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**STATUS ON FISHERIES  
EXPLOITATION AND POTENTIAL  
YIELD OF ROUND SCADS  
AND MACKERELS IN THE REGION**

**By**

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# STATUS ON FISHERIES EXPLOITATION AND POTENTIAL YIELD OF ROUND SCADS AND MACKERELS IN THE REGION

## INTRODUCTION

The South China Sea Area is one of the most important areas for marine capture fisheries in the world, and the marine catches of the region accounted for around 10% of the world grand total. This paper describes the facts and figures on fisheries of three major species groups, round scads (*Decapterus* spp.), Indian mackerels (*Rastrelliger kanagurta* and *R. faughni*) and Indo-Pacific mackerel (*Rastrelliger brachysoma*) in the region.

The combined catch quantity of these three species groups was 1,155,000 MT in 1992 and accounted for 12% of the grand total in the region. The references of data examined were Fishery Statistical Bulletin and Catch-effort Statistics for the South China Sea Area which have been published annually by SEAFDEC.

## 1. MARINE PRODUCTION OF ROUND SCADS AND MACKERELS IN THE REGION

This section describe the catch quantity (Metric ton), catch value (US\$) and unit price (US\$/kg) of three species groups of round scads, Indian mackerels and Indo-Pacific mackerel from 1976 to 1992 in the region.

### 1-1 Catch Trend

Catch by three species groups from 1976 to 1992 in the region is shown in **Table 1** and **Figure 1**.

The sub-total of three species groups in the region recorded at 646,000 MT (accounted for 11.2% of the grand total) in 1976 and it decreased to 480,000 MT in 1979. After 1979, combined catch showed steady increase to 1,155 MT (12.1%) in 1992 with an exception of a slight decreasing of 1988.

Round scads catch in the region recorded at 405,000 MT (accounted for 7.0% of the grand total) in 1976 and remained constant in 1977. The catch decreased drastically from 1978 and then recorded at 193,000 MT in 1980, but it increased to 446,000 MT in 1987. In 1988, the catch decreased slightly, but it increased again steadily and reached at 596,000 MT in 1991 and remained constant in 1992.

Indian mackerel catch in the region recorded at 84,000 MT (accounted for 1.5% of the grand total) in 1976. The catch increased to 279,000 MT in 1983, then remained constant until 1989 and it increased again and reached at 357,000 MT (3.8%) in 1992.

Indo-Pacific mackerel catch in the region recorded at 156,000 MT (accounted for 2.7% of the grand total) in 1976, but it recorded at 164,000 MT (1.9%) in 1991 as similar as the quantity of 1976. During the period from 1976 to 1992, the catch showed no big variations with a minimum of 92,000 MT in 1981 and a maximum of 206,000 MT in 1992.

### 1-2 Catch Value

Catch value by three species groups from 1976 to 1992 in the region is shown in **Table 2** and **Figure 2**. Data from 1976 to 1985 were obtained from all countries, but data from 1986 to 1992 were excluded the data of Indonesia.

The sub-total catch value trend of three species groups in the region from 1976 to 1985 was divided into two periods, i.e., from 1976 to 1980 which showed US\$ 300 million level, and from 1981 to 1985 which showed US\$ 400 million level. After 1985, the combined sub-total catch value of 1986 showed US\$ 312 million and showed a steady increase to US\$ 556 million in 1992.

Round scads catch value in the region from 1976 to 1985 varied in general from US\$ 155 million to US\$ 198 million with exceptions of US\$ 142 million in 1980 and over US\$ 200 million in 1981 and 1982. After 1985, the catch value of 1986 showed US\$ 156 million and increased steadily to US\$ 270 million in 1992.

Indian mackerels catch value trend in the region from 1976 to 1985 was divided into two, i.e., from 1976 to 1980 which showed less than US\$ 100 million, and from 1981 to 1985 which showed around US\$150 million. After 1985, the catch value of 1986 showed US\$83 million and increased steadily to US\$157 million in 1992.

Indo-Pacific mackerel catch value in the region from 1976 to 1985 showed less variations from US\$67 million to US\$ 92 million with exceptions of around US\$ 55 million in 1981 and 1982. After 1985, the catch value showed a increase trend generally to US\$129 million in 1992.

### 1-3 Unit Price

Estimated unit price (catch value/catch quantity) of three species groups in the region from 1976 to 1992 is shown in **Table 3** and **Figure 3**. The price shows the producer price at the landing center.

On round scads unit price in the region from 1976 to 1992, the price increased from US\$0.47 per kilogram in 1977 to US\$0.76/Kg. in 1979, then it remained constant until 1981. The price decreased to US\$ 0.49/kg in 1984, but it recorded at US\$ 0.69/kg. in 1986, then it showed less variations until 1992.

On Indian mackerels unit price in the region from 1976 to 1992, the price increased dramatically from US\$ 0.48/kg. in 1977 to US\$ 0.74/kg. in 1978, but it showed general decreasing trend to US\$ 0.55/kg. in 1985. After 1985, the price remained constant around US\$ 0.63/kg. for five years, then increased to US\$ 0.91 in 1991.

On Indo-Pacific mackerel unit price in the region from 1976 to 1992, the price showed less variations through this period with a minimum of US\$ 0.44/kn. in 1976 and a maximum of US\$ 0.66/kg. in 1992.

## 2. CATCHES OF ROUND SCADS AND MACKERELS BY TYPE OF FISHING GEAR

This section describes the catch quantity and its percentage by type of fishing gear for round scads, Indian mackerels and Indo-Pacific mackerel in 1976, 1981, 1986 and 1992.

### 2-1 Round Scads

Round scads catch by type of fishing gear from 1976, 1981, 1986 and 1992 is shown in **Table 4**. Percentage of type of fishing gear for round scads is shown in **Figure 4**.

The purse seine catch, the most dominant for the round scads, was 253,000 MT (accounted for 77.3 % of the total round scad catch) in 1976. In 1981, the purse seine catch decreased to 126,000 MT (59.4%), and the other fishing gear catches were increased, especially lift net catch for round scads showed dramatic increase to 39,000 MT (18.5%). In 1986, the purse seine catch for round scads increased to 150,000 MT (68.1%), and lift net catch showed a decrease. The trawl catch in 1986 showed still 23,000 MT and accounted for 10% of the round scads catch, and gill net catch accounted for 4.9% and hook-and-line showed 3.5%. In 1992, the purse seine catch increased steadily to 332,000 MT (84.5%), followed by lift net (31,000 MT; 7.9%) and trawl (12,000 MT; 3.0%).

### 2-2 Indian Mackerels

Indian mackerel catch by type of fishing gear from 1976, 1981, 1986 and 1992 is shown in **Table 5**. Percentage of type of fishing gear for Indian mackerels is shown in **Figure 5**.

The purse seine catch, the most dominant for the Indian mackerels catch, was 44,000 MT (accounted for 53.0% of the total Indian mackerels catch), trawl catch showed 13,000 MT (15.2%) and gill net catch showed 3,600 MT (4.3%) in 1976. In 1981, purse seine catch showed 80,000 MT (61.5%), followed by gill net (24,000 MT; 18.5%) instead of trawl (increased to 21,000 MT, but accounted for 15.8%). In 1986, the purse seine catch was still accounted for over 60 % of Indian mackerel catch and quantity of 80,000 MT. The gill net and trawl catches in 1986 were almost the same of 16,000 MT (13%), and hook-and-line showed 6,300 MT (5.0%). In 1992, the purse seine catch showed 94,000 MT, still the most dominant, but it accounted for 52.4%. On the other hand, gill net catch in 1992 increased to 45,000 MT and accounted for 24.9%, followed by trawl catch (25,000 MT; 13.9%).

### 2-3 Indo-Pacific Mackerel

Indo-Pacific mackerel catch by type of fishing gear from 1976, 1981, 1986 and 1992 is shown in **Table 6**. Percentage of type of fishing gear for Indo-Pacific mackerel is shown in **Figure 6**.

The purse seine catch, the most dominant for the Indo-Pacific mackerel, was 45,000 MT (accounted for 55.5% of the total Indo-Pacific mackerel catch), followed by trawl (12,000 MT; 14.5%) and gill net (8,600 MT; 4.3%) in 1976. In 1981, the purse seine catch remained 44,000 MT but it accounted for less than 50%, on the other hand, gill net catch increased to 28,000 MT and accounted for 31.0% with a dramatic increase. The trawl catch in 1981 was still 12,000 MT (13.3%). In 1986, the purse seine catch increased both quantity (75,000 MT) and percentage (52.0%), followed by the gill net catch (42,000 MT; 29.3%) and the trawl catch (15,000 MT; 10.2%). In 1992, the purse seine catch increased to 101,000 MT (65.9%) instead of decreasing of gill net at 26,000 MT (17.1%). The trawl catch in 1992 increased a bit to 18,000 MT and accounted for 11.6%.

### 3. CATCH-EFFORT DATA ON ROUND SCADS AND MACKERELS

This section describes the CPUE value of round scads, Indian mackerels and Indo-Pacific mackerel from 1978 to 1991 in the region. Operating days were used as the effort for estimation of CPUE value for purse seine, trawl (instead of trawling hours because of data availability) and drift gill net.

#### 3-1 Round Scads

The CPUE value (MT/day) for round scads by purse seine from 1978 to 1991 in the region is shown in **Table 7** and **Figure 7**.

The CPUE value of round scads by purse seine in 1978 showed 0.624 MT per day, it was very high value, but then it ranged from 0.095 MT/day (1990) to 0.323 MT/day (1987) with some variations. After 1985, the CPUE value varied up and down repeatedly by year until 1991 with more variations than the previous years.

#### 3-2 Indian Mackerels

The CPUE value (MT/day) for Indian mackerels by purse seine from 1978 to 1991 in the region is shown in **Table 8** and **Figure 8**.

The CPUE value of Indian mackerel by purse seine showed 0.124 MT/day in 1978 and decreased to 0.081 MT/day in 1981. Then, the CPUE value increased dramatically to 0.434 MT/day in 1983. After 1983, the CPUE value showed a clear decreasing trend to 0.120 MT/day in 1990 with variations of up and down repeatedly by year.

The CPUE value (MT/day) for Indian mackerels by trawl from 1978 to 1991 in the region is shown in **Table 9** and **Figure 9**, and that by drift gill net is shown in **Table 10** and **Figure 10**.

The CPUE value of Indian mackerels by trawl ranged from 0.003 MT/day (1978, 1979 and 1980) to 0.008 MT/day (1982) with an average of 0.005 MT/day. The CPUE value of Indian mackerels by drift gill net showed less than 0.003 MT/day with exceptions of 0.009 MT/day in 1979 and 0.005 MT/day in 1982.

#### 3-3 Indo-Pacific Mackerel

The CPUE value (MT/day) for Indo-Pacific mackerel by purse seine from 1978 to 1991 in the region is shown in **Table 11** and **Figure 11**.

The CPUE value of Indo-Pacific mackerel by purse seine showed 0.078 MT/day in 1978 and showed a general increase trend to 0.337 MT/day in 1985 with some up and down variations. After 1985, the CPUE value showed general decrease trend to 0.191 MT/day in 1990 before increasing again to 0.258 MT/day in 1991.

The CPUE value (MT/day) for Indo-Pacific mackerel by trawl from 1978 to 1991 in the region is shown in **Table 12** and **Figure 12**, and that by drift gill net is shown in **Table 13** and **Figure 13**.

The CPUE value of Indo-Pacific mackerel by trawl showed decrease trend from 0.008 MT/day in 1981 to 0.003 MT/day in 1983, and then it increased a bit to 0.006 MT/day in 1988 and remained constant until 1990. The CPUE value of Indo-Pacific mackerel by drift gill net showed less than 0.003 MT/day during the period from 1978 to 1991 with an exception of 0.007 MT/day in 1981.

### 4. POTENTIAL YIELD

Provisional estimation of the potential yield for the South China Sea Area was done by Yanagawa and Wongsanga (1993). In the report, the potential yield was estimated provisionally on the basis of the relationship between catch data and their percentages from 1976 to 1989. Therefore, estimated potential yield in the report means that the estimated maximum possible catch based on the actual catch trend and the species composition (percentage) by fisheries during the examined period.

Estimated potential yield, the latest three-year mean (1990-1992) and catch in 1992 for round scads, Indian mackerels and Indo-Pacific mackerel are shown in **Table 14**.

On round scads, the catch increased steadily from 1981 to 1992 (**Fig.14**) and the CPUE value by the purse seine can be considered as no big fluctuations from 1979 to 1991 (**see Fig. 7**). Therefore, it can be considered that there are certain possibilities of more increase of round scad catch in the region instead of the catches in 1990, 1991 and 1992 which were included in the potential yield zone.

On Indian mackerels, the catches from 1983 to 1988 remained constant at the potential yield zone and then it showed increasing trend until 1992 (**Fig. 15**), on the other hand the CPUE values by purse seine from 1984 to 1990 showed a clear decreasing trend (**see Fig. 8**). Therefore, it can be considered that there are certain possibilities of over exploitation of Indian mackerels in the region.

On Indo-Pacific mackerel, the catches from 1982 to 1992 showed an increasing trend with some fluctuations under the potential yield zone (**Fig.16**), on the other hand the CPUE values by purse seine from 1986 to 1990 showed a decreasing trend (**see Fig. 11**). Therefore, it can be considered that there are certain possibilities of over exploitation of Indo-Pacific mackerel even the catches were under the potential yield zone.

As the general consideration for the status of round scads, Indian mackerels and Indo-Pacific mackerel was described above on the basis of general fisheries statistics, more detailed examinations for the major species (group) should be done in the near future. For the purpose of doing the detailed analysis, good quality data on various fishery biology items for important species, more reliable catch and effort statistics and so on are necessary to collect and exchange the information among the researchers and the organizations concerns.

## **5. BIOLOGICAL INFORMATION**

Regarding biological information of round scads, Indian mackerels and Indo-Pacific mackerel, information obtained from the report, “**Distribution and important biological features of coastal fish resources in Southeast Asia by Chullasorn and Martosubroto, 1986; FAO Fisheries Technical Paper No. 278**”, are shown in the following pages.

For fish in general, the information on length-weight relationship of 26 fish species belonging to 17 families from the Gulf of Thailand is obtained from the report, “**Length-weight relationship of Gulf of Thailand fishes by Yanagawa, 1994; Naga, ICLARM Quarterly 17 (4)**” is shown also the following page.

[From Hiroyuki Yanagawa, 1993]

**Table: Summarized length-weight relationships of fish obtained from the Gulf of Thailand**

Species	N	Range of		Adjusted $r^2$	b	a	Survey
		Total	length				
Holocentridae							
<i>Sargocentron rubrum</i>	8	124.4	— 184.5	0.871	2.658	0.05710	R-2
<i>Myripristis hexagonus</i>	11	142.2	— 189.4	0.872	3.040	0.01869	R-1
Serranidae							
<i>Epinephelus bleekeri</i>	11	142.4	— 269.0	0.976	3.126	0.00889	R-3 dan P-2
<i>Epinephelus tauvina</i>	9	126.6	— 377.9	0.996	2.957	0.01563	P-2
<i>Cephalopholis pachycentron</i>	3	109.0	— 174.5	0.991	3.207	0.00990	P-2
<i>Cephalopholis boenack</i>	8	156.0	— 238.2	0.982	3.002	0.01554	R-1, 3
Apogonidae							
<i>Archamia lineolata</i>	63	70.0	— 102.8	0.907	3.207	0.01066	R-3
Sillaginidae							
<i>Sillago sihama</i>	8	170.5	— 207.8	0.905	3.362	0.00285	P-1
Carangidae							
<i>Selaroides leptolepis</i>	25	99.2	— 163.6	0.983	3.101	0.00745	R-2
Lutjanidae							
<i>Lutjanus russelli</i>	31	114.1	— 337.8	0.991	3.234*	0.00708	P-1, 2
<i>Lutjanus vitta</i>	95	83.7	— 209.2	0.970	3.110	0.00999	R-1, 3
<i>L. vitta</i>	41	131.6	— 218.7	0.946	2.913	0.01871	R-2
<i>L. vitta</i>	30	102.2	— 160.8	0.919	3.103	0.01142	P-1, 2
<i>Lutjanus lineolatus</i>	90	102.4	— 163.8	0.892	2.807	0.02351	R-2, 3
Nemipteridae							
<i>Nemipterus hexodon</i>	11	131.4	— 217.0	0.990	3.277*	0.00576	R-2, 3
<i>Scolopsis ciliatus</i>	9	159.8	— 261.2	0.964	2.480*	0.06405	R-1
<i>Scolopsis dubiosus</i>	4	219.2	— 248.0	0.995	3.280	0.00542	R-3
<i>Scolopsis temporalis</i>	5	153.0	— 231.4	0.967	3.090	0.01129	R-2
Pentapodidae							
<i>Pentapodus setosus</i>	20	119.5	— 213.5	0.984	3.073	0.01062	R-2, 3
Pomadasyidae							
<i>Plectorhynchus pictus</i>	11	155.4	— 566.2	0.983	3.019	0.01302	R-3, P-2
Theraponidae							
<i>Therapon jarbua</i>	6	96.4	— 267.8	0.999	2.884	0.02215	R-3

**Table 2**

Important biological features and parameters; coastal small pelagic fish in the region  
(1) Mackerels. See Sections 5 and 6.1.1 for annotations and broader references

(Body size refers to total length unless specified as FL: fork length or SL: standard length; sexes are combined unless specified as M: male or F: female)

Species	Area (country) surveyed	Vertical distribution range (m)	Body size captured		Spawning		Fecundity	Recruitment		Size at first maturity (cm)	Sex ratio (M:F)	Growth (rate or coefficient)	Mortality (coefficient)	Life span (year)	Food organisms	Length-weight relationship
			Mean (cm)	Maximum (cm)	Area	Season (month)		Size (cm)	Season (month)							
FAMILY SCOMBRIDAE <i>Rastrelliger brachysoma</i>	Gulf of Thailand <sup>a</sup>	20-40	15.0	20.95	10-40 mi off Prachuab-Suratani	2-4, 6-8	egg= $9 \times 10^{-8} L^{4.8356}$ 200 000 500 000, 20 000- 30 000/ batch	10.25	1-3, 7-9	17.5	1:1	k=0.33	Z=1.06	2-3	Phytoplanktons, zooplanktons	W = $0.006138L^{3.215}$ M:W = $0.000005732L^{3.1235}$ F:W = $0.000006578L^{3.1235}$
	Andaman Sea <sup>b</sup> (Thailand)	—	17.5	—	Koh Yao, Krabi	2-3, 8-9	30 000/ batch 97 250- 241 832	9.5- 12.5	4, 8-10	17.5	1:1.3	—	—	—	Phytoplanktons, zooplanktons, diatoms, copepods	Log W = $1.8874 + 3.214 \text{ Log } L$
	North of Java <sup>c</sup>	—	—	22.92	—	6-10	—	—	—	17.3	1.3:1	k=0.19	Z=0.88	3-4	—	—
	Malacca Strait <sup>d</sup> (Malaysia)	—	—	19.6- 20.1	—	10-12	20 000- 30 000/ batch	10.0	1-3	18.5	—	k=0.36- 0.44	M=0.38 Z=0.82	—	—	—
	Manila Bay <sup>e</sup>	—	—	34.0	—	6-2	11 300- 119 300	—	—	15.0- 16.0	—	k=1.1	M=1184 Z=4.27	—	—	—
	Samar Sea <sup>f</sup>	—	—	25.0	—	—	—	—	—	—	—	k=1.60	M=2.56 Z=4.49	—	—	—

a Boonprakob (1965, 1967, 1972); Tabtimtai (1968); Suchondhamarn *et al.* (1970); Somjaiwong *et al.* (1970); Suvapepun and Suwanrumpha (1970).

b Boonragsa *et al.* (1984); Bussarawitch (1984, 1984a, 1984b).

c Sujastani (1974).

d Pathansali (1961, 1967); Chong and Chua (1974).

e Ingles and Pauly (1984); Tan (1970).

f Ingles and Pauly (1984).

Table 2 (1) Mackerels (continued)

Species	Area (country) surveyed	Vertical distribution range (m)	Body size captured		Spawning		Fecundity	Recruitment		Size at first maturity (cm)	Sex ratio (M:F)	Growth (rate or coefficient)	Mortality (coefficient)	Life span (year)	Food organisms	Length-weight relationship
			Mean (cm)	Maximum (cm)	Area	Season (month)		Size (cm)	Season (month)							
FAMILY SCOMBRIDAE <i>Rastrelliger brachysoma</i> (continued)	Andaman Sea <sup>a</sup> (Burma)	—	19.3FL	23.0FL	—	10-5	20 000-30 000/batch	13.7FL	2, 5-6	—	1:1.7	—	—	—	—	—
<i>R. kanagurta</i>	Gulf of Thailand <sup>b</sup>	30-60	16.0	22.9	—	2-4, 7-8	200 000	11.0	5-6	18.6	1:1	—	—	2-3	Phytoplanktons, zooplanktons, diatoms, copepods	M:W = 0.0000001958L <sup>3.7653</sup> F:W = 0.000009454L <sup>3.0375</sup>
	Andaman Sea <sup>c</sup> (Thailand)	—	—	19.2	—	12.2	25 000/batch 94 495 263 178	13.0-14.0	5-12	18.67	1:0.93	—	—	—	Phytoplanktons, diatoms, zooplanktons, crustaceans, dinoflagellates	—
	North of Java <sup>d</sup>	—	11.9-12.4	23.89	—	10-2, 6-9	200 000 500 000	18.8	—	19.0	1:1.1	k=2.78 k=1.63	Z=1.2 Z=0.58	3-4	Filamentous algae, zolina, ceratium	M:W = 1.35 x 10 <sup>-5</sup> L <sup>2.9927</sup> F:W = 2.16x10 <sup>-5</sup> L <sup>2.9281</sup>
	Malacca Strait <sup>e</sup> (Malaysia)	—	16.75	—	—	All around 5-1, 11-4,	20 000-30 000-batch	—	—	18.75	—	—	—	—	Phytoplanktons, crustaceans, copepods, decapods, dinoflagellates	—

a Druzhinin (1968).

b Vanichkul and Hongskul (1965); Boonprakob (1967); Tantiswetratana (1979).

c Boonragsa *et al.* (1984); Bussarawitch (1984).

d Sujastani (1974); Gafa (1982); Dwiponggo and Pauly (in press).

e Pathansali (1961, 1967); Chee; (1980).



Table 2 (1) Mackerels (continued)

Species	Area (country) surveyed	Vertical distribution range (m)	Body size captured		Spawning		Fecundity	Recruitment		Size at first maturity (cm)	Sex ratio (M:F)	Growth (rate or coefficient)	Mortality (coefficient)	Life span (year)	Food organisms	Length-weight relationship
			Mean (cm)	Maximum (cm)	Area	Season (month)		Size (cm)	Season (month)							
FAMILY SCOMBRIDAE <i>R. kanagurta</i> (continued)	Palawan waters <sup>a</sup>	—	—	28.0	—	—	—	—	—	—	—	k=1.55	Z=8.27 M=2.43	—	—	—
	Andaman Sea <sup>b</sup> (Burma)	—	20.47FL	—	—	9-5	—	14.0FL	6-7	—	1:1.39	—	—	—	—	—

a Ingles and Pauly (1984).

b. Druzhinin (1968).

Table 2 (continued)

(2) Round scads. See Sections 5 and 6.1.2 for annotations and broder references

Species	Area (country) surveyed	Vertical distribution range (m)	Body size captured		Spawning		Fecundity	Recruitment		Size at first maturity (cm)	Sex ratio (M:F)	Growth (rate or coefficient)	Mortality (coefficient)	Life span (year)	Food organisms	Length-weight relationship
			Mean (cm)	Maximum (cm)	Area	Season (month)		Size (cm)	Season (month)							
FAMILY CARANGIDAE <i>Decapterus macrosoma</i>	Manila Bay and Palawan waters <sup>a</sup>	50-90	M:17.7 F:17.6	25.0	Manila Bay to Palawan	11-3	67 000-106 200	7.0-8.0	2-3	—	1:0.99	0.56 cm/month	—	3-6	Crustaceans, zooplanktons, fish, molluscs	W = 0.005639L <sup>3.167</sup>
	Java Sea <sup>b</sup>	—	—	25.4	—	—	—	17.6	—	—	—	k=0.98	Z=6.22	—	—	—
	Gulf of Thailand <sup>c</sup>	30-60	—	—	—	12-5	—	—	—	16.5	1:0.9	—	—	—	—	—

a Magnusson (1970); Tiews, Ronquillo and Caces-Borja (1970); Ronquillo (1974).

b. Dwiponggo and Pauly (in press).

c Chullasorn and Yusukswad (1977).

Table 2 (2) Round scads (continued)

Species	Area (country) surveyed	Vertical distribution range (m)	Body size captured		Spawning		Fecundity	Recruitment		Size at first maturity (cm)	Sex ratio (M:F)	Growth (rate or coefficient)	Mortality (coefficient)	Life span (year)	Food organisms	Length-weight relationship
			Mean (cm)	Maximum (cm)	Area	Season (month)		Size (cm)	Season (month)							
FAMILY CARANGIDAE <i>Decapterus maruadsi</i>	Gulf of Thailand <sup>a</sup>	30-70	13.2	23.1	Central Gulf	2-3, 7-8	38 000-515 000	5.5-6.5	1-2, 6-8	16.1	1:1.2	k=0.11 1-2 cm/month	—	2-3	crustaceans, copepods	W = 0.00005L <sup>2.811</sup>
<i>Decapterus russelli</i>	Java Sea <sup>b</sup>	—	—	26.8	—	—	—	9-14.2	—	18.3	—	k=0.95-1.04	Z=3.5-4.79 M=1.3	—	—	—
	Malacca Strait <sup>c</sup> (Malaysia)	—	—	—	—	—	—	7.5	7	—	—	—	—	—	—	—
	Palawan waters <sup>d</sup>	36-180	M:16.72 F:16.5	33.0	Palawar to Manila	11-3 1-4	29 000-49 000	8.0-9.0	2-3	16.6	1:1.04	k=0.2 0.6 cm/month	Z=2.62	3-6	Zoo-planktons, crustaceans, fish	W = 0.0098L <sup>3.0152</sup>
	Java Sea <sup>e</sup>	—	—	26.8	—	—	20 000-84 000	14.6	—	—	—	k=1.09	Z=4.09	—	—	—

- a Chullasorn and Yusukwad (1977); Chantarasri (1980); Cheunpan (1981).
- b Sadhotomo *et al.* (1983); Atmadja (1982).
- c Southeast-Asian Fisheries Development Centre (1982).
- d Tiews, Ronquillo and Caces-Borja (1970); Magnusson (1970); Ronquillo (1974); Ingles and Pauly (1984).
- e Dwiponggo and Pauly (in press).

[From Somsak Chullasorn and Purwito Martosubroto, 1986]

<i>Species</i>	<i>N</i>	<i>Range of</i>		<i>Adjusted</i>	<i>b</i>	<i>a</i>	<i>Survey</i>
		<i>Total</i>	<i>length</i>	<i>r</i> <sup>2</sup>			
Sciaenidae							
<i>Johnius belengerii</i>	13	150.8 —	194.2	0.918	3.388	0.00385	P-1
Lethrinidae							
<i>Lethrinus lentjan</i>	60	143.4 —	227.4	0.984	2.938	0.01894	R-1, 2, 3
Mullidae							
<i>Upeneus tragula</i>	8	153.4 —	216.8	0.976	2.845	0.01438	R-1
Chaetodontidae							
<i>Chelmo rostratus</i>	10	136.3 —	170.4	0.811	2.289*	0.12803	R-1
Siganidae							
<i>Siganus oramin</i>	4	66.5 —	250.7	0.991	3.011	0.01201	R-3
<i>Siganus javus</i>	35	89.0 —	163.1	0.984	3.208*	0.00912	R-2
Scombridae							
<i>Rastrelliger kanagurta</i>	18	106.7 —	137.6	0.867	2.755	0.01634	R-2
Aluteridae							
<i>Monacanthus chinensis</i>	4	68.8 —	199.8	0.999	2.447*	0.07038	R-3
<i>M. chinensis</i>	7	152.4 —	245.2	0.900	2.506*	0.07978	P-2

\* Significant difference from  $b = 3$  at the 5% level.

## 6. REFERENCES OF DATA EXAMINED

Fishery Statistical Bulletins for the South China Sea Area from 1976 to 1992 issued by SEAFDEC annually.

Catch-effort Statistics for the South China Sea Area from 1978 to 1991 issued by SEAFDEC annually.

Review of Fishery Production, Provisional Estimation of Potential Yield and the Situation of Fisheries in the Southeast Asian Region — 1976 to 1989. Yanagawa, H. and Pouchamarn Wongsanga, SEAFDEC TD/SP/18: 114 PP.1993.

**Table 1: Catch by three species groups and the grand total from 1976 to 1992 in the region. On data in 1979, Indonesian data was estimated as same as the actual results of the previous year**

(MT)					
<i>Year</i>	<i>Grand total</i>	<i>Sub-total</i>	<i>Round scads</i>	<i>Indian mackerels</i>	<i>Indo-Pacific mackerel</i>
1976	5,769,755	645,508	405,339	83,824	156,345
1977	6,601,423	640,112	419,743	83,035	137,334
1978	6,714,387	559,769	283,006	123,976	152,787
1979	6,198,419	479,942	203,526	88,664	187,752
1980	6,119,952	492,208	192,565	138,476	161,167
1981	6,386,088	594,352	285,981	216,739	91,632
1982	6,644,305	649,022	326,359	210,833	111,830
1983	7,163,755	713,710	321,435	278,913	113,362
1984	6,663,749	779,188	344,189	268,438	166,561
1985	6,835,037	808,669	365,923	282,846	159,900
1986	7,296,718	815,645	414,686	257,197	143,762
1987	8,017,748	876,083	445,607	275,589	154,887
1988	8,008,984	841,747	403,275	262,679	175,793
1989	8,290,739	934,163	464,285	289,693	180,185
1990	8,511,397	989,511	509,909	313,006	166,596
1991	8,784,641	1,060,273	595,692	301,071	163,510
1992	9,514,250	1,155,026	591,816	356,971	206,239

**Table 2: Value of catch by three species groups and the grand total from 1976 to 1992 in the region. On data in 1979 and 1982, Indonesian data were estimated as same as the actual results of the previous years. On data from 1986 to 1992, Indonesian data were excluded**

(US\$1000)					
<i>Year</i>	<i>Grand total</i>	<i>Sub-total</i>	<i>Round scads</i>	<i>Indian mackerels</i>	<i>Indo-Pacific mackerel</i>
1976	2,315,758	307,201	194,303	44,430	68,468
1977	2,821,188	309,181	197,766	39,905	71,510
1978	3,581,855	346,187	167,967	91,626	86,594
1979	3,912,661	307,300	154,505	63,769	89,026
1980	4,037,649	312,756	142,342	78,769	91,645
1981	4,498,282	411,197	212,932	144,712	53,553
1982	4,482,420	420,013	223,802	138,051	58,160
1983	4,234,580	401,648	173,333	161,289	67,026
1984	4,171,953	404,622	169,323	147,727	87,572
1985	4,172,318	414,370	186,145	154,368	73,857
1986	3,912,775	312,107	155,874	83,350	72,883
1987	4,316,862	341,681	181,974	88,075	71,632
1988	3,500,643	355,937	179,756	82,101	94,080
1989	4,034,149	409,595	213,030	93,952	102,613
1990	3,822,715	406,588	199,215	107,389	99,984
1991	4,210,336	495,912	262,122	142,807	90,983
1992	4,743,290	555,939	269,698	156,932	129,309

**Table 3: Estimated unit price of three species groups from 1976 to 1992 in the region. Price is the producer one at the landing center (wholesale price). On data from 1986 to 1992, Indonesian data were excluded.**

(US\$/Kg.)					
<i>Year</i>	<i>Grand total</i>	<i>Sub-total</i>	<i>Round scads</i>	<i>Indian mackerels</i>	<i>Indo-Pacific mackerel</i>
1976	0.48	0.48	0.48	0.53	0.44
1977	0.50	0.48	0.47	0.48	0.52
1978	0.61	0.62	0.59	0.74	0.57
1979	0.68	0.64	0.76	0.72	0.47
1980	0.71	0.64	0.74	0.57	0.57
1981	0.76	0.69	0.74	0.67	0.58
1982	0.72	0.65	0.69	0.65	0.52
1983	0.64	0.56	0.54	0.58	0.59
1984	0.64	0.52	0.49	0.55	0.53
1985	0.62	0.51	0.51	0.55	0.46
1986	0.67	0.63	0.69	0.67	0.51
1987	0.65	0.57	0.61	0.57	0.49
1988	0.60	0.61	0.65	0.61	0.54
1989	0.67	0.64	0.67	0.65	0.57
1990	0.62	0.60	0.59	0.64	0.60
1991	0.67	0.71	0.69	0.91	0.56
1992	0.70	0.72	0.68	0.87	0.66

**Table 4: Catch by type of fishing gear for round scads from 1976, 1981, 1986 and 1992 in the region. Data were obtained from Malaysia, Philippines and Thailand.**

(MT)				
<i>Gear/Year</i>	<i>1976</i>	<i>1981</i>	<i>1986</i>	<i>1992</i>
Total	326,789	212,684	220,086	392,583
Purse seine	252,667	126,279	149,858	331,744
Trawl	14,546	21,181	22,873	11,862
Gill net	1,103	13,569	10,778	6,658
Lift net	7,129	39,258	27,229	30,832
Hook and line	29	8,716	7,774	5,136
Trap	10,803	1,009	325	176
Others	40,512	2,672	1,249	6,175

**Table 5: Catch by type of fishing gear for Indian mackerels from 1976, 1981, 1986 and 1992 in the region. Data were obtained from Malaysia, Philippines and Thailand.**

(MT)				
<i>Gear/Year</i>	<i>1976</i>	<i>1981</i>	<i>1986</i>	<i>1992</i>
Total	83,753	130,798	124,826	179,769
Purse seine	44,386	80,471	79,661	94,231
Trawl	12,759	20,725	15,695	24,989
Gill net	3,568	24,171	16,775	44,822
Lift net	933	1,372	3,412	3,278
Hook and line	253	2,663	6,276	6,318
Trap	678	662	1,702	1,017
Others	21,176	734	1,305	5,114

**Table 6: Catch by type of fishing gear for Indo-Pacific mackerel from 1976, 1981, 1986 and 1992 in the region. Data were obtained from Malaysia, Philippines and Thailand.**

(MT)

<i>Gear/Year</i>	<i>1976</i>	<i>1981</i>	<i>1986</i>	<i>1992</i>
Total	80,991	91,632	143,762	153,254
Purse seine	44,941	43,547	74,774	101,043
Trawl	11,735	12,182	14,617	17,844
Gill net	8,646	28,418	42,093	26,214
Lift net	2,535	800	770	217
Hook and line	10	1,487	4,859	2,415
Trap	1,333	3,186	5,460	1,997
Others	11,791	2,012	1,189	3,524

**Table 7: CPUE value of round scads by purse seine from 1978 to 1991 in the region. Data were obtained from west and east coasts of Peninsular Malaysia, Sabah, Visayas, Mindanao, Gulf of Thailand and Andaman Sea (available data were not always same by year).**

<i>Year</i>	<i>Purse Seine</i>		
	<i>Effort (Days)</i>	<i>Catch (MT)</i>	<i>CPUE M(T/Day)</i>
1978	169,352	105,675	0.624
1979	127,681	22,430	0.176
1980	126,494	32,239	0.255
1981	143,485	36,397	0.254
1982	288,465	55,939	0.194
1983	247,912	44,529	0.180
1984	331,958	51,928	0.156
1985	311,647	46,769	0.150
1986	319,841	40,894	0.128
1987	332,606	107,402	0.323
1988	281,628	32,057	0.114
1989	362,020	77,820	0.215
1990	357,982	33,945	0.095
1991	390,354	92,937	0.238

**Table 8: CPUE value of Indian mackerels by purse seine from 1978 to 1991 in the region. Data were obtained from west and east coasts of Peninsular Malaysia, Sarawak, Sabah, Visayas, Gulf of Thailand and Andaman Sea (available data were not always same by year).**

<i>Year</i>	<i>Purse Seine</i>		
	<i>Effort (Days)</i>	<i>Catch (MT)</i>	<i>CPUE (MT/Day)</i>
1978	169,352	21,050	0.124
1979	127,681	15,411	0.121
1980	177,110	18,216	0.103
1981	194,123	15,660	0.081
1982	310,124	60,925	0.196
1983	253,716	110,006	0.434
1984	331,958	95,230	0.287
1985	311,647	91,716	0.294
1986	319,841	61,745	0.193
1987	332,606	77,738	0.234
1988	381,218	48,811	0.128
1989	362,020	52,628	0.145
1990	459,822	55,299	0.120
1991	390,354	56,656	0.145

**Table 9:** CPUE value of Indian mackerels by trawl from 1978 to 1991 in the region. Data were obtained from Hong Kong, west and east coast of Peninsular Malaysia, Sarawak, Sabah, Visayas, Gulf of Thailand and Andaman Sea (available data were not always same by year).

<i>Year</i>	<i>Trawl</i>		
	<i>Effort (Days)</i>	<i>Catch (MT)</i>	<i>CPUE (MT/Day)</i>
1978	1,436,181	4,135	0.003
1979	1,340,590	4,004	0.003
1980	3,099,825	9,466	0.003
1981	3,266,860	16,868	0.005
1982	3,076,809	25,109	0.008
1983	3,046,472	21,021	0.007
1984	3,058,556	16,090	0.005
1985	2,717,905	13,929	0.005
1986	3,059,537	12,388	0.004
1987	2,918,059	19,419	0.007
1988	3,022,672	17,960	0.006
1989	2,840,876	20,115	0.007
1990	3,349,605	21,142	0.006
1991	3,488,685	15,119	0.004

**Table 10:** CPUE value of Indian mackerels by drift gill net from 1978 to 1991 in the region. Data were obtained from west and east coasts of Peninsular Malaysia, Sarawak, Sabah, Gulf of Thailand and Andaman Sea (available data were not always same by year).

<i>Year</i>	<i>Drift</i>	<i>Gill</i>	<i>Net</i>
	<i>Effort (Days)</i>	<i>Catch (MT)</i>	<i>CPUE (MT/Day)</i>
1978	33,941	36	0.001
1979	48,530	432	0.009
1980	1,180,830	299	0.000
1981	—	—	—
1982	40,302	214	0.005
1983	47,253	16	0.000
1984	2,351,343	3,981	0.002
1985	44,862	25	0.001
1986	63,192	81	0.001
1987	67,036	94	0.001
1988	76,915	37	0.000
1989	51,498	26	0.001
1990	750,848	38	0.000
1991	799,093	1,921	0.002

**Table 11: CPUE value of Indo-Pacific mackerel by purse seine from 1978 to 1991 in the region. Data were obtained from Sabah, Viasayas, Mindanao, Gulf of Thailand and Andaman Sea (available data were not always same by year).**

<i>Year</i>	<i>Purse Seine</i>		
	<i>Effort (Days)</i>	<i>Catch (MT)</i>	<i>CPUE (MT/Day)</i>
1978	169,352	13,269	0.078
1979	127,681	29,603	0.232
1980	124,694	18,080	0.145
1981	141,707	38,327	0.270
1982	180,710	50,982	0.282
1983	157,180	36,530	0.232
1984	203,271	62,968	0.310
1985	183,258	61,683	0.337
1986	224,926	65,693	0.292
1987	236,670	61,979	0.262
1988	281,628	60,226	0.214
1989	266,561	67,948	0.255
1990	357,982	68,209	0.191
1991	282,112	72,895	0.258

**Table 12: CPUE value of Indo-Pacific mackerel by trawl from 1978 to 1991 in the region. Data were obtained from Sabah, Visayas, Mindanao, Gulf of Thailand and Andaman Sea (available data were not always same by year).**

<i>Year</i>	<i>Trawl</i>		
	<i>Effort (Days)</i>	<i>Catch (MT)</i>	<i>CPUE (MT/Day)</i>
1978	1,609,332	11,643	0.007
1979	1,522,551	11,840	0.008
1980	1,324,450	10,139	0.008
1981	1,139,621	8,599	0.008
1982	1,432,124	9,380	0.007
1983	1,502,230	4,675	0.003
1984	1,450,520	6,494	0.004
1985	1,277,720	6,099	0.005
1986	1,895,219	9,903	0.005
1987	1,853,233	9,534	0.005
1988	1,886,182	11,943	0.006
1989	1,896,830	12,206	0.006
1990	1,911,625	11,549	0.006
1991	1,824,463	8,378	0.005



**Table 13: CPUE value of Indo-Pacific mackerel by drift gill net from 1978 to 1991 in the region. Data were obtained from Sabah, Gulf of Thailand and Andaman Sea (available data were not always same by year).**

<i>Year</i>	<i>Drift</i>	<i>Gill</i>	<i>Net</i>
	<i>Effort (Days)</i>	<i>Catch (MT)</i>	<i>CPUE (MT/Day)</i>
1978	26,857	4	0.000
1979	48,357	48	0.001
1980	—	—	—
1981	41,478	306	0.007
1982	3,872	7	0.002
1983	48,463	23	0.000
1984	43,318	21	0.000
1985	44,862	19	0.000
1986	732,583	22	0.000
1987	743,885	56	0.000
1988	789,655	12	0.000
1989	791,411	77	0.000
1990	750,848	557	0.001
1991	785,178	26	0.000

**Table 14: Estimated potential yield (Yanagawa and Wongsanga, 1993), 3-year mean catch from 1990 to 1992 and catch quantity in 1992 for three species groups in the region.**

(MT)

<i>Species group</i>	<i>Estimate potential yield</i>	<i>3-year mean</i>	<i>Catch in 1992</i>
Round scads	486,000 — 607,000	565,806	591,816
Indian mackerels	253,000 — 316,000	323,683	356,971
Indo-Pacific mackerel	205,000 — 257,000	178,782	206,239

**Table 2**

Important biological features and parameters; coastal small pelagic fish in the region

(1) Mackerels. See Sections 5 and 6.1.1 for annotations and broader references

(Body size refers to total length unless specified as FL: fork length or SL: standard length; sexes are combined unless specified as M: male or F: female)

Species	Area (country) surveyed	Vertical distribution range (m)	Body size captured		Spawning		Fecundity	Recruitment		Size at first maturity (cm)	Sex ratio (M:F)	Growth (rate or coefficient)	Mortality (coefficient)	Life span (year)	Food organisms	Length-weight relationship
			Mean (cm)	Maximum (cm)	Area	Season (month)		Size (cm)	Season (month)							
FAMILY SCOMBRIDAE <i>Rastrelliger brachysoma</i>	Gulf of Thailand <sup>a</sup>	20-40	15.0	20.95	10-40 mi off Prachuab-Suratani	2-4, 6-8	egg= $9 \times 10^{-8} L^{4.8356}$ 200 000 500 000, 20 000- 30 000/ batch	10.25	1-3, 7-9	17.5	1:1	k=0.33	Z=1.06	2-3	Phyto-planktons, zoo-planktons	W = $0.006138L^{3.215}$ M:W = $0.000005732L^{3.1235}$ F:W = $0.000006578L^{3.1235}$
	Andaman Sea <sup>b</sup> (Thailand)	—	17.5	—	Koh Yao, Krabi	2-3, 8-9	30 000/ batch 97 250- 241 832	9.5- 12.5	4, 8-10	17.5	1:1.3	—	—	—	Phyto-planktons, zoo-planktons, diatoms, copepods	Log W = $1.8874 + 3.214 \text{ Log } L$
	North of Java <sup>c</sup>	—	—	22.92	—	6-10	—	—	—	17.3	1.3:1	k=0.19	Z=0.88	3-4	—	—
	Malacca Strait <sup>d</sup> (Malaysia)	—	—	19.6- 20.1	—	10-12	20 000- 30 000/ batch	10.0	1-3	18.5	—	k=0.36- 0.44	M=0.38 Z=0.82	—	—	—
	Manila Bay <sup>e</sup>	—	—	34.0	—	6-2	11 300- 119 300	—	—	15.0- 16.0	—	k=1.1	M=1184 Z= 4.27	—	—	—
	Samar Sea <sup>f</sup>	—	—	25.0	—	—	—	—	—	—	—	k=1.60	M=2.56 Z=4.49	—	—	—

a Boonprakob (1965, 1967, 1972); Tabtimtai (1968); Suchonatham *et al.* (1970); Somjaiwong *et al.* (1970); Suvapepun and Suwanrumpha (1970).

b Boonragas *et al.* (1984); Bussarawitch (1984, 1984a, 1984b).

c Sujastani (1974).

d Pathansali (1961, 1967); Chong and Chua (1974).

e Ingles and Pauly (1984); Tan (1970).

f Ingles and Pauly (1984).

Table 2 (1) Mackerels (continued)

Species	Area (country) surveyed	Vertical distribution range (m)	Body size captured		Spawning		Fecundity	Recruitment		Size at first maturity (cm)	Sex ratio (M:F)	Growth (rate or coefficient)	Mortality (coefficient)	Life span (year)	Food organisms	Length-weight relationship
			Mean (cm)	Maximum (cm)	Area	Season (month)		Size (cm)	Season (month)							
FAMILY SCOMBRIDAE <i>Rastrelliger brachysoma</i> (continued)	Andaman Sea* (Burma)	—	19.3FL	23.0FL	—	10-5	20 000-30 000/batch	13.7FL	2, 5-6	—	1:1.7	—	—	—	—	—
<i>R. kanagurta</i>	Gulf of Thailand <sup>b</sup>	30-60	16.0	22.9	—	2-4, 7-8	200 000	11.0	5-6	18.6	1:1	—	—	2-3	Phytoplanktons, zooplanktons, diatoms, copepods	M:W = 0.000001958L <sup>3.7653</sup> F:W = 0.000009454L <sup>3.0375</sup>
	Andaman Sea <sup>c</sup> (Thailand)	—	—	19.2	—	12.2	25 000/batch 94 495 263 178	13.0-14.0	5-12	18.67	1:0.93	—	—	—	Phytoplanktons, diatoms, zooplanktons, crustaceans, dinoflagellates	—
	North of Java <sup>d</sup>	—	11.9-12.4	23.89	—	10-2, 6-9	200 000 500 000	18.8	—	19.0	1:1.1	k=2.78 k=1.63	Z=1.2 Z=0.58	3-4	Filamentous algae, zolina, ceratium	M:W = 1.35 x 10 <sup>-5</sup> L <sup>2.9927</sup> F:W = 2.16 x 10 <sup>-5</sup> L <sup>2.9281</sup>
	Malacca Strait <sup>e</sup> (Malaysia)	—	16.75	—	—	All around 5-1, 11-4,	20 000-30 000-batch	—	—	18.75	—	—	—	—	Phytoplanktons, crustaceans, copepods, decapods, dinoflagellates	—

a Druzhinin (1968).

b Vanichkul and Hongkul (1965); Boonprakob (1967); Tantiswetratana (1979).

c Boonragsa *et al.* (1984); Bussarawitch (1984).

d Sujastani (1974); Gafa (1982); Dwiponggo and Pauly (in press).

e Pathansali (1961, 1967); Chee; (1980).

Table 2 (1) Mackerels (continued)

Species	Area (country) surveyed	Vertical distribution range (m)	Body size captured		Spawning		Fecundity	Recruitment		Size at first maturity (cm)	Sex ratio (M:F)	Growth (rate or coefficient)	Mortality (coefficient)	Life span (year)	Food organisms	Length-weight relationship
			Mean (cm)	Maximum (cm)	Area	Season (month)		Size (cm)	Season (month)							
FAMILY SCOMBRIDAE <i>R. kanagurta</i> (continued)	Palawan waters <sup>a</sup>	—	—	28.0	—	—	—	—	—	—	—	k=1.55	Z=8.27 M=2.43	—	—	—
	Andaman Sea <sup>b</sup> (Burma)	—	20.47FL	—	—	9-5	—	14.0FL	6-7	—	1:1.39	—	—	—	—	—

a. Ingles and Pauly (1984).

b. Druzhinin (1968).

Table 2 (continued)

(2) Round scads. See Sections 5 and 6.1.2 for annotations and broader references

Species	Area (country) surveyed	Vertical distribution range (m)	Body size captured		Spawning		Fecundity	Recruitment		Size at first maturity (cm)	Sex ratio (M:F)	Growth (rate or coefficient)	Mortality (coefficient)	Life span (year)	Food organisms	Length-weight relationship
			Mean (cm)	Maximum (cm)	Area	Season (month)		Size (cm)	Season (month)							
FAMILY CARANGIDAE <i>Decapterus macrosoma</i>	Manila Bay and Palawan waters <sup>a</sup>	50-90	M:17.7 F:17.6	25.0	Manila Bay to Palawan	11-3	67 000-106 200	7.0-8.0	2-3	—	1:0.99	0.56 cm/month	—	3-6	Crustaceans, zooplanktons, fish, molluscs	W = 0.005639L <sup>3.167</sup>
	Java Sea <sup>b</sup>	—	—	25.4	—	—	—	17.6	—	—	—	k=0.98	Z=6.22	—	—	—
	Gulf of Thailand <sup>c</sup>	30-60	—	—	—	12-5	—	—	—	16.5	1:0.9	—	—	—	—	—

a. Magnusson (1970); Tiews, Ronquillo and Caces-Borja (1970); Ronquillo (1974).

b. Dwiponggo and Pauly (in press).

c. Chullasorn and Yusukswad (1977).

Table 2 (2) Round scad (continued)

Species	Area (country) surveyed	Vertical distribution range (m)	Body size captured		Spawning		Fecundity	Recruitment		Size at first maturity (cm)	Sex ratio (M:F)	Growth (rate or coefficient)	Mortality (coefficient)	Life span (year)	Food organisms	Length-weight relationship
			Mean (cm)	Maximum (cm)	Area	Season (month)		Size (cm)	Season (month)							
FAMILY CARANGIDAE <i>Decapterus maruadsi</i>	Gulf of Thailand <sup>a</sup>	30-70	13.2	23.1	Central Gulf	2-3, 7-8	38 000-515 000	5.5-6.5	1-2, 6-8	16.1	1:1.2	k=0.11 1-2 cm/month	—	2-3	crustaceans, copepods	$W = 0.00005L^{2.811}$
<i>Decapterus russelli</i>	Java Sea <sup>b</sup>	—	—	26.8	—	—	—	9-14.2	—	18.3	—	k=0.95-1.04	Z=3.5-4.79 M=1.3	—	—	—
	Malacca Strait <sup>c</sup> (Malaysia)	—	—	—	—	—	—	7.5	7	—	—	—	—	—	—	—
	Palawan waters <sup>d</sup>	36-180	M:16.72 F:16.5	33.0	Palawan to Manila	11-3 1-4	29 000-49 000	8.0-9.0	2-3	16.6	1:1.04	k=0.2 0.6 cm/month	Z=2.62	3-6	Zoo-planktons, crustaceans, fish	$W = 0.0098L^{3.0152}$
	Java Sea <sup>e</sup>	—	—	26.8	—	—	20 000-84 000	14.6	—	—	—	k=1.09	Z=4.09	—	—	—

- a Chullasorn and Yusukwad (1977); Chantarasri (1980); Cheunpan (1981).
- b Sadhotomo *et al.* (1983); Atmadja (1982).
- c Southeast-Asian Fisheries Development Centre (1982).
- d Tiews, Ronquillo and Caces-Borja (1970); Magnusson (1970); Ronquillo (1974); Ingles and Pauly (1984).
- e Dwiponggo and Pauly (in press).

[From Somsak Chullasorn and Purwito Martosubroto, 1986]

[From Hiroyuki Yanagawa, 1993]

**Table: Summarized length-weight relationships of fish obtained from the Gulf of Thailand**

Species	N	Range of		Adjusted $r^2$	b	a	Survey
		Total	length				
Holocentridae							
<i>Sargocentron rubrum</i>	8	124.4	— 184.5	0.871	2.658	0.05710	R-2
<i>Myripristis hexagonus</i>	11	142.2	— 189.4	0.872	3.040	0.01869	R-1
Serranidae							
<i>Epinephelus bleekeri</i>	11	142.4	— 269.0	0.976	3.126	0.00889	R-3 dan P-2
<i>Epinephelus tauvina</i>	9	126.6	— 377.9	0.996	2.957	0.01563	P-2
<i>Cephalopholis pachycentron</i>	3	109.0	— 174.5	0.991	3.207	0.00990	P-2
<i>Cephalopholis boenack</i>	8	156.0	— 238.2	0.982	3.002	0.01554	R-1, 3
Apogonidae							
<i>Archamia lineolata</i>	63	70.0	— 102.8	0.907	3.207	0.01066	R-3
Sillaginidae							
<i>Sillago sihama</i>	8	170.5	— 207.8	0.905	3.362	0.00285	P-1
Carangidae							
<i>Selaroides leptolepis</i>	25	99.2	— 163.6	0.983	3.101	0.00745	R-2
Lutjanidae							
<i>Lutjanus russelli</i>	31	114.1	— 337.8	0.991	3.234*	0.00708	P-1, 2
<i>Lutjanus vitta</i>	95	83.7	— 209.2	0.970	3.110	0.00999	R-1, 3
<i>L. vitta</i>	41	131.6	— 218.7	0.946	2.913	0.01871	R-2
<i>L. vitta</i>	30	102.2	— 160.8	0.919	3.103	0.01142	P-1, 2
<i>Lutjanus lineolatus</i>	90	102.4	— 163.8	0.892	2.807	0.02351	R-2, 3
Nemipteridae							
<i>Nemipterus hexodon</i>	11	131.4	— 217.0	0.990	3.277*	0.00576	R-2, 3
<i>Scolopsis ciliatus</i>	9	159.8	— 261.2	0.964	2.480*	0.06405	R-1
<i>Scolopsis dubiosus</i>	4	219.2	— 248.0	0.995	3.280	0.00542	R-3
<i>Scolopsis temporalis</i>	5	153.0	— 231.4	0.967	3.090	0.01129	R-2
Pentapodidae							
<i>Pentapodus setosus</i>	20	119.5	— 213.5	0.984	3.073	0.01062	R-2, 3
Pomadasyidae							
<i>Plectorhynchus pictus</i>	11	155.4	— 566.2	0.983	3.019	0.01302	R-3, P-2
Theraponidae							
<i>Therapon jarbua</i>	6	96.4	— 267.8	0.999	2.884	0.02215	R-3

<i>Species</i>	<i>N</i>	<i>Range of Total length</i>	<i>Adjusted r<sup>2</sup></i>	<i>b</i>	<i>a</i>	<i>Survey</i>
Sciaenidae						
<i>Johnius belengerii</i>	13	150.8 — 194.2	0.918	3.388	0.00385	P-1
Lethrinidae						
<i>Lethrinus lentjan</i>	60	143.4 — 227.4	0.984	2.938	0.01894	R-1, 2, 3
Mullidae						
<i>Upeneus tragula</i>	8	153.4 — 216.8	0.976	2.845	0.01438	R-1
Chaetodontidae						
<i>Chelmo rostratus</i>	10	136.3 — 170.4	0.811	2.289*	0.12803	R-1
Siganidae						
<i>Siganus oramin</i>	4	66.5 — 250.7	0.991	3.011	0.01201	R-3
<i>Siganus javus</i>	35	89.0 — 163.1	0.984	3.208*	0.00912	R-2
Scombridae						
<i>Rastrelliger kanagurta</i>	18	106.7 — 137.6	0.867	2.755	0.01634	R-2
Aluteridae						
<i>Monacanthus chinensis</i>	4	68.8 — 199.8	0.999	2.447*	0.07038	R-3
<i>M. chinensis</i>	7	152.4 — 245.2	0.900	2.506*	0.07978	P-2

\* Significant difference from  $b = 3$  at the 5% level.