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Distribution of Food Items of Six Commercially Important Demersal Fishes in the South China Sea

[1]SAKRI IBRAHIM, [1]MUHAIMI MUHAMMAD, [1]MOHD AZMI AMBAK,
[1]MOHAMAD ZAIDI ZAKARIA, [2]MANSOR MAT ISA & [3]SUKREE HAJISAMAE

[1]Faculty of Agrotechonology and Food Sciences
Kolej Universiti Sains dan Teknologi Malaysia
21030 Kuala Terengganu, Malaysia
[2]Department of Marine Fishery Resources Development and Management
Southeast Asian Fisheries Development Center (SEAFDEC)
21080 Kuala Terengganu, Malaysia
[3]Faculty of Science and Technology,
Prince of Songkla University,
94000 Pattani, Thailand

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ABSTRAK

Taburan jenis makanan bagi enam spesies komersial yang penting di perairan pantai timur Semenanjung Malaysia telah dikaji. Tinjauan pukat tunda telah dijalankan di 24 stesen di kawasan antara 12 hingga 200 batu nautika daripada pantai yang meliputi keluasan anggaran 27,785.54 batu nautika persegi. Perut spesies ikan yang dipungut dikeluarkan segera, diawet dan dibawa ke makmal untuk dianalisis kandungannya. Kaedah 'occurrence' digunakan untuk menentukan kuantiti makanan. Penaeus sp. *telah didapati sebagai jenis makanan utama ikan* Carangoides malabaricus, Nemipterus marginatus, Priacanthus tayenus, *dan* Upeneus bensasi *sementara* Loligo sp. *bagi* Saurida undosquamis *dan* Sphyraena forsteri. *Kawasan sub 0, I, II dan III merupakan kawasan paling produktif bagi ikan kajian dan jenis makanan. Keputusan menunjukkan bahawa terdapat perhubungan ketara di antara jenis makanan dan taburan ikan. Maklumat mengenai kedapatan dan taburan jenis makanan adalah penting bagi pengurusan sumber perikanan dan pengeksploitasian spesies ikan dengan efisien.*

ABSTRACT

Distribution of food items of six commercially important fish species in waters off the east coast of Peninsular Malaysia were studied. Trawl surveys were conducted in 124 stations in areas between 12 to 200 nautical miles from shore covering an estimated area of 27,785.54 square nautical miles. Stomachs of fish species collected were removed onboard, preserved and taken to the laboratory for analysis of the contents. The occurrence method was used to quantify the diet. Penaeus sp. *was found to be the main food item of* Carangoides malabaricus, Nemipterus marginatus, Priacanthus tayenus, *and* Upeneus bensasi *while* Loligo sp. *for* Saurida undosquamis *and* Sphyraena forsteri. *Sub-areas 0, I, II and III appeared to be the most productive areas for the studied species and the food items. The results also show that there exist significant relationships between the food items and fish distribution. Information on the availability and distribution of food items is important for the management of fishery resources as well as for the efficient exploitation of the species.*

INTRODUCTION

The decline in the abundance of demersal fish resources is always an issue in fishing industry (Hadzley 1997). This decline is thought to prevail due to either over-exploitation of the demersal resources using highly efficient harvesting gears or factors relating to availability of food in the area. A few reports have discussed this issue but the distribution of fish has not been studied extensively, so until now not much information

on the location of potential fishing grounds is available.

According to Hadzley (1997), the distribution of fish in the sea is related to certain physical and chemical parameters of the water. Since these parameters in Malaysian waters have not changed much over the years, it may be assumed that the distribution of species has also not changed in the whole area. But the availability and distribution of food resources as well as seabed conditions are the main factors that affect the distribution of fish.

The objective of this study is to determine the distribution of food items of the commonly found species of *Carangoides malabaricus, Nemipterus marginatus, Priacanthus tayenus, Saurida undosquamis, Sphyraena forsteri* and *Upeneus bensasi.* In addition, the relationship of the food items and fish distribution is also studied.

MATERIALS AND METHODS

Survey Area

The survey was carried out in the Exclusive Economic Zone (EEZ) off the east coast of Peninsular Malaysia in the months of September to November 1999 using K.K. Manchong, a research vessel of the Southeast Asian Fisheries Development Centre (SEAFDEC) of Malaysia. The survey areas extended from 12 nautical miles to 200 nautical miles offshore, bounded by latitudes 7.73 °N and 1.53 °N, and longitudes of 103.00 °E and 104.61 °E with an estimated total area of 27,785.54 sq. nm. This area was further divided into 5 sub-areas and 124 stations were selected to cover the whole study area (*Fig. 1*).

Selection of Species

Six important demersal fish species were selected based on factors such as the high demand for the species for downstream industries and the increase in annual landings in the last decade (DOF 1990-1998).

Sampling Methods

Fish samples were collected using a high-opening trawl net. The net was made of polyethylene materials with a cod-end mesh size of 38 mm. The net was towed at approximately 4 knots for a one-hour duration at specific stations.

During the survey, the total catch of each haul was sorted out into commercial fish and trash fish categories. Subsequently, the commercial fish species were sorted according to their family group. The selected species were identified and sorted out from each family group. The Total Length (TL) of individual fish was measured to the nearest mm.

The stomachs of the fish were then removed and preserved in 10% formalin to prevent any further digestion and decomposition of the contents. The fish species from each sampling station were kept frozen and brought back to the laboratory for further examination. In the laboratory, the stomachs were dissected to remove the contents. The stomach contents were then identified to the lowest practical taxon.

The occurrence method was used to quantify the stomach content where the number of stomachs in which each food type occurs is expressed as a percentage of the total number of stomachs containing food (Gunn and Milward 1985; Kennedy and Fitzmaurice 1972). This method requires minimum time and apparatus and is simple to apply when food items are readily identifiable. The presence of food items that could not be enumerated (e.g. digested matter) is regarded as one occurance of that item.

RESULTS AND DISCUSSIONS

Percentage of Food Items

The result of stomach content analysis using occurrence method is given in Table 1. The result from this study indicates that *C. malabaricus* feed primarily on crustacean, particularly *Penaeus sp.*, being present in 16.8% of stomach containing food and this is in agreement with the results of the study conducted in the same waters by Mansor *et al.* (1998) and Mohsin and Ambak (1996). The fact that *N. marginatus* was found to feed mainly on crustacean in particular *Penaeus sp.* (59.1%), supplements the work done by Mansor *et al.* (1998), and Mohsin and Ambak (1996) which generally stated that this species feeds on small animals. Crustaceans (*Penaeus sp.*) are also the most commonly occurring identifiable food item in *P. tayenus* (78.5% of stomach containing food) demonstrating the importance of this food item for the species. Work done by other researchers in the same waters also found that *P. tayenus* feed mainly on *Penaeus sp.* (Mansor *et al.* 1998; Daud and Taha 1986; Mohsin *et al.* 1987; Mohsin *et al.* 1988).

Eighteen types of food items were identified from the stomach contents of *S. undosquamis.* Cephalopod in particular *Loligo sp.* (25.0%) is

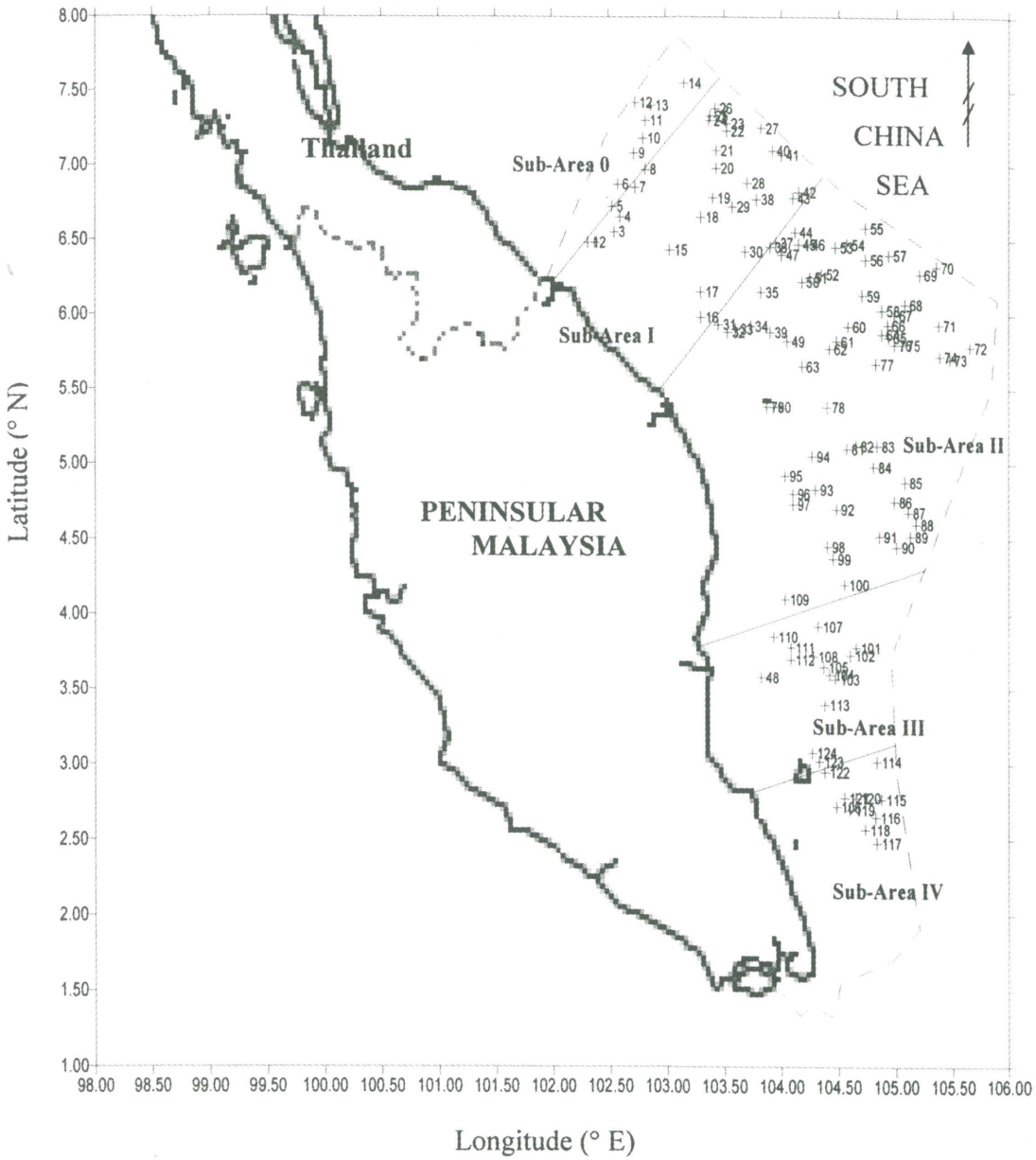

Fig. 1: Map showing the sampling stations in the study area

the most important diet of this species, followed by *Stolephorus spp.* (16.4%). The high diversity of prey items found in the stomachs of *S. undosquamis* suggests that this species is a generalist predator. *S. forsteri* is found to be dependent on *Loligo sp.* (30.8%) and small fishes for their food. Mohsin and Ambak (1996) reported that this species could be found around coral reef areas hunting for small fishes and squids.

Penaeus sp. is the most frequently occurring food item in the stomach contents of *U. bensasi* (98.8%). During one of the research expeditions conducted in similar waters, Daud and Taha (1986) found that 74.6% of the food items of *Upeneus sp.* were crustaceans.

Distribution of Major Food Items in the Sea Areas

The distribution of major food items of the selected species is given in Table 5. *Penaeus spp.*

TABLE 1
Percentage occurrence of food items in the diet of six fish species

Fish species	*C. malabaricus*	*N. marginatus*	*P. tayenus*	*S. undosquamis*	*S. forsteri*	*U. bensasi*
Number of fish examined	156	128	329	558	54	181
Number of stomachs containing food	131	110	304	531	52	160
Food items						
Pisces						
Apogon sp.	-	-	0.7	1.3	-	-
Ariomma indica	-	-	-	0.2	-	-
Brachypleura novazeelandiae	-	-	-	0.6	-	-
Decapterus sp.	-	-	-	11.5	11.5	-
Dipterygonatus batteatus	-	-	-	0.6	-	-
Fistullaria villusa	-	-	-	0.7	-	-
Leiognathus sp.	1.5	-	-	5.5	-	-
Nemipterus sp.	-	-	-	0.2	-	-
Saurida sp.	0.8	-	-	0.9	-	-
Sphyraena sp.	-	-	-	0.4	-	-
Stolephorus sp.	3.0	32.7	2.6	16.4	3.8	-
Upeneus sp.	-	-	-	0.9	-	-
Crustacean						
Crab	-	7.3	1.6	-	-	0.6
Metapenaeus sp.	-	1.8	-	0.2	-	-
Penaeus sp.	16.8	59.1	75.3	2.4	1.9	98.8
Squilla sp.	-	2.7	1.6	0.2	-	1.2
Trachypenaeus sp.	-	-	-	0.4	-	-
Cephalopod						
Loligo sp.	5.3	19.1	20.0	25.0	30.8	0.6
Sepia sp.	6.9	-	0.7	0.6	1.9	-
Polychaete	-	7.3	23.7	-	-	-
Decomposed unidentified tissue	70.2	-	27.0	31.5	51.9	-

- Represents zero occurrence.

is the main diet of *C. malabaricus* and it was found that this food item is distributed in sub-area II with a percentage occurrence of below 10%. Meanwhile, for *N. marginatus*, sub-area I has the highest abundance of food items of *Penaeus spp.*, *Stolephorus spp.* and *Loligo spp.*, with the percentage occurrence of 0.1% to 20.0%.

The abundance of *Penaeus spp.* and *Loligo spp.* in the diet of *P. tayenus* are higher in sub-area II with the percentage occurrence of 0.1% to 10.0%. *S. undosquamis* feed mainly on *Loligo spp.*, *Decapterus spp.* and *Stolephorus spp.* and their distribution is dense in sub-area II with the percentage occurrence of 0.1% to 10.0%.

Loligo spp. and *Decapterus spp.* are the main food items of *S. forsteri* and the abundance of these diets are higher in sub-area 0 and sub-area I respectively. *U. bensasi* feeds mainly on *Penaeus spp.* and this food item is distributed mainly in sub-area II.

Comparison is not possible as this is the first study conducted in this area and with these species of fish.

Distribution of Fish Species

The average catch rate of fish species by depth stratum and by sub-areas are tabulated in Table 2 and Table 3, respectively. Most of the fishes were caught in the deeper water with different degrees of abundance. *S. undosquamis* was the major species caught from the survey area followed by *P. tayenus*, *C. malabaricus*, *U. bensasi*, *N. marginatus* and *S. forsteri.*

S. undosquamis could be classified as a widely distributed species, based on their abundance in all depth strata especially in the 40 – 70 m depth. This species was found distributed along the east coast mostly in the sub-areas I and II. Sub-areas III and IV recorded lower abundance in comparison to sub-areas I and II. The second

TABLE 2
Catch rate (kg/hr) distribution of fish species by depth caught from the South China Sea, in order of abundance

Species name	Depth (m)					Mean
	30-40	40-50	50-60	60-70	70 - >	
S. undosquamis	0.72	1.06	1.70	1.11	1.06	1.13
P. tayenus	0.36	1.28	1.13	0.96	0.35	0.82
C. malabaricus		0.56	0.73	0.55	0.88	0.68
U. bensasi	0.11	1.46	0.40	0.32	0.06	0.47
N. marginatus	0.31	0.69	0.50	0.10		0.40
S. forsteri			0.45	0.22		0.34
Average catch (kg/hr)	0.38	1.01	0.82	0.54	0.59	

TABLE 3
Average catch rate (kg/hr) distribution of selected fishes by sub-areas

Sub-Area	Fish species					
	Cm	Nm	Pt	Su	Sf	Ub
0	1.33	0.59	0.41	0.71	1.39	0.3
I	0.52	0.77	1.4	2.14	0.58	0.36
II	0.62	0.15	0.91	1.39	0.17	0.37
III	1.06	0.05	1.25	0.41	0.14	0.86
IV	0.34	0.03	0.75	0.18	0.17	0.05

Note: Cm – *Carangoides malabaricus*; Nm – *Nemipterus marginatus*; Pt – *Priacanthus tayenus*; Su – *Saurida undosquamis*; Sf – *Sphyraena forsteri*; Ub – *Upeneus bensasi.*

selected species was *P. tayenus* and this species was found mostly in the 40 – 60 m depth and distributed in the sub-areas I, II and III. Sub-area IV recorded the lowest abundance of this species compared to the other sub-areas.

C. malabaricus was found in 40 – 70 m depth especially in sub-areas 0, II and III with the average catch of 1.33 kg/hr, 0.62 kg/hr and 1.06 kg/hr respectively. *U. bensasi* was distributed in all depth strata but is most abundant in 40 – 50 m depth. The highest density in abundance of this species was found in sub-areas I, II and III. Sub-area IV recorded the lowest abundance as compared to the others.

N. marginatus was found distributed in the 40 – 60 m depth especially in sub-areas 0 and I. There was no catch of this species recorded in the water deeper than 70 m depth. Sub-area IV, with the average catch of 0.03 kg/hr was the lowest abundance of this species as compared to other locations. Although *S. forsteri* was found distributed along the east coast (mostly in sub-area 0), this species was not widely distributed, as it was abundant only in 50 - 70 m depth.

The result from this study indicates that *P. tayenus* was found mostly in the 40 – 60 m depth and distributed in sub-areas I and III and this is in agreement with the result of the study conducted by Hadzley (1997). The fact that *N. marginatus* was found distributed in the depth of 40 – 60 m especially in sub-areas 0 and I, supplements the work done by Hadzley (1997).

Previous surveys (Pathansali *et al.* 1974; Jothy *et al.* 1975; Lamp and Shaari 1976; Ahmad 1990) concluded that progressive decline in yield occurred in the deeper zones. The depths from 21 to 40 meters usually were more productive areas. The fish resources off the east coast of Peninsular Malaysia appear to be poor beyond the 40-mile line. This is probably due to a relatively lower content of *chlorophyll a*, zooplankton and fish larvae (Mohsin *et al.* 1987a). The present study indicates that the average catch at different depth strata is lower towards deeper areas.

In this survey, sub-areas 0 to III showed high abundance of the studied fish species and appeared to be the most productive areas as compared to the other sub-areas. This distribution pattern is probably due to the bigger number of sampling stations in these particular sub-areas. The least productive area is Sub-area IV which is located near the busy shipping lane where fishing activities are restricted.

Relationship of Food Items and Fish Distributions

Four out of six species, namely *Penaeus spp.*, *Loligo spp.*, *Stolephorus spp.*, and *Decepterus spp.*, were selected to analyse their relationship with fish distribution. These food items were selected from the percentage occurrence of the identifiable food items with the percentage of 10.0% and above and consumed at least by two of the selected species. The total percentage occurrence of main food items was calculated for each sub-area. The average percentage occurrence was calculated by dividing the total percentage by the number of the sampling station in each sub-area (Table 4).

The result shows that the distribution of all main food items is higher in sub-areas 0, I and II. Distribution on catches of six fish species as presented in Table 3 shows that sub-areas 0, I, II and III recorded the highest catch rates for all species. It can be stated that there is a significant relationship between the food item and fish distribution ($P<0.05$). This result suggested that the distribution of fish species could be affected by the availability and distribution of food resources.

TABLE 4
Average percentage occurrence of the main food items by sub-areas

Sub-Area	Food items			
	Penaeus spp.	*Loligo spp.*	*Stolephorus spp.*	*Decapterus spp.*
0	0.81 ± 0.08	1.41 ± 0.12	2.21 ± 0.31	0.19 ± 0.07
I	1.02 ± 0.05	1.25 ± 0.04	1.75 ± 0.08	2.51 ± 0.11
II	0.88 ± 0.01	0.77 ± 0.01	0.42 ± 0.01	0.42 ± 0.01
III	0.39 ± 0.04	0.19 ± 0.02	0.19 ± 0.03	0
IV	0.08 ± 0.01	0.15 ± 0.02	0.28 ± 0.09	0.19 ± 0.06

TABLE 5
Distribution of dominant food items with sub-areas (in parenthesis)

Fish species	Food items			
	Penaeus sp. (%)	*Loligo sp.* (%)	*Stolephorus sp.* (%)	*Decapterus sp.* (%)
C. malabaricus	0.1 – 10.0 (II)			
N. marginatus	0.1 – 10.0 (I)	0.1 – 10.0 (I)	10.1 – 20.0 (I)	
		0.1 – 10.0 (I)	10.1 – 20.0 (I)	
P. tayenus	0.1 – 10.0 (II)	0.1 – 10.0 (II)		
S. undosquamis		0.1 – 10.0 (II)	0.1 – 10.0 (II)	0.1 – 10.0 (I)
S. forsteri		10.1 – 20.0 (I, II, III)		
		20.1 – 30.0 (0)		10.1 – 20.0 (0, I)
U. bensasi	0.1 – 10.0 (II)			

CONCLUSION

The study on the distribution of six selected fish species and their food items suggests that these fish species were predominantly located in a few specific areas. Based on the distribution of each species as shown in Table 5, it was found that sub-areas 0, I, II and III appeared to be the most productive areas. The depth of 40 to 60 meters recorded the highest abundance of the fish species in the whole survey areas. The occurrence of *Penaeus sp.* in the stomachs of *C. malabaricus, N. marginatus, P. tayenus* and *U. bensasi* shows that these fish species depend mainly on *Penaeus sp.* as food. However, *S. undosquamis* and *S. forsteri* depend on *Loligo sp.* as their food.

It was also found that the distributions of the main food items of the studied fish species are higher in sub-areas 0, I and II. Since these sub-areas are the most productive areas for the fish species and their food items, it can thus be postulated that there is a significant relationship between the food items and fish distributions. This information is very important for those involved in the management and efficient exploitation of fishery resources.

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