

FOOD AND FEEDING HABITS OF THE SPOTTED HERRING,
HERKLOTSICHTHYS PUNCTATUS (RUPPELL)
FROM THE ANDAMAN SEA

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ABSTRACT

Herklotsichthys punctatus (Ruppell) which contributes a significant percentage to the clupeid catches in the Andaman Islands is a carnivorous surface plankton feeder, its diet being composed entirely of zooplankton. Copepods, especially *Pseudodiaptomus* spp., form the main item of its diet. The euphausiid *Pseudeuphausia* sp. and megalopa occupy the second and third places in its diet. Other copepods like species of *Pontella*, *Temora*, *Calanus*, *Tortanus*, *Euterpina*, *Corycaeus*, *Anamalocera*, *Sapphirina*, *Epilabidocera* and *Microsetella* contribute a minor percentage to the diet. Larvae of *Penaeus* sp., mysid, *Lucifer* and fish, and the pteropod *Cavolina* and the heteropod *Atlanta* were also found to form the food. Generally intense feeding activity was noticed during June to September corresponding to the south-west monsoon period. The feeding intensity was also found to be generally higher during the early hours of the day than during the afternoon hours. Fish in the size group 65-90 mm (total length) feed mainly on small organisms like copepods. As the fish grow there is a change in the feeding habit, fishes of larger size (120-140 mm) feeding on larger organisms like euphausiids, megalopa and pteropods. Mature fish occurring in the commercial catches exhibit a high feeding intensity during April and August-September and this coincides with the pre-spawning period of the fish.

INTRODUCTION

Clupeids being economically important food fishes in India, their food and feeding habits have been investigated in detail by many workers. Special mention may be made of the investigations on *Sardinella longiceps* (Hornell and Nayudu, 1924; Nair, 1953; Dhulkhed, 1962), *Sardinella gibbosa* (Devanesan, 1932; Ganapati and Rao 1957), *Kowala coval* (Nair, 1951), *Thrissocles mystax*, (Venkataraman, 1956), *Raconda russellina* (Varghese, 1961) and *Coilia borneensis* (Varghese, 1961). However, practically no information is available on the food and feeding habits of *Herklotsichthys punctatus* (Ruppel) a clupeid which is commercially important in the waters around Andaman Islands. A detailed study on the biology of *H. punctatus* was undertaken during the years 1965-67 and the present account relates to the food and feeding habits of this species.

MATERIAL AND METHODS

The material for this study was obtained from the commercial catches at different fishing centres in and around Port Blair. The bulk of the catches was by

cast-nets from inshore waters. A total of 1,025 specimens collected during different hours of the day and ranging in total length from 64 mm to 145 mm have been examined. The total length and stage of maturity (according to the scale fixed by the International Council for the Exploration of the Seas) of individual fish were recorded. The stomachs were preserved in 5% formalin for subsequent analysis.

Both quantitative and qualitative analyses of gut contents were made. The volume of the stomach contents was determined by the displacement method. The numerical method and the occurrence method were followed in elucidating the relative abundance of organisms comprising the diet of the fish. The fish examined were classified into 10 mm size intervals and the percentage occurrence of the various food items in different size groups was calculated. The feeding intensity in various months was ascertained from the state of distension of stomach and the volume of food contained in it, and categorized as full, 3/4 full, 1/2 full, 1/4 full, trace and empty. The percentage occurrence of each category of stomach was calculated from the total number of the fish examined in a month. The monthly average volume of the food was calculated by dividing the total volume of food by the number of fish.

CONDITION OF FEED

Active feeding was considered to have taken place when the stomachs were full and 3/4 full, moderate feeding when the stomachs were 1/2 full and poor when stomachs were 1/4 full and trace.

In 1966 there was active feeding during June, September and December, and in 1967, during February, April, July, August and September. The analysis of the data for the two years revealed that the fish fed actively at irregular intervals. For example, while poor feeding was noticed in February, July and August 1966, the feeding was high in the same period of 1967. Similarly active feeding was noticed in June and December 1966 while it was poor in the corresponding months of 1967. Generally the feeding intensity was high during April and September of both the years.

MATURITY AND FEEDING

The average volumes of stomach contents in each month for mature (stages IV and V) as well as immature fish (Stages I - III) are presented in Fig. 1 for the years 1966 and 1967. In 1966, 354 immature and 136 mature fishes and in 1967, 259 immature and 144 mature fishes were examined.

During 1966 the immature fish showed a high average volume of stomach contents in April, June, September and December with the maximum average volume of 1.22 ml in September. The mature specimens also exhibited a similar trend with a maximum average volume of 1.99 ml in September. During May 1966 fishes with mature gonads were not available for the study. During 1967 for immature fish the pattern was slightly different. High average volumes of stomach contents were seen

in February, April, July and September. For the mature fish the high average volumes occurred in January, April and August.

Large numbers of fish in the commercial catches during the months of March-April and August-September were found to possess gonads in stages IV and V of maturity. The fact that mature fishes show a high average volume of stomach contents in these months seems to indicate that the fish feed actively during this period. The state of feeding in spawning individuals is not known since they were not met with in the commercial catches.

FOOD ITEMS AND THEIR SEASONAL VARIATION

Among larval forms zoea, megalopa, cypris and veliger were the major dietary inclusions of the fish. Cypris larvae were recorded throughout, except for May and November 1966 and May 1967 and were dominant in June and July 1967, accounting for nearly 31 to 38%. Zoea were few but megalopa formed the predominant item of food in March, May, July, August and September 1966 and also August and December 1967, with the highest percentage of 56.6 in May 1966. Veligers were noticed during October and November 1965, July-October and December 1966, and in all the months except July in 1967, with the maximum of 17.4% in November 1967. Fish larvae were present only in a few months, with a maximum of 4.4% during February 1967. Polychaete larvae and alima larvae were present in minor proportions in certain months only. Zooantharian larvae constituting a high percentage of food were noticed only during April 1967.

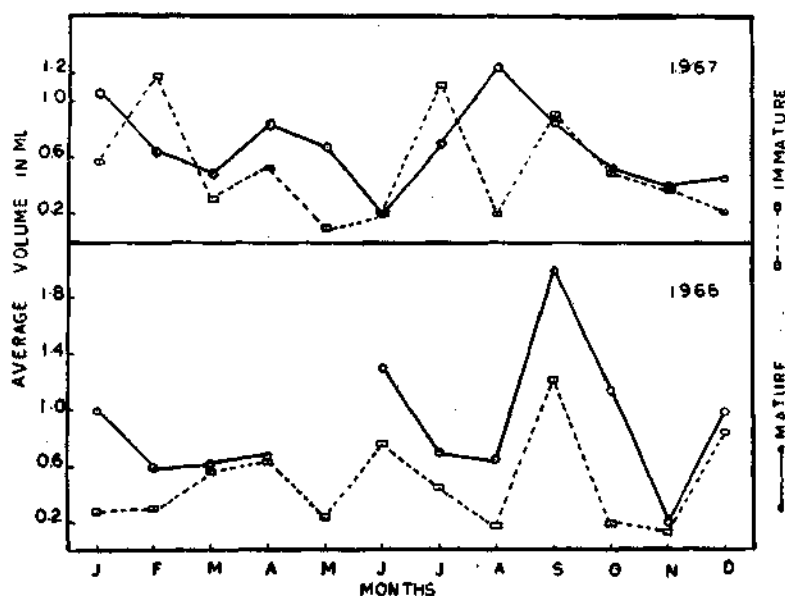


FIG. 1. Feeding intensity in relation to maturity in *H. punctatus*

Copepods formed the chief item of food, being consumed almost throughout the year in high proportions. During 1965, they constituted 71.7 and 64.9% in November and December respectively. In the subsequent year the maximum number of copepods was noticed in April and November. In 1967 the largest percentage was observed during May. Very few copepods were observed in May, August and December 1966 and also in January, February, July and October 1967. Among copepods species of *Pseudodiaptomus*, *Oithona*, *Calanus*, *Pontella*, *Tortanus*, *Euterpina*, *Corycaeus* and *Microsetella* were the common items noted in the diet of the fish, *Pseudodiaptomus* spp. being the most common. This item was present in stomach in most of the months, a high percentage occurring during November 1966 and May 1967. *Calanus* spp. were encountered in the range 0.2 - 23.3% and a high percentage was noticed in November and December 1965 and April 1966. In most of the months during 1967 this item was absent. *Oithona* spp. were fairly common during November and December 1965, but present only in minor quantities during some of the other months and were completely absent during the latter half of 1967. *Pontella* spp. also were present only in certain months, the maximum occurring in July and November 1966. This item was also not present during a major part of 1967. *Tortanus* spp. were noticed in the stomach in most of the months during 1966 and a maximum percentage (43.7%) was recorded in April 1966. In 1967 this item was not met with in the diet from May onwards. *Euterpina* sp. and *Corycaeus* spp. occurred in small numbers during some months in 1966, while in 1967 the former was present in poor numbers in March and April, and the latter in April. *Epilabidocera* sp. appeared in the stomach in June 1966 in fairly high percentage and in September 1966 in minor proportions; it was absent during the rest of the period. *Microsetella* sp. was present only from November 1965 to March 1966. Other copepods, viz. species of *Sapphirina*, *Temora*, *Anamalocera* and *Macrosetella* were noticed throughout the period of investigation except in November 1966 and December 1967.

Euphausiids, mostly represented by *Pseudeuphausia* sp. were common in the gut and formed an important item of food in most of the months, ranging from 3.0 to 81.4%. This item of food occupied the first rank in diet composition during February, June, October and December 1966. A high percentage (80-81%) of this item was found in January and February 1967. The percentage was generally high in stomach during January-March, June-July, and October and December. It was completely absent during 1965 and also in March-May and November 1966. In the subsequent year it was recorded in all the months except June.

Penaeus spp. were present in the stomach in many months during 1966, a high percentage occurring in January. In 1967 it was found only during January, February, April, August and October.

Amphipods were noticed in the range 0.3-6.3% and the highest percentage was found during September 1967. Mysids formed a dominant item of food in October 1965 only but occurred in small numbers in January-March and July 1966. In 1967 it appeared in minor proportions during January, March and June.

Lucifer sp. constituted a high percentage (24.8%) of food during May 1966. Its occurrence was poor during the rest of the period. Other crustacean forms like Cladocera, *Sergestes*, *Squilla* and alima larvae, forming minor items of food, ranged from 0.4 to 11.7% and the maximum number was recorded during October 1966.

Fish eggs constituted an important item of food during 1965-66 and a high percentage was encountered during October 1965. It was not present in the gut inclusions during May and December 1966. In 1967 it was noticed during March, April and July-September.

Among pteropods, *Cavolinia* was fairly common accounting for nearly 21% of diet during July 1966. Other pteropods like *Clio*, *Creseis* and heteropods like *Atlanta* were occasionally present. Cercariae of flukes were quite common among gut inclusions during most of the months.

The percentage values of the chief constituents of food, viz. euphausiids, copepods, megalopa, cypris larvae, and *Pseudodiaptomus* in different months are presented in Fig. 2.

Certain interesting features were brought out by the stomach analysis. For example in November and December 1965 when the percentage of copepods was as high as 72 - 65% the large-sized items of food such as euphausiids, megalopa, *Lucifer* and *Cavolinia* were few in number. Again in April and November 1966 and in May 1967 when copepods formed the dominant item of food, megalopa and euphausiids were few in number and sometimes completely absent. A poor consumption of copepods was noticed when the big-sized organisms such as euphausiids, megalopa, *Lucifer* etc. were found in large numbers as in the months of May, August, December 1966, January-March, July, October and December 1967. The occurrence of megalopa and euphausiids in high percentage in the stomach of *H. punctatus* was seen to coincide with the period of high feeding intensity.

FOOD IN RELATION TO DIFFERENT SIZE GROUPS

The percentage occurrence of the important food organisms in the gut contents of *H. punctatus* of different size groups for the year 1966 and 1967 is presented in Table 1.

Analysis of the data revealed that euphausiids, although present in small percentage in the stomachs of fish of all size groups, were present in greater percentage in the size group 120-149 mm and the maximum percentage was seen in the size group 140-149 mm. Similarly megalopa was also present in high percentage in the stomachs of fish of size group 100 - 149 mm. They were absent from the stomach of fish of 60-69 mm.

Penaeus spp. were present in greater percentage in the fish of 70-109 mm size group; they were few in bigger-sized fish. Large numbers of amphipods occurred

in the fish of size group 140-149 mm. Cypris larvae, though present in the fish of all size groups, were dominant in the size group 70-79 mm. Veligers were predominant in the 70-79 mm group. Fish below 100 mm do not appear to feed on *Cavolinia* and *Atlanta*. But in the higher size groups, especially in 140-149 mm group, they were predominant.

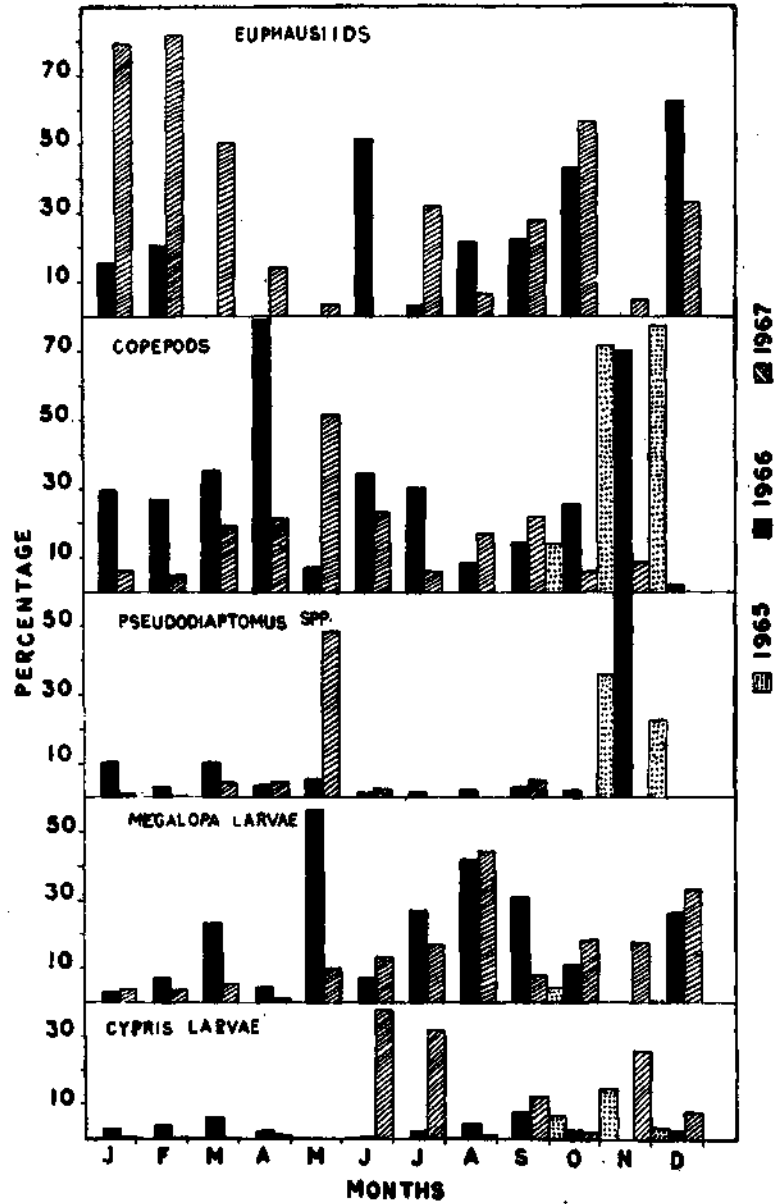


FIG. 2. Percentage composition of major food items in *H. punctatus*

TABLE 1. Percentage occurrence of some important food items in the stomach contents of *H. punctatus* in various size groups during 1966-1967

Size group (mm)	1966									1967						
	60-69	70-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	90-99	100-109	110-119	120-129	130-139	140-149	
No. of fish examined	8	29	45	51	61	102	98	82	14	8	99	147	90	53	4	
Food items:																
Euphausiids	12.5	10.3	8.9	9.8	8.2	15.7	30.6	28.0	35.7	12.5	22.2	17.7	22.2	24.5	25.0	
Megalopa larvae		13.8	11.1	27.4	32.3	29.4	53.0	45.1	28.6	13.0	25.3	18.4	26.8	37.7	50.0	
<i>Penaeus</i> spp.		17.2	17.8	17.6	19.7	5.9	3.1	4.8	14.3		1.0	0.7	4.4	1.8		
Amphipods				3.9	8.2	4.9	9.2	12.2	28.6		7.1	3.4	3.3	3.6		
Cypris larvae	12.5	31.0	17.8	17.6	13.1	16.7	20.4	18.3	14.3		13.1	11.6	10.0	7.2	25.0	
Veliger larvae		34.5	6.7	7.8	11.5	11.8	18.4	10.9	7.1	12.5	15.2	9.5	5.5	11.3		
<i>Cavolinia</i>					1.6	0.9	12.3	17.1	28.6		3.0	6.1	21.1	26.4	50.0	
<i>Pseudodiaptomus</i> spp.	87.5	86.1	80.0	49.0	32.3	11.8	9.2	12.2	14.3		7.1	6.1	2.2			
<i>Calanus</i> spp.	25.0	10.3	20.0	23.5	13.1	7.8	10.2	2.4				1.4	2.2			
<i>Tortanus</i> spp.		10.3		5.9	11.5	7.8	14.3	3.7	7.1	12.5	3.0	4.1	1.1			
<i>Pontella</i> spp.		3.5		3.9	8.2	14.7	14.3	7.3		12.5	5.0		2.2			
Fish eggs		24.1	24.4	5.9	6.6	12.8	10.2	4.8			6.1	2.7	6.7	9.4		
Fish larvae						1.8	1.0	4.8			2.0	4.1				
<i>Atlanta</i>							1.0	3.7	14.3							

On the other hand smaller organisms like *Pseudodiaptomus*, *Calanus* etc. were generally present in higher percentage in fish of the size group 60-99 mm. *Pseudodiaptomus* spp. were seen in very high percentage (80-87%) in the fish of the size group 60-89 mm, *Tortanus* spp. and *Pontella* spp. though present in smaller sized fish, were dominant in the fish of size group 90-129 mm.

Fish eggs were present in greater percentage in the fish of size group 70-89 mm. The fish larvae were seen in smaller percentage in the fish of size group 100-139 mm.

The study has revealed that *H. punctatus* when young, feed on small organisms like copepods, veligers, larval stages of *Penaeus* and fish eggs. As the fish grow in size a change in the diet composition is noticed. Adult *H. punctatus* was found to feed on bigger organisms like euphausiids, megalopa, amphipods, fish larvae and *Cavolinia* and *Atlanta*.

FEEDING HABITS

As stated already the samples for analysis have been obtained both in the early and the late hours of the day. To assess whether there is any diurnal fluctuation in the feeding intensity of the fish, the samples collected in the forenoon and those collected in the afternoon were analysed separately. The percentage occurrence of empty stomachs in the samples from forenoon and afternoon is presented in Table 2. The analysis showed that the occurrence of empty stomach was generally high in fishes caught in the afternoon. Even the few items of food that were noticed in the stomach of fish from the afternoon catches were comparatively in an advanced stage of digestion. On the other hand, the stomach of fish from the morning catches contained more number of organisms in a fresh state at the anterior end of the stomach. Moreover, only a few fishes from the forenoon catches showed empty

TABLE 2. Percentage occurrence of empty guts according to the time of catch of the fish during 1965-67.

	J	F	M	A	M	J	J	A	S	O	N	D
1965 Forenoon										12.5	25.0	5.5
										(24)	(28)	(54)
Afternoon										10.5		83.3
										(19)		(6)
1966 Forenoon	25.9	13.8	41.6	0.0	37.5	8.3	14.6	16.2	0.0	1.9	10.0	9.0
	(58)	(58)	(60)	(14)	(8)	(48)	(41)	(37)	(33)	(54)	(10)	(22)
Afternoon		100.0			100.0			69.2	50.2			
		(10)			(14)			(13)	(10)			
1967 Forenoon	0.0	11.1	11.9	0.0	18.0	0.0		0.0	0.0	5.5	20.0	
	(19)	(27)	(42)	(16)	(11)	(12)		(12)	(38)	(18)	(20)	
Afternoon	0.0	52.9	42.9		82.6		41.0	46.1	15.4	87.5		31.8
	(11)	(17)	(14)		(17)		(29)	(39)	(13)	(16)		(22)

The figures given within parantheses indicate the number of the fish examined.

stomach. *H. punctatus* being a surface feeder, the occurrence of a large percentage of empty stomachs in the afternoon catches was perhaps due to the paucity of food organism in the surface waters during these hours. The study revealed that the feeding intensity in *H. punctatus* was greater in the earlier part of the day.

DISCUSSION

Various authors have observed that the inshore clupeoid fishes feed entirely on planktonic organisms. Fishes like *Sardinella longiceps* and *S. albella* exhibit a preference for phytoplankton (Venkataraman, 1960; John and Menon, 1942; Chidambaram 1950; and Nair, 1953). Venkataraman (1960) had noticed that *Anchoviella* spp. *Dussumieria hasselti* and *Ambassis gymnocephalus* show a preference for zooplankton, while *Sardinella fimbriata* feed both on phyto and zooplankton. The present study has shown that *Herklotsichthys punctatus* feed exclusively on zooplankton. The copepods particularly *Pseudodiaptomus*, constitute an important food item. Next comes the euphausiids, chiefly represented by *Pseudeuphausia* sp. Among larval forms megalopa, cypris and veliger were chiefly consumed by the fish. The pteropod *Cavolinia* formed an important item of food in large-sized fishes. An interesting feature found in the diet of *H. punctatus* was the complete absence of phytoplankton in the gut contents. Unlike as in *Sardinella* spp. where numerous closely arranged gill rakers form an efficient filtering apparatus retaining phytoplankton which constitute an important food item of these fishes, in *H. punctatus* the gill rakers are few, with wide interspaces, allowing the phytoplankton to pass through.

The feeding habit of the fish varied among the different size groups. Venkataraman (1956) noticed that juvenile specimens of *Thrissocles mystax* showed a marked preference for *Lucifer*, *Acetes*, larval penaeids and post-larvae of fish while larger specimens preferred prawns, fish and polychaetes. In *H. punctatus* the small specimens measuring 60-99 mm were found to feed on species of small copepods like *Pseudodiaptomus*, *Calanus*, *Microsetella*, *Euterpina* and *Oithona*, polychaete larvae and cypris larvae. Copepods of slightly bigger size like *Tortanus* spp., *Pontella* spp. and *Epilabidocera* sp., and also *Penaeus* spp., amphipods and other crustacean forms like alima larvae, *Squilla* and *Sergestes* were quite common in the fish of the size range 90-129 mm. In the adult fish of 120-149 mm megalopa, euphausiids and *Cavolinia* were the chief food items.

The wide variation in the intensity of feeding in different size of the fish seems to indicate that the feeding intensity depends mainly on environmental factors such as the abundance and fluctuation of planktonic organisms. This observation is in agreement with the findings of Dhulkhed (1962) in oil sardine.

The intensity of feeding was found to be high in the earlier hours of the day and this may probably be correlated with the abundance of planktonic organisms in the morning hours in the surface waters of the tropical seas. Rao (1967) investigating the food and feeding habits of fishes from the trawl catches in the Bay of Bengal

has noticed copepods in the stomach of plankton feeders obtained during the morning hours only. *H. punctatus* being a surface feeder, it is quite likely that fewer organisms would be met with in the gut contents of fish caught in the afternoon hours. This has been clearly brought out in the present study by the occurrence of higher percentage of empty stomachs in the afternoon hours. The intensity of feeding in mature fish was found to be highest during April and August-September which coincided with the pre-spawning period of the fish.

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