TABLE 3. *Species diversity index and dominance index of four stations*

	Station I	Station II	Station III	Station IV
Species diversity index ..	0.169	0.332	0.468	0.577
Dominance index (%) ..	84.3	58.8	48.2	36.5

of station II-IV were 0.332, 0.468 and 0.577 respectively (Table 3); it proves that when the effect of the physical factors over environment decreases the number of dominant species as well as species diversity increases. During extreme environmental conditions, only a few species are adapted to it, but they grow maximum in number which might be due to less competition.

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COMPARATIVE STUDIES ON THE FEEDING HABITS OF MARINE AND ESTUARINE CARANGIDS

ABSTRACT

The gut contents of 42 species of carangid fishes occurring at Visakhapatnam on the east coast of India are analysed. Of these eleven species also occur in Godavary and Vellar Estuaries on the east coast. The gut contents of *Alepes djedaba* from Visakhapatnam region, Godavary Estuary and Vellar Estuary and of *Alepes kalla* from Visakhapatnam and Vellar Estuary are compared.

CARANGIDS constitute a commercially important group of fishes along the Indian Coast. The juveniles and subadults of some species are also reported from the estuaries and brakish-water areas where they constitute a fishery. Some of the earlier work done on the food of carangids was based on observations on single species. Chacko (1949) analysed the food of *Caranx hippos* and *Caranx sansun* from the Gulf of Mannar. Bapat and Bal

(1952) gave a brief account of the food of *Chorinemus toloo*. Datar (1954) and Sreenivasan (1975) reported the food and feeding habit of *Selaroides leptolepis*. Kagwade (1965) reported the food of *Caranx kalla*. Reuben (1969) investigated the food of Malabar trevally *Carangoides malabaricus* from Bay of Bengal. Sreenivasan (1979) gave an account of feeding biology of the scad *Decapterus* Novo. The present investigation is on the qualitative analysis of the food contents of the horse mackerels collected for the systematic study.

The author is grateful to Prof. S. Dutt, under whose guidance this investigation has been carried out.

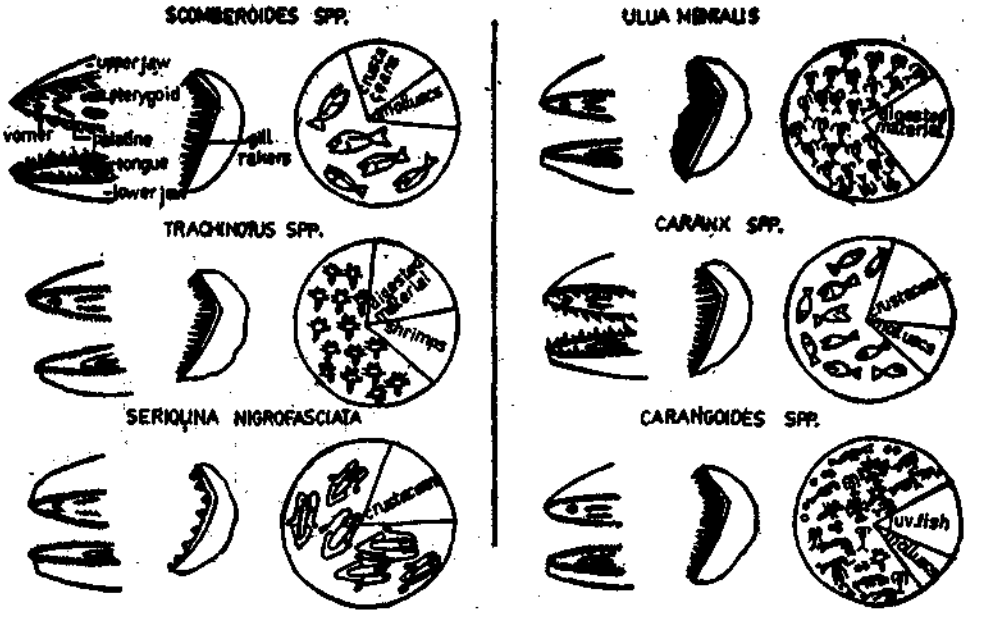

FIG. 1. Relation between dentition, gillrakers and stomach contents in carangid fishes.

dayi from Cochin region. Venkataraman (1961), while giving the food and feeding relationships of the inshore fishes off Calicut region on the Malabar Coast, described the food of *Caranx kalla* and *C. djedaba*. Rao (1967) while giving an account of food and feeding habits of fishes from trawl catches in the Bay of Bengal, described the food of a few carangid species such as *Chorinemus lysan*, *Atropus atropus*, *Caranx sexfasciatus*, *Carangoides malabaricus*, *C. chrysophrys* and *C. armatus* from Visakhapatnam region. Venkatramani and Natarajan (1983) described the food of *C. malabaricus* and *Alepes kalla* from Porto

Material and Method

The present study is based on the monthly and fortnightly samples obtained from the trawl catches at Visakhapatnam during 1977 to 1985 and also from samples collected from the Gautami-Godavari Estuary (Yanam) and Vellar Estuary during 1985. Based on the state of distention of stomachs, the intensity of feeding was recorded, they were classified as empty, 1/4 full, 1/2 full, 3/4 full and gorged depending on the amount of food present in the stomochs. The food elements were identified as far as possible upto family or genus level depending upon the intactness of

organisms and the state of digestion. A total of 435 specimens belonging to 42 species 17 genera and 4 subfamilies were studied.

Discussion

The carangid fishery at Visakhapatnam starts generally during August to March with peak season from September to February. At this time the inshore waters are rich in plankton comprising a large variety of edible zooplankton after the monsoon period. Hence it seems that carangids and most other fishes utilise the continental waters with plenty of food as feeding grounds and breed elsewhere. This abundance of zooplankton is also noticed in the stomachs of the fishes.

length were noted to consume microplanktonic forms like copepods and larval crustaceans. Horse mackerels are generally pelagic in habitat (a few are demersal) and they are generally carnivorous in habit. The change in the food pattern between the juvenile and adult carangids is dependent upon the area of filtration formed by the gill apparatus as demonstrated by Magnuson and Helt (1971). Sreenivasan (1979) has also observed the change in the food pattern of juvenile and adult scad *Decapterus dayi*.

Eventhough planktonic forms such as chaetognaths (*Sagitta*, *Krohnitta*), coelenterates, ctenophores (*Pleurobrachia*, *Beroe*), urochor-

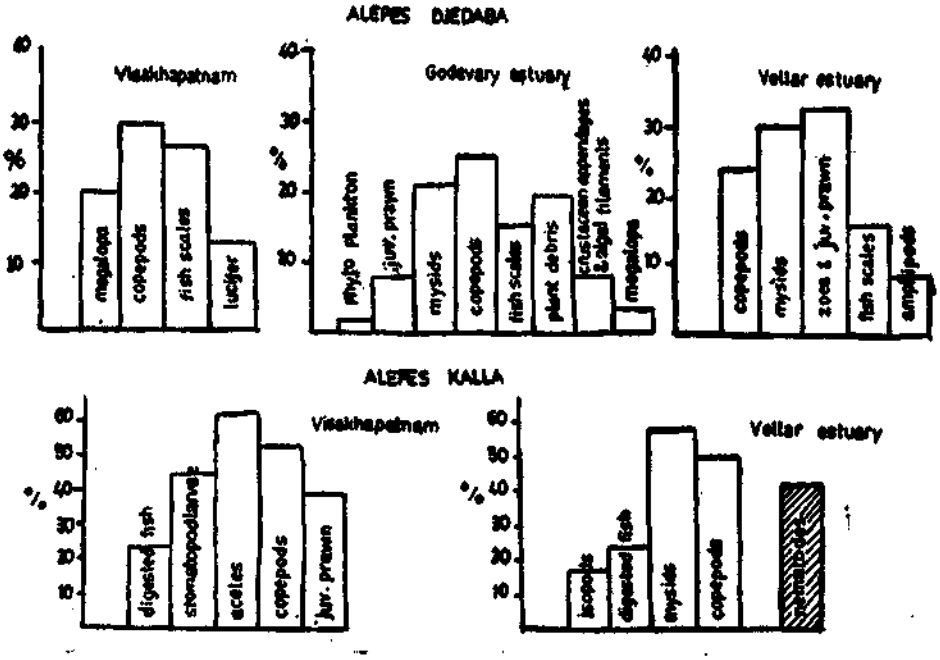

FIG. 2. Percentage occurrence of food items in the stomachs of *A. djedaba* and *A. kalla*.

It appears from Table 1 that the main food constituents of carangids are macroplanktonic forms, such as shrimps (*Acetes* spp.) prawn larvae, crab larvae, stomatopod larvae, squids and juvenile fishes like clupeids, leiognathids, etc. Fishes below 10 cm in total

dates (*Oikopleura*, *Fritillaria*, *Doliolum* and *Salpa*), polychaetes, ostracods and echinoderm larvae are very common in the plankton of this region, they are absent in the gut contents of carangids. It shows that Horse mackerels are selective in the food habits.

TABLE 1. *Stomach contents of carangids collected from trawl catches at Waltair region*

Species	No. of specimens examined	No. of specimens with empty stomachs	Size range (TL in mm)	Total gill rakers	Stomach contents	Remarks
1	2	3	4	5	6	7
Scomberoides commersonianus	25	8	84-1000	13-19	Juveniles have small fish, cephalopods and fish scales. Adults have anchovies and teleost remains	Well developed canine teeth on jaws.
S. tala	3	1	190-193	12-13	Digested remains of cephalopods, teleost fish and decapod crustaceans	same
S. lysan	25	10	202-421	21-26	*Acetes*, juvenile clupeid fishes	same
S. tol	30	18	181-344	22-27	Stomatopod larvae, *Anchoviella*, *Acetes*, *megalopa*, copepods like *Pontella*, *Labidocera* & *Lucifera*, zoea and mysis stages of prawns	same
Trachinotus blochii	5	2	120-185	14-19	Digested material, appendages of shrimps	Jaw teeth feeble, pharyngeal teeth molari form.
T. russellii	6	2	155-432	23-25	Digested material, megalopa larvae	same
T. baillonii	2	—	262-300	23-25	Digested material, crab juveniles	same
Elagatis bipinnulatus	4	..	281-350	35-37	Juveniles of prawn, crab and remains of teleost fishes	
Gnathanodon speciosus	8	1	45-60	26-30	*Acetes*, ostracods, copepods, mollusc larvae, leiognathid juveniles and sand grains	
Sertolina nigrofasciata	6	2	260-345	8-10	*Loligo*, juvenile prawns	Demersal feeder Gill rakers reduced in size.

TABLE 1. (*Contd.*)

1	2	3	4	5	6	7
Seriola rivoliana	2	—	280-310	15-16	Juvenile squids, juvenile fish	Gill rakers not reduced in size.
Decapterus russelliii	38	—	142-214	44-51	Acetes, juvenile prawns, juvenile leiognathids, juvenile clupeids, *Stolephorus* spp. fish scales. Contained the same variety of organisms	
D. macrosoma *D. maccarellus* and *D. kurroides*						
Megalaspis cordyla	43	12	84-365	25-33	Juveniles have copepods like *Labidocera*, *Undinula* & *Eucalanus*, Megalopa, mysids. Adults have *Anchoviella*, spp., leiognathids, sciaenids, *Rastrelliger* spp. *Trichiurus* spp.	
Alectis ciliaris	3	...	148-174	19-21	Megalopa, lucifer, juvenile teleost and crustacean remains and cuttlefish juveniles.	
A. indicus	20	13	87-190	31-36	*Acetes*, stomatopod larvae, juvenile cephalopods.	
Uraspis helvius	10	—	140-267	19-25	Digested remains of fish and crabs.	
Carangoides malabaricus					*Acetes*, juvenile clupeids, leiognathids, Lucifer, megalopa, mysis, alima larvae and cephalopods.	
C. praeustus, *C. talampanoides*, *C. chrysophrys*, *C. coeruleopinnatus*, *C. ferdau*, *C. gymnostethus*, *C. uii*, *C. hedlandensis* & *C. armatus*, etc.					Contained almost the same variety of organisms.	
Ulua mentalis	2	1	153-155	80	Digested material copepods.	Gill rakers numerous.
Atropus atropus	39	10	149-212	30-34	*Acetes*, alima and crab larvae, copepods like *Temora*, *Pontella*, *Eucalanus* and detritus	Probably a demersal feeder.

TABLE 1. (*Contd.*)

1	2	3	4	5	6	7
Selar crumenophthalmus	18	—	170-263	38-42	*Acetes*, juvenile crabs, fishes, fish eggs, Foraminiferans.	
Alepes djedaba	60	15	130-255	37-45	Copepods, Lucifer, megalopa, cycloid scales.	
A. kalla	25	7	78-178	36-45	Copepods, *Acetes*, prawn larvae stomatopod larvae.	
A. melanoptera	12	2	168-240	25-31	Copepods, *Acetes*.	
A. vari	13	2	131-343	32-36	*Acetes*, *copepods*, megalopa, juvenile clupeids.	
Caranx sixfasciatus	18	4	102-252	22-25	Juveniles feed on *Acetes* and larvae of crustaceans. Adults feed on juveniles of clupeids, leiognathids engraulids, trichiurids and cephalopods.	canine teeth on jaws
C. sem., *C. melampygus*					Feed on same catgory of organisms.	
C. ignobilis and *C. tille*						

Instances of food preferences have also been observed earlier by Sreenivasan (1974) in *Megalaspis cordyla* where even the larvae show selectivity of feeding preferring only a few of the many copepods found predominantly in the environment. Karuna (1959) and Venkatramani (1983) have reported an instance of cannibalism twice in the guts of *A. atropus*. There appears some correlation between the maturity of the fish and feeding intensity. Strikingly the stomachs of immature and spent forms are empty. But in a few instances full stomachs were observed even in ripe females of *D. russellii*.

A comparison of food constituents of marine and estuarine carangid species

Most of the juveniles and subadults of carangids enter the estuaries or brackishwater which they utilise as feeding grounds. Species such as *S. commersonianus*, *A. kalla*, *A. djedaba*, *A. mate*, *C. sexfasciatus*, *C. sem*, *C. ignobilis*, *C. melampygus*, *C. malabaricus*, *C. gymnostethus* and *C. crysophrys* are recorded from Godavari Estuary as well as Vellar Estuary. Some specimens of *A. djedaba* and *A. kalla* are collected from Godavari Estuary, Vellar Estuary and from Visakhapatnam Coast. Since they are collected in the same season and they belong to the same length group a comparative study made regarding the gut contents of *A. djedaba* from all the three regions and of *A. kalla* between Vellar Estuary and Waltair region.

Specimens of *A. djedaba* (130-185 mm TL) from Visakhapatnam Coast have copepods such as *Temora*, *Pseudodiaptomus Centropages*,

etc. *Lucifera*, megalopa larvae and teleost scales in their guts. Phytoplankton or filamentous algae are not observed in the stomachs of fishes examined from this region. Specimens of *A. djedaba* (125-154 mm TL) from Godavari Estuary have mostly digested material of unknown origin, copepods such as *Temora*, *Oncaea*, etc., juvenile prawn, crustacean appendages, megalopa larvae and mysids in their guts. In addition most of the stomachs have plant debris, algal filaments, sandy clay and cycloid scales. Phytoplankton is represented by *Coscinodiscus* and *Thalssiothrix*. Specimens of *A. djedaba* (90-182 mm TL) from Vellar Estuary have mostly mysids, juvenile prawns, zoea larvae, amphipods, copepods, cycloid scales and sand grains in their guts. Phytoplankton or algae are absent in the stomachs.

Specimens of *A. kalla* (80-150 mm TL) collected from Visakhapatnam region have copepods, *Acetes*, juvenile prawns, alima larvae and digested fish remains in their stomachs. Specimens of *A. kalla* (65-145 mm TL) collected from Vellar Estuary have mostly copepods, mysids, isopods, digested fish remains and grains in their stomachs. The presence of phytoplankton, algal filaments, plant debris and clay particles in the stomachs of *A. djedaba* collected from Godavari Estuary may be due to their abundance in the surface regions, and the presence of which in the stomachs appear to be strange, because the carangids are considered as selective feeders. Specimens of *A. djedaba* and *A. kalla* collected from Vellar Estuary have mostly mysidy and juvenile prawns, which are replaced by *Acetes* spp. in most of the specimens from Visakhapatnam region. Sand grains are abundant in the stomachs of *A. djedaba* and *A. kalla* collected from the estuaries. The remaining food items such as copepods and fish scales are same in all three regions. Probably *A. djedaba* also shows scale feeding behaviour since fish are absent in the diet and teeth are feeble in this species.

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