

## Fisheries on *Mesopodopsis* (Mysida: Mysidae) and *Acetes* (Decapoda: Sergestidae) in Indonesia

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### Abstract

Edible crustaceans belonging to mysids and *Acetes* have been studied in Indonesia based on field samplings at fishing grounds and buying materials. Interview surveys were also conducted at public offices and processing industries. Various fishing gears were employed by fishermen to catch these crustaceans. *Acetes* was caught throughout the year, but the peak fishing season varied depending on the fishing grounds and the alternation of monsoons. There is no exact information regarding the peak season of mysids, but they were available in brackish and salt ponds throughout the year. Best fishing time for mysids and *Acetes* was during darkness. The catches and values of a mixture of mysids and *Acetes* ("rebon") were fluctuating year-by-year and there was a greater annual catch in the sea than in brackish ponds. The catch of "rebon" in Madura was the highest among all locations surveyed, which was about 4 tons/day with the value of Indonesian Rupiah (IDR) 15,300,000 (about US\$1,700)/ton in the peak fishing season from February to March. The important species of mysid were *Mesopodopsis orientalis* and *M. tenuipes*, and of *Acetes* were *A. indicus*, *A. serrulatus*, *A. erythraeus*, *A. sibogae sibogae*, *A. japonicus*, and *A. vulgaris*. They were all used for making shrimp paste, the so called "terasi". The price at market for "rebon" and "terasi" varied depending on the quality of the product and the locality. Dried and fresh "rebon" were sold for IDR 5,000 to 15,000/kg, whereas "terasi" was sold at IDR 3,000 - 40,000/kg.

**Key words:** Mysids, *Acetes*, Fisheries, Indonesia

### Introduction

Pelagic crustaceans such as mysids and *Acetes* are important organisms in coastal and estuarine food webs and for humans as food, in particular in Asian countries (Omori, 1975, 1978; Mauchline, 1980). For example, the following species of mysids are harvested as food for humans or live food for cultured aquatic organisms in these areas such as Japan: *Neomysis awatschensis*, *N. japonica*, *Acanthomysis mitsukurii* (Murano, 1963; Mauchline, 1980; Toda *et al.*, 1982; Hanamura, 2001) and India: *Mesopodopsis orientalis*, *M. zeylanica*, *Gangemysis assimilis* (Jadhav and Josekutty, 2003; Mauchline, 1980; Paul and Josekutty, 2005). The annual catch of *N. awatschensis* in the Lake Kasumigaura, eastern Japan, during 1954–1980, reached up to 2,000

metric tons in wet weight and was composed of 10–20% of the total fisheries landings from that lake (Toda *et al.*, 1982). In Mumbai, India, the fishery of *Mesopodopsis orientalis* is lucrative and regularly conducted by local fishermen, and the overall catch reached 1250 kg/month in 2004 (Paul and Josekutty, 2005).

The pelagic shrimp *Acetes* has also been commercially harvested in Asian countries such as in China, Korea, Japan, Vietnam, Indonesia, Thailand, Malaysia and India for over 200 years (Koba, 1941; Omori, 1975; Xiao and Greenwood, 1993). The following eight species are captured on fishery grounds in Asia: *Acetes chinensis*, *A. japonicus*, *A. indicus*, *A. erythraeus*, *A. serrulatus*, *A. intermedius*, *A. sibogae sibogae*, and *A. vulgaris* (Omori, 1975). According to Omori (1975), seven of the *Acetes* species, other than *A. chinensis*, are distributed in Indonesia. Omori (1975) confirmed that *A. intermedius* and *A. vulgaris* were seen on markets in Jakarta and

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Pelabuhan Ratu, Indonesia. Although the annual catch of *Acetes* was not addressed in Indonesia, the world catch of *Acetes* was recorded to be at least 170,000 tons per year (Omori, 1975).

In Indonesia, fisheries of mysids and *Acetes* have been intensively continued since 1930s (Djajadiredja and Sachlan, 1956; Omori, 1975). Locally fresh or dried mysids and *Acetes* are called “jembret” and “rebon”, respectively. Both “jembret” and “rebon” are processed for making fermented shrimp paste called “terasi”. This product is commercially important in Indonesia to make chili sauce (= “sambal terasi” in Indonesian) or flavor cooking. “Rebon” is also utilized to make shrimp sauce (= “petis”).

The purpose of this study is to get detailed information about fisheries of the mysid *Mesopodopsis* and the shrimp *Acetes* in Indonesia, because the current status of these fisheries has never been addressed since the contribution of Omori (1975). In addition, we would like the Indonesian Government to provide the fisheries statistics of these crustaceans in consideration of the economic importance. This paper deals with the current fisheries status of these organisms such as target species at each locality, kinds of gears employed by fishermen, the amount of catches, and the processing to make shrimp paste “terasi” on the basis of our field samplings and interview assessments as well as fisheries statistics of the

Ministry of Marine Affairs and Fishery, Indonesia.

## Materials and methods

### Sampling

To find out the fishery species of mysids and *Acetes* in Indonesia and species composition in shrimp paste “terasi”, samples were obtained either by field sampling or by buying fresh and dried materials and shrimp paste “terasi” at various local markets in Indonesia. Field samplings were carried out by fishermen in December 2008, June and July 2009, and June and July 2010 at fishing grounds in the mouth of rivers, seashores, shallow water, brackish and salt culture ponds, and lakes across Indonesia (Fig. 1, Table 1). Additional samples examined were provided by local fishermen during other fishing seasons.

Fresh samples were fixed with 70% ethanol immediately after capture. In the laboratory, mysids and *Acetes* were identified to species level using a dissecting microscope (Olympus SZ60), following the identification keys of Hanamura *et al.* (2008) and Omori (1975), respectively. Surface water temperatures and salinity were simultaneously recorded at some collection sites with a salinometer (YSI Model 556 MPS).

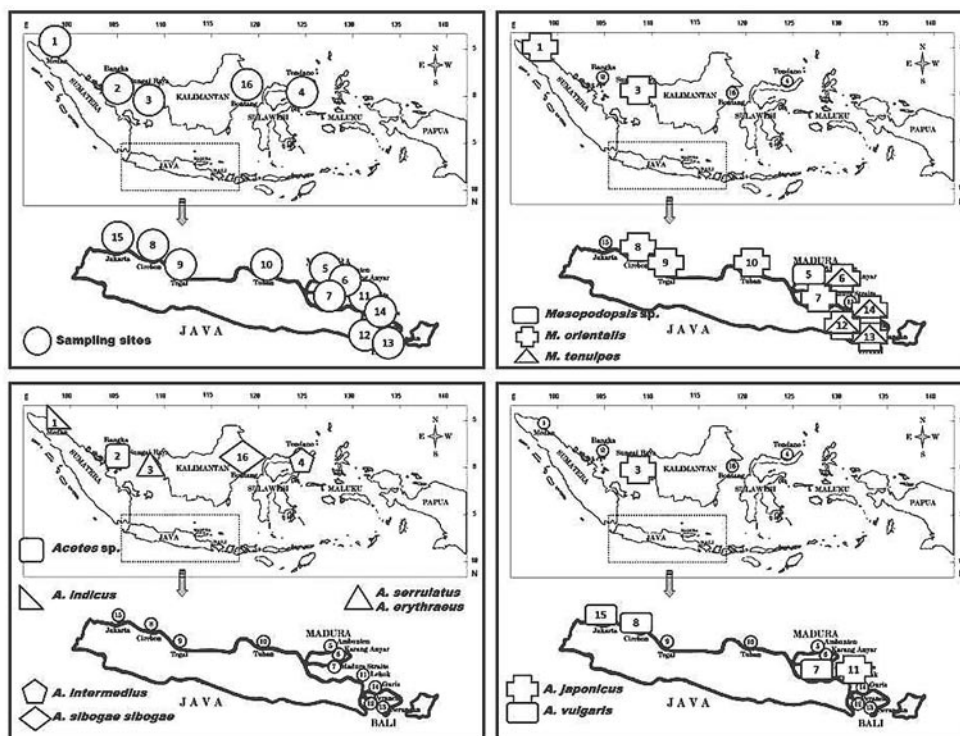


Fig. 1. Map of study area and fishery sites for mysid *Mesopodopsis* and shrimp *Acetes* in Indonesia (see Table 1).

**Table 1. Sampling sites and species of mysid *Mesopodopsis* and shrimp *Acetes* in Indonesia. Abbreviation: A, *Acetes*; M, *Mesopodopsis*.**

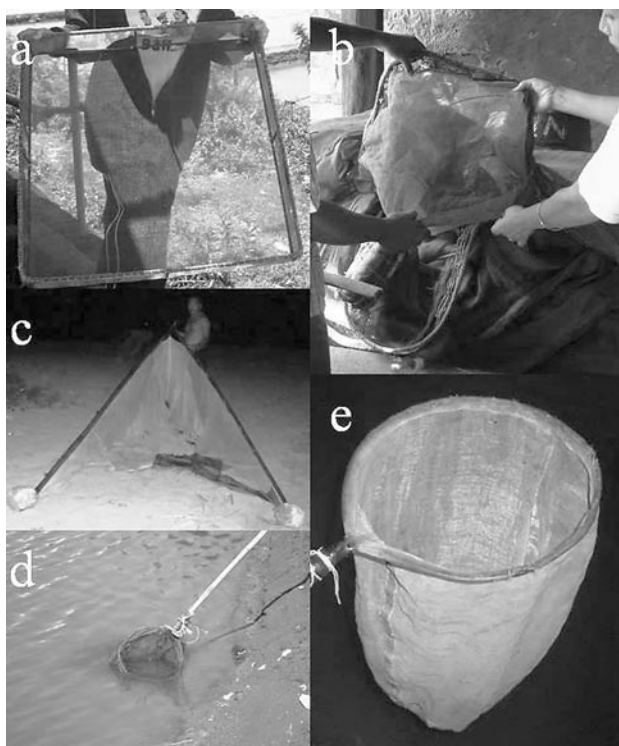
Sta.	Locality	Date/Time	Remarks	Temp. °C	Sal.	Species	Type of sample
1	Medan, Sumatera Is. 03°40.000' N 98°38.000' E	July 2010 Daytime	Market	-	-	<i>A. indicus</i> <i>M. orientalis</i>	Dried materials
2	Bangka, Bangka-Belitung Is. 02°00.000' S 105°50.000' E	June 2009 Daytime	Market	-	-	<i>Acetes</i> sp.	Shrimp paste
3	Sungai Raya, Kalimantan Is. 00°42.448' N 108°52.260' E	08 July 2010 04:00	Mouth of river (sandy and muddy bottom)	28.0	18.0	<i>A. japonicus</i> <i>A. serrulatus</i> <i>A. erythraeus</i> <i>M. orientalis</i>	Fresh materials
4	Tondano, Sulawesi Is. 01°35.000' N 124°54.000' E	20 December 2008 04:00	Lake (4,278 ha) Market	23.4	0.3	<i>A. intermedius</i>	Fresh & dried materials
5	Ambunten, Madura Is. 07°30.000' S 114°00.000' E	05 July 2010 Daytime	Processing factory	-	-	<i>Mesopodopsis</i> sp.	Shrimp paste
6	Karanganyar, Madura Is. 07°38.000' S 113°37.000' E	12 July 2010 07:00	Salt pond (1 ha) Market	27.3	25.1	<i>M. orientalis</i> <i>M. tenuipes</i>	Fresh materials Shrimp paste
7	Madura strait, Madura Is. 07°38.533' S 113.33.417°E	11 July 2010 10:00	Shallow seawater Market	30.0	32.4	<i>A. vulgaris</i> <i>M. orientalis</i>	Fresh materials Shrimp paste
8	Cirebon, Java Is. 06°42.561' S 108°34.310' E	05 July 2009/14:00 25 June 2010/05:00	Seashore (sandy and muddy bottom) Market	30.4	25.3	<i>A. vulgaris</i> <i>M. orientalis</i>	Fresh & dried materials Shrimp paste
9	Tegal, Java Is. 06°50.681' S 109°08.506' E	03 July 2009 23:00	Shallow seawater (sandy and muddy bottom)	29.8	30.4	<i>M. orientalis</i>	Fresh materials
10	Tuban, Java Is. 06°51.435' S 112°01.665' E	01 July 2009 13:00	Seashore (sandy and muddy bottom)	27.9	29.8	<i>M. orientalis</i>	Fresh materials
11	Lekok, Java Is. 07°39.360' S 112°59.175' E	30 June 2009 Daytime	Shallow seawater (sandy and muddy bottom) Home industry	29.2	29.2	<i>A. japonicus</i>	Dried materials Shrimp paste
12	Perancak, Bali Is 08°24.361' S 109°08.506' E	03 June 2010 19:00	Shrimp brackish cul- ture pond (2500m <sup>2</sup> )	28.0	25.6	<i>M. orientalis</i> <i>M. tenuipes</i>	Fresh materials
13	Serangan, Bali Is. 08°50.681' S 115°14.575' E	01 June 2010 05:00	Shrimp brackish cul- ture pond (2500m <sup>2</sup> )	26.1	26.3	<i>M. orientalis</i> <i>M. tenuipes</i>	Fresh materials
14	Guris, Bali Is. 08°25.556' S 114°34.420' E	04 June 2010 18:00	Fish brackish culture pond (5000m <sup>2</sup> )	28.3	26.2	<i>M. orientalis</i> <i>M. tenuipes</i>	Fresh materials
15	Jakarta, Java Is. 06°09.000' S 106°49.000' E	June 2009 Daytime	Coastal area, brackish pond Market	28.0	25.9	<i>A. vulgaris</i> <i>M. orientalis</i>	Dried materials Fresh materials
16	Bontang, Kalimantan Is. 00°10.000' N 117°30.000' E	June 2010 Daytime	Coastal area Market	30.0	31.4	<i>A. sibogae sibogae</i> <i>Acetes</i> sp.	Dried materials Shrimp paste

### Interview assessments and fisheries statistics

To describe the mysids and *Acetes* fisheries and processing procedures, we tried to obtain data during a 3-year investigation as accurate information as possible from 17 interviewees from different fields and localities such as governmental officers, owners of processing factories, fishermen, teachers and local people. Inquiries were fishing grounds, fishing seasons and time, fishing gears (Fig. 2), prices (fresh and dry organisms, shrimp paste), food process, and environmental conditions. The first author visited a home factory in Lekok, Java (Sta. 11) on 30 June 2009 and a traditional processing factory in Ambunten, Madura, Java (Sta. 5) on 5 July 2010. The factory owners and fishermen answered our inquiries

concerning fisheries of mysids and *Acetes*, and showed how they collected these pelagic crustaceans and processed them to produce shrimp paste. Additional interviews were carried out with several residents living near fishing grounds and officers belonging to the regional offices of marine affairs and fisheries in Lekok, Bali, and Kalimantan. Since the present study largely depended on comments of interviewees, we tried to obtain as accurate information as possible from other people during the 3-year investigation. In the present study, currency conversion from Indonesian Rupiah (IDR) to US dollar (US\$) were made to express the economic aspects using a factor of US\$1=IDR 9,000.

The Ministry of Marine Affairs and Fisheries,



**Fig. 2. Fishing gears of mysid *Mesopodopsis* and shrimp *Acetes* in Indonesia (See Table 2).**

a) Lift-net, b) Boat-seine, c) Push-net, d) Scoop-net with long handle and e) Scoop-net with short handle.

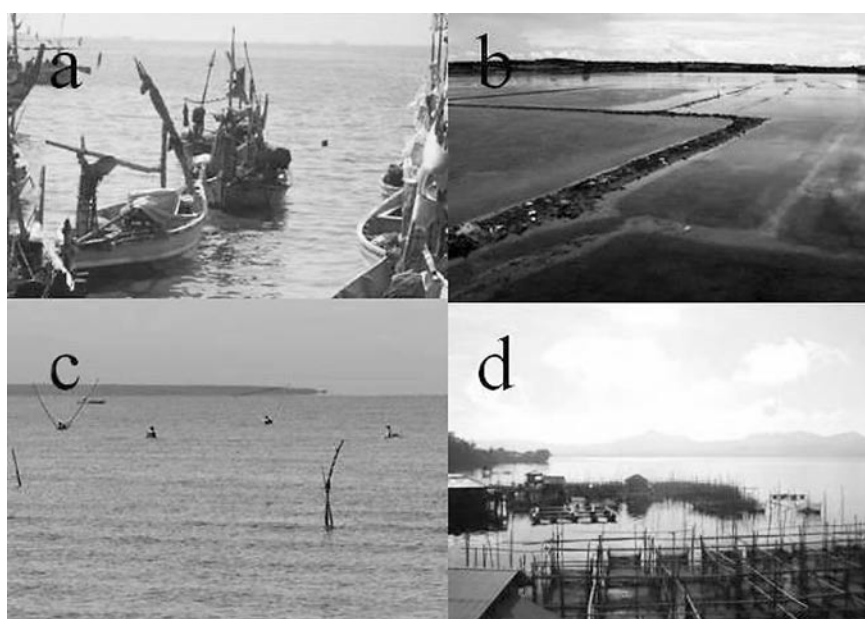
Indonesia provided us with official data concerning the amount and price of mysids and *Acetes* products. The owner of a traditional processing factory in Madura and a

fisherman in Kalimantan (Sta. 3) also gave us some additional information about the amount of catch. There is no detailed and complete statistics available at the national level and it is not recorded in FAO statistics. It is difficult to collect such data because there is no awareness from local people or fishermen.

## Results and discussion

### Fishing grounds and gears

Mysids and *Acetes* were distributed on sandy and muddy bottoms of shallow and calm waters, at river mouths, and brackish water culture ponds (Fig. 3). They were mainly caught from the shoreline at depths of 10–20 m, along the coast. Brackish and salt ponds are mostly utilized for fisheries of mysids. In Bali, brackish ponds (Sta. 12–14 in Table 1) were occupied mostly by *Mesopodopsis orientalis*. This species occurred at high abundance in salt ponds in Madura (Sta. 6), whereas *Acetes* preferably occurred at shallow seawaters and lakes. The fishing grounds were located in the innermost parts of the sea, lakes and ponds because these organisms tended to aggregate near the edges of these grounds. The surface water temperature ranged from 23.4°C in December (Sta. 4) to 30.4°C in July (Sta. 8), and salinity from 0.3 in the lake Tondano (Sta. 4) to 32.4 in the shallow seawater of the Madura Strait (Sta. 7). The transparency at all stations was about 1 m and mysid



**Fig. 3. Some fishing grounds of mysid *Mesopodopsis* and shrimp *Acetes* in Indonesia.** a) Shallow seawater (sandy and muddy bottoms) of Lekok, East Java (Sta. 11), b) Salt pond (1 ha in Table 1) of Karanganyar, Madura Is. (Sta. 6), c) Mouth of river (sandy and muddy bottom) of Sungai Raya, West Kalimantan (Sta. 3) and d) Lake Tondano (4,278 ha) North Sulawesi (Sta. 4).



swarms could be seen at most locations. In the previous studies (Djajadiredja and Sachlan, 1956; Omori, 1975, 1978; Mauchline, 1980; Christensen, 1983; Xiao and Greenwood, 1993; Chan, 1998), these edible crustaceans were also collected from mangrove swamps and brackish culture ponds of penaeid shrimps, where the salinity fluctuated seasonally, ranging from 1.5–35.0 (Chan, 1998), and the tidal range was considerable (Omori, 1975).

Fishing gears for mysids and *Acetes* varied depending on the types of fishing grounds (Fig. 3, Table 2). For example, boat-seine was used in deeper water at 10–20 m depths and push-net was employed at seashore, whereas lift-net and scoop-net with a long handle were utilized in brackish ponds close to seashore and in lakes at a depth of 6 m. The fishing gears for these organisms were relatively simple and usually operated manually.

Lift-net (Fig. 2a) called “bagan” usually needed a light to attract mysids and *Acetes* at night. It was used in shallow waters and brackish ponds of Java (Sta. 8–11), Madura (Sta. 5, 7), Bali (Sta. 12–14), and in lakes of Sulawesi (Sta. 4). “Bagan” was used for the first time in South Sulawesi by Makassar and Bugis fishermen in the early 1950s (Hakim, 2010) and then spreads widely in Java, Sumatra and other places (Mr. Asep S., personal communication). The size of this gear varied depending on the place where it was set up. In Pelabuhan Ratu, west Java, it was set at depths of 10–20 m with the net size about 20 m long and 8 m wide (Omori, 1975). In Bali, “bagan” was set at the edge of a pond, around 1 m deep with a net size of 1 m x 1 m and a mesh size of 3 mm (present study).

A boat-seine or surrounding net (Fig. 2b), called “pajeng bering” or “odeng mayangan” in Madura, was used in deeper waters about 1 km from the shoreline or at depths of 10–20 m in Java (Sta. 8–11) and Madura (Sta. 5, 7). The size of boat seine was 40 m in length

and 2 m in width with a mesh size of 3 mm. To operate the nets, usually fishermen employed one or two boats, but nowadays they have used only one boat due to high prices of fuel. The nets with buoys were dropped into the water and the boat started to move ahead in a circular path. After completing the circle in less than 5 minutes, the fishermen retrieved the buoy in order to take aboard the net. The bottom of the net was gradually being drawn tight so that the organisms were kept still inside the net.

Push-net (Fig. 2c) was used in seashores of Java (Sta. 8–11), Madura (Sta. 5), and Kalimantan (Sta. 3). In Sungai Raya, west Kalimantan a single type of gear, push-nets was in use by fishermen to catch mysids and *Acetes*. Push-nets, called “sudu” in Kalimantan and “odeng sotal” in Madura, were operated at seashore by one or two persons who are capable to push the net in the water against the flow of tides. The gear was 3 m long and 2 m wide with a mesh size of 1 mm.

Scoop-net (Fig. 2d, e), called “serok”, had two types with a long or a short handle, and was used depending on the types of fishing grounds. For example in Madura (Sta. 5), scoop-net with the long handle called “odeng soddu” was used in the middle area of seawater where the water reached around the neck of an adult. These nets were also used in most brackish ponds in Java (Mr. Asep S., personal communication) and Bali (Sta. 12–14), and in salt ponds of Madura (Sta. 6) to catch the crustaceans at the middle part of the pond. On the other hand the short-handle net was used just near the edge of the brackish (Sta. 12–14) and salt ponds (Sta. 6) and in the lake Tondano of North Sulawesi (Sta. 4). Scoop-nets were operated easily by dragging or pulling in the water using the handle. The size of the long-handle net was 2 m in length and 30 cm in diameter with a mesh size of 3 mm, whereas the short-handle net was 30 cm in length and 30 cm in diameter with a mesh size of 1 mm.

**Table 2. Descriptions of fishing gears for mysid *Mesopodopsis* and shrimp *Acetes* in Indonesia.**

Gear	Local name	Size	Type of fishing ground	Locality (Sta.)
lift-net	“bagan”	Mesh size : 3 mm Net length : 1 m Net width : 1 m	Brackish culture pond, Shallow water 6-20m depths, Lake	Java (8-11), Madura (5, 7), Bali (12-14), Sulawesi (4)
boat-seine / surrounding net	“pajeng bering” (Madura)	Mesh size : 3 mm Net length : 40 m Net height : 2 m	Shallow water 10-20m depths	Java (8-11), Madura (5, 7)
push-net	“odeng sotal” (Madura) “sudu” (Kalimantan)	Mesh size : 1 mm Net length : 3 m Net width : 2 m	Seashore < 1m depth	Java (8-11), Madura (5, 7), Kalimantan (3)
scoop-net with long handle	“odeng soddu” (Madura) “serok” (Bali)	Mesh size : 3 mm Net length : 2 m Net diameter : 30 cm	Brackish culture pond, Seashore 6m depth	Java (8-11), Madura (5, 6), Bali (12-14)
scoop-net with short handle	“odeng soddu” (Madura) “serok” (Bali)	Mesh size : 1 mm Net length : 30 cm Net diameter: 30 cm	Brackish culture pond, Lake	Java (8-11), Madura (6), Bali (12-14), Sulawesi (4)

In other Southeast Asian countries, similar types of fishing gears were used by fishermen for catching mysids and *Acetes* (Omori, 1975; Xiao and Greenwood, 1993; Jadhav and Josekutty, 2003; Paul and Josekutty, 2005; Dineshbabu *et al.*, 2006). In China, larger set-nets called “hole-in-belly” are commonly employed (Xiao and Greenwood, 1993).

**Fishing season and time**

The fishery species of pelagic crustaceans in Indonesia and the season and the time of fishing are summarized in Table 1. *Acetes* was caught to a certain amount throughout the year in Indonesia, although its peak fishing season varied depending on the location of the fishing grounds and the alternation of the West and the East monsoons (Mr. Saleh, personal communication). During our collection, *A. japonicus* was fished in shallow water of Lekok (Sta. 11) in June 2009, *A. vulgaris* at seashore of Cirebon (Sta. 8) in June 2010 and *A. japonicus*, *A. serrulatus* and *A. erythraeus* at the mouth of the river in Kalimantan (Sta. 3) in July 2010. According to the owner of a processing factory and local people in Madura, June and July were not good seasons for fishing *Acetes* in Ambunten, Madura (Sta. 5), because of the strong wind at the sea, while February-March was the best for these crustaceans.

There is no exact information regarding the peak season of mysid fisheries in Indonesia. During our collection in July 2009, *Mesopodopsis orientalis* was caught at seashore of Cirebon (Sta. 8). In June 2010, swarms of this species and *M. tenuipes* were found in brackish culture ponds in Bali (Sta. 12–14) and in July 2010 in a salt pond in Madura (Sta. 6). According to local people these species were available in brackish and salt ponds throughout the year (Mr. Samad, personal communication).

Fishing seasons for *Acetes* are different at localities in every country and are largely determined by monsoons (Omori, 1975; Xiao and Greenwood, 1993). For example, in Thailand, the fishing season in the Gulf of Thailand is determined by southwest and northeast monsoons, whereas in other localities fishing takes place throughout the year (Xiao and Greenwood, 1993). The main fishing season in Pelabuhan Ratu (west Java,

Indonesia) was in the transitional period between the West and the East monsoons, from the end of March to June, while fishing was not carried out off Pelabuhan Ratu during the West monsoon, from December to February, because of strong landward winds (Omori, 1975). Djajadiredja and Sachlan (1956) stated that in Indonesia, the availability of *Mesopodopsis* and *Acetes* coincided with periods of high tides during the months of April–June and November–January. The fishing season for *Acetes* was during September to October in Murdeswar Bay of India (Dineshbabu *et al.*, 2006). Dineshbabu *et al.* (2006) stated that the regularity and success of the fishery depends on the magnitude and patterns of the currents. In Mumbai, India, the fishing season of *Mesopodopsis zeylanica* and *M. orientalis* was during April to May (Jadhav and Josekutty, 2003; Paul and Josekutty, 2005).

Fishing time for *Mesopodopsis* and *Acetes* was either day or nighttime at high tides. In the present study, the best time for fishing was during darkness, either at dusk or dawn. In Kalimantan, fishing time started from dawn, around 04:00 until 10:00 am. According to Mr. Made (personal communication) who run a seahorse aquaculture, the coma move to after in Bali fishing time for *M. orientalis* and *M. tenuipes* in brackish culture ponds was usually at dawn around 04:00. He usually buys mysids from the fishermen at around 05:00. According to fishermen and local people in Cirebon (Ms. Ijah, personal communication) and Madura (Mr. Samad, personal communication), at the peak season, fishermen went fishing at daytime whenever they saw the water color turned to reddish or brownish indicating mysid swarms. The fishing activity was carried out by fisherman’s family members, especially for fishing in shallow waters without a boat.

**Catches and species**

The catches and values of a mixture of mysids and *Acetes* (“rebon”) fluctuated year-by-year (Table 3). There was much greater annual catch in the sea in 1954 than in brackish ponds during 1999–2005. The catch of “rebon” in Madura (Madura Strait; Sta.7) was the highest among all locations at the study sites where 50kg/day were yielded. Madura Island has a reputation for a long tradi-

**Table 3. Annual catch and value of mysid *Mesopodopsis* and shrimp *Acetes* (“rebon”) in Indonesia.**

DATA	1954*	1999**	2000**	2001**	2002**	2003**	2004**	2005**
Production (metric ton)	1826	90	544	610	415	700	315	172
Value (US\$)	328.7	96.3	1867.7	332.7	499.1	463.3	266.8	230.2

\* “Rebon” from the sea, based on Djajadiredja and Sachlan (1956).

\*\* “Rebon” from brackish ponds, based on Ministry of Marine Affairs and Fisheries, Indonesia (2010).

tion of shrimp paste “rebon” preparation. According to the owner of a traditional processing factory in Madura (Sta. 5), the catch in a peak fishing season from February to March was about 4 tons/day with a value of IDR 15,300,000/ton (US\$ 1,700/ton). The catch in Sungai Raya, east Kalimantan (Sta. 3) from March to August was 20 kg/day on the average (Mr. Muchtar, personal communication), and the catch in the other sites (Sta. 6, 8–10, 12–14) was less than 1 kg/day.

Table 1 shows the fisheries species belonging to mysids and *Acetes* in Indonesia found in the present study. No dried or fresh mysids were found to be on sale alone without being mixed with *Acetes*. A small number of the mysid *Mesopodopsis orientalis* were found to be sold being mixed with *A. vulgaris* in our collection of fresh “rebon” from Cirebon (Sta. 8), whereas in Sungai Raya, east Kalimantan (Sta. 3) *M. orientalis* were found to be sold being mixed with *A. japonicus*, *A. serrulatus*, and *A. erythraeus* in 2010. *Acetes vulgaris* was also found being mixed with *M. orientalis* in our collection of fresh “jembret” from Cirebon (Sta. 8) in 2009.

*Acetes vulgaris* was identified from dried materials (as “rebon”) bought at supermarkets in Jakarta (Sta. 15), and *A. japonicus* in the collection of dried materials provided by the owner of a home factory in Lekok (Sta. 11)

in 2009. In 2010, *A. sibogae sibogae* was identified from dried materials from Bontang, east Kalimantan (Sta. 16), and in our collection of dried materials from Medan (Sta. 1) *M. orientalis* and *A. indicus* were found being mixed together (Fig. 4a). *Mesopodopsis tenuipes* was also mixed with *M. orientalis* at Sta. 6 and 12–14.

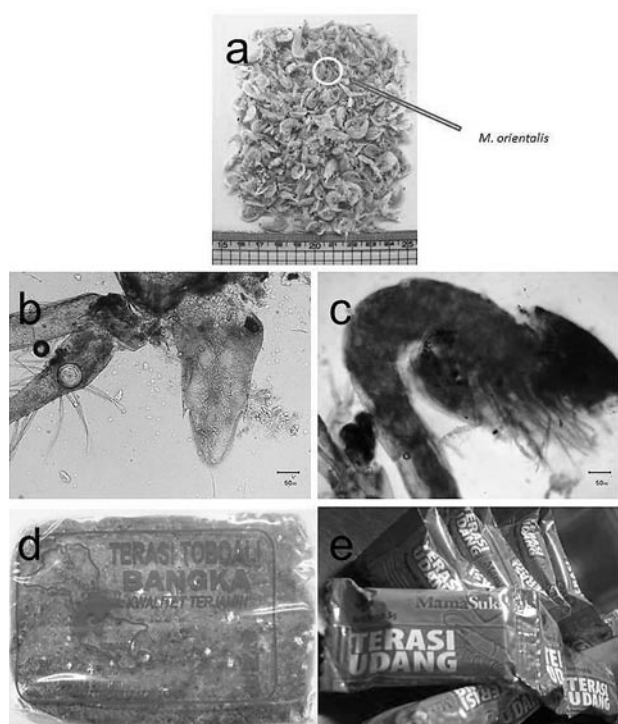
We identified *Acetes* sp. mixed with *Mesopodopsis* sp. in the composition of “terasi” from the Madura Strait (Sta. 7). In the composition of “terasi” we found *Acetes* sp. from Bangka, Sumatra (Sta. 2) and from Bontang, Kalimantan (Sta. 16). We could not identify them at species level, due to fragmentation of specimens. Since we could identify the intact specimen at its material, we found that “terasi” from Madura (Sta. 6, 7) was exclusively composed of *M. orientalis* (Fig. 4b, c).

#### Utilization and processing of mysids and *Acetes*

In Indonesia, several types of “rebon” were usually on sale at markets; raw or fresh materials, dried in the sun materials, and fermented with salt (shrimp paste “terasi” and shrimp sauce “petis”). Most of the products were sold at modern markets as dried materials and shrimp paste (“terasi”), while fresh materials were found only at a traditional market in Cirebon in June 2010 (Sta. 8). “Terasi” is very popular in Indonesia, because it gives more taste and strong flavor to cooked food. Most people especially in Java use “terasi” for making “sambal terasi” (a chili sauce with terasi) and eat it with raw vegetables and fried chicken/fish, because it makes a good appetite. According to Omori (1975), dried *Acetes* and fermented shrimp paste and shrimp sauce made of *Acetes* are highly desired by people in Asian countries.

During our study, there were three types of shrimp paste, i.e. a mixture of mysids and *Acetes*, exclusive of *Acetes*, and mysids alone. According to the owners of “terasi” home factory in Lekok (Sta. 11) and a “terasi” traditional processing factory in Ambunten, Madura (Sta. 5), their main material was *Acetes* but was partly mixed with mysids. However, in Madura (Sta. 5) if *Acetes* is unavailable, then they produce “terasi” from the mysid *M. orientalis* and *M. tenuipes* taken from salt ponds (Sta. 6) or *M. orientalis* from the Madura Strait (Sta. 7). The owner of the traditional processing factory further said that “terasi” made of mysids was tastier than if made of *Acetes* alone.

Figure 5 shows the manufacturing process of “terasi” based on the explanation of the owners of a “terasi” home factory in Lekok (Sta. 11) and a “terasi” traditional processing factory in Madura (Sta. 5). The process of fermentation, crashing, and drying can be repeated 2 or 3 times before pressing it into a hard mass, to get a good



**Fig. 4.** Some examples of “terasi” sold in Indonesia. a) Materials for terasi (Sta. 1), dried *A. indicus* mixed with *M. orientalis*, b) & c) pictures of mysid fragments in the shrimp paste (terasi) made of *M. orientalis* only (Sta. 6), d) & e) samples of shrimp paste (terasi) made of “rebon” (Sta. 2 & 8).



“terasi”. The product remains in good condition for a long time. The longer it is kept the better it tastes.

The selling price at markets for “rebon” and “terasi” varied depending on the quality and the locality of the products. Usually the price at traditional markets was different according to the localities. Dry and fresh “rebon” were sold at markets for IDR 15,000/ kg (US\$ 1.7/ kg) in Ambunten, Madura (Sta. 5), IDR 10,000/ kg (US\$ 1.1/ kg) in Medan (Sta. 1), Cirebon (Sta. 8) and Jakarta (Sta. 15), and IDR 5,000/ kg (US\$ 0.6/ kg) in Tondano (Sta. 4), Lekok (Sta. 11) and Bontang (Sta. 16).

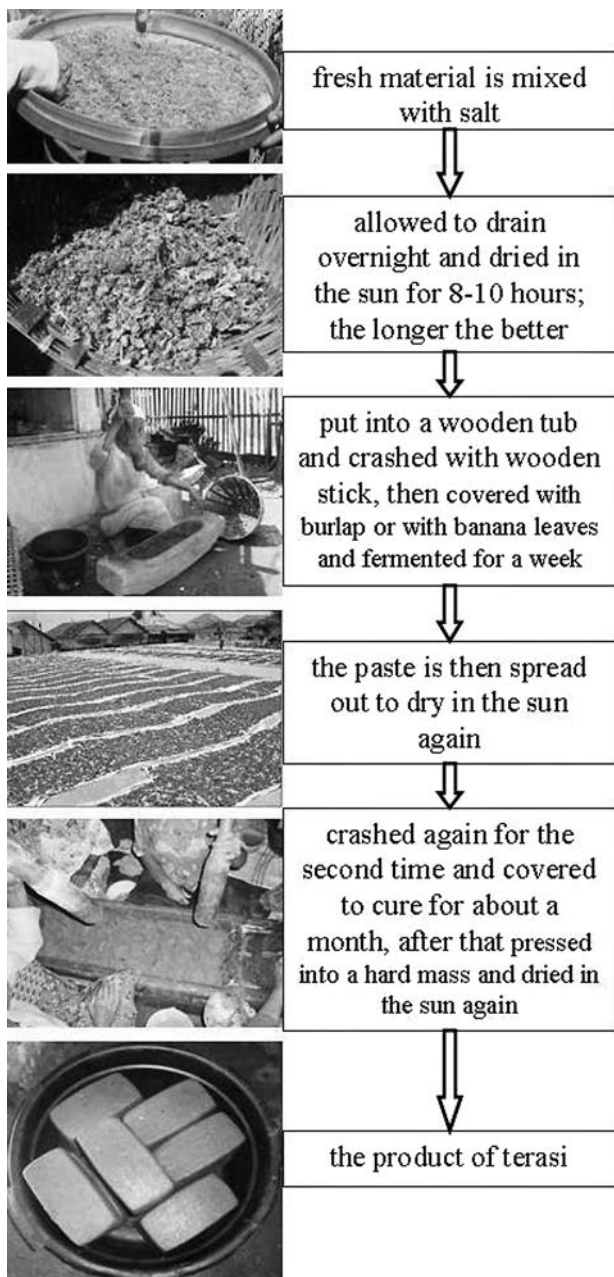


Fig. 5. The process of how to make shrimp paste (“terasi”) in Indonesia (Sta. 5 & 11) (Mr. Ahmad & Ms. Sarmini, personal communication).

The selling price of “terasi” of high quality was IDR 30,000/ kg (US\$ 3.3/ kg) in Sumenep, Madura (Sta. 5) and IDR 40,000/ kg (US\$ 4.4 /kg) in Bangka (Sta. 2, Fig. 4d). On the other hand, the price for low quality of “terasi” was IDR 15,000/ kg (US\$ 1.7/ kg) in Madura, IDR 20,000/ kg (US\$ 2.2/ kg) in Bangka, and IDR 3,000–4,000/ kg (US\$ 0.3–0.4/ kg) in Pelabuhan Ratu, Sukabumi, Bogor, Cianjur and Cirebon. At modern markets “terasi” was only sold in small sachets or in one pack containing 20 sachets; for Mama Suka product (Fig. 4e) the price was IDR 10,000/pack of 20 sachets (US\$ 1.1/ pack).

### Economical aspects

Growing demands for commodities made of mysids and *Acetes* seem to have been getting remarkable in Indonesia. For example, the economical importance of the crustacean products in Berau, east Kalimantan, has been increasing, because of exporting “terasi” to Lombok and other places (Kaltim Post, 2010). “Terasi” exported to Lombok by one factory owner approximately reached up to about 400 tons/month, corresponding to the value of IDR 50,000,000 (US\$ 5,555.6). Table 3 shows that the production from the sea was higher than from the brackish ponds. However, these data seemed to be too insufficient in consideration of our interview in the present study (see “Catches and species”). According to Hutomo *et al.* (2009) or more recent and reliable data, the total marine capture production in Indonesia in 2007 was about 4.73 million tones with estimated value of IDR 48.4 trillion (US\$ 53,777,778). Unfortunately the data did not separate between the respective percentages of mysids and *Acetes*.

Since mysids and *Acetes* are important organisms in coastal and estuarine food webs at lower trophic levels (Omori, 1975; Mauchline, 1980), these crustaceans can influence the production of marine animals at higher trophic level. As mentioned in the introduction, these crustaceans are economically important for fisheries in Asian countries. Unfortunately fisheries statistics are not sufficient in many southeastern Asian countries, which makes a sustainable management difficult. A long-term monitoring of catches of these marine organisms is urgently required in order to maintain sustainable catches from coastal waters.

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## インドネシアにおける*Mesopodopsis*属アミ類とアキアミ類の漁業の実態について

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### 要 旨

浮遊性小型甲殻類のアミ類とアキアミ類は東南アジアでは重要な食料になっているが、インドネシアでの漁業実態はあまりわかっていなかった。そこで2008年12月、2009年6、7月、2010年7月の3回、インドネシア各地の漁場や市場において漁具、対象種、価格等を調査した。漁獲対象種が*Mesopodopsis orientalis*、*M. tenuipes*、*Acetes indicus*、*A. serrulatus*、*A. erythraeus*、*A. sibogae sibogae*、*A. japonicus*、*A. vulgaris* であり、単独あるいはこれらの混合が生あるいは乾燥食品“rebon”あるいは発酵食品“terasi”の原料であることが判明した。価格は“rebon”がIDR 5,000~15,000 / kg (US\$ 0.6-1.7 / kg)、“terasi”がIDR 3,000~40,000 / kg (US\$ 0.3-4.4 / kg) で取引されている。

キーワード：アミ類、アキアミ類、漁業、インドネシア