

## Catch Rate of Oceanic Squid by Jigging Method in the South China Sea Area III: Western Philippines

**Ludivina L. Labe**

Bureau of Fisheries and Aquatic Resources (BFAR),  
860 Arcadia Bldg., Quezon Avenue, Quezon City 1103, Philippines.

### ABSTRACT

This paper presents the preliminary result of the exploratory fishing for oceanic squid by automatic jigging method in the South China Sea Area III: western Philippines. This was part of SEAFDEC's collaborative research survey on the fisheries resources of Area III with focus on tuna, oceanic squid and other migratory species. The research vessel M/V SEAFDEC covered 31 predetermined stations for oceanographic and fisheries survey, 10 of which were squid jigging stations. Jigging effort of four automatic jiggers at each station varied from 2-8 hours. The Indo-Pacific squid, *Sthenoteuthis (Symplectoteuthis) oualaniensis* (Lesson, 1830) was the only species caught throughout the fishing area. The total catch for 51.6 fishing hours consisted of 2538 individuals weighing 393.1 kg. The female-dominated catch had individuals with mantle length ranging from 9.8-24 cm and average weight of 155g. Catch-per-unit-effort (CPUE) of automatic jiggers averaged 6 ind/line/hour (968 g/l/h) or 0.4 ind/jig/h (45 g/j/h). High concentration of squid was observed at the northern portion of the survey area. Catch rates were high within 0-100 m jigging depth. *S. oualaniensis* in Area III occurred in two forms: the dwarf, early-maturing form without dorsal photophore (9.8-12 cm mantle length; 43 g average weight) and the middle-sized form with dorsal photophore (12-24 cm ML; 174 g average weight). The middle-sized form dominated the catch representing 86% of the total catch. The dwarf form was less abundant in all catches but occurred throughout the area. The middle-sized and dwarf forms had total weight of 377.5 kg (2175 individuals) and 15.6 kg (363 individuals), respectively. The females were dominant in both forms. The biomass of *S. oualaniensis* standing stock in the SCS Area III was estimated at 283 thousand metric tons.

**Keywords:** South China Sea; *Sthenoteuthis oualaniensis* (Lesson, 1830); jigging; catch-per-unit-effort (CPUE); biomass; stock density.

### Introduction

The squid continuously occupies a leading place among the living resources of the sea that are the target of worldwide exploitation. The depletion of a number of fish stocks, the continued increase in the demand for squid products in domestic and foreign markets, and the valuable use of squids in biomedical research are some of the reasons many nations had focused their attention on the development of the fishery.

In the Philippines, the neritic squids form the basis of the country's cephalopod fishery. Since its advent, fishing for squids and other cephalopods is limited to coastal areas. There is

now a felt need to extend fishing operation to new and deeper waters where the potential yield is believed to be large. The oceanic squids remain largely untapped.

The Philippines with its offshore area covering about 88% of its territorial waters offers vast potential for future harvesting of oceanic squid. At least two Ommastrephidae and one Onychoteuthidae species were reported to be present in Philippine waters. Test fishing study using giant squid jig in Calauag Bay (Pacific Ocean) yielded the diamondback flying squid, *Thysanoteuthis rhombus* [Dickson and Ramiscal (1992)].

This study on the oceanic squid resources was a part of SEAFDEC's collaborative research program in one of the most productive fishing areas – the South China Sea, specifically Area III which is the northern portion of the SCS off the west coast of the Philippines. Area III covers a total of 86,400 square miles from latitude 11°N to 20°N and longitude 11°E to 121°E, 95% of the area being deeper than 1,000 m. The research vessel M/V SEAFDEC covered 31 predetermined stations for the oceanographic survey and fishing activities from 15 April to 12 May 1998 to collect baseline information on the fisheries resources of SCS Area III with focus on tuna, oceanic squid and other migratory species (Fig. 1). The objective of this particular study was to determine the species composition and estimate the abundance of oceanic squid in this area based on automatic jig catches.

### Materials and Methods

Materials were collected from the 10 designated squid jigging stations, which represented the entire survey area. The jigging stations were located at latitude 11°59.8'N to 20°2.3'N (80 mi off the coast of Malampaya, NW Palawan to 95 mi off Batanes coast) longitude 117°4.77'E to 119°9'E (210 mi off the coast of La Union, Northern Luzon to 55 mi off the coast of Calamianes Islands, Northern Palawan). Water depths range from 1,260 to 4,657 m.

At each station, squids were fished using four automatic jigging machines. Each machine was equipped with two nylon monofilament lines, each line having a sinker and 18-30 jigs spaced at 1.0m interval (Fig. 2). The machines were set up at the portside of the research vessel illuminated by 40 (500W) light bulbs. Jigging was done at depths of 50 to 170 m. Jigging effort at each station varied from 2 to 8 hours.

The catch of *S. oulaniensis* at each jigging station was monitored and recorded to determine the average stock density expressed in kg/m<sup>3</sup> and come up with an estimate of the biomass of squid and potential yields in the survey area. The distribution of the species in terms of the catch-per-unit-effort (CPUE) is presented as follows: number of individuals and weight in gram per line per hour (i.e., ind/l/h and g/l/h) and number of individuals per jig per hour (i.e., ind/j/h and g/j/h). All squid catches were identified to species level [Roper et al. (1984)] and the following biological measurements were obtained: individual size (dorsal mantle length in cm), weight(g), sex and maturity stage (when evident).

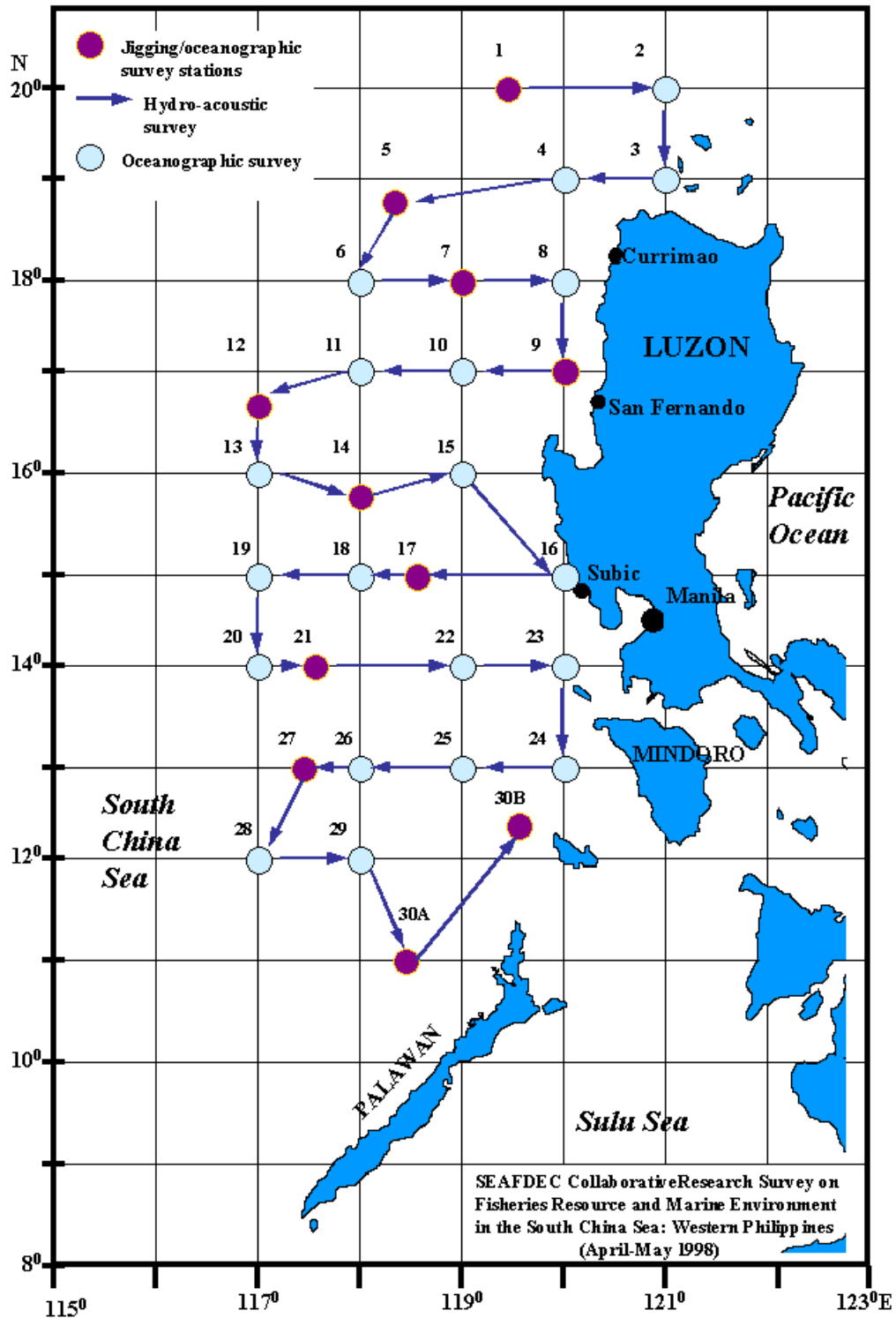


Fig. 1. Stations for oceanographic survey and fishing activities in the SCS Area III: Western Philippines.



Fig. 2. The automatic jigging machine used in squid fishing operations in the SCS Area III.



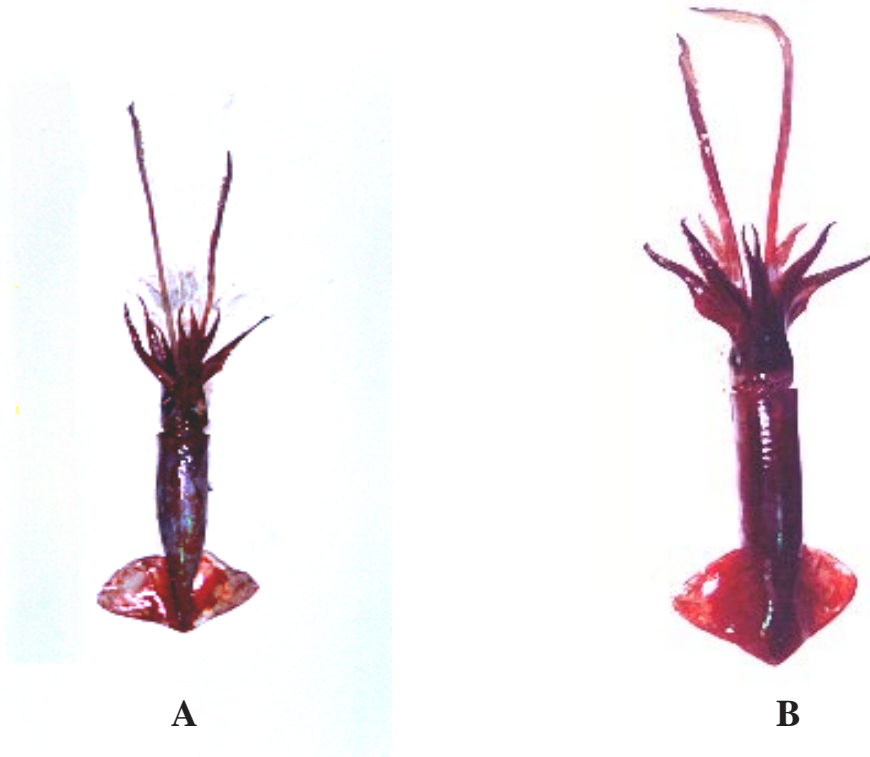


Fig.3. Dwarf *Sthenoteuthis oualaniensis* collected by automatic jiggers in the SCS Area III. A) 9.8 cm ML B) 11.4 cm ML.



Fig. 4. Middle-sized *S. oualaniensis*, 18-24 cm ML.

Table 1. Catch rates of *S. oualaniensis* by automatic jiggers in the SCS Area III.

STATION NO.	1	5	7	12	14	17	21	27	30A	30B	T/AVE.
No. of lines	8	8	8	8	8	8	8	8	8	6	78
No. of jigs	240	128	154	178	176	176	176	182	153	132	1695
Total fishing hours	4.9	2.5	4.5	5.4	3.8	5	5.2	6.6	5.7	8	51.6
<b>ALL SIZES:</b>											
Total catch (no. of ind.)	116	26	422	739	141	130	267	138	159	400	2538
Total catch (g)	25900	4900	71500	100300	2300	23500	39600	16500	25700	62200	393100
ind/fishing hour	24	10	94	137	37	26	51	21	28	50	48
g/fishing hour	5286	1960	15888	18574	6052	4700	7616	2500	4508	7775	7486
ind//h	3	1	12	17	5	3	6	3	3	8	6
g//h	661	245	1986	2322	757	587	952	313	564	1296	968.3
ind/j/h	0.1	0.1	1	1	0.2	0.2	0.3	0.1	0.2	0.4	0.4
g/j/h	22	15	103	104	34	27	43	14	30	59	45.1
<b>DWARF FORM:</b>											
<b>( 9-12 cm ML)</b>											
Total catch (ind.)	3	2	30	111	35	20	54	43	21	44	363
Total catch (g)	126	85	1291	4774	1503	860	2321	1848	899	1888	15595
ind/fishing hour	0.6	0.8	7	21	9	4	10	7	4	6	7
g/fishing hour	26	34	287	884	396	172	446	280	158	236	291.9
ind//h	0.05	0.1	1	3	1	0.5	1	1	0.5	1	1
g//h	3	4	36	111	49	21	56	35	20	39	37.4
ind/j/h	0.002	0.01	0.04	0.1	0.05	0.02	0.1	0.04	0.02	0.04	0.04
g/j/h	0.1	0.3	2	5	2	1	3	1	1	2	1.7
<b>MIDDLE-SIZED FORM</b>											
<b>(12-24 cm ML)</b>											
Total catch (ind.)	113	24	392	628	106	110	213	95	138	356	2175
Total catch (g)	25774	4815	70209	95526	21497	22640	37279	14652	24801	60312	377505
ind/fishing hour	23	10	87	116	28	22	41	14	24	44	41
g/fishing hour	5260	1926	15603	17690	5657	4528	7169	2220	4351	7539	7194
ind//h	3	1	11	14	3	3	5	2	3	7	5
g//h	657	241	1951	2211	707	566	896	277	544	1257	930.7
ind/j/h	0.1	0.1	1	1	0.2	0.1	0.2	0.1	0.2	0.3	0.3
g/j/h	22	15	101	99	32	26	41	12	29	57	43.4

**Legend:** ind – number of individuals; jm – jigging machine; h – hour; l – line;  
g – gram; j – jig

## Results and Discussion

The ommastrephid *Sthenoteuthis oualaniensis* (Lesson, 1930) was the only species caught at the 10 designated squid jigging stations in the SCS Area III. This species is distributed throughout the equatorial, tropical and subtropical waters of the Indo-Pacific Region [Roper, et al. (1984); Piatkowski and Welsch (1991); Nesis (1993); Yatsu, et al. (1998)] which makes the target species for commercial fishery. Its biomass in the Region has been estimated at 8 to 11 million metric tons [Young and Hirota (1998)].

Nesis (1993) reviewed the worldwide population structure of *S. oualaniensis* indicating that this species has the most complicated population structure having three main forms: the dwarf (modal mantle length 9 to 12 cm) early-maturing individuals without the light organ (photophore) on the dorsal mantle; the middle-sized (modal ML 12 to 25 cm) most common and widespread form with dorsal photophore; and the giant (modal ML 30 to 40 cm) late-maturing form with dorsal photophore. In Area III, *S. oualaniensis* apparently occurs in two forms: the dwarf without dorsal photophore (Fig. 3) and the dominant middle-sized form with dorsal photophore (Fig. 4).

### Abundance of *S. oualaniensis* based on catch-per-unit-effort.

Catch rates and catch-per-unit-effort (CPUE) of automatic jiggers are summarized in Table 1. Graphical presentations of these data are shown in Figures 5-7. The total catch obtained for 51.6 hours of fishing consisted of 2538 predominantly female *S. oualaniensis* weighing 393.1 kg (35 - 690 g) or an average weight of 155 g/ind. Mantle lengths were within the 9.8 to 24 cm limit. The catch rates ranged from 1 - 17 ind/l/h (245 g - 2.3 kg) and 0.1 - 1 ind/j/h (14 - 104 g) or an average CPUE of 6 ind/l/h (968 g) and 0.4 ind/j/h (45 g) (Fig. 5). The catch rates at the jigging stations indicated a proportion of 1 dwarf to 5 middle-sized form.

*S. oualaniensis* occurred throughout Area III but higher concentration was observed at the northern portion off the coasts of Northern Luzon Provinces from lat. 16°59.64'N to 20°2.3'N and long. 117°4.77'E to 119°56.7'E. The highest CPUE of 17 ind/l/h (2.3 kg) was obtained at 16°59.64'N 117°4.77'E (St. 12) off the coast of San Fernando, La Union. Another significant catch of 12 ind/l/h (1.99 kg) was obtained at 18°0.4'N 119°0.28'E (St. 7) off the coast of Currimaos, Ilocos Norte.

At the central and southern portions of the survey area, CPUEs were high at 14°0.5'N 117°59.9'E (St. 21) about 155 mi off Batangas Coast and at 12°47.6'N 119°9'E (St. 30B) approximately 55 mi off the coast of Calamianes Islands, Northern Palawan with 6 ind/l/h (952 g) and 8 ind/l/h (1.3 kg), respectively.

### The middle-sized form.

A total of 2175 middle-sized *S. oualaniensis* weighing 377.6 kg were caught at the jigging stations. Mantle length of individuals ranged from 12 - 24 cm and average weight of 174 g (50 - 690 g). The dominance of the middle-sized squid, representing 86% of the total catch is another proof that this form is the most common and widespread. The catch rates were 1 to 14 ind/l/h (241g - 2.2 kg) or 0.1 to 1 ind/j/h (12 - 100 g) and average CPUE of 5 ind/l/h (931 g) or 0.3 ind/j/h (43.4 g). It was notably high at St. 12 (14 ind/l/h) and St. 7 (11 ind/l/h) as shown in Fig. 6. The

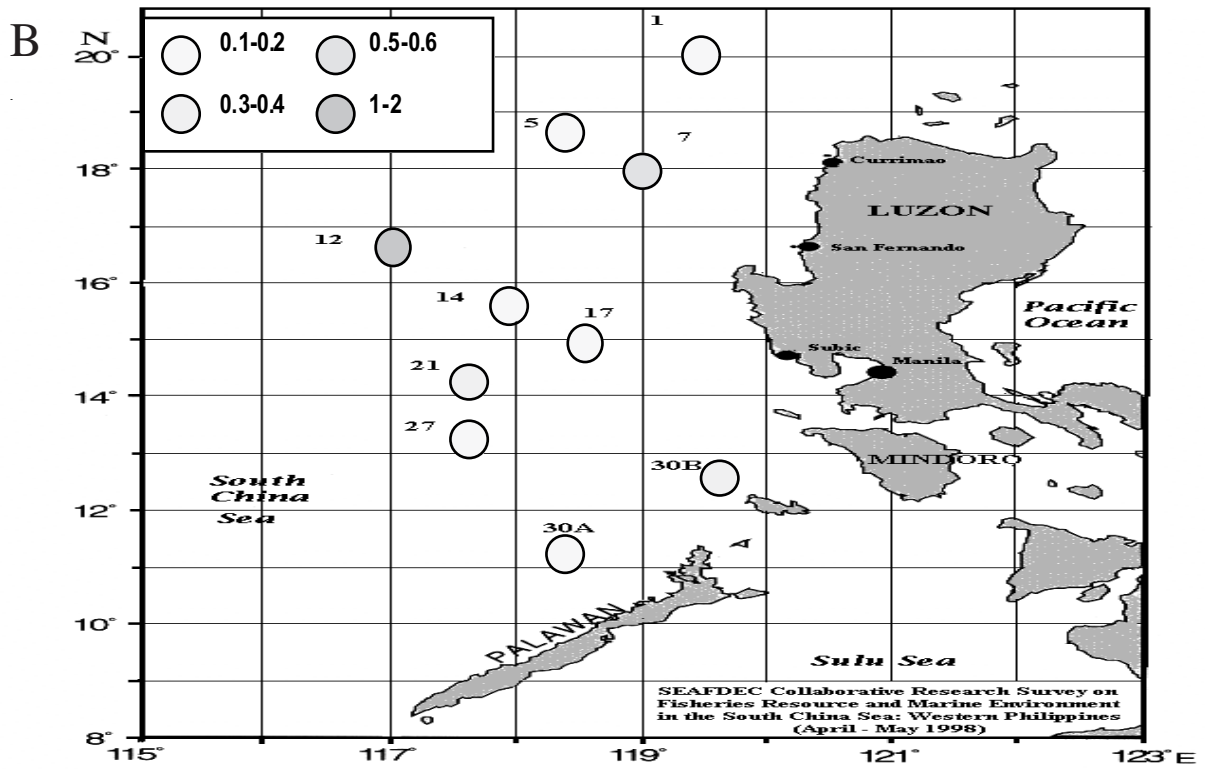
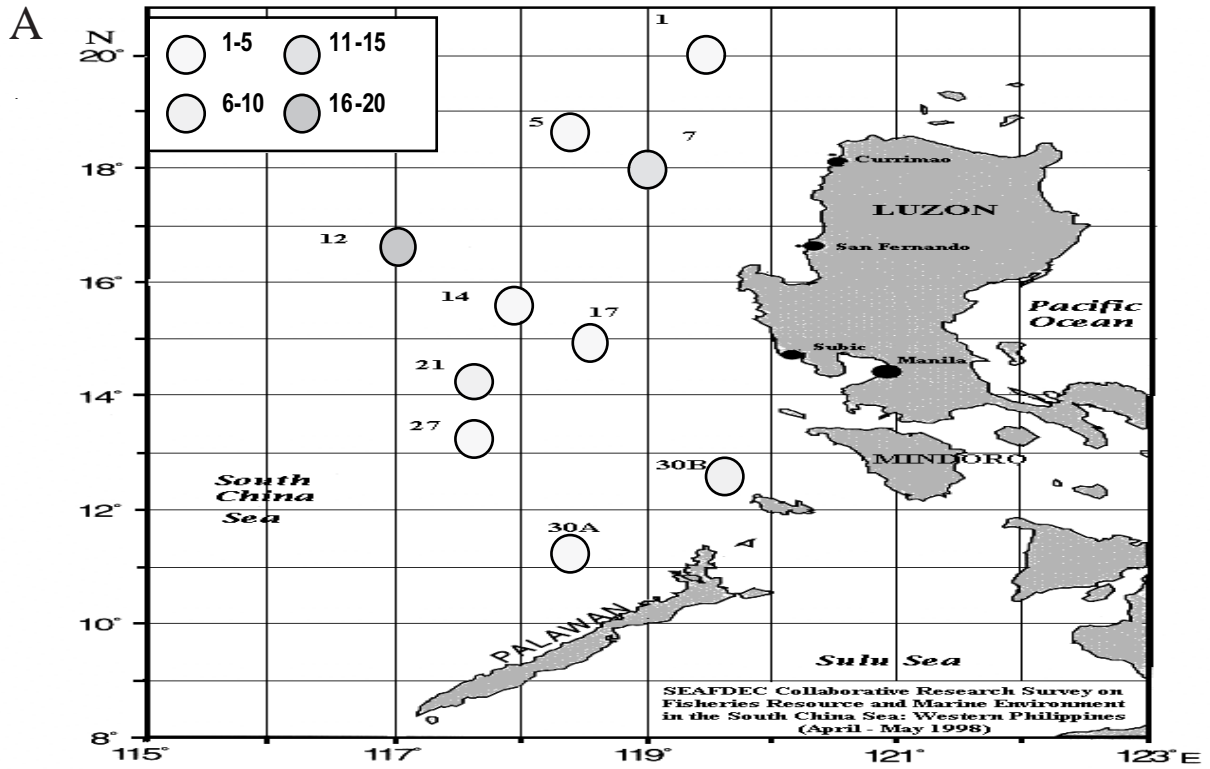


Fig.5. Catch-per-unit-effort (CPUE) of automatic jiggers for *S. oualaniensis*: A) ind/fishing hour, B) ind/jm/h.



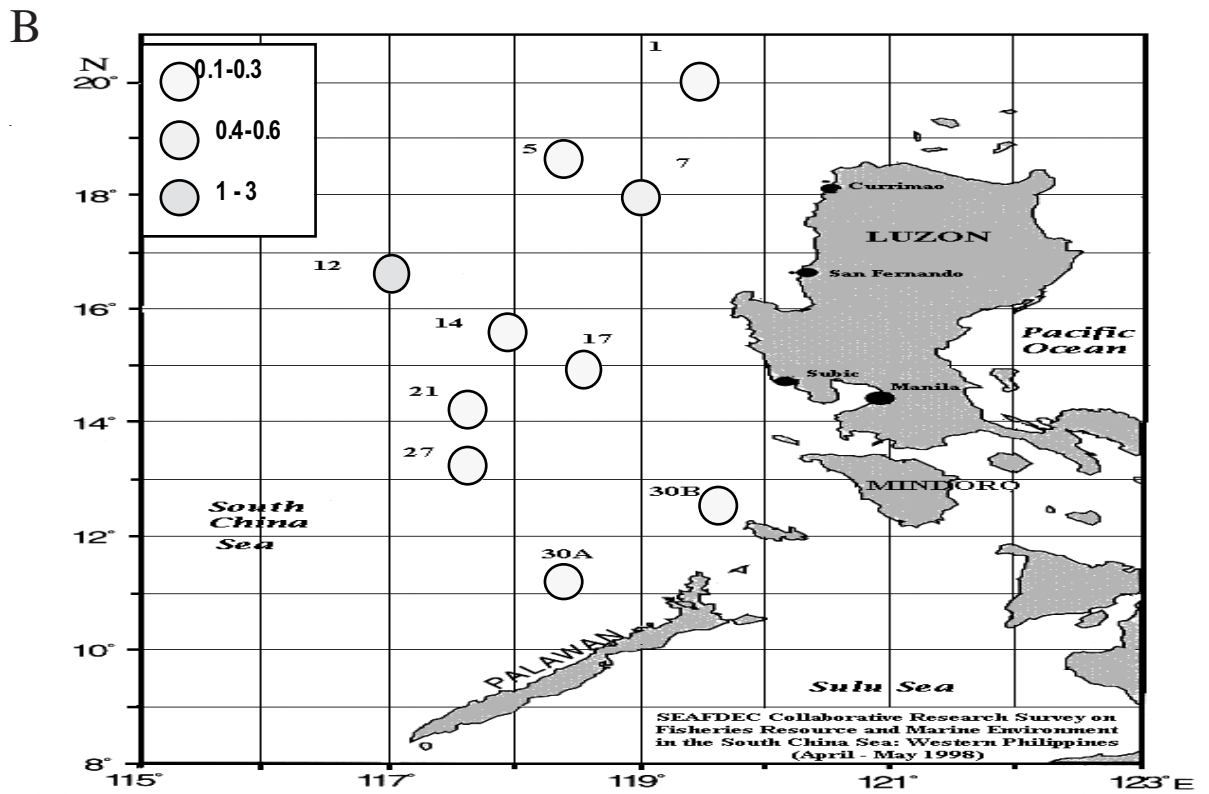
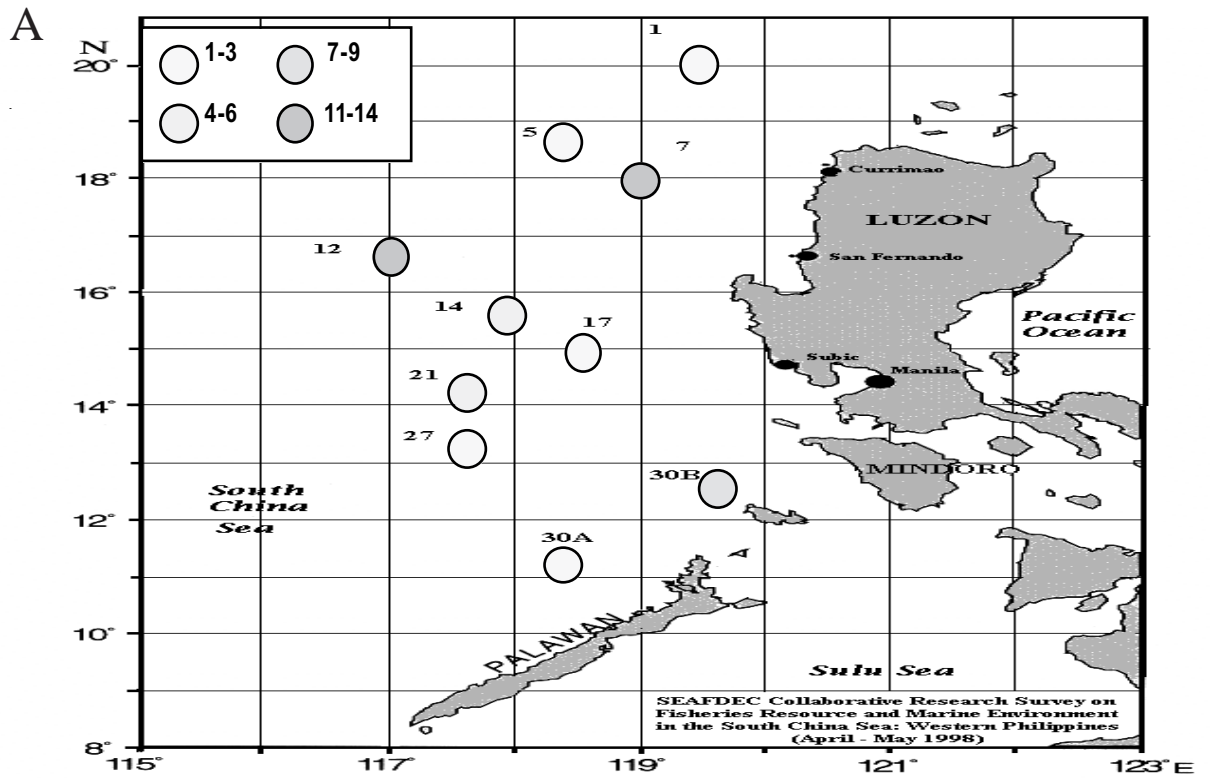


Fig. 6. CPUE of automatic jiggers for *S. oualaniensis*: A) ind/l/h , B) ind/j/h.

females dominated the males at about 1:5 ratio.

### **The dwarf form.**

The dwarf *S. oualaniensis* (9.8-12 cm ML; 35-100 g), although less abundant, were caught throughout the survey area representing 14% of the total catch. The 363 dwarf individuals weighed 15.6 kg or an average of 43 g/ind. Like the middle-sized form, the females were abundant accounting for 70% of the total catch. Catch rates at the stations ranged from 0.05 to 3 ind/l/h (3 – 111 g) or 0.002 to 0.1 ind/j/h (0.1 – 5 g) and average CPUE of 1 ind/l/h (37.4 g) or 0.04 ind/j/h (1.7 g). St. 12 was also the jigging station with the highest CPUE for the dwarf form (Fig. 7).

The catches showed high concentration of *S. oualaniensis* within the 80 to 130 m jigging depths and highest at 100 m where 51% of the total catch was obtained. This observation supports the findings of earlier studies on the diurnal vertical movements of the species. Nesis (1993) indicated that *S. oualaniensis* ascends to the surface at night and some of them remain dispersed in the 0 to 100 m layer. During daytime, the dwarf form descends not deeper than 150 to 200 m while the middle-sized form would probably occupy the depths of 200 to 400 m, most of them at 350 to 400 m. Roper and Young (1975) reported that the species appeared to be some 120 to 200 m deep in the daytime but move up to the surface and near surface layers at night.

### **Stock density of *S. oualaniensis*.**

During the entire squid fishing survey, M/V SEAFDEC covered a total drifting area of 601,678 m<sup>2</sup> and maximum jigging depth of 150 m (Table 2). Squid catches were obtained within water volume ranging from 2.713 x 10<sup>6</sup> to 1.934 x 10<sup>7</sup> cubic meter or an average of 8.96 x 10<sup>6</sup> cubic meter. Figure 8 shows the stock density at each jigging station, which averaged to 7.16 x 10<sup>-6</sup> kg/m<sup>3</sup> or 7,160 kg/km<sup>3</sup>. The highest densities were obtained at St. 7 with 2.64 kg x 10<sup>-5</sup> (26,357 kg/km<sup>3</sup>), St. 12 with 1.04 x 10<sup>-5</sup> (10,390 kg/km<sup>3</sup>) and St. 30B with 9.56 x 10<sup>-6</sup> (9,564 kg/km<sup>3</sup>).

If the SCS Area III covers a total area of 86,400 square nautical miles, approximately 44,000 km<sup>3</sup> can be assumed as fishing area for the purpleback flying squid *Sthenoteuthis oualaniensis*. By extrapolating the average stock density at the jigging stations and considering the mean weight of 0.155 kg, the biomass of squid in the SCS Area III is estimated at 319 thousand metric tons or 2.1 billion individuals within 0 to 150 m jigging depth. With this estimate, we can further assume a yield of 1.1 MT/km<sup>2</sup> or about 7,000 ind/km<sup>2</sup> from the survey area.

This study provides a glimpse into the population structure of the purpleback flying squid *Sthenoteuthis oualaniensis* (Lesson, 1830) in the South China Sea: west coast of the Philippines and its abundance based on the automatic jig catches. The findings, although preliminary, indicated the potential of *S. oualaniensis* for commercial fisheries. These data shall be correlated with the biological and ecological aspects of the species, which shall be discussed in detail in separate papers as part of the collaborative research survey. There is a need for more surveys to further understand the population dynamics and status of the species in this area for the sustainable utilization and management of this valuable resource.

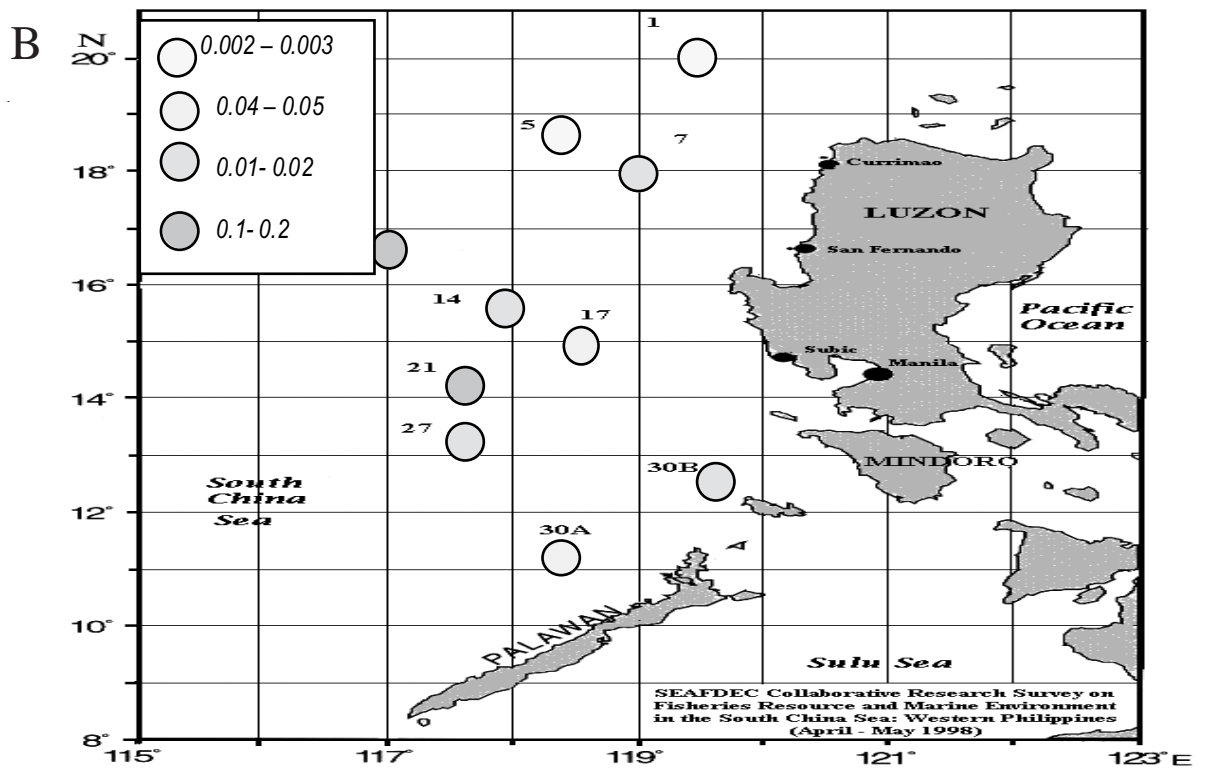
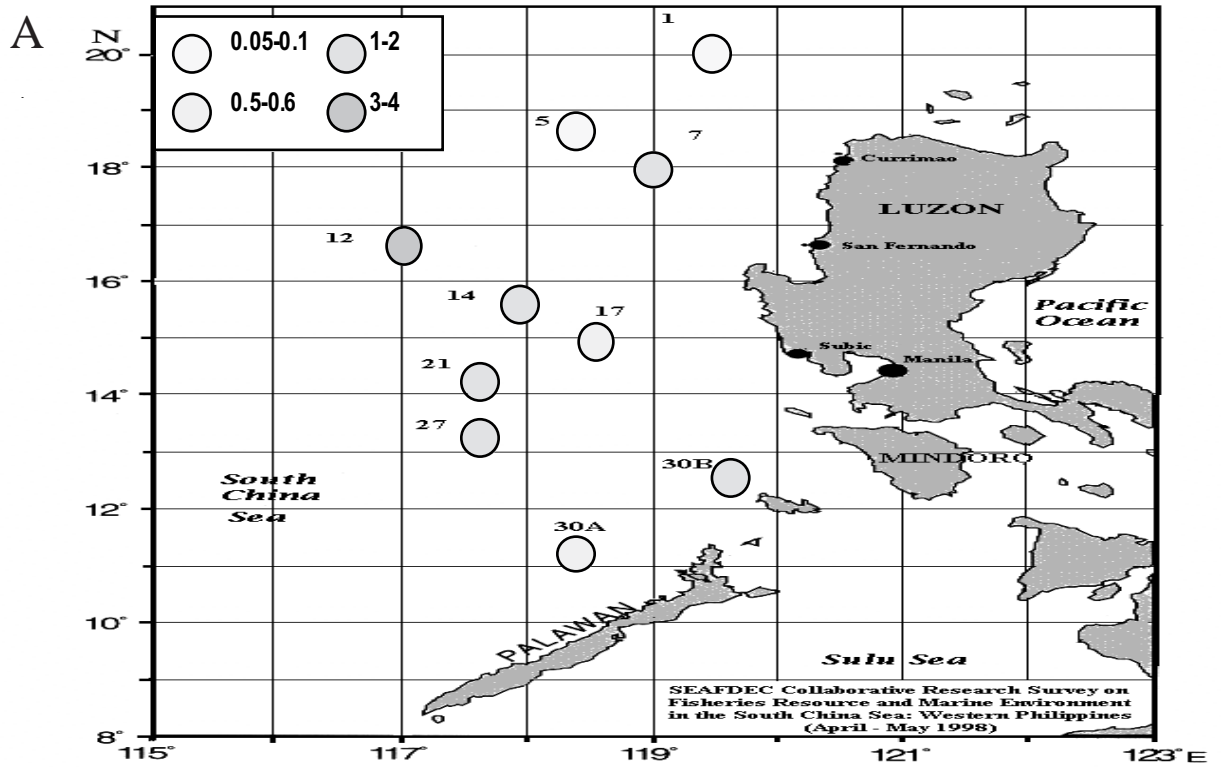


Fig. 7. CPUE for dwarf *S. oualaniensis*: A) ind/fishing hour B) ind/jm/h.

Table 2. Estimated density of *S. oualaniensis* at the jigging stations.

STATIONS	1	5	7	12	14	17	21	27	30B	Ave.
Distance drifted (m)	1343.1	7437	1043.4	4828.5	4861.8	3041.4	4084.4	1276.5	2890.4	
Length of jiggers (m)	20	20	20	20	20	20	20	20	15	
Max. jigging depth (m)	150	130	130	100	130	150	150	170	150	
Total weight (kg)	25.9	4.9	71.5	100.3	23	23.5	39.6	16.5	62.2	
Volume (V) = m <sup>3</sup>	$4.03 \times 10^6$	$1.934 \times 10^7$	$2.713 \times 10^6$	$9.7 \times 10^6$	$1.2641 \times 10^7$	$9.124 \times 10^6$	$1.225 \times 10^7$	$4.3401 \times 10^6$	$6.5034 \times 10^6$	
Density (J) = kg/m <sup>3</sup>	$6.43 \times 10^{-6}$	$2.53 \times 10^{-7}$	$2.64 \times 10^{-5}$	$1.04 \times 10^{-5}$	$1.82 \times 10^{-6}$	$2.58 \times 10^{-6}$	$3.23 \times 10^{-6}$	$3.8 \times 10^{-6}$	$9.56 \times 10^{-6}$	$7.16 \times 10^{-6}$
= kg/km <sup>3</sup>	6,433	253.4	26,357	10,390	1,819	2,576	3,232	3,802	9,564	7,160

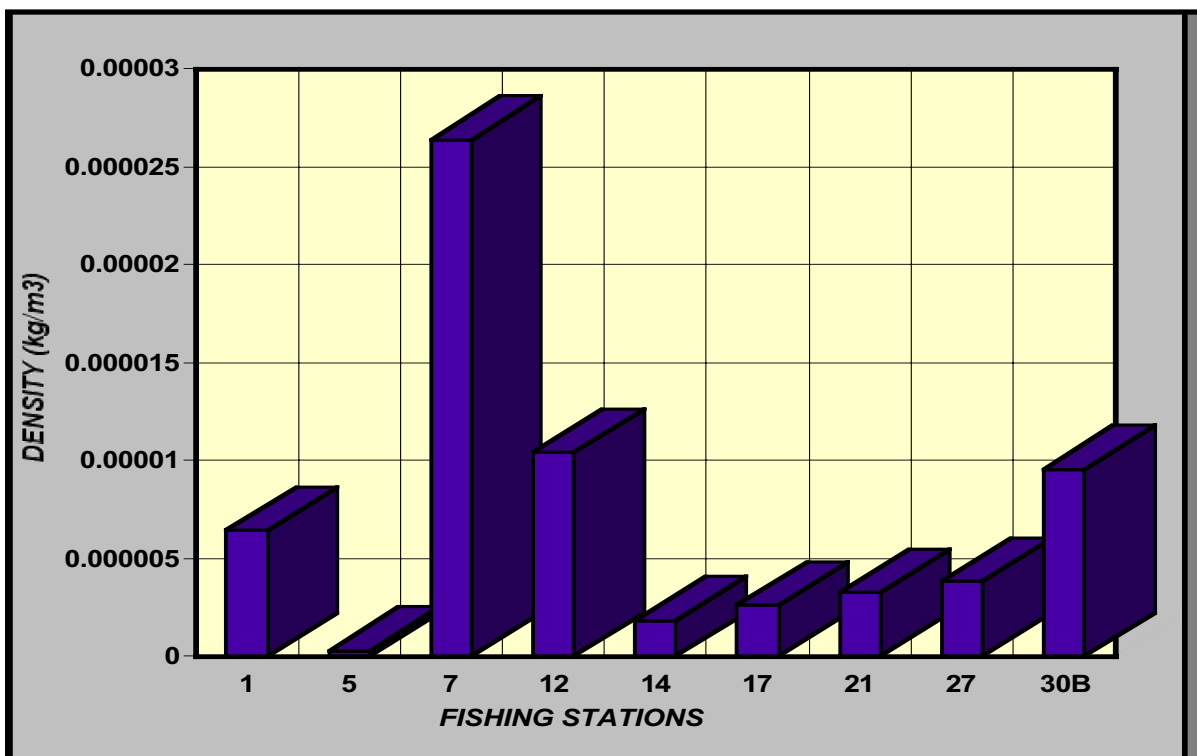


Fig. 8. Estimated stock density of *S. oualaniensis* at the jigging stations

### Acknowledgement

I thank the officers and crew of M/V SEAFDEC, our Technical Coordinator – Mr. Cielito L. Gonzales and my fellow researchers for their cooperation to make this cruise a success. I am grateful to the following cephalopod scientists: R. Young (Univ. of Hawaii), K. Nesis (Russian

Academy of Sciences) and W. Piatkowski (Univ. of Kiel) for their support by providing me their valuable publications. My special thanks to my colleague – Ms. Rosarie G. Arreza for assisting in the organization of raw data, my peer reviewer – Mr. Gerry Silvestre for his valuable comments and suggestions, our Division Chief – Mr. Jose A. Ordonez for giving me the opportunity to participate in this endeavor, and to my Section Chief and mentor – Ms. Corazon M. del Mundo for cultivating my interest to work on cephalopods.

### References

- Dickson, J.O. and R.V. Ramiscal. 1992. Test fishing using the giant squid jig in Calauag Bay and vicinities. DA-BFAR. (Unpublished)
- Nesis, K.N. 1993. Population structure of oceanic ommastrephids, with particular reference to *Sthenoteuthis oualaniensis*: A review, In: *Recent advances in cephalopod fisheries biology*. Ed. by T. Okutani, R.K. O'Dor and T. Kubodera. Tokai Univ. Press, Tokyo. 365-373.
- Piatkowski, U. and W. Welsch. 1991. On the distribution of pelagic cephalopods in the Arabian Sea. *Bull. Mar. Sci.*, 49 (1-2):186-198.
- Roper, C.F.E., M.J. Sweeney and C.E. Nauen. 1984. FAO species catalogue Volume 3: Cephalopods of the world; an annotated and illustrated catalogue of species of interest to fisheries. *FAO Fisheries Synopsis*, 125 (3), 277 p.
- Roper, C.F.E. and R.E. Young. 1975. Vertical distribution of pelagic cephalopods. *Smithsonian Contr. Zool.*, 209: 1-51.
- Yatsu, A., K. Kouichi, F. Kakizoe, *et al.* 1988. Distribution and biology of *Sthenoteuthis oualaniensis* in the Indian Ocean – preliminary results from the research cruise of the R/V Shoyo-Maru in 1995, In: *Contributed papers to International Symposium on Large Pelagic Squids*, July 18-19, 1996 for JAMARC's 25<sup>th</sup> anniversary foundation. Ed. by T. Okutani. *Japan Marine Resources Research Center*, Tokyo, 145-153.
- Young, R.E. and J. Hirota. 1998. Review of the ecology of *Sthenoteuthis oualaniensis* near the Hawaiian Archipelago, In: *Contributed papers to International Symposium on Large Pelagic Squids*, July 18-19, 1996 for JAMARC's 25<sup>th</sup> anniversary foundation. Ed. by T. Okutani. *Japan Marine Resources Research Center*, Tokyo, 131-143.