Turkish Journal of Fisheries and Aquatic Sciences 3: 11-16 (2003)

Stomach Contents of Six Commercially Important Demersal Fishes in the South China Sea

Sakrı İbrahim[1,*], Muhaimi Muhammad[1], Mohd Azmi Ambak[1], Mohamad Zaidi Zakaria[1], Awang Soh Mamat[1], Mansor Mat İsa[2], Sukree Hajısamae[3]

[1]Faculty of Agrotechnology and Food Sciences, Kolej Universiti Sains dan Technologi 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.

* Corresponding Author: Tel.: +91. 463 725 46 40; Fax: -
E-mail: nagarajanmk@indiatimes.com

Received 08 April 2003
Accepted 21 October 2003

Abstract

Stomach contents of six commercially important fish species (Carangoides malabaricus, Nemipterus marginatus, Priacanthus tayenus, Upeneus bensasi, Saurida undosquamis and Sphyraena forsteri) in the east coast of Peninsular Malaysia were examined. Fishes were caught by trawl nets in 124 stations in areas between 12 to 200 nautical miles from shore covering an estimated area of 27,785.54 square nautical miles. After catching the fishes, stomachs were removed onboard, preserved and taken to the laboratory for analysis of the contents. Penaeus sp. was the most common diet for C. malabaricus, N. marginatus, P. tayenus, and U. bensasi while Loligo sp. was the main diet for S. undosquamis and S. forsteri. Sub-areas 0, I, II and III appeared to be the most productive areas for the studied species. The results suggested that the distribution of commercial fish species could be affected by the availability and distribution of their preys. This information is very important for those involved in the management of fishery resources as well as for the efficient exploitation of the species.

Key Words: Occurrence method, fish distribution, productive areas, trawl net, Exclusive Economic Zone (EEZ).

Introduction

There has been little detailed information on the diet"s of *Carangoides malabaricus, Nemipterus marginatus, Priacanthus tayenus, Saurida undosquamis, Sphyraena forsteri* and *Upeneus bensasi* in Malaysian waters despite their abundance and commercial importance (Mansor *et al*., 1998). These demersal species were reported to dominate in the catches of most of the fish resource surveys conducted off the Malaysian waters since 1970's but the abundance was reported to decrease (Mansor *et al*. 1999).

The decline in the abundance of demersal fish resources is always an issue in fishing industry (Hadzley, 1997). This declining trend is thought to prevail due to either overexploitation of the demersal resources using highly efficient harvesting gears or factors relating to availability of food in the area (Chang *et al*., 1975; Hadzley, 1997). Berg (1979) and Pillay (1952) reported that the analysis of stomach contents of fish could provide information about the niche of a particular of fish in its ecosystem and this has become a standard practice in fish ecology works (Hyslop, 1980). There are reports (Ahmad, 1990; Hadzley, 1997; Jothy *et al*., 1975; Lamp and Mohd Shaari, 1976) that discussed this issue but the distribution of fish as related to the distribution of preys has not been studied extensively. Presently, very little information is available on the location of potential fishing grounds as related to the availability of preys in the areas.

Distribution of fish in the sea is related to certain physical and chemical parameters of the water (Hadzley, 1997). 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, thus the availability and distribution of food resources and seabed conditions are the main factors that affected the distribution of fish (Mohsin *et al*., 1987 and 1988).

The objective of this study was to determine diet of the commonly found species of *Carangoides malabaricus*, *Nemipterus marginatus*, *Priacanthus tayenus*, *Saurida undosquamis*, *Sphyraena forsteri* and *Upeneus bensasi* and to determine the relationship of the preys and fish distribution.

Materials and Methods

Survey area and selection of fish species

The survey was conducted in the Exclusive Economic Zone (EEZ) off the east coast of Peninsular Malaysia from September 1999 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 divided into 5 sub-areas based on the coastline of east coast states of Peninsular Malaysia and in line

with guidelines used by the Fisheries Department of Malaysia for resource survey purposes. A total of 124 stations were selected to cover the whole study area (Fig. 1). Six important demersal fish species were selected based on factors such as the high demand of 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 were sorted out into commercial fish and trash fish categories. Subsequently, the commercial fish species were identified and sorted out from each family group. The Total Length (TL) of individual fish was measured to the nearest mm.

After catching the fishes, stomachs were 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 and then contents were identified to the lowest practical taxon. The occurrence method was used to quantify the stomach content (Gunn and Milward, 1985; Kennedy and Fitzmaurice, 1972). This method requires minimum time and apparatus and is simple to apply when stomach contents are readily identifiable. The presence of consumed food that could not be enumerated (e.g. digested matter) is regarded as one occurrence of that item. Commercial fishes and their prey's distribution were analysed using surface mapping system software, SURFER (WIN 32)-Version 6.01 to produce maps.

Results and Discussion

Percentage of preys

The results from this study indicated that *C. malabaricus* feed primarily on crustaceans, particularly *Penaeus sp*. (Table 1). Approximately 16.8% of *C. malabaricus* stomachs contained crustaceans and this in agreement with the results of the study conducted in the same waters by Mansor *et al*. (1998) and Mohsin and Ambak (1996). *Nemipterus marginatus* mainly consumed crustaceans in particular *Penaeus sp*. (59.1%) and this findings supplements the works done by other researchers (Mohsin and Ambak, 1996; Mansor *et al*., 1998) who stated that this species eats small animals. Crustaceans (*Penaeus sp*.) were also the most commonly occurring identifiable prey in *P. tayenus* (78.5% of stomach containing food) demonstrating the importance of this prey for the species. Works 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 preys were identified from the stomach contents of *S. undosquamis*. Cephalopod in

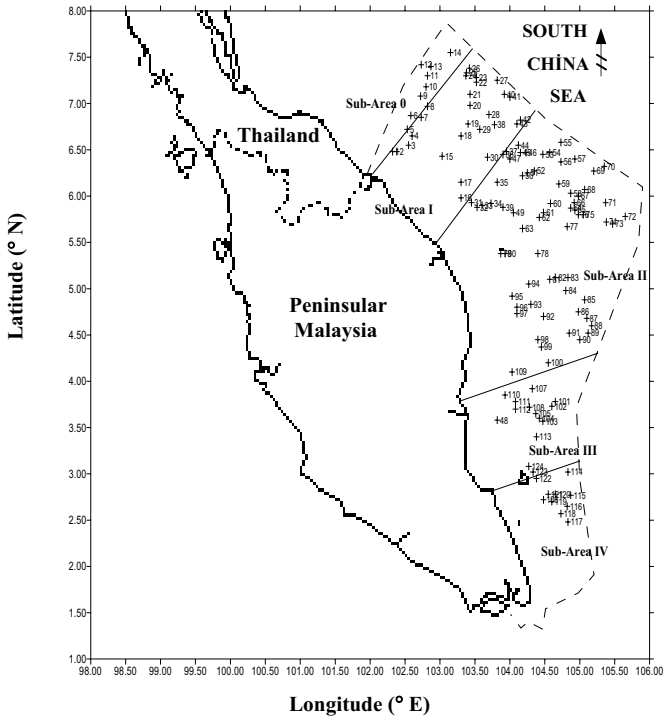

Figure 1. Map of the sampling stations in the study area

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.

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

	Depth (m)					
Species name	30-40	40-50	50-60	60-70	70 - >	Mean
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.

	Fish species					
Sub-Area	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 – S*aurida undosquamis*; Sf – *Sphyraena forsteri*; Ub – *Upeneus bensasi.*

Table 4. Average percentage occurrence of the main preys by sub-areas.

	Preys			
Sub-Area	*Penaeus sp.*	*Loligo sp.*	*Stolephorus sp.*	*Decapterus sp.*
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 preys with sub-areas (in parenthesis).

	Preys			
Fish species	*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)	0.1 – 10.0 (I)	
		10.1 – 20.0 (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)		10.1 – 20.0 (0, I)
		20.1 – 30.0 (0)		
U. bensasi	0.1 – 10.0 (II)			

particular *Loligo sp*. (25.0%) is the most important diet of this species, followed by *Stolephorus sp*. (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 diet of *U. bensasi* (98.8%). During one of the Research Expedition conducted in similar waters, Daud and Taha (1986) found that 74.6% of the food items of *Upeneus sp*. were crustaceans.

Distribution of major preys in the sampled areas

Penaeus sp. is the main diet of *C. malabaricus* and it was found that this food item was distributed in sub-area II with a percentage occurrence of below 10%. Meanwhile, for *N. marginatus*, sub-area I had the highest abundance of *Penaeus sp*., *Stolephorus sp.* and *Loligo sp.*, with the percentage occurrence of 0.1% to 20.0% (Table 5).

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

Loligo sp. and *Decapterus sp*. were the main diet of *S. forsteri* and the abundance of these diet were higher in sub-area 0 and sub-area I respectively. *Upeneus bensasi* fed mainly on *Penaeus sp*. That was distributed mainly in sub-area II.

Distribution of six selected fish species and their preys suggest that these fish species were predominantly located in a few specific areas. Based on the distribution of each species (Table 5), sub-areas 0, I, II and III appeared to be the most productive areas. The depth of 40 to 60 meter 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* indicated that these fish species depend mainly on *Penaeus sp*. and *S. undosquamis* and *S. forsteri* depend on *Loligo sp.* to survive.

Distribution of fish species

Most of the fishes were caught in the deeper water with different degrees of abundance. *Saurida undosquamis* was the major species caught from the survey area followed by *P. tayenus*, *C. malabaricus*, *U. bensasi*, *N. marginatus* and *S. forsteri* (Table 2). *Saurida undosquamis* could be classified as widely distributed species, based on their abundance in all depth strata especially in the 40 – 70 m depth. This species was found along the east coast mostly in the sub-areas I and II. The second selected species, *P. tayenus* was found mostly in the 40 – 60 m depth and distributed in the sub-areas I, II and III. *Carangoides 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. *Upeneus bensasi* was distributed in all depth strata but it was most abundant in 40 – 50 m depth. The highest density in abundance of this species was found in sub-

areas I, II and III. *Nemipterus marginatus* was found 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 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 in agreement with the result of the study conducted by Hadzley (1997). Works done by Hadzley (1997) also showed that *N. marginatus* was found in the depth of 40 – 60 m especially in sub-areas 0 and I.

Previous surveys (Pathansali *et al*., 1974; Jothy *et al*., 1975; Chang *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's 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 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 to the busy shipping lane where fishing activities are restricted.

Relationship of preys and fish distributions

Four main preys of six fish species were selected for analysing its relationship with the fish distribution namely, *Penaeus sp*., *Loligo sp*., *Stolephorus sp*., and *Decapterus sp*. These four dominant preys were selected from the list of identifiable preys having percentage occurrence of 10.0% or more and consumed by at least two of the selected fish 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 with the number of the sampling station in each sub-area (Table 4).

The result shows that the distribution of all main diets was 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 and these sub-areas are the most productive areas for the fish species and their preys. This result suggested that the distribution of fish species could be affected by the availability and distribution of food resources.

Acknowledgment

The authors wish to thank the Ministry of Science, Malaysia for providing research funds through IRPA (Intensification of Research in Priority Areas) scheme, the SEAFDEC and its staffs for providing research facilities and helping in the collection of data.

References

Ahmad, A.N. 1990. Demersal fish resources in Malaysian waters-6. Fifth trawls survey of coastal waters off the east coast of Peninsular Malaysia (June-July 1981). Fisheries Bulletin. No. 60. Department of Fisheries, Ministry of Agricultural Malaysia. 37p.

Berg, J. 1979. Discussion of methods of investigating the food of fishes with reference to a preliminary study of the prey of Gobiusculus flavescens. Marine Biology 50: 263-273.

Chang, L.W., Weber, W., Kean, L.A., Sin, O.K. and Chong, L.P. 1975. Demersal fish resources in Malaysian waters - 7. Third trawl survey off the east coast of Peninsular Malaysia (14th August – 20th September 1972). Fisheries Bulletin. No. 9. Ministry of Agricultural and Rural Development, Malaysia. 19p.

Daud, S.K. and Taha, S.M. 1986. Stomach contents of selected demersal fish species from South China Sea. In *Mohsin, Ekspedisi Matahari '85* eds. A.K.M. Mohsin, M.I.H. Mohamad and M.A. Ambak. Occasional Publication No.3, Faculty of Fisheries and Marine Science, Universiti Pertanian Malaysia, 187–192.

Department of Fisheries (DOF). 1990-1998. Annual Fisheries Statistics. Ministry of Agriculture Malaysia. Kuala Lumpur, Malaysia.

Gunn, J.S. and Milward, N.E. 1985. The food, feeding habits and feeding structures of the whiting species, *Sillago sihama* (Forsskal) and *Sillago analis* Whitley from Townsville, North Queensland, Australia. Journal Fish Biology, 26: 411-427.

Hadzley, H. 1997. Disribution and abundance of the selected fish species (Demersal fish) off the east coast of Peninsular Malaysia. Pages 50-71 in L.P. Chong ed. Proceeding of Fisheries Research Department of Fisheries, Kuala Lumpur.

Hyslop, E.J. 1980. Stomach contents analysis – a review of methods and their application. Journal Fish Biology 17: 411-429.

Jothy, A.A., Rauck, G., Mohd Shaari, S.A.L., Sin, O.K., Chong, L.P. and Carvalho, J.L. 1975. Demersal fish resources in Malaysian waters. Second trawl survey of the coastal waters off the east coast of Peninsular Malaysia. Fisheries Bulletin, No.4, 35p.

Kennedy, M. and Fitzmaurice, P. 1972. Some aspects of the biology of gudgeon *Gobio gobio* (L.) in Irish waters. Journal Fish Biology, 4: 425-440.

Lamp, F. and Mohd Shaari, S.A.L. 1976. Demersal fish resources in Malaysian waters - 10. Fourth trawl survey off the east coast of Peninsular Malaysia (13th July – 12th August 1971). Fisheries Bulletin. No. 12. Ministry of Agricultural and Rural Development, Malaysia. 25p.

Mansor, M.I., Kohno, H., Ida, H., Nakamura, H.T., Aznan, Z. and Syed, A.S.A.K. 1998. Field guide to important

commercial marine fishes of the South China Sea. SEAFDEC-MFRDMD/SP/2. 284p.

Mansor, M.I., Mohd-Taupek, M.N., Ibrahim, S., Kamariah, I. and Talib, A.A. 1999. Population structure of commercially important fishes in the Malaysia waters. Survey Report, Department of Fisheries Malaysia.

Mohsin, A.K.M. and Ambak, M.A. 1996. Marine Fishes and Fisheries of Malaysia and Neighbouring Countries. Universiti Pertanian Malaysia Press. 744p.

Mohsin, A.K.M., Ambak, M.A., Said, M.Z.M., Sakiam, M. and Hayase, S. 1987. A study of the feeding habits of fishes in the South Western portion of the South China Sea. In *Ekspedisi Matahari '86* (Eds.) A.K.M. Mohsin, M.I.H. Mohamad and M.A. Ambak. Occasional Publication No.4, Faculty of Fisheries and Marine Science, Universiti Pertanian Malaysia, Serdang.

Mohsin, A.K.M., Abdul Rahman, R. and Ambak, M.A. 1987a. A study on the offshore waters of Malaysian EEZ. In *Ekspedisi Matahari '86.* Faculty of Fisheries and Marine Science, Universiti Pertanian Malaysia. No. 4. 197p.

Mohsin, A.K.M., Hayase, S., Ambak, M.A., Said, M.Z.M. and Tanzimuddin Khan, A.H. 1988. Feeding habits of fishes found in the EEZ off Sarawak. In *Ekspedisi Matahari '87*. (Eds.) Mohsin, A.K.M; M. I. H. Mohamad and M. A. Ambak. Occasional Publication No. 8, Faculty of Fisheries and Marine Science, Universiti Pertanian Malaysia, Serdang.

Pathansali, D., Rauck, G. Jothy, A.A., Mohd Shaari, S.A.L. and Curtin, T.B. 1974. Demersal fish resources in Malaysian waters. Trawl survey of the coastal waters of the east coast of West Malaysia. Fisheries Bulletin, No.1, 47p.

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