CEPHALOPOD DISTRIBUTION AND ABUNDANCE IN THE NORTHERN PART OF PHANG-NGA PROVINCE, THAILAND

Praulai Chantawong & Chairat Suksawat
Andaman Sea Fisheries, Development Center 77, Tumbon Vichit Amphoe Maung, Phuket 83000, Thailand

ABSTRACT

Fifty-six night hauls (Mexican trawl net) were made during 5 cruises in the NE and SW monsoons 1992 to 1993. The average catch rate (CPUE) was 2.43 kg cephalopods hr^{-1}. The catch was composed of squid (40.08 %), octopus (30.17 %), cuttle fish (22.31 %), and sepiolid squid (7.44 %). Total biomass of cephalopods was 114.30 tons. Five species of Loliginidae (*Sepioteuthis lessoniana*, *Loligo chinensis*, *L. duvauceli*, *L. singhalensis* and *Loliolus sumatrensis*) five species of Sepioidea (*Sepia pharaonis*, *S. recurvirostra*, *S. aculeata*, *S. brevimana* and *Sepiella inermis*), one species of Sepiolidae (*Euprymna* sp.), and one genus of Octopoda (*Octopus* spp.) were found. *L. singhalensis* and *S. pharaonis* were the biggest of the squids and cuttle fish respectively. The catch rate of cephalopods during the SW monsoon was higher (4.12 kg hr^{-1}) than during the NE monsoon (1.92 kg hr^{-1}). The most productive area appeared at 66-75 m depth at a distance of more than 20 nautical miles from shore.

INTRODUCTION

Trawlers have played an important role in Thai fisheries since 1960. In 1992, the total catch of marine resources of Thailand was about 2.7 million tons of which about 76 % came from the Gulf of Thailand and the remaining 24 % from the Andaman Sea (Fish. Stat. Subdiv. 1994). The cephalopod catch from the Andaman Sea represented about 36,422 tons with a value of 1,924 million baht (1 US$ = ca. 25 baht).

The north western area of Phang-nga Province around Ko Pratong is a fertile mangrove forest. Primary production near the shore and far from shore have been estimated at 566 and 840 g C m^{-2} yr^{-1} respectively (Janekarn & Hylleberg 1989). The high primary production in the area may be caused by upwelling (Limpsaichol 1994) and nutrients in freshwater runoff. The bottom is characterised by sandy-mud and muddy-sand with soft coral and rocks around islands. Phang-nga Province is influenced by the north east monsoon (NE) from October to February, and the south west monsoon (SW) from May to September.

Spatio-temporal distribution, taxonomic composition, and abundance of cephalopods have been studied in the Gulf of Thailand by Chotiyaputta *et al.* (1992) and Chotiyaputta (1995). Taxonomy of cephalopods was studied in the Andaman Sea by Chotiyaputta *et al.* (1992) and Nateewathana (1992). However, species composition at the fishing grounds, which is essential information for establishing a fisheries management strategy under the multi-species system of tropical fisheries, remains to be studied. Changes in species composition of marine resources may be caused by many factors, such as natural fluctuations in abundance of certain species, overexploitation, and/or changes in environmental conditions of both near shore and off shore areas. The objective of the present study is to examine the spatio-temporal distribution and abundance of cephalopods in the northern part of Phang-nga Province.

MATERIALS AND METHODS

Sources of data

Since 1992, systematic monitoring of the demersal resources along the Andaman Sea Coast has been conducted by the Andaman Sea Fisheries Development Center, the Ma-

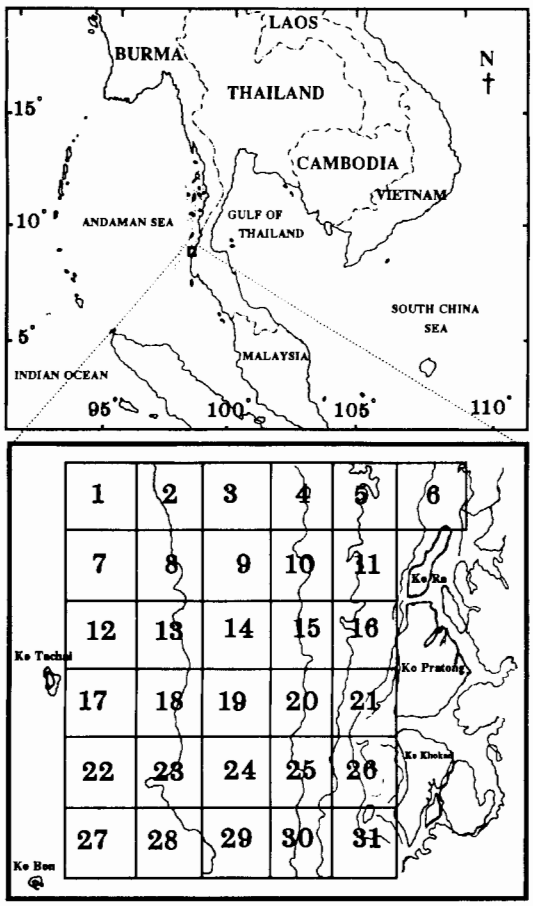

Figure 1. Survey stations in the northern part of Phang-nga province.

rine Fisheries Division, Department of Fisheries, Thailand with the "Pramong 10" research vessel, using a Mexican trawl net. This study is part of the monitoring survey in the Andaman Sea. The Mexican trawl has an upper head rope of 27.63 m and a codend of 2.5 m. It was operated at night at 31 stations in a fixed grid covering 2,007.3 km^2 (Fig. 1). Depths ranged from 15 to 75 m, and towing time was 1 hr at 2.5 knots speed. A total of 56 hauls were carried out during 3 cruises within the north east monsoon January, and December 1992, and February 1993, and 2 cruises during the south west monsoon May 1992 and May 1993.

Samples were sorted by distance from shore line: < 10 nautical miles (area 1), 10-15 nautical miles (area 2), 15.1-20 nautical miles (area 3) and > 20 nautical miles (area 4). Samples were also sorted according to depth: 15-25 m, 26-35 m, 36-45 m, 46-55 m, 56-65 m, and 66-75 m.

Analysis of data

All cephalopods caught were identified to genus and species, following the keys of Sithigornkul (1974), Roper *et al.* (1984), Chotiyaputta *et al.* (1992) and Nateewathana (personal communication).

Weight (g) and mantle length (cm) of each individual were measured. Catch composition, distribution and abundance of cephalopods were calculated. Data on catch was used to estimate the abundance/biomass. The mean catch per unit effort or per unit area is used as stock abundance index.

Biomass was estimated by the swept area method (equations [1] and [2] below) using the stock abundance index. It was assumed that the width as a fraction of the head rope was 2/3 and the proportion of fish retained in the swept area (or catchability) was 0.5 (Sparre & Venema 1992).

Swept Area (a) = $D \times h \times X_2$ ... [1]

where $D = V \times t$; V = velocity = 2.5 knots, t = time trawling = 1 hr;

h = length of the head rope = 27.63 m;

X_2 = fraction of the head rope = 2/3,

$h \times X_2$ = wing spread:

$a = (2.5 \times 1.852) \times 0.02763 \times (2/3) = 8.5 \times 10^{-2}$ km^2

Biomass (B) = $(Cw/a) \times A/X_1$ ... [2]

CW/a = mean catch per unit area of all hauls (CPUA)

X_1 = fraction of the biomass or catchability = 0.5,

A = total area (2,007.3 km^2).

RESULTS

Species encountered

The cephalopods caught during this survey belonged to 3 orders, 4 families, 7 genera, and 12 species as follows:

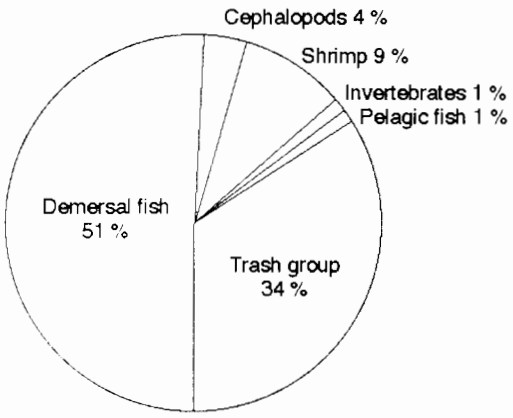

Figure 2. Catch composition of demersal resources from trawl survey.

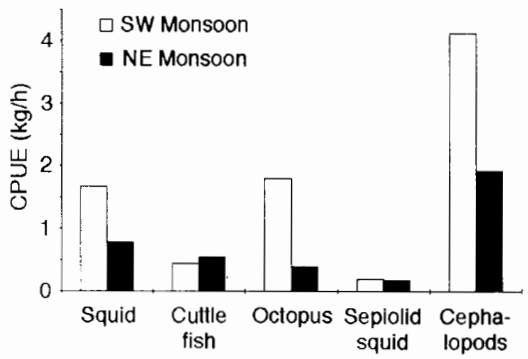

Figure 3. Catch by monsoon seasons of cephalopods in the northern part of Phang-nga Province.

Order Sepioidea: Family Sepiidae: *Sepia pharaonis* Ehrenberg, 1831, *Sepia recurvirostra* Steenstrup, 1875, *Sepia aculeata* Orbigny, 1848, *Sepia brevimana* Steenstrup, 1875, *Sepiella inermis* Orbigny, 1848; Family Sepiolidae: *Euprymna* sp. (see Nateewathana, this volume)
Order Teuthoidea: Family Loliginidae: *Sepioteuthis lessoniana* Lesson, 1830, *Loligo chinensis* Gray, 1849, *Loligo duvauceli* Orbigny, 1848, *Loligo singhalensis* Ortmann, 1891, *Loliolus sumatrensis* (Orbigny, 1835).
Order Octopoda: Family Octopodidae: *Octopus* spp. (see Nateewathana, this volume).

Catch and size distribution

The average CPUE of cephalopods was 2.43 kg hr^{-1} which was 3.64 % of the total demersal resource CPUE (Fig. 2). The total biomass of cephalopod was 114.30 tons.
Main components of the total cephalopods were squid (Loliginidae) (40.08 %), octopus (Octopodidae) (30.17 %), cuttle fish (Sepiidae) (22.31 %), and sepiolid squid (Sepiolidae) (7.44 %). The most dominant loliginid species was *L. chinensis* (46.40 %), followed by *L. duvauceli* (45.36 %), *S. lessoniana* (5.15 %), and *L. sumatrensis* (3.09 %). The most dominant species of the cuttle

Table 1. Range of mantle length, mode and mean of cephalopods in the northern part of Phang-nga Province.

Cephalopod species	Range (cm)	Catch (mode)	Length (mean)	SD
L. chinensis	5.0-27.5	7.10-15.00	13.87	± 4.40
L. duvauceli	5.0-30.0	9.10-19.00	15.63	± 5.24
L. singhalensis	10.5-31.5	-	21.32	± 5.86
S. lessoniana	6.5-23.0	6.00-10.00	10.16	± 3.96
S. recurvirostra	4.5-11.5	7.10-10.00	8.00	± 1.31
S. pharaonis	7.0-20.0	9.10-11.00	10.95	± 2.59
S. aculeata	6.0-8.5	-	7.20	± 0.82
S. inermis	7.3-10.6	-	9.03	± 2.51
S. brevimana	5.5-8.0	-	6.75	± 0.92

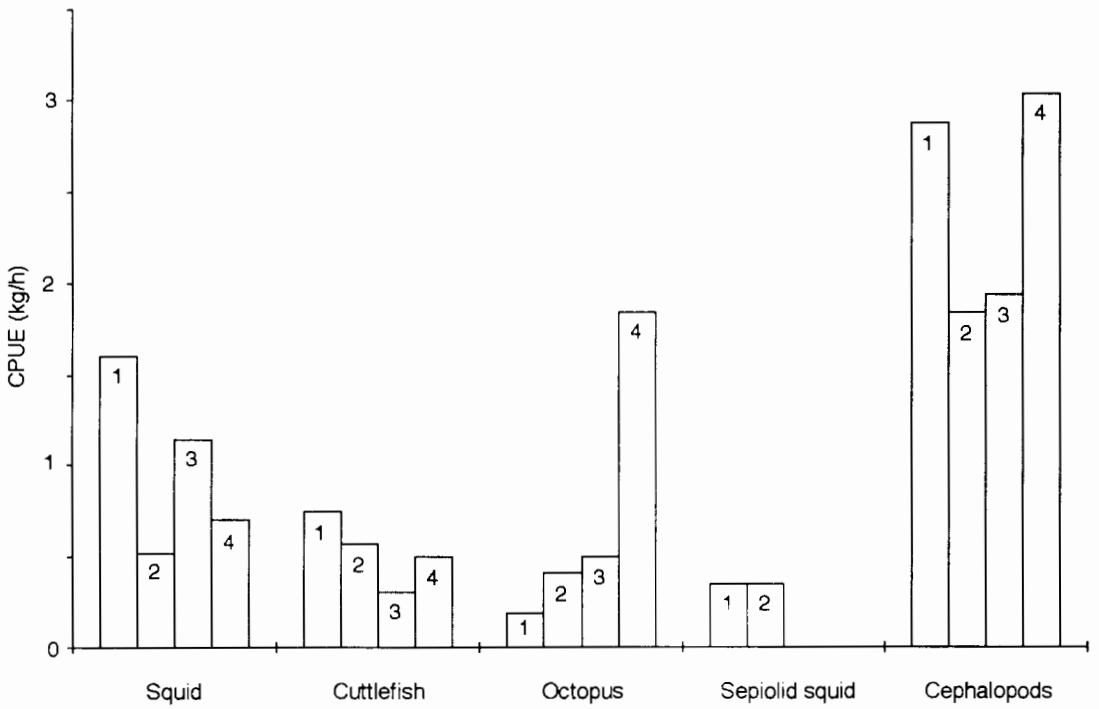

Figure 4. Catch by distance from shore line of cephalopods in the northern part of Phang-nga Province. Numbers 1-4 signify distance from shoreline.

fish was *S. recurvirostra* (37.04 %), followed by *S. pharaonis* (20.37 %), *S. aculeata* (3.70 %), *S. inermis* (3.70 %), and *S. brevimana* (1.85 %) of the total cuttle fish.

Tab. 1 shows the mantle length, mode and mean of cephalopods in all cruises. *L. singhalensis* was the biggest species of squid. Its ML size ranged from 10.5 to 31.5 cm with a mean of 21.32 cm (sd ± 5.86). *S. pharaonis* was the biggest species of cuttle fish. It ranged from 7.0 to 20.0 cm ML; modes and mean were 9.1 - 11.0 cm and 10.95 cm (sd ± 2.59).

Table 2. Catch per unit of effort (CPUE) (kg hr^{-1}), biomass (BIO) (tons) of total catch and cephalopods in the northern part of Phang-nga Province during the NE & SW monsoons 1992-1993; areas 1 to 4 signify distance from shore line.

Items	All		NE		SW		Area 1	Area 2	Area 3	Area 4
	CPUE	BIO	CPUE	BIO	CPUE	BIO	CPUE	CPUE	CPUE	CPUE
Total catch	66.75	3,143.75	53.06	2,500.11	111.98	5,275.87	82.26	78.60	61.18	44.87
Cephalopods	2.43	114.30	1.92	90.47	4.12	194.13	2.88	1.85	1.94	3.04
Squids	0.99	45.82	0.79	37.30	1.68	79.24	1.60	0.52	1.14	0.70
Cuttle fish	0.53	25.50	0.55	25.88	0.45	21.14	0.74	0.57	0.30	0.50
Octopus	0.73	34.48	0.40	18.79	1.80	85.00	0.19	0.41	0.50	1.84
Sepiolid squid	0.18	8.50	0.18	8.50	0.19	8.76	0.35	0.35	0.00	0.00

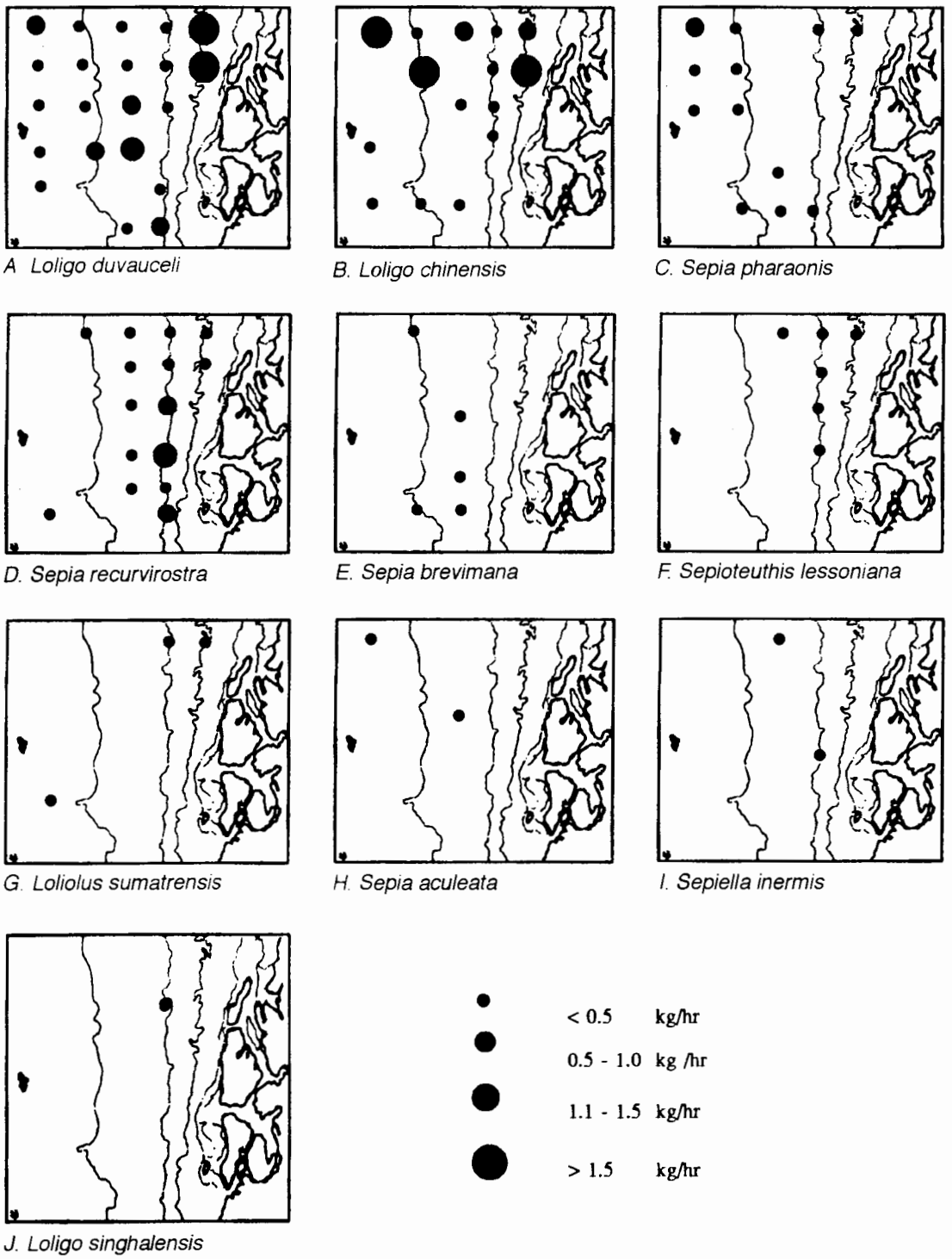

Figure 5. The quantitative distribution of *L. duvauceli* (A), *Loligo chinensis* (B), *Sepia pharaonis* (C), *Sepia recurvirostra* (D), *Sepia brevimana* (E), *Sepioteuthis lessoniana* (F), *Loliolus sumatrensis* (G), *Sepia aculeata* (H), *Sepiella inermis* (I), and *Loligo singhalensis* (J).

Table 3. Catch per unit of effort (CPUE) (kg hr^{-1}) of demersal resources by depth in the northern part of Phang-nga Province during 1992-1993.

Item	15-25 m	26-35 m	36-45 m	46-55 m	56-65 m	66-75 m
Total catch	76.16	107.21	63.86	48.78	53.58	40.52
Cephalopods	3.27	2.76	2.09	0.77	2.54	3.36
Squids	2.82	0.95	0.87	0.52	1.52	0.22
Cuttle fish	0.20	0.88	0.58	0.25	0.42	0.50
Octopus	0.25	0.40	0.42	-	0.60	2.64
Sepiolid squid	0.00	0.53	0.22	-	-	-

Table 4. Catch per unit of effort (CPUE) (kg hr^{-1}) of cephalopod resources during the NE and SW monsoons; areas 1 to 4 signify distance from the shore line. The northern part of Phang-nga Province.

Cephalopods	Total	NE	SW	area 1	area 2	area 3	area 4
L. duvauceli	0.44	0.36	0.74	0.92	0.46	0.26	0.14
L. chinensis	0.45	0.35	0.80	0.45	0.02	0.77	0.56
L. sumatrensis	0.03	0.04	-	0.12	0.01	-	-
L. singhalensis	0.00	0.01	-	0.02	-	-	-
S. lessoniana	0.05	0.03	0.14	0.09	0.02	0.11	-
Loliginidae	0.97	0.79	1.68	1.60	0.51	1.14	0.70
S. pharaonis	0.11	0.08	0.22	0.03	0.04	0.06	0.31
S. recurvirostra	0.20	0.23	0.10	0.41	0.30	0.09	0.01
S. aculeata	0.02	0.02	0.02	-	0.06	-	0.02
S. brevimana	0.01	0.01	-	-	0.02	0.01	0.01
S. inermis	0.02	-	0.06	0.01	-	0.05	-
Cuttle fishes	0.18	0.21	0.05	0.29	0.15	0.09	0.15
total cuttle fish	0.54	0.55	0.45	0.74	0.57	0.30	0.50
Euprymna sp.	0.18	0.18	0.19	0.35	0.35	-	-
Octopus spp.	0.73	0.40	1.80	0.19	0.41	0.50	1.84
Cephalopods	2.42	1.21	4.12	2.88	1.84	1.94	3.04

Seasonal and spatial distribution

Tab. 2 shows the average CPUE and biomass of total catch and cephalopods during NE, SW monsoons, and all cruises. The CPUE of each area was calculated and presented (Tab. 2).

Fig. 3 shows the average CPUE during SW and NE monsoons. The highest catches of cephalopods appeared during the SW monsoon with a mean CPUE of 4.12 kg hr^{-1} (3.68 % of total catch) whereas a mean CPUE of 1.92 kg hr^{-1} (3.62 % of total catch) was found during the NE monsoon. Catches by monsoons were compared by *t*-test at 95 % confidence and they were significantly different (Tab. 2 and Appendix 1).

Table 5. Catch per unit of effort (CPUE) (kg hr^{-1}) of cephalopod resources by depth zone. The northern part of Phang-nga Provinces.

Cephalopods	15-25 m	26-35 m	36-45 m	46-55 m	56-65 m	66-75 m
L. duvauceli	1.65	0.55	0.46	0.24	0.33	-
L. chinensis	0.64	0.31	0.29	0.28	1.19	0.21
L. sumatrensis	0.40	0.01	-	-	-	0.01
L. singhalensis	-	0.02	-	-	-	-
S. lessoniana	0.13	0.06	0.12	-	-	-
Loliginidae	2.82	0.95	0.87	0.52	1.52	0.22
S. pharaonis	0.06	0.02	0.03	0.15	0.21	0.26
S. recurvirostra	0.13	0.51	0.28	0.04	-	0.01
S. aculeata	-	-	0.06	-	0.04	-
S. brevimana	-	-	0.01	0.02	0.03	-
S. inermis	-	-	0.06	-	-	-
Cuttle fishes	0.01	0.35	0.13	0.04	0.14	0.23
total cuttle fish	0.20	0.88	0.57	0.25	0.42	0.50
Euprymna sp.	-	0.53	0.22	-	-	-
Octopus spp.	0.25	0.40	0.42	-	0.60	2.64
Cephalopods	3.27	2.76	2.08	0.77	2.54	3.36

Catches of cephalopods by area (distance from shore line) is presented in Fig. 4. The greatest abundance was found in area 4 and the smallest in area 2. Catches of cephalopods by area were not significantly different (Appendix 2).

Catch rates of cephalopods in each depth zone are shown in Tab. 3. The highest catch rate was found at 66-75 m depth and decreased in the following order: 15-25 m, 26-35 m, 56-65 m, 36-45 m, and 46-55 m where the catch rates were 3.36, 3.27, 2.76, 2.54, 2.09 and 0.77 kg hr^{-1} respectively. Catches of cephalopods by depth were not significantly different (Appendix 2).

Details of CPUE of each species in terms of monsoon, area and depth are reported in Tabs. 3 and 4 and details of length composition of each species are reported in Tab. 5.

L. chinensis was the dominant species, though caught more often during the SW monsoon season than the NE monsoon. The highest abundances were recorded in areas 3 and 4, and the depth zones 56-65 m and 15-25 m. Catches by season, area and depth were not significantly different (Tabs. 4 and 5, Appendices 1 and 2).

L. duvauceli was more abundant during the SW monsoon than during the NE monsoon. The highest abundances were found in areas 1 and 2, and the depth zone 15-25 m and 26-35 m. Catches by depth were significantly different between 15-25 m and 66-75 m (Tabs. 4 and 5, Appendices 1 & 2)

L. singhalensis was caught only during the NE monsoon in area 1 and at 26-35 m depth (Tabs. 4 and 5).

L. sumatrensis was found only during the SW monsoon in the areas 1 and 2, and at depths of 15-35 m and 66-75 m. Catches by depth were significantly different between depth zone 15-25 m compared to 26-35 and 66-75 m (Tabs. 4 and 5, Appendix 2).

S. lessoniana was most abundant during the SW monsoon season and areas of highest abundances were areas 1 and 3, and the depth zones 15-25 m and 36-45 m. Catch by season, area and depth were not significantly different (Tabs. 4 and 5, Appendices 1 and 2).

S. pharaonis, was most abundant during the SW monsoon season in area 4 at 56-75 m depth. Catch by area was significantly different between area 4 and the others (Tabs. 4 and 5, Appendices 1 and 2).
S. recurvirostra, was most abundant during the NE monsoon in areas 1 and area 2, and in the depth zone 26-35 m. Catch by area was significantly different between areas 1 and 4, and between depth zones 26-35 m and 56-65 m (Tabs. 4 and 5, Appendices 1 and 2).
S. aculeata occurred during both the NE and SW monsoons. The highest abundance was recorded in area 2, and in the depth zone 36-45 m. Catch by season, area and depth were not significantly different (Tabs. 4 and 5, Appendices 1 and 2).
S. brevimana occurred only during the NE monsoon. The species was most abundant in area 2 and at 56-65 m depth. Catch by area and depth were not significantly different (Tabs. 4 and 5, Appendix 2).
S. inermis occurred only during the NE monsoon in areas 1 and 3, and in the depth zone 36-45 m. Catch by area and depth were not significantly different (Tabs. 4 and 5, Appendix 2).
Euprymna sp. occurred during both SW and NE monsoons, being most abundant in areas 1 and 2, and in the depth zone 26-45 m. Catch by season, area and depth were not significantly different (Tabs. 4 and 5, Appendices 1 and 2).
Octopus spp., were found both during SW and NE monsoons, but catches were highest during the SW monsoon. The area of the highest abundance was area 4 (>20 nautical mile from shore) and in the depth zone 66-75 m. Catches by distance from shore line were significantly different between areas 4 and 1 (Tabs. 4 and 5, Appendices 1 and 2).

DISCUSSION AND CONCLUSION

The maximum catch rate of cephalopods in the northern part of Phang-nga Province was 2.43 kg hr^{-1}. This represented a decrease from 1978 and 1982 (2.75 and 3.77 kg hr^{-1} respectively) when a German trawler was operated during day-time (Chantawong *et al.* 1984).
The catch of cephalopods during the SW monsoon was twice the amount caught during the NE monsoon in agreement with findings of Kungvankij *et al.* (1973) in Phang-nga Bay and the west coast of Phuket Island. But, the result of Chantawong (1993) was that CPUE of cephalopod during the SW monsoon was only slightly higher than during the NE monsoon in Phang-nga Bay (3.608 and 3.52 kg hr^{-1}).
The highest abundance of cephalopods with respect to distance from shore was area 4 followed by the areas 1, 3 and 2.
Several fishery biologists have reported that water depth is a key factor which influences the catch (Aryuthaka & Thubthimsang 1991; Pokapunt & Tantivala 1987; Vadhanakul *et al.* 1985). They found that the catch of demersal resources increased with depth. In this study the highest abundance of cephalopods was found at 66-75 m depth and decreased in the order of 15-25 m, 26-35 m, 55-65 m, 36-45 m and 46-55 m. However, catch of squids was highest during the SW monsoon from near shore in the depth zone 15-25 m.
Chantawong (1993) reported that catch of squids by light luring was dominated by *L. duvauceli* followed by *L. chinensis* and *L. singhalensis*. Catches of *L. duvauceli* and *L. chinensis* clearly peaked during the NE monsoon, while *L. singhalensis* appeared to peak in March to April on the offshore continental shelf of Phuket and Phang-nga Provinces in depths of 80-200 m. Contrary to this we found peak abundance of *L. duvauceli* and *L. chinensis* during the SW monsoon. Our study on abundance of *L. singhalensis* by monsoon season is in agreement with Chotiyaputta (1995) who studied distribution and abundance by standard trawl gear in the western Gulf of Thailand and found the following abundances of squid: *L. duvauceli* (56.2 %), *L. chinensis* (15.0 %), *L. sumatrensis* (10.3 %), and *S. lessoniana* (6.2 %). She also reported that the sizes of *L. chinensis* caught were bigger than those

of *L. duvauceli*. We found the most dominant species to be *L. chinensis*, followed by *L. duvauceli*, *S. lessoniana*, *L. sumatrensis* and *L. singhalensis*. The distribution of *L. duvauceli* and *L. chinensis* in the western Gulf of Thailand were similar to the pattern found in this study. Studies on cephalopods in the Andaman Sea area are still insufficient, especially biological information (for example, length-weight relationships, size at maturity, spawning ground, spawning season, growth parameters). Therefore, further surveys should be conducted to obtain information on parameters controlling cephalopod populations in the Andaman Sea in order to develop resource management methods for cephalopods.

ACKNOWLEDGEMENTS

We are especially grateful to Dr. Suwanna Panutrakul of Institute of Marine Biology and Fisheries Research for their advice and helpful suggestions during the writing of this report. And thanks are due to officers and permanent employees of the Andaman Sea Fisheries Development Center for collected data.

REFERENCES

Aryuthaka, C. & W. Thubthimsang. 1991. Distribution of economically important demersal fish by depth off Chanthaburi, East Thailand. - Proceeding of the seminar on Fisheries 1991, Department of Fisheries, Thailand. 467-471.

Chantawong. P. 1993. Squid light luring fishery in Phuket and Phang-nga Provinces. Technical Paper no. 20/1993. - Marine Resource Survey Unit, Andaman Sea Fisheries Development Center, Marine Fisheries Division, Department of Fisheries, Ministry of Agriculture and Co-operation. 15 pp.

Chantawong. T. 1993. Monitoring in Phang-nga Bay. Technical paper no. 17/1993. - Marine Resource Survey Unit, Andaman Sea Fisheries Development Center, Marine Fisheries Division, Department of Fisheries, Ministry of Agriculture and Co-operation. 16 pp.

Chantawong T., V. Boonraksa & N. Bussarawit. 1984. The trawl fisheries and the status of demersal fish resources in the Andaman Sea. - Paper submitted at the Annual Meeting of Department of Fisheries, 4 -7 September 1984, Bangkhaen, Bangkok, Thailand. 40 pp.

Chotiyaputta C. 1995. Distribution , abundance, reproductive biology, age and growth of *Loligo chinensis* and *Loligo duvauceli* in the western Gulf of Thailand. - Technical Paper no. 20/1993. Marine Resource Survey Group, the upper Gulf Marine Fisheries Development Center, Marine Fisheries Division, Department of Fisheries, Ministry of Agriculture and Co-operation. 38 pp.

Chotiyaputta. C, T. Okutani & S. Chaitiamvong. 1992. Systematic study of Cephalopods in Thailand. - Paper presented to JSPS-NRCT under research project for scientific cooperation. 100 pp.

Department of Fisheries. 1995. Fisheries statistics of Thailand. - Fisheries Statistics subdivision, Fisheries Policy and Planning Division, Department of Fisheries 93 pp.

Janekarn, V. & J. Hylleberg. 1989. Coastal and offshore primary production along the west coast of Thailand (Andaman Sea) with note on physical-chemical variables. - Phuket Marine Biological Center Research Bulletin **55**: 20 pp.

Kangvankij, P., S. Dangsakul, S. Sanpakdee & C. Chirastit. 1973. A survey of the distribution and abundance of economically important shrimp along the Indian Ocean coast of Thailand. - Fisheries Contribution. Phuket Marine Fisheries Station, Phuket, Thailand. 9 pp.

Limpsaichol, P. 1994. The Andaman Sea coast, Thailand. An environmental assessment of the Bay of Bengal region. - Bay of Bengal Programme. BOBP/REP/67: 55-73.

Nateewathana, A. 1992. Taxonomic studies on loliginid squids (Cephalopoda: Loliginidae) from the Andaman Sea coast of Thailand. - Phuket Marine Biological Center Research Bulletin **57**: 1-40.

Pokapunt, W. & C. Tantivala. 1987. Observations on demersal fish resources and trash fish composition in the Andaman Sea, 1985. - Exploratory Fishing Division, Department of Fisheries, Bangkok, Thailand **23**: 44 pp.

Roper, C.F.E., M.J. Sweeney & C.E. Nauen. 1984. FAO Species Catalogue vol 3, Cephalopods of the world. An annotated catalogue of species of interest to fisheries. - FAO Fisheries Synopses (125): 1-277.

Sithigornkul, P. 1974. Taxonomic studies on cephalopods in the Gulf of Thailand. - M.Sc. Thesis, Chulalongkorn University. 237 pp.

Sparre, P. 1985. Introduction to tropical fish stock assessment FAO/DANIDA. Project training in Fish Stock Assessment. GCP/INT/392/DEN. - FAO manual, July 1985. 338 pp.

Sparre, P. & S.C. Venema. 1992. Introduction to tropical fish stock assesment. Part 1. Manual. FAO Fish. Tech. Rap. Rome-Italy no. 306/1. 376 pp.

Vadhanakul, S., Y. Memeskul & S. Pramokchutima. 1985. An analysis of demersal fish taken from otter-board trawling survey in the Gulf of Thailand, 1981. - Technical report no. 5/1985. Marine Fisheries Division, Department of Fisheries, Ministry of Agriculture and Co-operation. 71 pp.

ISSN 0858-3633

Appendix 1. *t*-test of catch data of cephalopods in the northern part of Phang-nga Province by NE and SW monsoon seasons. ns = not significant, ** = significant

Species	NE		SW		Statistic value			Significance
		SD		SD	t value	2-tail Prob	df	
L. duvauceli	0.36	±0.81	0.74	±0.80	-1.30	0.199	54	ns
L. chinensis	0.35	±0.87	0.80	±1.19	-1.22	0.242	54	ns
L. sumatrensis	0.04	±0.13	-	-	-	-	-	-
S. lessoniana	0.03	±0.08	0.14	±0.34	-1.24	0.237	54	ns
Loliginidae	0.79	±1.35	1.68	±1.61	-1.82	0.074	54	ns
S. pharaonis	0.08	±0.22	0.22	±0.39	-0.96	0.354	54	ns
S. recurvirostra	0.23	±0.44	0.10	±0.26	1.14	0.258	54	ns
S. aculeata	0.02	±0.09	0.02	±0.09	-	-	54	-
S. brevimana	0.01	±0.04	-	-	-	-	54	-
S. inermis	0.004	±0.02	0.06	±0.20	-0.93	0.368	54	ns
Cuttle fishes	0.55	±0.61	0.45	±0.55	0.78	0.436	54	ns
Euprymna sp.	0.18	±0.75	0.19	±0.54	-0.02	0.982	54	ns
Octopus spp.	0.40	±0.75	1.80	±2.49	-1.92	0.077	54	ns
Cephalopods	1.21	±1.74	4.12	±2.71	-2.54	0.022	54	**

Appendix 2. ANOVA from catch data of cephalopods in the northern part of Phang-nga Province by area and depth. Significance No. 1 to 6 refer to 15-25 m, 26-35 m, 36-45 m, 46-55 m, 56-65 m and 65-75 m depth. The character "&" refers to significant difference between specified depths. ns = not significant, ** = significant

Species	Source	SS	df	MS	F	P-value	Significance
L duvauceli	Area 1-4	4.6661	3	1.5554	2.5842	0.0638	ns
	Depth 15-75	7.4565	5	1.4913	2.6250	0.0357	** 1 & 6
L. chinensis	Area 1-4	4.4905	3	1.4968	2.0805	0.1149	ns
	Depth 15-75	5.0869	5	1.0174	1.3797	0.2490	ns
L. sumatrensis	Area 1-4	0.1747	3	0.0582	1.1572	0.3356	ns
	Depth 15-75	0.5887	5	0.1177	2.6981	0.0318	** 1 & 2-6
S. lessoniana	Area 1-4	0.1157	3	0.0386	1.1682	0.3314	ns
	Depth 15-75	0.1663	5	0.0333	0.9975	0.4296	ns
Loliginidae	Area 1-4	7.8729	3	2.6243	1.2694	0.2952	ns
	Depth 15-75	20.4715	5	4.0943	2.1695	0.0735	* 1 & 6
S. pharaonis	Area 1-4	0.7465	3	0.2488	3.9502	0.0133	** 4 &3,1
	Depth 15-75	0.5360	5	0.1072	1.5281	0.1993	ns
S. recurvirostra	Area 1-4	1.4005	3	0.4668	3.2681	0.0289	**1 & 4
	Depth 15-75	2.1081	5	0.4216	3.1495	0.0156	** 2 & 5
S. aculeata	Area 1-4	0.0059	3	0.0020	1.0273	0.3887	ns
	Depth 15-75	0.0083	5	0.0017	0.8474	0.5233	ns
S. brevimana	Area 1-4	0.0039	3	0.0013	0.9645	0.4170	ns
	Depth 15-75	0.0069	5	0.0014	1.0153	0.4194	ns
S. inermis	Area 1-4	0.0273	3	0.0091	0.8984	0.4488	ns
	Depth 15-75	0.0389	5	0.0078	0.7532	0.5880	ns
Cuttle fishes	Area 1-4	1.2093	3	0.4031	1.1579	0.3353	ns
	Depth 15-75	2.3994	5	0.4799	1.4213	0.2340	ns
Euprymna sp.	Area 1-4	1.7270	3	0.5757	1.1825	0.3261	ns
	Depth 15-75	2.7837	5	0.5567	1.1478	0.3489	ns
Octopus spp.	Area 1-4	17.5797	3	5.8599	2.9660	0.0410	** 4 & 1
	Depth 15-75	17.2336	5	3.4467	1.6674	0.1611	ns
Cephalopods	Area 1-4	8.2657	3	2.7552	0.5668	0.6395	ns
	Depth 15-75	27.8940	5	5.5788	1.1997	0.3240	ns