

# Synopsis of edible jellyfishes collected from Southeast Asia, with notes on jellyfish fisheries

MINORU KITAMURA<sup>1,†</sup> & MAKOTO OMORI<sup>2,\*</sup>

<sup>1</sup> *Tokyo University of Fisheries, 4–5–7 Konan, Minato-ku, Tokyo 108–8477, Japan*

<sup>2</sup> *Akajima Marine Science Laboratory, 179 Aka, Zamamison, Okinawa 901–3311, Japan*

Received 28 September 2009; Accepted 28 June 2010

**Abstract:** Based on sampling of specimens and field observations on jellyfish fisheries in Malaysia, Indonesia, and Myanmar, six trade types of edible jellyfish were identified and the proper scientific names were applied to them with synopses of their taxonomy. An identification key for the Suborder Daktyliophorae, allowing identification of edible species, is provided. Jellyfish fishing activities at various locations in Southeast Asia are reported.

**Key words:** edible jellyfish, morphology, Rhizostomeae, Southeast Asia

## Introduction

With increasing demand from markets in China, Japan, and Korea, fisheries for edible jellyfish have expanded since the 1970s in many countries in Southeast Asia such as the Philippines, Vietnam, Malaysia, Thailand, Singapore, Indonesia, and Myanmar. The average annual catch of jellyfish in Southeast Asia between 1988 and 1999 was about 169,000 metric tons wet weight and an average of 7,874 tons of semi-dried jellyfish commodities were exported annually to Japan during this period (Omori & Nakano 2001). FAO's jellyfish catch statistics from Southeast Asia seem to be an underestimate of the true figure (Omori & Nakano 2001). The data indicates that the average annual catch from the Philippines, Malaysia, Thailand, Indonesia, and Myanmar between 1988 and 1999 was about 88,570 tons. The catch has sharply declined from its peak of 179,086 tons in 2000 to 13,402 tons in 2004 (FAO 2007). Scientific studies on these edible jellyfish have not kept pace with their exploitation in the region.

Jellyfish are processed at local factories and the semi-dried commodities are exported with trade names such as Ball, China, Cilacap, Prigi, Red, River, Sand, Semi-China, Sunflower, and White types, that reflect either the character or the source of the commodities (Omori 1981, Omori & Nakano 2001). It is almost impossible to identify them and give proper scientific names based on the commodities at

market. Having described the main fishing grounds and fishing seasons, as well as the size of the catch of edible jellyfish in Southeast Asia, Omori & Nakano (2001) reported, by examination of the semi-dried commodities, that the jellyfish catch in the region is composed of more than eight species. They tentatively assigned scientific names to some of the trade names. We had the opportunity to visit some of the jellyfish fishing grounds where one or two of the trade types are landed and examined fresh specimens. Accordingly, we found that the presumptions by Omori & Nakano (2001) were correct in part but revision was necessary for several of the species.

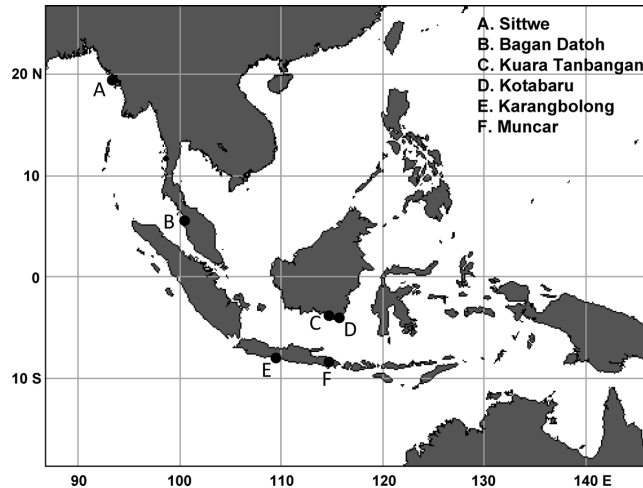
The present paper clarifies the scientific names of six edible jellyfish with taxonomic remarks. An identification key for the Suborder Daktyliophorae, enabling identification of edible species, is provided. Some interesting features of the local jellyfish fisheries are reported based on our surveys.

## Material and Methods

Surveys and samplings were carried out in 2001 and 2002 at six locations in Malaysia, Indonesia, and Myanmar (Fig. 1). We visited Kuala Tanbangan and Kotabaru, south Kalimantan, Indonesia, to collect specimens of the White and Sand types between September 8 and 12, and Karangbolong, central Java, Indonesia, to collect the Cilacap type on December 20, 2001. In 2002, we surveyed at Bagan Datoh, Malaysia, to collect the River type on April 29, and Sittwe, Myanmar, to collect the Ball and Sand types on May 6 to 8. In addition, we examined a specimen of the Prigi type that was collected at Muncar, east Java, Indone-

<sup>†</sup> Present address: Japan Agency for Marine-Earth Science and Technology; 2–15 Natsushima-cho, Yokosuka, Kanagawa 237–0061, Japan

\* Corresponding author: Makoto Omori; E-mail, makomori@amsl.or.jp



**Fig. 1.** Map of sampling sites. A. Sittwe, Myanmar, B. Bagan Datoh, Malaysia, C. Kuala Tanbangan, Indonesia, D. Kotabaru, Indonesia, E. Karangbolong, Indonesia, F. Muncar, Indonesia.

sia, by Dr. M. Toyokawa.

## Results and Discussion

Following are taxonomic descriptions and remarks on the six edible jellyfishes we investigated.

### *Lobonemoides robustus* Stiasny, 1920

(Fig. 2)

Trade name: White Type.

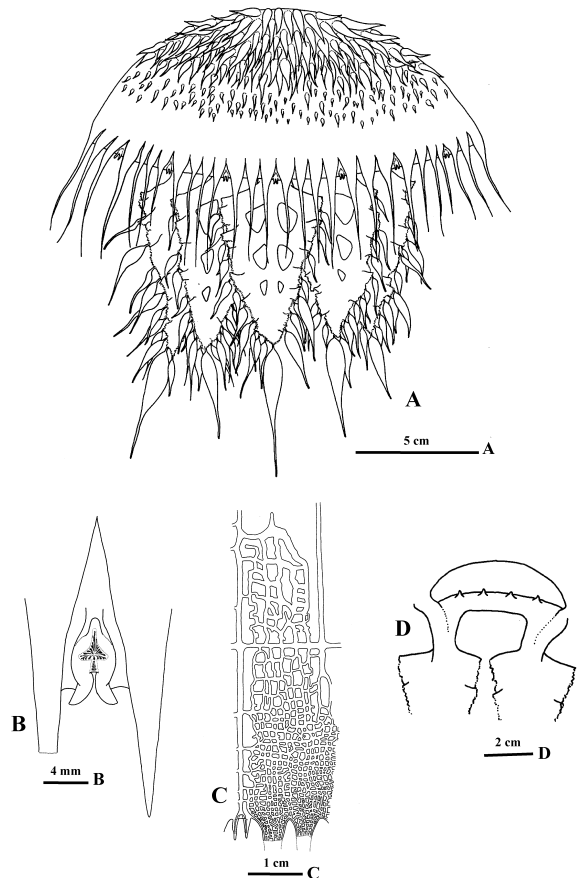
Material examined: Two specimens collected at Kuala Tanbangan, Kalimantan, Indonesia; two specimens collected at Kotabaru, Kalimantan, Indonesia; one specimen collected at Sittwe, Myanmar.

#### Description

Umbrella (Fig. 2A): 38–46 cm wide, flatter than hemisphere. Exumbrella with conspicuous, sharp papillae. The papillae long in apical one-third of exumbrella, short in middle one-third, and no papillae in marginal one-third. With 12–16 rhopalia. There are three or four elongated, tentacle-like marginal lappets between neighboring rhopalia. Rhopalar lappet short with rounded tip (Fig. 2B).

Canal system (Fig. 2C): with 24–32 radial canals. Rhopalar canals visible from base to marginal end, which forked and reached to tips of rhopalar lappets. Inter-rhopalar canals merged into extra-circular anastomosing canals. Intra-circular anastomosing canal system communicates only with rhopalar and ring canals. Mesh size of anastomosing canal system coarse in proximal part of subumbrella, fine in marginal part, and elongated in marginal lappets.

Subumbrellar muscle: well developed in intra-circular but weak in extra-circular parts. No muscle developed in marginal lappets. Muscle fields interrupted over radial canals except near margin where the muscle continues in a ring.



**Fig. 2.** *Lobonemoides robustus* Stiasny. A. Whole body in lateral view, B. Rhopalar lappets and a sensory pit, in exumbrellar view, C. Schematic drawing of anastomosing canal system of subumbrella, D. Schematic drawing of subgenital ostium.

Mouth-arms: eight in number, not coalesced with each other. Window-like openings located in the membranes of mouth-arms in three rows. Upper openings larger. With numerous, long spindle-shaped and thread-like appendages in

outer two wings of mouth-arm in Kalimantan (both Kuala Tanbangan and Kotabaru) specimens, though specimen collected from Sittwe has no thread-like appendages in the outer wings. Inner wing of mouth-arm with spindle-shaped appendage at near distal end of the arm and thread-like appendage in upper proximal portion in both the specimens from Kalimantan and Sittwe.

Genital ostia: four in number, widely opened. With tiny gelatinous projections from two to four in number, on each lower edge (Fig. 2D).

Coloration: usually white, but slightly pink in some specimens.

#### Remarks

Three species have been described in the genus *Lobonemoides*, i.e. *L. gracilis* Light, *L. robustus* and *L. sewelli* Rao. The present species is most similar to *L. gracilis* and there are few recognizable clear morphological differences. Characters of *L. gracilis* such as the small umbrella, the few small exumbrellar papillae, short marginal lappets, simple canal system, lack of subgenital papillae and lack of window-like openings in the mouth-arms suggest that *L. gracilis* is a younger stage of *L. robustus* as suggested by Kramp (1961). It seems that there has been no re-description of *L. gracilis* based on the newly collected material, since the original description by Light (1914). The type locality of *L. gracilis* (Philippines) lies within the distributional range of *L. robustus* (from the Philippines to Myanmar) (Stiasny 1920, 1921, present study). Although we tentatively regard *L. gracilis* as a valid species, further taxonomic study is needed. On the other hand, *L. robustus* is easily distinguished from *L. sewelli* by the absence of short and stiff rod-like appendages on the mouth-arms. Furthermore, the distribution ranges of the two species do not overlap.

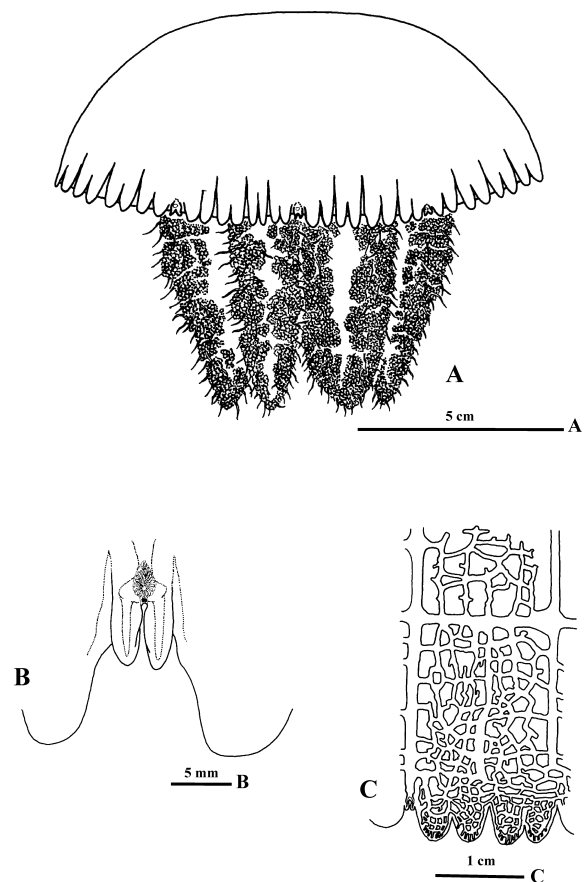
The present species is also similar to species of the genus *Lobonema*. Common characters include exumbrellar papillae, well elongated marginal lappets, and spindle-shaped appendages on the mouth-arms. However, the genus *Lobonemoides* is distinguished from *Lobonema* by its intracircular anastomosing canal system that communicates with the rhopalar and ring canals. Because the anastomosing connections are hard to observe when the subumbrellar muscle is well developed, identification of this genus is sometimes difficult. Several references such as Hong et al. (1978) and Hong & Zhang (1982) reported that the marginal lappets of the genus *Lobonemoides* were not elongated but were bluntly triangular, and this character was distinct from the genus *Lobonema*. This is however not correct. Our material of *L. robustus* had elongated lappets and previous reports (Stiasny 1921, Menon 1930, Kramp 1961) also described or figured the elongated lappets.

Species belonging to the genus *Lobonema* are widely distributed from the Philippines to the Indian Ocean (summarized by Kramp (1961)), and the range overlaps with *Lobonemoides robustus*. Because of the morphological sim-

ilarity and of the overlapping distributions, it is possible that the White type includes *Lobonema* species as well as *Lobonemoides robustus*.

#### Fishing grounds for the White type

According to Japanese and Indonesian dealers (Y. Kawamura, E.D. Kusuma, and E. Nakano, pers. comm.), the White type is the most important commercial jellyfish in Southeast Asia. They say that the main fishing grounds are Naga on southern Luzon Island, the east coast of Palawan Island (Philippines), Nha Trang, Cam Ranh Bay (Vietnam), Rayong in the Gulf of Thailand, Ranong, Phuket in the Andaman Sea (Thailand), Malayan Peninsula from Bagan Datoh to Kuala Selangor, Kelang, Kuching of Borneo (Malaysia), Straits of Malacca from Medan to Lampung in Sumatra, around Bangka Island, Balikpapan to Kotabaru in Kalimantan, Cirebon, Semarang to Surabaya in Java, Madura Island (Indonesia), Arakan State and Mergui in the Bay of Bengal (Myanmar).



**Fig. 3.** *Acromitus hardenbergi* Stiasny. A. Whole body in lateral view, B. Rhopalar lappets and a sensory pit, in exumbrellar view, C. Schematic drawing of anastomosing canal system of subumbrella.

***Acromitus hardenbergi* Stiasny, 1934**

(Fig. 3)

Trade name: River type.

Local name: Lambuh merah (freshwater jellyfish) at Bagan Datoh (Nishikawa et al. 2009).

Material examined: Eight specimens collected at the jellyfish fishing ground at Bagan Datoh, Malaysia.

## Description

Umbrella (Fig. 3A): up to 15 cm wide and 5 cm high, relatively flat. Umbrellar jelly relatively thin around apex (roof of gastric cavity), relatively thick in middle portion, and becomes thin toward margin. Exumbrella looks smooth, but is finely granulated overall. Regularly with eight but one specimen with nine rhopalia. Sensory pit tear shaped, located in exumbrella just above rhopalium (Fig. 3B). Marginal lappets small, with rounded edges, regularly eight in number but sometimes six between neighboring rhopalia. Vertical grooves running from between neighboring lappets, long and short ones alternately. Length of the former up to 2 cm, and that of the latter from half to two-thirds of the long one. Rhopalar lappets narrow, with rounded tips (Fig. 3B).

Canal system: with 16 radial canals and a ring canal. Intra-circular anastomosing canal system communicates with ring and rhopalar canals (Fig. 3C). The majority of the inter-rhopalar canals do not connect to the intra-circular anastomosing canal system. Rhopalar canals divide into two just above each rhopalium, penetrate into the rhopalar lappets, and reach to near the tip of each rhopalar lappet. Inter-rhopalar canals are indistinct from the anastomosing canal system in the extra-circular portions. Anastomosing canal system in a fine mesh, and elongated into the marginal lappets.

Subumbrellar muscle: well developed in inner margin. Muscle fields interrupted over rhopalar canals.

Mouth-arms: eight in number, not coalesced with each other. With three wings, two outer and one inner one. Without terminal appendages on each arm but with numerous tiny filamentous appendages on each wing. Mouth frills of inner wings reach to center of arm disk.

Genital ostia: half ellipse-shaped, four in number, with a prominent club- or slender fig-shaped gelatinous projection at the center of external margin. Center of ostial inner margin that is opposite to the club-shaped projection swelled.

Coloration: white or slightly brown, but faintly pink or purple in some live specimens.

## Remarks

So far five species have been described in the genus *Acromitus*, i.e. *A. flagellatus* (Maas), *A. hardenbergi*, *A. maculosus* Light, *A. rabanchatu* Annandale and *A. tankah-keei* Light. The present species is easily distinguished from the others by the absence of a terminal thread-like appendage on each mouth arm. Although each species except for *A. hardenbergi*, can reportedly be distinguished by the morphology of the subgenital projection, this is difficult in

practice due to the variety of morphology. The subgenital projection of *A. flagellatus* is reported to be hammer- or heart-shaped, which can lead to confusion with other species (Kramp 1961). Maaden (1935) states that *A. maculosus* is the only species of the genus and that all other species, including *A. hardenbergi*, are merely varieties of *A. maculosus*. This supposition was not followed, however, by later researchers such as Menon (1936), Uchida (1955), Kramp (1961), and Hsu & Chin (1962). The genus *Acromitus* needs further taxonomic study.

## Fishing grounds for the River type

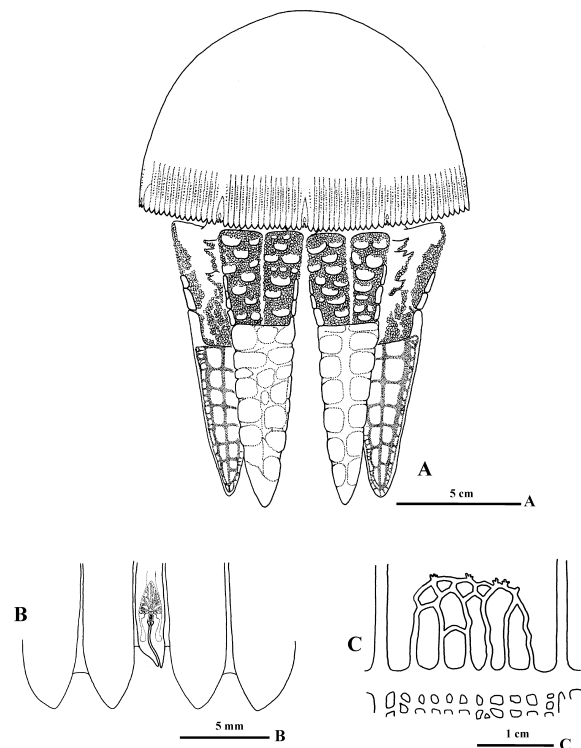
Besides Bagan Datoh, the River type is fished at Teluk Anson and Pangkor, Malaysia (Y. Kawamura pers. comm.) and Tanjungbalai, Sumatra, Indonesia (Omori & Nakano 2001). According to Dr. Benjawan Thumthanaruk (pers. comm.), *Acromitus* species are fished at Nong Khan Song and Tha Phrik at the mouth of the Trat River in Thailand.

***Crambionella annandalei* Rao, 1931**

(Fig. 4)

Trade name: Ball type. The Ball and Cilacap types are sometimes treated together and called the Sunflower type at market.

Materials examined: Five specimens collected at Sittwe, at the mouth of the Kalatan River, Myanmar.



**Fig. 4.** *Crambionella annandalei* Rao. A. Whole body in lateral view, B. Rhopalar lappets and a sensory pit, in exumbrellar view, C. Schematic drawing of intra-circular anastomosing canal system of subumbrella.

### Description

Umbrella (Fig. 4A): hemispherical, 12–14 cm wide, 8–9 cm high. Central part thick, but relatively thin at margin. Exumbrella looks smooth, but minute wrinkles run all over the surface. With eight rhopalia. Each octant with 14–15 marginal lappets but some have eight or 16–19. Marginal lappets triangular in shape with bluntly rounded tips. Marginal grooves running vertically from between neighboring lappets. With a median row of sharp-pointed projections in central one-third between adjacent marginal grooves. Some marginal grooves located on both sides of each rhopalium connected to each other. Rhopalar lappets short and slender (Fig. 4B).

Canal system: with 16 radial and a ring canal. Intra-circular anastomosing canal system communicates only with the ring canal (Fig. 4C). Terminal end of rhopalar canals forked and penetrates into rhopalar lappets. Inter-rhopalar canals indistinct through anastomosing system in extra-circular portion.

Subumbrellar muscle: well-developed. Muscle field interrupted over rhopalar canals, and its inner margin rounded.

Mouth-arms: eight in number, not coalesced with each other. Mouth-arms longer than umbrella height. Each mouth-arm has three wings, two outer and one inner one, with two types of appendages, a terminal and many small foliaceous ones (Fig. 4A). The terminal appendage is large, long, and triangular with a blunt tip. Its outer plate is elongated upward. The foliaceous appendages are large on outer two wings but small on inner wing.

Genital ostia: four in number, crescent shaped and with a narrow opening. No projection around genital ostium.

Color: faintly brown.

### Remarks

Previously, three species had been described in the genus *Crambionella*, i.e. *C. annandalei*, *C. orsini* (Vanhöffen), and *C. stuhlmanni* (Chun). Among them, *C. annandalei*, which was established by Rao (1931) based on the specimens collected from Andaman Sea and Bay of Bengal, is distinguishable from the other two species by the presence of foliaceous appendages on their mouth-arms. However, Stiasny (1937) doubted the validity of *C. annandalei*, and noted that the presence of foliaceous appendages was the only difference between *C. annandalei* and *C. stuhlmanni*. Kramp (1961) dealt with *C. annandalei* as a valid species, while drawing attention to Stiasny's doubts. We checked previous descriptions or sketches of *C. stuhlmanni* (Chun) by Chun (1896), Mayer (1910) and Stiasny (1921), but none mention or figure the existence of foliaceous appendages on the mouth-arms. Because of their large size, we do not believe that all the authors could have overlooked the foliaceous appendages. The distributional ranges of *C. stuhlmanni* and *C. annandalei* also differ from each other. The former species has been reported from the southwestern Indian Ocean such as off the coast of Mozambique and

Madagascar (summarized by Kramp (1961)). On the other hand, the latter species is distributed in the northeastern Indian Ocean such as the Bay of Bengal and the Andaman Sea (Rao 1931, present study). Thus, we concur with the establishment of *C. annandalei* as a valid species by Rao (1931) in this study. A species described as ?*C. stuhlmanni* by Menon (1930) was synonymized with *C. annandalei* by Rao (1931). Because of the presence of "accessory appendages" which may have the appearance of vesicles, and we also tentatively support the synonymies by Rao.

Omori & Nakano (2001) assumed that the Ball type was *Crambionella orsini* (Vanhöffen). However, the presence of foliaceous appendages and a median row of sharply pointed projections between adjacent marginal grooves clearly distinguishes the Ball type from *C. orsini*.

*Crambionella annandalei* is distributed in Madras, India (as ?*C. stuhlmanni*)(Menon 1930), near Port Blair, Andaman Sea and Bay of Bengal off Myanmar (Rao 1931), and Sittwe (present study).

Fishing grounds for the Ball type

Sittwe, Myanmar (Omori & Nakano 2001, present study).

### *Crambionella* species

(Figs. 5 and 6)

Trade name: Cilacap type. The Cilacap and Ball types are sometimes treated together and called the Sunflower type at market.

Local name: Ulbu ulbu biasa (common jellyfish) at Karangbolong.

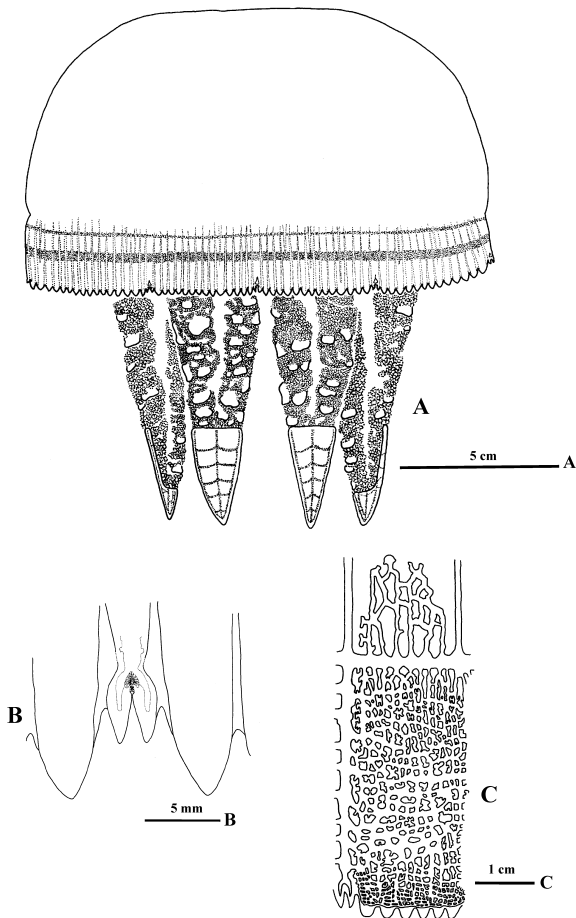
Material examined: eight specimens collected at Karangbolong near Cilacap, central Java, Indonesia.

### Description

Umbrella (Figs. 5, 6A): 10–15 cm wide and 6–11 cm high, with flat apex. Jelly thick in the apical part, but becomes suddenly thin in the extra-circular margin. Exumbrella has smooth surface. With eight rhopalia. Sensory pit



Fig. 5. Photograph of live specimen of *Crambionella* species.



**Fig. 6.** *Crambionella* species. A. Whole body in lateral view, B. Rhopalar lappets and a sensory pit, in exumbrellar view, C. Schematic drawing of anastomosing canal system of subumbrella.

nearly spade-shaped with rounded top and without grip (Fig. 6B). Marginal lappets small, triangular with dull tips, from eight to 15, mostly 14 in number in each octant. Vertical grooves run between neighboring lappets on umbrella margin. No median row of pointed projections between adjacent marginal grooves. Rhopalar lappets smaller than marginal ones, slender and slightly pointed at the tip (Fig. 6B).

Canal system (Fig. 6C): with 16 radial canals, eight rhopalar and eight inter-rhopalar ones. Intra-circular anastomosing canal system communicates with ring canal, but not with rhopalar or inter-rhopalar canals. Terminal end of rhopalar canal divided into two, penetrates into rhopalar lappet, and reaches to central level of the lappets. Inter-rhopalar canals visible in intra-circular portion only. Anastomosing canal system has very fine mesh in margin. Subumbrellar surface of marginal lappets lacks canal network.

Subumbrellar muscle: well developed. Muscle field interrupted over rhopalar canals, its inner margin rounded.

Mouth-arms: eight in number, almost of same length as umbrella height, not coalesced at their base. With two types of appendages, terminal and foliaceous (Fig. 6A). The for-

mer short, triangular, with its outer plate elongated upward. The latter small, few, and located among the mouth-frills. Terminal appendages shorter than those of *C. annandalei*.

Genital ostia: four in number, crescent-shaped with narrow opening. No projection around genital ostium.

Coloration (Fig. 5): umbrella whitish, with or without two reddish purple lines near margin of exumbrella. Outer line broad and inner one narrow. Inside of terminal appendages of mouth-arms also reddish purple.

#### Remarks

The present species have different morphology from the three previously described *Crambionella* species. From the viewpoint of the presence of foliaceous appendages, the present species is similar to *C. annandalei*, but is distinctive as follows: (1) flat apex of umbrella; (2) absence of a median row of pointed projections between adjacent marginal grooves; (3) short terminal appendage on each mouth-arm; (4) fewer foliaceous appendages on mouth-arms; and (5) coloration. The present species is also similar to *C. orsini*, but foliaceous appendages are not found in the latter species. The distribution of these two species differs. The present species was collected in central Java facing the Indian Ocean, while *C. orsini* has been reported from the coast of India, Red Sea, Krusadai Islands, Arabian Sea and Iranian Gulf (summarized by Kramp (1961)). Although the validity of the presence or absence of foliaceous appendages as a character to distinguish species is not completely clear yet, there is the possibility that the present species is an undescribed species. Nishikawa et al. (2009) reported that the mitochondrial COI gene sequences between the *Crambionella* species collected from Cilacap and *C. orsini* in the Gulf of Oman differed from each other. The present species can also be distinguished from *C. stuhlmanni* by the presence of the foliaceous appendages and the absence of a median row of pointed projections between adjacent marginal grooves.

#### Fishing grounds for the Cilacap type

Cilacap and Karangbolong, Indonesia (Omori & Nakano 2001, present study).

#### *Crambione mastigophora* Maas, 1903

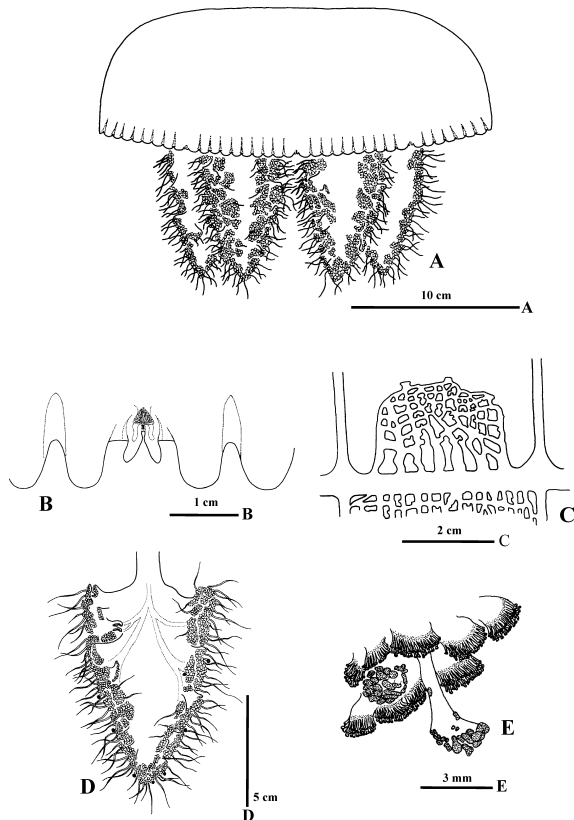
(Fig. 7)

Trade name: Prigi type. Prigi is a place name near Muncar in eastern Java, Indonesia.

Material examined: One specimen sampled at Muncar, eastern Java, Indonesia.

#### Description

Umbrella (Fig. 7A): 25 cm in diameter, relatively flat. With smooth exumbrella. Ten marginal lappets located in each octant although eleven lappets were counted in one octant. Each marginal lappet relatively wide with rounded margin. Rhopalar lappets short with rounded tips (Fig. 7B). Vertical grooves run between neighboring lappets on umbrella margin. With eight rhopalium. Sensory pit nearly



**Fig. 7.** *Crambione mastigophora* Maas. A. Whole body in lateral view, B. Rhopalar lappets and a sensory pit, in exumbrellar view, C. Schematic drawing of intra-circular anastomosing canal system of subumbrella, D. Mouth-arm, outer view, E. Club-shaped appendages among mouth-frills of mouth-arms.

equilateral triangle with blunt tips (Fig. 7B), located just above each rhopalium.

**Canal system:** with 16 radial canals, eight rhopalar and eight inter-rhopalar ones. Divided ends of rhopalar canal reach base of rhopalar lappets. Inter-rhopalar canals visible in their inner half of extra-circular portion, while merged into anastomosing canal system in outer half. Ring canal very broad. Intra-circular anastomosing canal system does not communicate with rhopalar or inter-rhopalar canals (Fig. 7C). Mesh size of intra-circular anastomosing canal system broad while that of extra-circular one is fine. Marginal edge of anastomosing canal system not elongated into marginal lappets.

**Subumbrellar muscle:** Muscle developed in extra-circular portion while weak in intra-circular one. Muscle field divided into eight groups, wider than semicircular in shape.

**Mouth-arms:** eight in number, not coalesced with each other. Mouth-arms are same or slightly longer than the umbrella diameter. Each arm has three wings, two outer and one inner one. With two types of appendages (Fig. 7D); numerous narrow and long filamentous appendages occur among mouth frills on three wings, the other appendage tiny and club-shaped, the terminal portion splitting finely

like a pinecone (Fig. 7E).

**Genital ostia:** narrow slits, without gelatinous projection around its margin.

**Coloration:** white or faintly brown.

#### Remarks

The genus *Crambione* is in taxonomical disorder. Among the three species of the genus, the present species is similar to *C. bartschi* (Mayer) because of (1) smooth exumbrella, (2) filamentous appendages on mouth-arms, and (3) number of marginal lappets. However, the present species is distinguished from *C. bartschi* by the presence of small club-shaped appendages on the mouth-arms. Although Stiasny (1921) considered *C. bartschi* and *C. mastigophora* to perhaps be the same species, we do not concur. The third *Crambione* species, *C. cookii* Mayer, is easily distinguished from the other two species by the presence of a reticulated network of deep furrows in the central part of the exumbrella. Unfortunately, the original description of *C. cookii* by Mayer (1910) was quite simple; there was no information about the subumbrellar canal system, which is the most important character for generic identification. Accordingly, Stiasny (1921) considered that the systematic position of this species was uncertain. Mayer (1910) noted that the intra-circular anastomosing canal system does not communicate with the radial canals in his diagnosis of the genus *Crambione*. We tentatively treat *C. cookii* as a valid species. After the original description, occurrence of this species has not been reported.

#### Fishing grounds for the Prigi Type

Prigi and Muncar, Java, Indonesia (Omori & Nakano 2001, present study).

#### *Rhopilema hispidum* (Vanhöffen, 1888)

**Trade name:** Sand Type.

**Local name:** Ulbu kiburu (sandpaper jellyfish) at Kotabaru. **Material examined:** One specimen collected at Kuala Tangangan, Indonesia; one specimen collected at Kotabaru, Indonesia; one specimen collected at Sittwe, Myanmar.

#### Description

**Umbrella:** 45–48 cm wide, with 16 radial canals and eight rhopalium.

**Exumbrella:** white, with numerous small, sharp-pointed, warts with round and pointed tips. Inter-circular anastomosing canal system communicates only with rhopalar canal. Muscle fields triangular, total 16 in number.

**Mouth-arms:** eight in number. With large scapulets, 16 blade-shaped, having many tentacles. A large club-shaped appendage exists on the junction point of the three wings.

**Genital ostia:** with a large, relatively compressed projection.

#### Remarks

We have encountered this species at the fishing grounds of White and Ball types jellyfish. The semi-dried product of

*R. hispidum* has numerous warts on its exumbrella as if dusted with sand (thus their name, Sand type). *Rhopilema hispidum* was re-described by Omori & Kitamura (2004) based on specimens collected from Japan.

#### Fishing grounds for the Sand type

Besides in Southeast Asian waters such as Thanh Hoa, Vietnam (Nishikawa et al. 2008) and Cirebon, west Java (Omori & Nakano 2001), *R. hispidum* is commonly fished in the Ariake Sea, Japan and along the southern Chinese coast (Omori & Nakano 2001, Omori & Kitamura 2004).

#### Key to species belonging to Daktyliophorae

All edible jellyfish species reported to date from Southeast Asian waters belong to the suborder Daktyliophorae in the order Rhizostomeae, class Scyphozoa. The genera and species can be identified with the following keys. Taxonomic remarks were added for several taxa where taxonomic confusion exists.

#### Class Scyphozoa Order Rhizostomeae Suborder Daktyliophorae

Diagnosis emended from Kramp (1961): Intra-circular canal system does not communicate with the gastric cavity.

#### Key to superfamily:

- (1) Without scapulets on mouth-arms .....(2) Inscapulatae  
With scapulets on upper portion of mouth-arms  
.....(28) Scapulatae
- (2) Superfamily Inscapulatae

#### Key to family:

- (2) Intra-circular canals form anastomosing network...(3)  
Intra-circular canals are centripetal.....(4) Lychnorhizidae
- (3) Without window-like openings in mouth-arms, marginal lappets of umbrella are not elongated.....(10) Catostylidae  
With window-like openings in mouth-arms, marginal lappets of umbrella are elongated  
.....(24) Lobonematidae

#### (4) Family Lychnorhizidae

Diagnosis emended from Mianzan & Cornelius (1999): Inscapulatae with centripetal canals that blindly end and which do not anastomose in intra-circular portions of sub-umbrella.

#### Key to genera:

- (4) With axial terminal appendage on mouth-arm .....(5)  
Without axial terminal appendage on mouth-arm  
.....(6) *Lychnorhiza*
- (5) Terminal appendage is slender club-shaped; thread-like filamentous appendages are scattered on mouth-arm .....(8) *Anomalorhiza*  
Terminal appendage is very large; no other appendages on mouth-arm.....(9) *Pseudorhiza*

#### (6) Genus *Lychnorhiza*

Diagnosis emended from Kramp (1961): Lychnorhizidae without axial terminal appendage. With or without filamentous appendages on mouth-arms. Rhopalar canals reaching umbrella margin, inter-rhopalar canals only reaching ring canal. With two to four centripetal canals between adjacent radial canals.

#### Key to species:

- (6) Radial ribs run from apex towards margin of exumbrella.....*L. arubae* Stiasny  
No radial ribs on exumbrella.....(7)
- (7) With long filamentous appendages on mouth-arms  
.....*L. lucerna* Haeckel  
Without appendages on mouth-arms  
.....*L. malayensis* Stiasny

#### (8) Genus *Anomalorhiza*

Diagnosis: Lychnorhizidae with an axial terminal club and thread-like filamentous appendages on each mouth-arm. Wart-like projections occur in central part of exumbrella. With only one intra-circular centripetal canal between adjacent radial canals.

Remarks: This is a monotypic genus for *A. shawi* Light recorded from the Philippines.

#### (9) Genus *Pseudorhiza*

Diagnosis: Lychnorhizidae with very large axial terminal appendage on mouth-arm. No other clubs or filaments on mouth-arms. Over ten intra-circular centripetal canals occur between adjacent radial canals.

#### Key to species:

- (9) With six marginal lappets in each octant, and each lappet consists of three secondary lappets. With eight large terminal appendages on mouth-arms  
.....*P. aurosa* von Lendenfeld  
With six marginal lappets in each octant, but without secondary lappets. With a single large terminal appendage arising from one of the mouth-arms  
.....*P. haeckeli* Haacke

#### (10) Family Catostylidae

Diagnosis emended from Kramp (1961): Inscapulatae with intra-circular anastomosing canal network. Eight rhopalar canals extending to umbrella margin, while eight inter-rhopalar ones extend only to the ring canal. Without window-like openings in mouth-arms. Marginal lappets of umbrella not elongated.

#### Key to genera:

- (10) Intra-circular anastomosing canal system communicates with radial canal.....(11)  
Intra-circular anastomosing canal system not communicating with radial canal.....(12)
- (11) The canal system communicates with inter-rhopalar canals .....(13) *Acromitoides*  
The canal system communicates with rhopalar canals .....(14) *Acromitus*



The canal system communicates with rhopalar and inter-rhopalar canals.....(15) *Catostylus*

- (12) Mouth-arms without terminal clubs  
.....(19) *Crambione*  
Mouth-arms with triangular pyramidal terminal  
clubs.....(21) *Crambionella*

(13) Genus *Acromitoides*

Diagnosis emended from Kramp (1961): Catostylidae where intra-circular anastomosing canal system communicates with ring and inter-rhopalar canals, but not with rhopalar-canals. No appendages on mouth-arms.

Remarks: Although *A. purpurus* (Mayer) and *A. stiphropterus* (Schultze) are included in the genus *Acromitoides*, morphological differences between the two species are not clear. No identification key for the genus will be provided in this study.

(14) Genus *Acromitus*

Diagnosis emended from Kramp (1961): Catostylidae where intra-circular anastomosing canal system communicates with ring and rhopalar canals, but not with inter-rhopalar canals. Mouth-arms with whip-like filamentous appendages, except for *A. hardenbergi*.

Remarks: Five species, *A. flagellatus* (Maas), *A. hardenbergi*, *A. maculosus* Light, *A. rabanchatu* Annandale and *A. tankahkeei* Light, have been previously described. Although the morphology of the subgenital papillae is used for distinction of the four species, except for *A. hardenbergi*, we were unable to identify to species using this character. See detailed discussion under the remarks for *A. hardenbergi*.

Key to species:

- (14) Each mouth-arm without a terminal filament  
..... *A. hardenbergi* Stiasny  
Each mouth-arm with a long whip-like terminal filament.....other four species

(15) Genus *Catostylus*

Diagnosis emended from Kramp (1961): Catostylidae where intra-circular anastomosing canal system communicates with rhopalar, inter-rhopalar and ring canals. Without appendages on mouth-arms.

Remarks: Among the previously described *Catostylus* species, *C. tripterus* (Haeckel) and *C. viridescens* (Chun) have been considered as doubtful (Stiasny 1921), *C. cruciatus* (Lesson) was synonymized into *Lychnorhiza lucerna* (Morandini 2009). Although *Catostylus mosaicus sensu* Tahera & Kazmi (2006) which has six mouth-arms has been reported from Pakistani waters, we did not include the species into the following key. Recently, *C. mosaicus* (Quoy & Gaimard) has been divided into two subspecies, *C. mosaicus mosaicus* and *C. mosaicus conservativus*, by Dawson (2005).

Key to species:

- (15) With coarse granulations on exumbrella.....(16)

With smooth surface on central part of exumbrella  
.....(18)

- (16) Exumbrellar granules fuse into rows on the marginal lappets.....*C. ornatellus* (Vanhöffen)  
Without such a row of granules on lappets .....(17)  
(17) Proximal part of mouth-arm short, 1/6 as long as distal three-winged part  
.....*C. mosaicus* (Quoy & Gaimard)  
Proximal part of mouth-arm long, from 1/2 to 1/4 of length of distal three-winged part; with conspicuous purple-brown spots on exumbrella  
.....*C. townsendi* Mayer  
(18) With rows of prominent rugged papillae radiating toward the margin on exumbrella, mouth-arm sub-cylindrical.....*C. perezii* Ranson  
With shallow dendritically branching furrows near umbrella margin, distal end of mouth-arm tapering to a point .....*C. tagi* (Haeckel)

(19) Genus *Crambione*

Diagnosis emended from Kramp (1961): Catostylidae where intra-circular anastomosing canal system communicates only with the ring canal. With clubs and whip-shaped filaments on mouth-arms, but without terminal appendages.

Key to species:

- (19) Central portion of exumbrella smooth.....(20)  
Central portion of exumbrella is reticulated by a network of deep furrows .....*C. cookii* Mayer  
(20) Mouth-arms with club-shaped and filamentous appendages.....*C. mastigophora* Maas  
Mouth-arms without club-shaped appendages  
.....*C. bartschi* (Mayer)

(21) Genus *Crambionella*

Diagnosis emended from Kramp (1961): Catostylidae where intra-circular anastomosing canal system communicates only with ring canal. Each mouth-arm with a terminal appendage, but without whip-like filaments.

Key to species:

- (21) Mouth-arms with small foliaceous appendages....(22)  
Mouth-arms without foliaceous appendages .....(23)  
(22) Umbrella with a median row of sharp-pointed projections between adjacent marginal grooves  
.....*C. annandalei* Rao  
Without such a median row of projections  
.....*Crambionella* species  
(23) Umbrella with a median row of sharp-pointed projections between adjacent marginal grooves  
.....*C. stuhlmanni* (Chun)  
Without such a median row of projections  
.....*C. orsini* (Vanhöffen)

(24) Family Lobonematidae

Diagnosis emended from Kramp (1961): Inscapulatae where intra-circular canal system forms anastomosing network. With window-like openings in membranes of mouth-

arms. With papillae on exumbrella.

Key to genera:

- (24) Intra-circular anastomosing canal system communicates with rhopalar, inter-rhopalar, and ring canals .....(25) *Lobonema*  
 Intra-circular anastomosing canal system communicates with rhopalar and ring canals, but not with inter-rhopalar canal.....(26) *Lobonemoides*

(25) Genus *Lobonema*

Diagnosis emended from Kramp (1961): Lobonematidae where intra-circular anastomosing canal system communicates with ring, rhopalar and inter-rhopalar canals. With flat umbrella, elongated marginal lappets. Mouth-arms have window-like openings.

Remarks: Two species, *L. mayeri* Light and *L. smithi* Mayer, have been previously described. However, morphological differences are not clear and the distributions of the two species overlap (Philippines and adjacent waters). Under this situation, several studies (e.g. Rao 1931) have regarded *L. mayeri* as a synonym of *L. smithi*. No identification key for the genus is provided in this study.

(26) Genus *Lobonemoides*

Diagnosis emended from Kramp (1961): Lobonematidae where intra-circular anastomosing canal system communicates with ring and rhopalar canals, but not with inter-rhopalar canals.

Key to species:

- (26) With long pointed papillae on exumbrella. With filamentous appendages on mouth-arms.....(27)  
 Without long papillae but with tiny ones. With short, stiff rod-like appendages on mouth-arms .....*L. sewelli* Rao  
 (27) Umbrella small, 50–85 mm in width. Exumbrellar papillae few. Marginal lappets short .....*L. gracilis* Light  
 Umbrella large, up to 320 mm in width. Exumbrellar papillae many. Marginal lappets long .....*L. robustus* Stiasny

(28) Superfamily Scapulatae

Diagnosis emended from Kramp (1961): Daktyliphorae with scapulets on upper portion of mouth-arms.

Key to family:

- (28) Without a primary mouth opening in center of arm disk .....(29) Rhizostomatidae  
 With a primary mouth opening .....(39) Stomolophidae

(29) Family Rhizostomatidae

Diagnosis: Scapulatae without central mouth opening. Distal part of mouth-arms forms 3-winged structure.

Key to genera:

- (29) Mouth-arms with appendages.....(30)  
 Mouth-arms without appendages

.....(32) *Eupilema*

- (30) With large scapulets. With numerous club-like, spindle-shaped or filamentous appendages on each mouth arm.....(31)

With small scapulets. With a club-like terminal appendage on each mouth-arm, but without secondary club-like or filamentous appendages

.....(33) *Rhizostoma*

- (31) Mouth-arms with window-like openings

.....(34) *Nemopilema*

Mouth-arms without window-like openings

.....(35) *Rhopilema*

(32) Genus *Eupilema*

Diagnosis emended from Mianzan & Cornelius (1999): Rhizostomatidae without appendages on mouth-arms.

Key to species:

- (32) Marginal lappets triangular. Usually eight lappets present in each octant

.....*E. inexpectata* Pagès, Gili & Bouillon

Marginal lappets long, narrow and rectangular. Eight pairs of lappets present in each octant

.....*E. scapulare* Haeckel

(33) Genus *Rhizostoma*

Diagnosis emended from Mianzan and Cornelius (1999): Rhizostomatidae with a terminal club-like appendage on each mouth-arm. But without secondary appendages on lateral surface of mouth-arms. Scapulets small. Intra-circular anastomosing canal system has large meshes and connects with ring canal only.

Key to species:

- (33) Terminal appendage long, thin, and whip-shaped

.....*R. luteum* (Quoy & Gaimard)

Terminal appendage club-shaped, large and translucent, about one third of total length of mouth-arms

.....*R. pulmo* (Macri)

(34) Genus *Nemopilema*

Diagnosis emended from Omori & Kitamura (2004): Rhizostomatidae with exumbrellar warts, the size of them increasing towards the center. With a narrow central mouth covered by a membrane at center of arm disk. No projection at the entrance of genital ostia. Mouth-arms fused along the basal one-fourth, with whip-shaped appendages but without fusiform or club-shaped ones. Outer two wings of the mouth-arms have window-like openings.

Remarks: The genus *Nemopilema* was originally established by Kishinouye (1922) for *N. nomurai*. But later, Uchida (1936) and Kramp (1961) synonymized the genus into *Stomolophus*. Omori & Kitamura (2004) redescribed *N. nomurai* based on material collected from the Sea of Japan and concluded that the synonymizing was erroneous. This is a monotypic genus for *N. nomurai* that occurs from China to Japan.

(35) Genus *Rhopilema*

Diagnosis emended from Kramp (1961): Rhizostomatiidae with club, spindle-shaped, vermicular or filamentous appendages on mouth-arms. Mouth-arms without window-like openings. Scapulets large.

Key to species:

- (35) Exumbrella rough .....(36)  
 Exumbrella smooth .....(37)
- (36) Exumbrella with tiny pointed warts. Each mouth-arm with a terminal club-shaped appendage .....*R. hispidum* (Vanhöffen)  
 Exumbrella with tiny blunt warts. Each mouth-arm with a terminal vermicular appendage .....*R. nomadica* Galil, Spanier & Ferguson
- (37) Each mouth-arm with a terminal appendage ..... (38)  
 Each mouth-arm without terminal appendage .....*R. esculentum* Kishinouye
- (38) Frilled surface of outer two wings of mouth-arms elongated vertically. With few small club-shaped appendages on each mouth-arm .....*R. rhopalophorum* Haeckel  
 Frilled surface elongated horizontally. With many blunt and spindle-shaped appendages sprinkled with nematocyst warts on each mouth-arm .....*R. verrilli* (Fewkes)

## (39) Family Stomolophidae

Diagnosis emended from Mianzan & Cornelius (1999): Scapulatae with a permanent central mouth opening at center of the arm disk. Mouth-arms coalesced throughout their entire length. No club-shaped or filamentous appendages on mouth-arms. Without ring canal. Only the genus *Stomolophus* is included in this family.

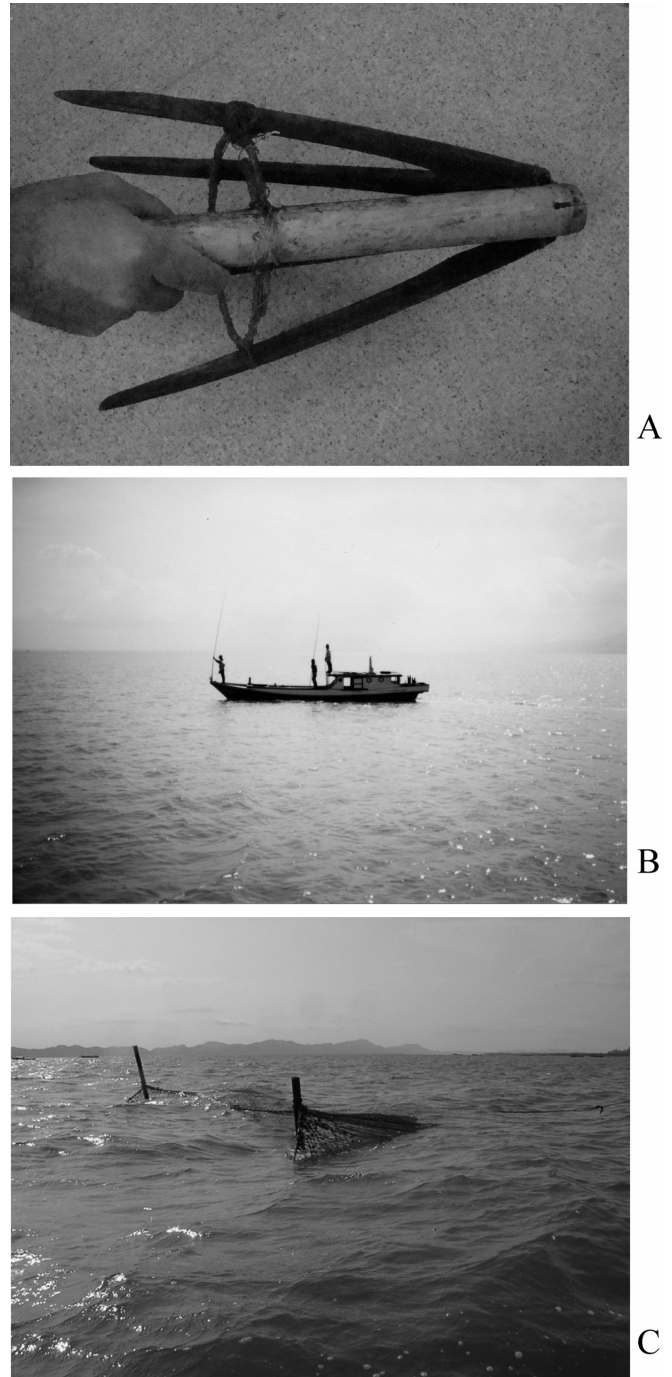
Genus *Stomolophus*

Diagnosis: See diagnosis of family Stomolophidae.

Remarks: Although the genus *Stomolophus* includes two species, *S. meleagris* L. Agassiz and *S. fritillarius* Haeckel, several authors have suggested that the latter species is a synonym of the former (Mayer 1910, Bigelow 1914, Bigelow 1940, Kramp 1955, Morandini et al. 2006). So, no identification key to the species will be supplied in this study.

**Jellyfish fishery in Southeast Asia**

In Southeast Asia, jellyfish are caught by set-net, drift-nets, push-nets, beach-seines, weirs and hooks. There is no distinctive difference in the fishing methodology applied to different species (Omori & Nakano 2001). Small shrimp trawls have been employed at Kuala Tanbangan, while hooks are used in Kotabaru. The hook is furnished with four wood sticks on the tip of a 4–5 m long bamboo pole (Fig. 8A). Two or three fishermen on board look for jellyfish near the surface and hook them individually by hand (Fig. 8B). In Bagan Datoh and Sittwe, jellyfish are caught using a set-net with a rectangular mouth set across a tidal current (Fig. 8C). Gill-nets are used at Karangbolong.



**Fig. 8.** Fishing of jellyfish. A. Jellyfish hook used at Kotabaru, Indonesia, B. Jellyfish fishing by hook at Kotabaru, Indonesia, C. Jellyfish fishing by set-net at Sittwe, Myanmar.

The entire bodies of the Cilacap type and Ball type are brought back and sent to the local processing factory, but for the White type, fishermen often cut off the mouth-arms while at the sea and only the umbrellas are loaded into the boat. This is because the demand from the Japanese market is restricted to semi-dried umbrellas. However, requests for the mouth-arms have increased recently, as they are preferred in China.

**Table 1.** Commercially exploited edible jellyfish in Southeast Asia: list of species and their fishing grounds.

Taxa	Trade name (Type)	Local name	Country
Lobonematidae			
* <i>Lobonemoides gracilis</i> Light, 1914	?White		
<i>Lobonemoides robustus</i> Stiasny, 1920	White		Philippine, Vietnam, Thailand, Malaysia, Indonesia, Myanmar
* <i>Lomonema smithi</i> Mayer, 1910	?White		
Catostylidae			
<i>Acromitus hardenbergi</i> Stiasny, 1934	River	Lambung merah (at Bagan Datoh)	Malaysia, Indonesia
<i>Crambione mastigophora</i> Maas, 1903	Prigi		Indonesia
<i>Crambionella annandalei</i> Rao, 1931	Ball, Sunflower		Myanmar
<i>Crambionella</i> sp.	Cilacap, Sunflower	Ulbu ulbu biasa (at Karangbolong)	Indonesia
Rhizostomatidae			
* <i>Rhopilema esculentum</i> Kishinouye, 1891	?Red, ?China		Vietnam, ?Malaysia
<i>Rhopilema hispidum</i> (Vanhöffen, 1888)	Sand	Ulbu kiburu (at Kotabaru)	Vietnam, Indonesia

\*Not collected in the present study.

So far, six types of edible jellyfish that have been marketed with trade names have been collected in the present surveys and identified to scientific name. The seventh type, Red or China type is the most favored at markets in China and Japan. This type is probably *Rhopilema esculentum* (Omori & Nakano 2001) that is distributed along the Chinese coast from the Yellow Sea to the South China Sea, Vietnam, and Ariake Sea, Japan (Hong et al. 1978, Omori & Kitamura 2004, Nishikawa et al. 2008). The taxonomy of this species has been re-studied in detail (Omori & Kitamura 2004). Remaining to be identified is the Semi-China type that is fished occasionally in the Straits of Malacca and Bacan Island, Indonesia (Omori & Nakano 2001). Although the semi-dried commodity of the Semi-China type is similar to the Red type, we reserve identification of that species until we encounter intact, unprocessed specimens. Except for the Semi-China type, all commercially exploited edible jellyfish in Southeast Asia are listed in Table 1.

People who are engaged in the jellyfish fishery are most interested in finding fishing grounds where great numbers of the favored jellyfish type is distributed and then understanding how the amount of catch can be maintained over time. Jellyfish fisheries are often vulnerable to low market prices or competition with catches in other places, as the commodities are sold almost solely to China, Korea, and Japan. For example, although the White type was abundant at Malampaya Sound in Palawan Island, Philippines, fishing has stopped since October 2008, because large quantities have been caught at Kotabaru, Indonesia from July to September, and the transport cost of the product from Palawan to Japan was higher than that from Kotabaru (E. Nakano pers. comm.).

### Acknowledgements

The present investigation was carried out with financial support provided to M. Kitamura by the Institute of Marine

Invertebrates, Tokyo and to M. Omori by Mr. E. Nakano. S. Kanou, Y. Kawamura, M. Matsumura, M. Nagaoka, E. Nakano, and A.N. Oe offered inside advice about jellyfish fisheries in Southeast Asia and introduced us to a number of traders and dealers of jellyfish commodities in Indonesia, Malaysia, and Myanmar. M. Toyokawa kindly allowed us to examine his specimen from Muncar. While we were in Indonesia, very thoughtful assistance was given from R. Mine, F. Yamagami, H. Irisawa, E.D. Kusuma, and Sulistiono. G.S. Teoh in Malaysia and Hla Win and U Kyaw Lwin in Myanmar also helped in our surveys. Claudia Mills and D.M. Checkley, Jr improved the early manuscript through kind reading and comments. We are grateful for the assistance of all of the above.

### References

- Bigelow HB (1914) Note on the medusan genus *Stomolophus* from San Diego. Univ Calif Publ Zool 13: 239–241.
- Bigelow HB (1940) Medusae of the Templeton Crocker and Eastern Pacific, Zaca Expeditions, 1936–1938. Zoologica NY 25: 281–321, text-figs. 1–20.
- Chun C (1896) Beiträge zur Kenntniss ostafrikanischer Medusen und Siphonophoren nach dem Sammlungen Dr. Stuhlmann's Jb. Hamburg. Wiss Anst Jahrg 13: 1–19, 1 pl.
- Dawson MN (2005) Morphologic and molecular redescription of *Catostylus mosaicus conservativus* (Scyphozoa: Rhizostomeae: Catostylidae) from south-east Australia. J Mar Biol Ass UK 85: 723–731.
- Food and Agriculture Organization of United Nations (2007) Fishery statistics, Capture production. FAO Statistics Series 194, Rome.
- Hong H, Zhang S, Wang C (1978) *Hai tsue* (edible jellyfish). Science Publications, Beijing, 70 pp. (in Chinese)
- Hong H, Zhang S (1982) Edible jellyfish in the coasts of China. J Xiamen Fish College 1: 12–17. (in Chinese)
- Hsu CT, Chin TG (1962) Studies on the medusae from the Fukian coast. J Xiamen Univ 9: 206–224. (in Chinese with English ab-

- stract)
- Kishinouye K (1922) Echizen kurage, *Nemopilema nomurai*. Dobutsugaku Zasshi, Tokyo 34: 343–346, pl. 9. (in Japanese)
- Kramp PL (1955) A revision of Ernest Haeckel's determinations of a collection of medusae belonging to the Zoological Museum of Copenhagen. Deep-Sea Res 3 Suppl: 149–168.
- Kramp PL (1961) Synopsis of the medusae of the world. J Mar Biol Ass UK 40: 1–469.
- Light (1914) Some Philippine Scyphomedusae, including two new genera, five new species, and one new variety. Philipp J Sci 9D: 195–231.
- Maaden H van der (1935) Kritische Bemerkungen über die beschriebenen Arten der Rhizostomeen-Gattung *Acromitus*. Zool Meded 18: 228–236.
- Maas O (1903) Die Scyphomedusen der Siboga Expedition. Siboga Exped Monogra 11: 1–91, pls. 1–12.
- Mayer AG (1910) *Medusae of the World. Scyphomedusae*, Vol. 3, pp. 499–735, Pls. 56–76. Washington, DC.
- Menon MGK (1930) The Scyphomedusae of Madras and the neighbouring coast. Bull Madras Govt Mus 3: 1–28, 3 pls.
- Menon MGK (1936) Scyphomedusae of Kurusadai Island. Bull Madras Govt Mus NS, Nat Hist Sec 1(2): 1–9, 1 pl.
- Mianzan HW, Cornelius PFS (1999) Cubomedusae and Scyphomedusae. In: South Atlantic Zooplankton (ed Boltovskoy D). Backhuys Publishers, Leiden, pp. 513–559.
- Morandini AC, Soares MO, Matthews-Cascon H, Marques AC (2006) A survey of the Scyphozoa and Cubozoa (Cnidaria, Medusozoa) from the Ceara coast (NE Brazil). Biota Neotropica 6(2): BN01406022006.
- Morandini AC (2009) Case 3485, *Lychnorhiza lucerna* Haeckel, 1880 (Cnidaria, Scyphozoa, Rhizostomeae): proposed conservation of generic and specific name. Bull Zool Nomenclature 66: 242–246.
- Nishikawa J, Thu NT, Ha TM, Thu PT (2008) Jellyfish fisheries in northern Vietnam. Plankton Benthos Res 3: 227–234.
- Nishikawa J, Thu NT, Yusoff FM, Lindsay DJ, Mulyadi, Mujiono N, Ohtsuka S, Nishida S (2009) Jellyfish fisheries in Southeast Asia, with special reference to those in Vietnam, Indonesia and Malaysia. Kaiyo Monthly 41(7): 401–411. (in Japanese)
- Omori M (1981) Edible jellyfish (Scyphomedusae, Rhizostomeae) in the Far East waters: a brief review of the biology and fishery. Bull Plankton Soc Japan 28: 1–11. (in Japanese)
- Omori M, Kitamura M (2004) Taxonomic review of three Japanese species of edible jellyfish (Scyphozoa: Rhizostomeae). Plankton Biol Ecol 51: 36–51.
- Omori M, Nakano E (2001) Jellyfish fisheries in southeast Asia. Hydrobiologia 451: 19–26.
- Rao HS (1931) Notes on Scyphomedusae in the Indian Museum. Records Indian Mus 33: 25–55, pls. 3–4.
- Stiasny G (1920) Die Scyphomedusen-Sammlung des Naturhistorischen Reichsmuseums in Leiden. III. Rhizostomae. Zool Meded Leiden 5: 213–230.
- Stiasny G (1921) Studien über Rhizostomeen mit besonderer Berücksichtigung der Fauna des malayischen Archipels nebst einer Revision des Systems. Capita Zool Deel I (2): pp. viii+179.
- Stiasny G (1934) *Acromitus hardenbergii* nov. spec., eine neue Rhizostome Meduse aus dem Malayischen Archipel. Zool Meded 17: 1–7.
- Stiasny G (1937) Scyphomedusae. Sci Rep Murray Exped 1933–34 4(7): 203–242, pl. 1.
- Tahera Q, Kazmi QB (2006) New records of two jellyfish medusae (Cnidaria: Scyphozoa: Catostylidae: Cubozoa: Chirodromidae) from Pakistani waters. J Mar Biol Ass UK 2, biodiversity records 2: doi: 10.1017/S1755267206002612.
- Uchida T (1936) Class Scyphozoa. Fauna Nipponica 3(2), Sanseido, Tokyo, pp. 1–94. (in Japanese)
- Uchida T (1955) Scyphomedusae from the Loochoo Islands and Formosa. Bull Biogeog Soc Japan 16–19: 14–16.
- Vanhöffen E (1888) Untersuchungen über semäostome und rhizostome Medusen. Bibliotheca Zoologica, Stuttgart, 1(3), 52 pp., 6 pls., 1 map.