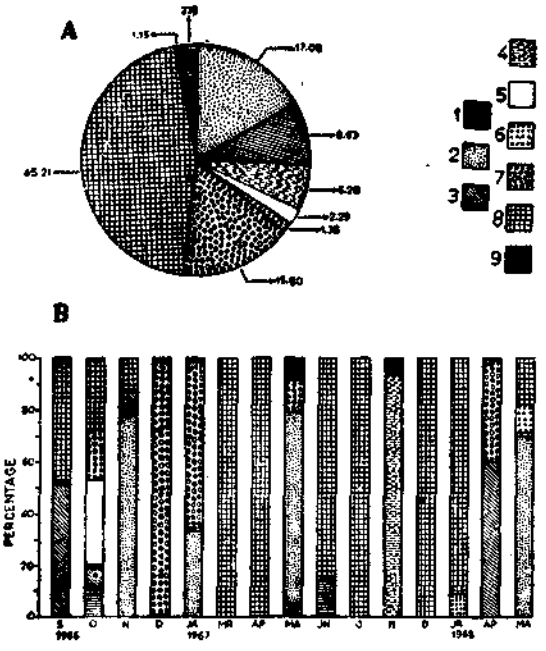

FIG. 6. Food of *Pomadasys hasta*. A—Percentage composition of the food items; B—Composition of food items in different months of observation. 1—prawns; 2—stomatopods; 3—crabs; 4—crustacean remains; 5—bivalves and gastropods; 6—cephalopods; 7—polychaetes; 8—teleosts; 9—miscellaneous items, which include amphipods, salps, plant matter and sand grains.

11. *Polydactylus indicus* (Shaw)

The species, popularly called 'dara', is a prime fish, the catches of which have dwindled much in the last ten years (Rao, 1967) and samples for the present studies were scarce because of its meagre and irregular representation in the trawl catches. This appears to be a predacious carnivore the food items of which are mainly free-living crustaceans and fishes that live near the bottom. The stomach contents of the immature specimens examined revealed a diet of prawns, *Parapenaeopsis stylifera Parapenaeopsis* sp., *Metapenaeus affinis*, *Solenocera indica* and *Palaemon* sp. and teleost fishes, *Johnius dussumieri*, *Coilia dussumieri* and *Thrissocles malabarica*, along with a number of other organisms such as stomatopods, crabs, *Acetes indicus*, bivalves, gastropods (*Murex* sp. and *Umbonium* sp.) and scaphopods (*Dentalium*).

Chacko (1949) observed that *P. indicus* is carnivorous actively predacious at surface and mid water and recorded *Penaeus* sp. and *Acetes* sp. in its diet. Mohamed (1955*b*) reported that this species is predatory in its habit, the juveniles being predominantly crustacean feeders and piscivorous. Karekar and Bal (1958) showed that

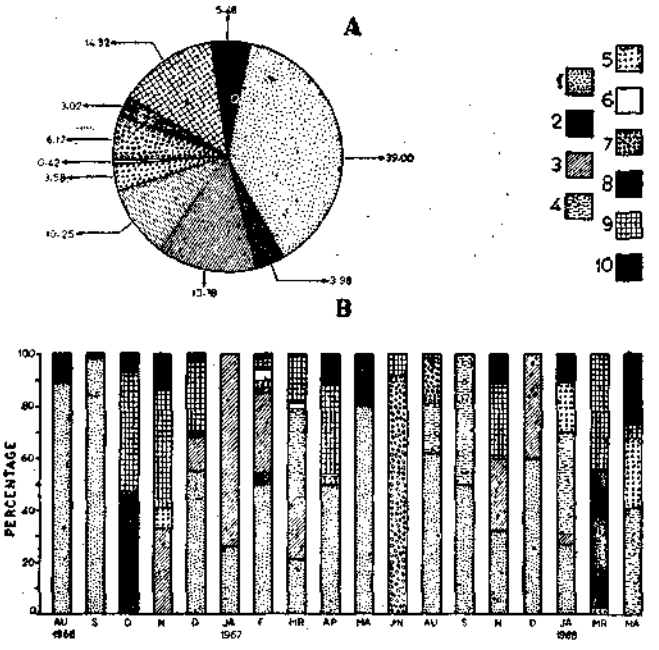

FIG. 7. Food of *Polynemus heptadactylus*. A—Percentage composition of the food items; B—Composition of food items in different months of observation. 1—prawns; 2—*Acetes;* 3—stomatopods; 4—crabs; 5—amphipods; 6—copepods; 7—megalopa larva; 8—polychaetes; 9—teleosts; 10—miscellaneous items, which include ostracods, euphausiids, alima larva, *Lucifer*, other crustacean remains, bivalves, gastropods, fish eggs, sand grains and mud.

the juveniles are chiefly crustacean feeders, mostly on prawns and *Squilla* with a small percentage of crabs. Bony fishes were observed in the stomachs of larger juveniles. In the adults, teleosts contributed the major item of food. Basheeruddin and Nayar (1961) found that the juveniles feed on prawn larvae, mysids and amphipods. Bhatt *et al.* (1964) observed that crustaceans constituted the largest single item of food, followed by teleost fishes.

12. *Muraenesox talabonoides* (Bleeker)

This eel, locally known as 'wam', supports a fishery of much importance on the north-western coast of India and is obtained almost throughout the year. A total number of 52 specimens of size range 86 - 190 cm was examined.

The species appears to be essentially a carnivore and actively predacious, feeding mainly on fishes, *Coilia dussumieri*, *Harpodon nehereus*, *Opisthopterus tardoore*, *Johnius axillaris*, *Polydactylus indicus*, *Saurida* sp., *Trichiurus* sp. and young eels, with less preference to stomatopods, crabs, prawns and cephalopods (Fig. 8 A, B). Most of the specimens examined were with empty stomachs. Mohamed (1955*a*) also observed a high percentage of empty stomachs in the specimens from trawl catches and stated that it may be due to disgorging. Juvenile sharks were also

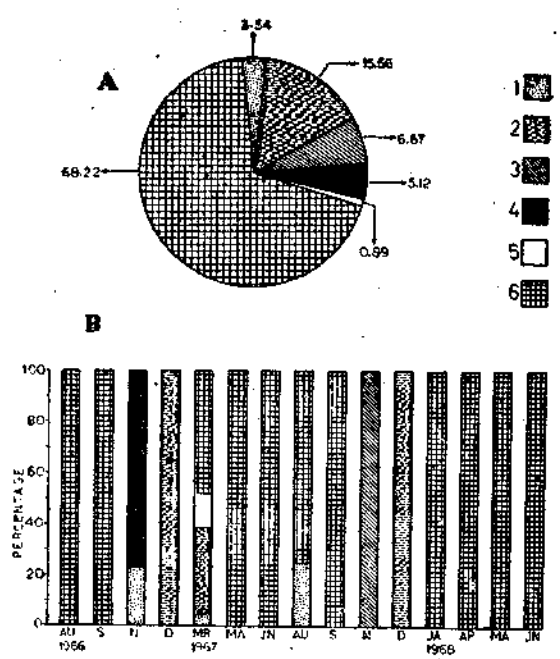

FIG. 8. Food of *Muraenesox talabonoides*. A—Percentage composition of the food items B—Composition of food items in different months of observation. 1—prawns; 2—stomatopods; 3—crabs; 4—cephalopods; 5—sharks; 6—teleosts.

encountered in the stomach and they formed a small portion of the diet in March 1967. The feeding intensity was relatively high during the second half of the year than in the first half.

Mohamed (1955*a*) has observed that *M. talabonoides* is a carnivore, predatory in its habit, feeding mainly on fishes followed by crustaceans and cephalopods, though the juveniles showed a preference to crustaceans. The feeding activity was low during the spawning period, February to May, and active feeding resumed after the spawning. The present observations also have shown that the feeding activity of this fish is similarly influenced by the maturity stages.

13. *Arius thalassinus* (Ruppell)

Arius thalassinus and *A. dussumieri* contribute to a major part of the cat-fish catches landed by trawlers, the former being available throughout the year. A total number of 40 specimens in the size range 20.5 - 57.6 cm was examined.

A. thalassinus is carnivorous and the food comprises mostly organisms of the benthic epifauna and infauna along with fishes. The stomach contents analysed included a higher percentage of crabs and teleosts (*Cynoglossus* sp., *Saurida* sp., *Otolithus ruber* and young eels) and a lesser but significant quantity of prawns (*Parapenaeopsis stylifera* and *Metapenaeus affinis*), *Acetes indicus*, stomatopods, polychaetes, bivalves, gastropods, cephalopods and salps (Fig. 9A, B). The presence of big teleost vertebrae in the stomach at times is indicative that this species is partly a scavenger feeding on the carcasses at the sea bottom.

According to Chacko (1949), this fish is omnivorous, feeding at the surface and also browsing at the bottom.

Three cat-fish eggs in an advanced stage of maturity were encountered in the stomach of a male specimen of 46 cm length in November 1967. No other item was observed along with the eggs, which were in a perfectly fresh condition. In *Arius* and other allied genera when the males carry the eggs in their mouth for incubation they do not take any food (Gill, 1906). Wyman, as quoted by Gill (*op. cit.*), observed one instance of mature foetuses in the stomach, bearing no mark of the action of gastric juice and assumed that they found their way into the stomach after death of the parent fish in consequence of the relaxation of the oesophagus which acts as a sphincter between oral cavity and stomach. Smith (1949) notes that some of the eggs carried in the mouth of the male for hatching may in times of danger be swallowed which may be regurgitated later. In the present case also the fish might have accidentally swallowed the eggs or the eggs might have entered the stomach after its death.

14. *Arius dussumieri* Cuvier and Valenciennes

This is also a carnivore, predacious at the bottom deriving its food from benthic organisms and fishes. The stomach contents showed a high percentage of bivalves

and crabs along with *Acetes*, amphipods, polychaetes, gastropods (*Umbonium* sp.), small brittle-stars and teleosts, as also sand grains and mud. The stomach of a single specimen collected in March 1967 was observed with more than 30 numbers of salps, the presence of which appears to be only accidental. Venkataraman (1960) noted polychaetes, ophiuroids, bivalves and sea-weeds among the stomach contents of this fish.

15. *Arius jella* Day

This species is fairly common in the offshore cat-fish catches. The few stomachs of the species examined showed a diet based on *Squilla*, prawns and bivalve (*Arca* sp.).

Rao (1964) observed *A. jella* to be an omnivorous and voracious feeder. He recorded from its stomach benthic forms like anemones, polychaetes, crabs, amphipods, anomurans, stomatopods, bivalves and gastropods and indicated the bottom feeding nature.

16. *Ilisha filigera* (Valenciennes)

Ilisha filigera, popularly called 'kati', constitutes a minor fishery throughout the year. A total of 60 specimens in the size range 20.5 - 39.0 cm was examined.

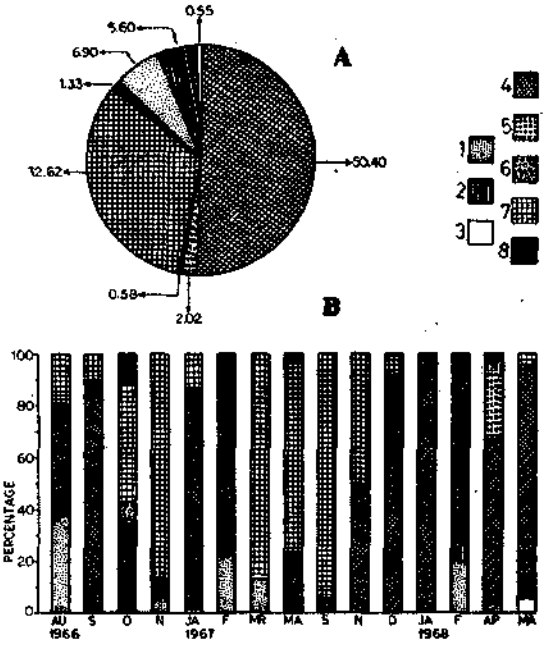

FIG. 9. Food of *Arius thalassinus*. A—Percentage composition of the food items; B—Composition of food items in different months of observation. 1—prawns; 2—*Acetes;* 3—stomatopods; 4—crabs; 5—cephalopods; 6—polychaetes; 7—teleosts; 8—miscellaneous items, which include crustacean remains, bivalves, gastropods and salps.

The species is carnivorous feeding mainly on *Acetes indicus*, as also on stomatopods, crabs, pelagic amphipods (*Oxycephalus* sp.), isopods, copepods, crustacean larvae (megalopa and alima), euphausiids, ostracods, brachiopods, salps, teleost fish and fish eggs (Fig. 10 A, B). Many stomachs examined contained a high percentage of unrecognisable digested matter. The feeding intensity, which was generally low in this species (Table 1), did not show any significant variation in different seasons or in relation to maturity stages.

Bapat and Bal (1950) observed that the post-larvae of *I. filigera* are surface plankton feeders, consuming comparatively higher percentage of prawn larvae and copepods along with amphipods, *Mysis*, *Gammarus*, other crustaceans and *Megalops cyprinoides*. According to Meenakshisundaram and Marathe (1962), *I. filigera* is a predacious carnivore, the food consisting mainly of crustaceans, teleosts and cephalopods together with small quantities of salps, polychaetes and phytoplankton. They also noted that the juveniles feed chiefly on crustaceans and that there is no wide fluctuation in the feeding intensity of the species. In the course of the present studies, however, cephalopods were not observed to form any part in the food of this fish.

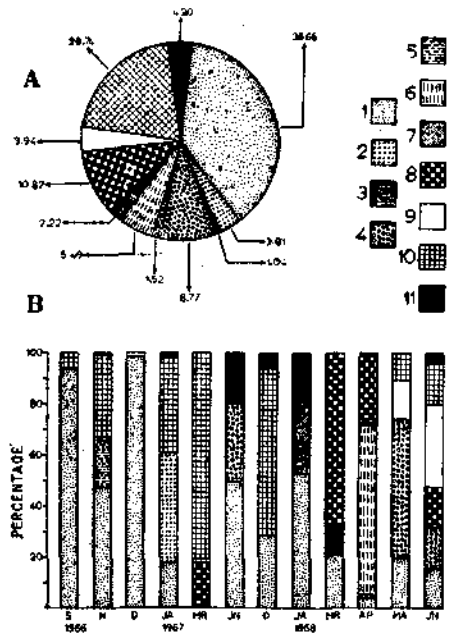

FIG. 10. Food of *Ilisha filigera*. A—Percentage composition of the food items; B—Composition of food items in different months of observation. 1—*Acetes*; 2—stomatopods; 3—crabs; 4—amphipods; 5—ostracods; 6—euphausiids; 7—alima larva; 8—crustacean remains; 9—salps; 10—teleost remains; 11—miscellaneous items, which include isopods, copepods, megalopa larva, brachiopods and teleost eggs.

17. *Thrissocles malabarica* (Bloch)

This clupeoid fish is met with in the trawl catches very frequently. *Acetes indicus*, penaeid prawns, *Euchaeta* sp. and other calanoid copepods, ostracods (*Pyrocypris* sp.), *Lucifer*, macruran larvae, crustacean eggs and diatoms were the various food items recorded from the stomach contents of a few specimens examined. Teleost scales were also observed occasionally. *T. malabarica* is thus mainly a plankton feeder, although it takes prawns and *Acetes* at times. Venkataraman (1960) found penaeid prawns, polychaetes, copedods, *Acetes*, decapod larvae, amphipods, *Hippa*, larval bivalves, *Squilla* and megalopa in its diet.

General Considerations

The variations of the different food items generally depend upon their availability or any preference shown by the fish, as also the intensity of feeding which is influenced by the growth and maturation in many fishes. The variations were studied by finding out the 'food index' (Kow, 1950), and the 'food indices' for different food organisms between July 1966 and June 1968 are given in Table 2.

It is evident from the table that prawns occurred fairly abundantly in all the months. The maximum occurrence of prawns among the stomach contents was in July 1966 and September 1967. In 1968 it was higher in January and March than in April - June. Prawn catches in the trawl landings increase from April - May and peak catches are obtained in July to September (Kagwade, 1967), the period of higher occurrence of prawns in the stomach also. The species commonly occurring in the environment were abundant in the stomach contents also.

Acetes indicus was quite common in the stomach during August to December 1966, January, May, June, August and October 1967 and March and June 1968, when greater abundance of this species was observed in the inshore waters.

The teleostean fishes which form one of the major sources of the food of trawl fishes had a high frequency of occurrence in all the months. Stomatopods and crabs were the other two important items in the stomachs. The occurrence of *Squilla* in the stomach showed a marked seasonal intensity, being heavy in November and December.

Table 1 shows the feeding intensity of ten species of fishes that are most common in the trawl catches, based on the maximum number of stomachs observed with that feeding intensity. A 'feeding index' as suggested by Kow (1950) was also worked out in order to assess the variations in the feeding intensity of all the fishes treated together. The 'feeding index' for any particular month is the ratio of the number of species whose feeding intensity was either heavy or good to the total number of species examined during that month multiplied by 100.

TABLE 2. *Food indices for various food items in different months of the period July 1966—June 1968*

Food items	1966 J	A	S	O	N	D	1967 J	F	M	A	M	J	J	A	S	O	N	D	1968 J	M	A	M	J
Prawns	71	53	30	16	18	22	20	41	37	26	38	29	50	41	36	16	31	22	27	46	16	20	24
Acetes	—	11	13	22	18	17	16	9	4	2	17	8	—	10	—	11	4	—	2	9	—	—	8
Squilla	—	3	—	26	22	24	32	32	15	—	8	—	—	20	4	—	14	17	2	2	7	9	—
Crabs	—	20	15	18	20	10	11	18	13	—	14	17	—	6	15	—	12	13	12	5	14	17	—
Amphipods	—	—	—	2	2	2	—	1	—	4	—	8	—	—	—	—	11	—	7	5	—	10	16
Isopods	—	—	—	—	—	1	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Copepods	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other crustaceans	—	3	1	19	9	1	—	—	1	20	—	—	—	—	—	—	15	—	2	8	20	5	8
Crustacean larvae	—	—	—	—	—	4	—	—	—	—	—	4	—	6	—	—	—	—	2	2	—	—	8
Gastropods and bivalves	2	—	5	—	—	10	—	—	—	8	—	—	—	—	—	—	—	—	—	—	—	—	—
Cephalopods	—	3	—	—	11	3	—	2	5	—	1	—	30	—	3	—	—	—	3	—	5	2	—
Polychaetes	—	—	—	19	—	10	13	2	—	—	3	—	—	—	—	—	—	—	5	6	5	—	—
Salps	—	—	—	—	—	—	1	—	7	5	8	—	—	—	—	—	—	—	—	—	5	1	16
Sharks	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Teleosts	39	33	59	66	34	31	38	42	55	35	51	40	75	60	43	34	28	39	14	22	21	29	45
Teleost eggs	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	5	—	—	—	—	—	—

Data not available for February 1968.

It can be seen from the table that there was no appreciable seasonal fluctuations in the value of the 'feeding index'. However, it had been comparatively higher in July - September than in other months.

Kow (*op. cit.*) states that the fishes, both pelagic and demersal, of Singapore Straits feed throughout the year, the feeding intensity varying in relatively narrow limits. Longhurst (1957) observed that the fishes of Sierra Leone River, which feed on benthic infauna and epifauna and fishes, show no evidence of seasonal variations in the feeding activity. Among the inshore fishes of Malabar coast, Venkataraman (1960) noticed that the feeding intensity, in common, is correlated with the abundance of plankton in the environment and also with the maturity stages of many species studied.

The analysis of the food of different species of trawl fishes has shown that most of them are predators on actively moving benthic invertebrates and teleost fishes.

Acknowledgements

The authors are very grateful to Mr. K. Virabhadra Rao, Central Marine Fisheries Research Institute, for his kind guidance and encouragement during the course of this study and for suggesting improvements in the manuscript. They also thank the crew of the Government of India fishing vessels and the New India Fisheries Company's trawlers based at Bombay for making available the fish samples for the present study.

References

Bapat, S.V. and D.V. Bal. 1952. The food of some young fishes from Bombay. *Proc. Indian Acad. Sci.*, **35B**: 78-92.

Basheeruddin, S. and K. Nagappan Nayar. 1961. A preliminary study of the juvenile fishes of the coastal waters off Madras City. *Indian J. Fish.*, **8** (1): 169-188.

Bhatt, Y.M., M. Narayanan Kutty, K. Venkatasubba Rao and D.M. Punwani. 1964. "Ghol-Dara" fishery off Bedi Port in the Gulf of Kutch. *Indian J. Fish.*, **11A** (1): 135-156.

Chacko, P.I. 1949. Food and feeding habits of the fishes of the Gulf of Mannar. *Proc. Indian Acad. Sci.*, **29B**: 83-97.

Gill, T. 1906. Parental care among fresh water fishes. *Rep. Smithsonian Inst., Washington:* 403-531.

Hynes, H.B.N. 1950. The food of the freshwater stickle-backs (*Gasterosteus aculeatus* and *Pygosteus pungitius*) with a review of methods used in studies of the food of fishes. *J. Anim. Ecol.*, **19**: 36-58.

Jacob, P.K. 1948. Sciaenids of the west coast of Madras Province. *J. Bombay Nat. Hist. Soc.*, **48** (1): 118-124.

Kagwade, P.V. 1967. Prawn catches by mechanised vessels in the trawling grounds of Bombay and Saurashtra. *Proc. Symp. Crustacea*, Part 4: 1348-1381. Mar. biol. Ass. India.

KARANDIKAR, K.R. AND S.S. THAKUR. 1951. *Sciaenoides brunneus* Day (anatomy with notes on distribution and bionomics). *Zool. Mem. Univ. Bombay*, **3**: 1-89.

KAREKAR, P.S. AND D.V. BAL. 1958. The food and feeding habits of *Polynemus indicus* (Shaw). *Indian J. Fish.*, **5** (1): 77-94.

KOW, T.A. 1950. The food and feeding relationships of the fishes of Singapore Straits. *Colonial Office Fishery Publications, U. K.*, **1** (1): 1-35.

KUTTY, M. NARAYANAN 1967. A note on the biology of the 'Koth' *Otolithoides brunneus* (Day). *J. mar. biol. Ass. India*, 9(1): 197-198.

LONGHURST, A.R. 1957. The food of the demersal fish of a West African estuary. *J. Anim. Ecol.*, **26**: 369-387.

MEENAKSHISUNDARAM, P.T. AND V.B. MARATHE. 1962. Food and feeding habits of the Indian herring, *Ilisha filigera* (Val.). *J. Univ. Bombay*, **31**: 53-60.

MOHAMED, K.H. 1955*a*. A study on marine eels of Bombay. M.Sc. Thesis, University of Bombay.

MOHAMED, K.H. 1955*b*. Preliminary observations on the biology and fisheries of the thread-fin, *Polydactylus indicus* (Shaw), in the Bombay and Saurashtra waters. *Indian J. Fish.*, **2** (1): 164-179.

NAYAK, P.D. 1965. Study on biology and fishery of *Polynemus heptadactylus* Cuv. and Val. Ph.D. Thesis, University of Bombay.

PILLAY, T.V.R. 1952. A critique of the methods of study of food of fishes. *J. zool. Soc. India*, **4**: 185-200.

RAO, K. SRINIVASA 1964. Food and feeding habits of fishes from trawl catches in the Bay of Bengal with observations on the diurnal variation in the nature of the feed. *Indian J. Fish.*, **11**(1): 277-314.

RAO, K. VENKATASUBBA 1963. Some aspects of the biology of 'Ghol' *Pseudosciaena diacanthus* (Lacepede). *Indian J. Fish.*, **10** A (2): 413-459.

RAO, K. VIRABHADRA 1967. Exploratory fishing. In: *Souvenir, 20th Anniversary* 25-36. Central Marine Fisheries Research Institute.

SAVANT, V.V. 1963. A study on a sciaenid, *Johnius dussumieri* (Cuv. & Val.). M.Sc. Thesis, University of Bombay.

SMITH, J.L.B. 1949. *The sea fishes of South Africa*. Central News Agency Ltd., Cape Town.

VAIDYA, V.M. 1960. A study on the biology of *Otolithes ruber* (Bl. & Schn.). M.Sc. Thesis, University of Bombay.

VENKATARAMAN, G. 1960. Studies on the food and feeding relationships of the inshore fishes off Calicut on the Malabar Coast. *Indian J. Fish.*, 7'(2): 275-306.