

SPECIES COMPOSITION, DISTRIBUTION, AND POTENTIAL YIELD OF DEEP SEA SHRIMP RESOURCES IN THE WESTERN SUMATERA OF THE INDIAN OCEAN EEZ OF INDONESIA WATERS

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ABSTRACT

Study on the catch composition, distribution and potential yield of deep sea shrimp in the western off Sumatera waters was conducted on June to July 2005 using RV Baruna Jaya IV with trawl net. This study was basically carried out by employing swept area method. The results show that the catch of shrimps were consisted of five families with 33 species and the catch of shrimp was dominated by *Heterocarpus* sp. around of 31% and stout red shrimp (*Aristeus virilis*) around of 24%. In general, distribution of deep sea shrimp resources found on the depth range of 200 to 1,000 m and species *Aristeus virilis* has a wide distribution in this area. Distribution of deep sea shrimp resources was higher on the depth of 750 to 1,000 m and lower on the depth of 200 to 500 m and distributed mostly at S-1 area (off Enggano Island) and rarely at S-5 area (off Aceh). Stock density of deep sea shrimp in this area fluctuated from 1,7 to 88,1 kg km⁻² with the mean of stock density was 22.0 kg km⁻². The biomass of deep sea shrimp in the west off Sumatera waters was estimated 217 ton with potential yield around of 109 ton/year.

KEYWORDS: species composition, distribution, potential yield, deep sea shrimp resources, Indian Ocean

INTRODUCTION

Shrimp production in Indonesia was mostly resulted from small scale fisheries. Generally fishing ground of the shrimp was only located around on shallow waters less than 100 m depth which occupied about 50% of Indonesian waters (Naamin, 1987). The production of shrimp in this area has already been in stagnant level due to the increase of fishing effort. In the recent estimation of shrimp production in the waters has been reached 268% of its (maximum sustainable yield) level (RCCF, 2003). This fact informed that the shrimp resource in this water was seriously in danger. Therefore, exploitation of shrimp resource in the waters should strongly be reduced in order to save the resources.

Study to find extended shrimp fishing ground is urgently needed to recover national shrimp production due to the limitation of shrimp exploitation in Indonesian waters below 100 m depth. Deep sea shrimp is one of new shrimp resources in Indonesian waters. This resource has not properly utilized yet due to huge area of Indonesian deep sea waters. Three type of research activities related to biology aspect, fishing ground, and stock abundance of the deep sea shrimp have been carried out in the Indian Ocean Indonesia especially in south of Java and western

of Sumatera. Naamin (1984) stated that information of new shrimp resource is very important to develop utilization of the shrimp stock. Furthermore Sumiono & Iskandar (1993) reported that some species of deep sea shrimps were found during Karubar expedition, conducted around of Kai, Aru, and Tanimbar waters. Another research in deep sea waters using Korean Research Vessels, Oh Dae San informed that *Solenocera prominentis* was caught around south of Java Island in the depth of 200 m (Anonymous, 1972). George (1967) also reported that some penaeid prawn that was found from the offshore of Bali waters, Flores Sea, Makassar Strait, Banda Sea, and Arafuru Sea.

This study discusses species composition, distribution, and stock density of the deep sea shrimp in the Indian Ocean especially in the waters western of Sumatera. The result of this study can hopefully be used as a fundamental information for further research and developing the deep sea shrimp utilization.

MATERIALS AND METHODS

The study was conducted in the Indian Ocean western of Sumatera as shown in Figure 1 and implemented in the frame work of the Deep Sea Fisheries Resources Joint Exploration Project

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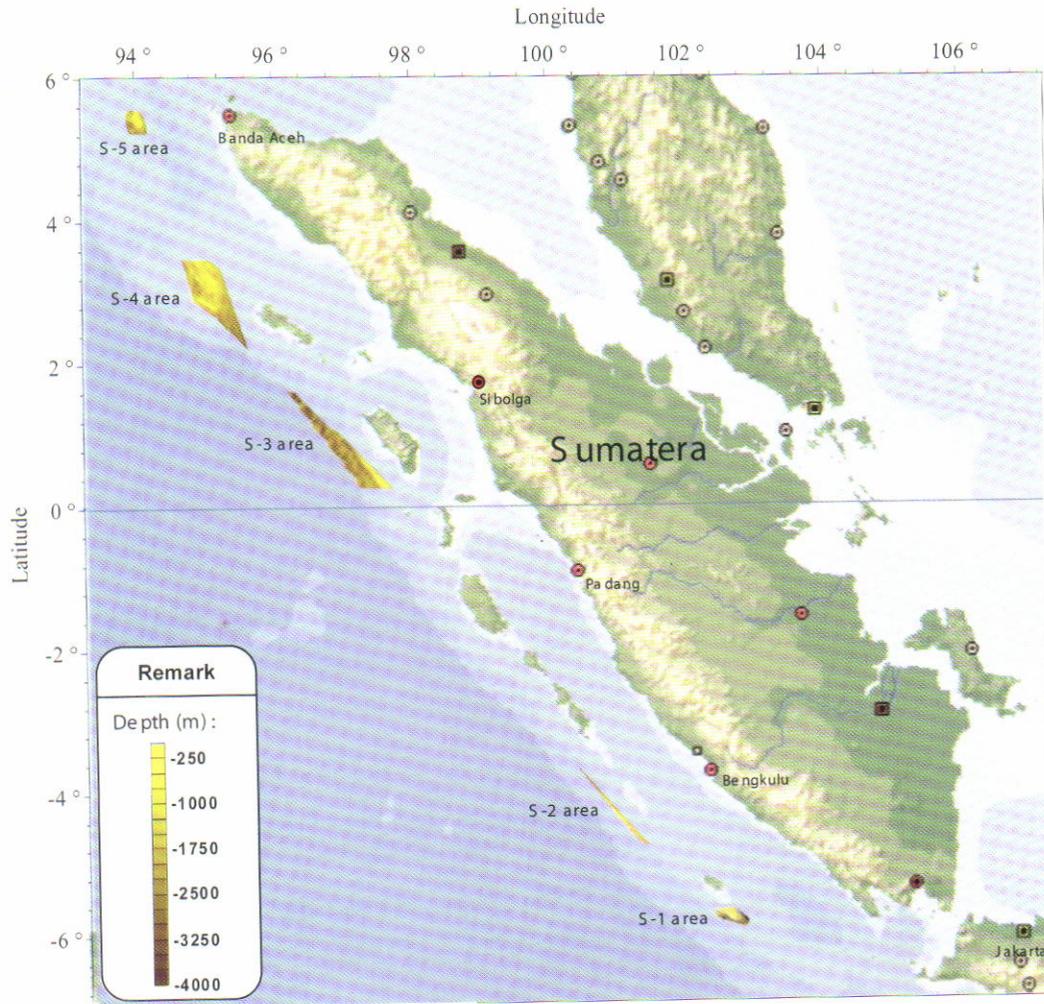


Figure 1. Map of Indian Ocean west off Sumatera showing location of survey area.

between Overseas Fishery Cooperation Foundation Japan and Agency of Marine and Fisheries Research; Indonesia. The period of this study was from June to July 2005.

The survey area in the waters west of Sumatera Island was divided into five sub areas along longitudinal line, for the sake of convenience for allocating trawl stations (Figure 1). Nevertheless, one of those areas (S-3 area, in the western part of Nias Island) was cancelled because of the absence of trawl suitable depth zone. Each sub area was stratified into three depth zones by the depth contours of 500 and 750 m according to the result of the survey in 2004 (Anonymous, 2005). The number of trawl stations based on area surveyed and depth stratified as illustrated in Table 1.

The research was conducted using Baruna Jaya IV (1,219 GT) by operating trawl net with head rope of 31.6 m in length (Anonymous, 2005). Species identification for deepsea shrimp was based on

King (1986); Holthuis (1991); Carpenter & Niem (1998).

For estimation of stock density was applied formula that introduced by Shindo (1973); Saeger *et al.* (1976); Sparre and Venema (1992) as follow:

$$a = V \cdot t \cdot h \cdot X^2$$

$$Q = Cw/a \text{ (kg km}^{-2}\text{)}$$

$$B = \text{average } Q/0.5 \text{ (kg km}^{-2}\text{)}$$

$$Py = 0.5 B$$

where:

- a = area swept by the trawl square of sweep area (mil²)
- V = vessel Speed (knot)
- t = towing time (hour)
- h = length of heap rope (m)
- X² = constant (0.67)
- Q = catch per area (kg km⁻²)
- Cw = catch rate (kg per hour)
- B = stock density (kg km⁻²)
- Py = potential yield (kg)

Table 1. Survey areas and allocated trawl stations for fish stock assessment in west off Sumatera waters

| Area code | Area (km ²) | | | | Number of trawl stations | | | |
|-----------------------|-------------------------|-----------------|-----------------|-----------------|--------------------------|-----------|------------|-----------|
| | 200-500m | 500-750m | 750-1,000m | Sub total | 200-500m | 500-750m | 750-1,000m | Total |
| Sumatera | | | | | | | | |
| S-1 area | 308.24 | 309.76 | 414.96 | 1,032.96 | 3 | 3 | 4 | 10 |
| S-2 area | 0.00 | 18.37 | 98.31 | 116.68 | 0 | 2 | 2 | 4 |
| S-4 area | 218.70 | 1,871.97 | 2,429.85 | 4,520.51 | 1 | 12 | 12 | 25 |
| S-5 area | 341.72 | 510.00 | 602.46 | 1,454.18 | 3 | 4 | 4 | 11 |
| Sumatera total | 868.66 | 2,710.09 | 3,545.57 | 7,124.32 | 7 | 21 | 22 | 50 |

RESULTS AND DISCUSSION

Species Composition of Deep Sea Shrimp

Total catch of deepsea shrimp during survey in the western of Sumatera waters recorded 29.88 kg which consisted of 33 species, was dominated by

Heterocarpus sp. (30.75%) and *Aristeus virilis* (23.79%) as presented in Table 2. That also shows that some commercially species were found in this area as *Aristeus virilis*, *Plesiopenaeus edwardsianus*, *Heterocarpus* spp., and *Plesionika* spp., as shown in Appendix 1. Those species have been exploited by commercial fishing industries in

Table 2. Catch composition of deep sea shrimp in Indian Ocean west off Sumatera

| Species | Percentage (%) |
|-----------------------------------|----------------|
| <i>Aristaeomorpha foliacea</i> | 0.93 |
| <i>Aristeus virilis</i> | 23.79 |
| <i>Plesiopenaeus edwardsianus</i> | 10.68 |
| <i>Nephrops stewartii</i> | 0.28 |
| <i>Puerulus angulatus</i> | 0.27 |
| <i>Acanthephyra armata</i> | 8.18 |
| <i>Acanthephyra</i> sp. | 0.52 |
| <i>Eugonatonotus</i> sp. | 0.05 |
| <i>Heterocarpus dorsalis</i> | 0.04 |
| <i>Heterocarpus ensifer</i> | 0.27 |
| <i>Heterocarpus laevigatus</i> | 3.65 |
| <i>Heterocarpus parvispina</i> | 0.42 |
| <i>Heterocarpus</i> sp. | 30.75 |
| <i>Heterocarpus</i> sp.1 | 0.38 |
| <i>Heterocarpus</i> sp. 2 | 0.64 |
| <i>Heterocarpus</i> sp. 3 | 1.42 |
| <i>Parapandalus seratifrons</i> | 0.54 |
| <i>Periclimenes</i> sp. | 0.06 |
| <i>Plesionika ensis</i> | 3.66 |
| <i>Plesionika longirostris</i> | 0.61 |
| <i>Plesionika martia</i> | 1.78 |
| <i>Plesionika</i> sp. | 0.1 |
| <i>Stylodactylus stebbingi</i> | 0.2 |
| <i>Stylodactylus</i> sp. | 0.03 |
| <i>Parapenaeopsis</i> sp. | 0.03 |
| <i>Penaeopsis eduardoi</i> | 0.51 |
| <i>Acetes</i> sp. | 3.94 |
| <i>Acetes</i> sp. 1 | 1.19 |
| <i>Sergestes</i> sp. | 1.07 |
| <i>Sergestes</i> sp. 1 | 0.96 |
| <i>Solenocera alfonso</i> | 1.29 |
| <i>Solenocera</i> sp. | 1.49 |
| <i>Solenocera</i> sp. 1 | 0.26 |

West Australia waters since 20 years ago (Wallner & Phillips, 1988).

A research conducted in Kai, Aru, and Tanimbar Islands waters also found the same species very abundant that reported around 75% from total shrimp catch (Sumiono & Soselisa, 1993). The similar result was also reported during research in deep sea of Pacific and Indian Oceans where Caridea was dominantly catch (Holthuis, 1980; King, 1986).

During this study some dominant species was also included. The carapace length of deep sea shrimp in west of Sumatera waters ranged from 11.0 to 84.5 mm (Table 3). This fact indicated that shrimp stock in this area consisted of several cohort. There was no relationship between the water depth of fishing ground with size of deep sea shrimp.

Distribution of Deep Sea Shrimp

Table 4 presents distribution and occurrence of deep sea shrimp in west Sumatera waters from 50 trawl stations. The high percentage of occurrence of the catch were *Aristeus virilis* (86%) followed by *Acanthephyra armata* (76%) and *Heterocarpus* sp. (76%). Distribution of the those species in west of Sumatera waters was very wide. This phenomenon was quite similar with those reported by Sumiono & Soselisa (1993) in Kai, Aru, and Tanimbar Islands waters. In contrast the least percentage of occurrence was occupied by group of deep sea scampi such as *Nephropsis stewarti* and *Puerulus angulatus*. This fact that might be caused by small number of trawl stations was carried out around coral waters as original fishing ground of these species (Carpenter & Niem, 1998).

Distribution of deep sea shrimp has a relation with waters depth of fishing ground. Each species occupies and overlaps in certain the depth ranged, they usually like to live in sandy waters while family

of Caridea tends to habit in coral waters (King, 1986). In general, the deep sea shrimps distribute in water depth of 200 to 1,000 m except for scampi (*Nephropsis stewarti*, *Puerulus angulatus*) which dwelling in depth below 300 m (Table 4). All of penaeid shrimp (family Penaeidae and Aristeidae) could be found in all range of water depth from 200 to 1000 m.

Table 4 also shows that family Sergestidae did not distribute in all depth range. They were not found in depth of 200 to 500 m. While scampi shrimp family Nephropidae and Palinuridae were only found in this area on the depth of 200 to 500 m. This might be due to their habitat in coral waters whereas in west of Sumatera waters, the depth of this fishing ground was 200 to 500 m. In the western Australian waters it was found the commercial deep sea shrimp that mostly distributed in the depth of 400 to 500 m. This resource had already been exploited commercially by trawl net (Wadley & Morris, 1991). Sumiono & Soselisa (1993) pointed out that the distribution of Penaeid shrimp (Aristeidae and Pandalidae) was at the depth of 200 to 1000 m while scampi shrimp was only caught in the depth of 300 to 500 m. Distribution of scampi was quite similar pattern with result of research done in north and west of Australian waters (Wallner & Phillips, 1988; Davis & Ward, 1984).

For all species, the highest density of deep sea shrimp resources was recorded in the depth of 750 to 1,000 m while the smallest density occurred in the depth of 300 to 500 m as illustrated in Figure 2. It could be concluded that the best fishing ground of deep sea shrimp resources in west of Sumatera waters was located in the depth of 750 to 1,000 m.

Stock Density and Potential Yield

Information of stock density, biomass, and potency is needed to arrange development and planning for utilization in fisheries. Table 5 shows

Table 3. Range of carapace length for deep water shrimp in west of Sumatera waters

| Jenis (Species) | Carapace length range (mm) |
|-----------------------------------|----------------------------|
| <i>Aristaemomorpha foliacea</i> | 26.0–42.0 |
| <i>Aristeus virilis</i> | 22.0–54.1 |
| <i>Plesiopenaeus edwardsianus</i> | 25.9–84.5 |
| <i>Acanthephyra armata</i> | 15.6–27.0 |
| <i>Heterocarpus</i> sp. | 19.0–45.5 |
| <i>Heterocarpus ensifer</i> | 16.0–20.5 |
| <i>Heterocarpus laevigatus</i> | 21.2–65.0 |
| <i>Plesionika longirostris</i> | 19.7–29.5 |
| <i>Plesionika martia</i> | 11.0–23.0 |

Table 4. Distribution and occurrence (%) of deep sea shrimp caught in the Sumatera waters of western Indian Ocean

| Species/Family | Depth (m) | | | Occurrence (%) |
|-----------------------------------|-----------|---------|-----------|----------------|
| | 200-500 | 500-750 | 750-1,000 | |
| Aristeidae | | | | |
| <i>Aristeomorpha foliacea</i> | xxxx | xxxx | xxxx | 10 |
| <i>Aristeu virillis</i> | xxxx | xxxx | xxxx | 86 |
| <i>Plesiopenaeus edwardsianus</i> | xxxx | xxxx | xxxx | 22 |
| Nephropidae | | | | |
| <i>Nephropsis stewarti</i> | -- | xxxx | -- | 2 |
| Palinuridae | | | | |
| <i>Puerulus angulatus</i> | xxx | -- | -- | 4 |
| Pandalidae | | | | |
| <i>Acanthephyra armata</i> | -- | xxxx | xxxx | 76 |
| <i>Acanthephyra</i> sp. | -- | xxxx | xxxx | 8 |
| <i>Eugonatonotus</i> sp. | -- | xxxx | -- | 2 |
| <i>Heterocarpus dorsalis</i> | -- | -- | xxxx | 2 |
| <i>Heterocarpus ensifer</i> | xxxx | -- | xxxx | 4 |
| <i>Heterocarpus laevigatus</i> | xxxx | xxxx | xxxx | 28 |
| <i>Heterocarpus parvispina</i> | xxxx | xxxx | xxxx | 2 |
| <i>Heterocarpus</i> sp. | xxxx | -- | xxxx | 76 |
| <i>Heterocarpus</i> sp.1 | xxxx | xxxx | xxxx | 4 |
| <i>Heterocarpus</i> sp.2 | -- | xxxx | xxxx | 32 |
| <i>Heterocarpus</i> sp.3 | -- | xxxx | xxxx | 22 |
| <i>Parapandalus serratifrons</i> | -- | xxxx | xxxx | 10 |
| <i>Periclimenes</i> sp. | -- | xxxx | xxxx | 4 |
| <i>Plesionika ensis</i> | xxxx | xxxx | xxxx | 54 |
| <i>Plesionika longirostris</i> | xxxx | xxx | xxxx | 10 |
| <i>Plesionika martia</i> | xxxx | xxxx | xxxx | 18 |
| <i>Plesionika</i> sp. | -- | xxxx | -- | 2 |
| <i>Stylodactylus stebbingi</i> | xxxx | -- | -- | 2 |
| <i>Stylodactylus</i> sp. | -- | xxxx | -- | 2 |
| Penaeidae | | | | |
| <i>Parapenaeopsis</i> sp. | -- | xxxx | -- | 2 |
| <i>Penaeopsisedwardoi</i> | xxxx | xxxx | -- | 10 |
| Sergestidae | | | | |
| <i>Acetes</i> sp. | -- | xxxx | xxxx | 66 |
| <i>Acetes</i> sp.1. | -- | xxxx | xxxx | 22 |
| <i>Sergestes</i> sp. | -- | xxxx | xxxx | 42 |
| <i>Sergestes</i> sp.1 | -- | xxxx | xxxx | 30 |
| Solenoceridae | | | | |
| <i>Solenocera alfonso</i> | -- | xxxx | xxxx | 34 |
| <i>Solenocera</i> sp. | xxxx | xxxx | xxxx | 24 |
| <i>Solenocera</i> sp.1 | -- | xxxx | xxxx | 8 |

Remarks: -- = not found; xxxx = found

stock density of deep sea shrimp in west Sumatera waters from 50 trawl stations.

Table 5 indicates that stock density of deep sea shrimp in west Sumatera waters was fluctuated from 1.6 to 90.38.5 kg km⁻² with averaged of 19.8 kg km⁻². The lowest density was obtained in station 17 located in around off Simeulu Island waters, Aceh Province and the highest one was recorded at station 2 in around of Enggano Island waters.

According to spatial stock distribution, it could be stated that south area of west Sumatera waters such as around off Enggano Island (S-1 area) and west off Bengkulu (S-2 area) had higher stock density than north area such as around off Simeulu Island (S-4 area) and west off Aceh waters (S-5 area). In general, stock density in this area was higher than that of in the southern of Irian Jaya waters with stock density around of 7.9 kg km⁻² (Suman et al., 1993).

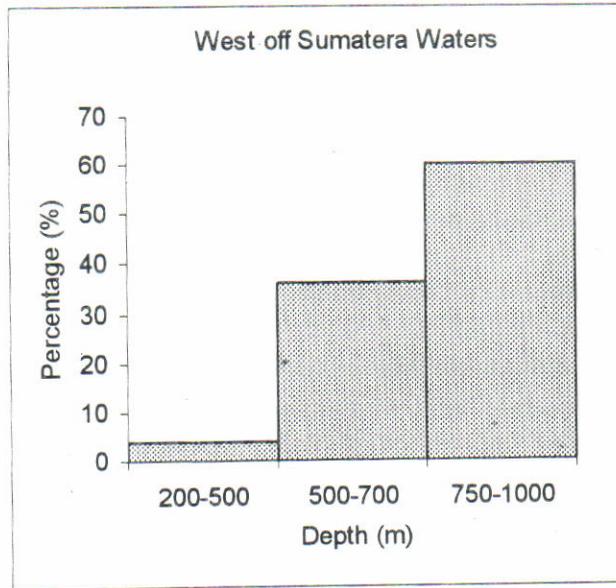


Figure 2. Distribution of deep sea shrimps in the Western Indian Ocean EEZ off Sumatera according to the depth of waters.

Table 5. Stock density of deep sea shrimp (kg km⁻²) in the Indian Ocean west off Sumatera by area

| Area | No.Station | Stock density (kg/km ²) |
|--|------------|-------------------------------------|
| S-1 area (Around off Enggano Island Waters) | 1 | 26.89 |
| | 2 | 90.38 |
| | 3 | 11.06 |
| | 4 | 20.90 |
| | 5 | 24.20 |
| | 6 | 6.16 |
| | 7 | 8.33 |
| | 8 | 47.25 |
| | 9 | 65.09 |
| | 10 | 18.45 |
| S-2 area (Around off Bengkulu Waters) | 11 | 10.99 |
| | 12 | 13.62 |
| | 13 | 15.15 |
| | 14 | 17.67 |
| S-4 area (Around off Simeulu Island Waters) | 15 | 13.28 |
| | 16 | 20.09 |
| | 17 | 1.60 |
| | 18 | 46.37 |
| | 19 | 15.35 |
| | 20 | 15.42 |
| | 21 | 41.77 |
| | 22 | 5.58 |
| | 23 | 38.47 |
| | 24 | 14.47 |
| | 25 | 15.29 |
| | 26 | 16.55 |
| | 27 | 10.04 |
| | 28 | 11.58 |
| | 29 | 14.78 |
| | 30 | 13.00 |
| | 31 | 33.87 |

Table 5. Countinous

| Area | No.Station | Stock density (kg/km ²) |
|--------------------------------------|----------------|-------------------------------------|
| S-5 area (Around off Aceh Waters) | 32 | 7.83 |
| | 33 | 15.66 |
| | 34 | 34.32 |
| | 35 | 12.90 |
| | 36 | 28.36 |
| | 37 | 23.15 |
| | 38 | 24.82 |
| | 39 | 16.78 |
| | 40 | 16.34 |
| | 41 | 3.47 |
| | 42 | 14.23 |
| | 43 | 11.54 |
| | 44 | 0 |
| | 45 | 20.94 |
| | 46 | 4.59 |
| | 47 | 1.70 |
| | 48 | 30.81 |
| | 49 | 29.55 |
| | 50 | 18.79 |
| | Average | 20.34 |

Based on 50 research stations, average of stock density was 20.34 kg km⁻² in the total area estimated 7,124.32 km². It could be predicted that total biomass of deep sea shrimp in west off Sumatera waters was 145 ton. Because of no fishing effort exploited this resources in this area, potency of deep sea shrimp stock in west Sumatera waters would be a half of total biomass (Gulland, 1983), so the potency of deep sea shrimp in this area was estimated 73 ton. Identification in each area shows that the highest potency was recorded in S-1 area (around off Enggano Island), it could be stated that in this area might be the most suitable area for development of the deep sea shrimp exploitation in west off Sumatera waters.

CONCLUSION

1. The deep sea shrimps caught in EEZI area of west Sumatera waters consisted of 33 species that were dominated by *Heterocarpus* sp. recorded 30.75%. Most of them categorized as commercially species.
2. The deep sea shrimp could be found in the depth of 200 to 1000 m with the highest density found in the depth of 500 to 750 m, and the widest area distribution was stout red shrimp (*Aristeus virilis*) about 86%.
3. Area S-1 around off Enggano Islands waters and area S-2 west off Bengkulu waters had higher stock density compared with those of

around area S-4 off Simeulue waters and area S-5 west off Aceh waters.

4. Potential yield of deep sea shrimp in west Sumatera of Indian Ocean EEZI waters was estimated about 73 ton per year and the most suitable area for exploitation of deep sea shrimp found in S-1 area (around off Enggano Island waters).

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Appendix 1. Photo of some dominant species of deep sea shrimps in the Indian Ocean of west off Sumatera



