

BIODIVERSITY OF SCYPHOZOAN AND CUBOZOAN JELLYFISH  
IN KOTA KINABALU WATERS,  
SABAH, MALAYSIA

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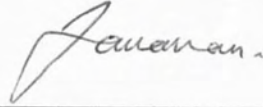
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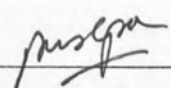
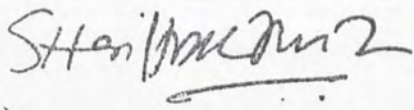
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## ABSTRACT

The Biodiversity of Scyphozoan and Cubozoan jellyfish in Kota Kinabalu waters was carried out via ecological observation and taxonomic studies. Jellyfishes were captured from two main sites, BMRI jetty waters and Tanjung Aru Beach, and also random sites, Pantai Dalit and Trayong (Tuaran District). Captured specimens were preserved in 5% formalin buffered seawater and identified to species level through Kramp (1961). Sampling was also done for planulae and ephyrae with plankton nets with 80 micron mesh size in the two main sites, but failed to obtain any results. Throughout the study period of 5 months from September 2006 to January 2007, eleven species of Scyphozoan jellyfish and one Cubozoan box jellyfish was found. The jellyfish from Class Scyphozoa were *Aurelia aurita* (Linne, 1758), *Aurelia sp.*(not able to identify to species level), *Mastigias papua* (Lesson, 1830), *Mastigias sp.* (not able to identify to species level), *Thysanostoma thysanura* (Haeckel, 1880), *Drymonema dalmatinum* (Haeckel, 1880), *Acromitus flagellatus* (Maas 1903), *Chrysaora sp.*(not able to identify to species level), and 3 different Rhyzostome species that were not able to be identified to genus level. The jellyfish from Class Cubozoa was *Chiropsalmus quadrigatus* (Haeckel, 1880) as of Kramp (1961). There is possibility that this Cubozoan jellyfish might be a new species.



## ABSTRAK

Kajian Biodiversiti Ubur-ubur Kelas Scyphozoa dan Cubozoa dijalankan melalui pemantauan ekologi dan kajian taksonomi. Ubur-ubur ditangkap daripada dua kawasan kajian utama iaitu Jeti IPMB dan Pantai Tanjung Aru dan juga kawasan yang dipilih secara rawak, Pantai Dalit dan Trayong (Daerah Tuaran). Specimen yang ditangkap diawet di dalam air laut dengan kandungan 5% formalin, dan kemudiannya dikaji untuk menentukan kedudukan taksonomi menggunakan Kramp (1961). Pensampelan juga dilakukan untuk larva ubur-ubur (planula) dan juvenil ubur-ubur (ephyra) dengan menggunakan pukot plankton bersaiz 80 micron di kawasan kajian utama. Dalam kajian selama 5 bulan daripada September 2006 hingga January 2007, 11 species ubur-ubur daripada kelas Scyphozoa telah ditemui, iaitu, *Aurelia aurita* (Linne, 1758), *Aurelia* sp. (tidak dikenal pasti ke tahap species), *Mastigias papua* (Lesson, 1830), *Mastigias* sp. (tidak dapat dikenal pasti ke tahap species), *Thysanostoma thysanura* (Haeckel, 1880), *Drymonema dalmatinum* (Haeckel, 1880), *Acromitus flagellatus* (Maas 1903), *Chrysaora* sp. (tidak dapat dikenal pasti ke tahap species), dan 3 species daripada famili Rhyzhostomatidae yang tidak dapat dikenalpasti ke tahap genus. Hanya satu ubur-ubur daripada kelas Cubozoa ditemui, iaitu, *Chiropsalmus quadrigatus* (Haeckel, 1880) sebagaimana yang diterangkan oleh Kramp (1961). Wujud kemungkinan species ini mungkin species baru.



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## CHAPTER 1

### INTRODUCTION

#### 1.1. Jellyfish

Also known simply as medusae especially in the academic world, the term jellyfish comprises both fresh water and sea water species. The fresh water species being only Hydrozoans, and Cubozoans and Scyphozoans being only marine.

##### 1.1.1 Overview

Many researches around the world have gained interest on this classes of cnidarians, resulting in publications on the identification. The interest on jellyfish rose due to rising number of them in our seas and also due to the ecological importance of these animals to other marine organisms as well as food for humans. Many local fishermen have started claiming that the numbers of jellyfishes in the sea today are far much higher than it was before. The ballast water, being the reason for this has raised attention for studies to be done on the jellyfish (Brightsurf, 2005). Another main reason for the raise of interest on jellyfish was since it became an edible organism (Omori and Eiji, 2001).



## 1.2 Ecological Importance

Many would say that jellyfishes do not carry an ecological importance, but, just like any other organism, they also play a part in the marine ecosystem. Jellyfishes are known to be the favourite food of marine turtles, which are greatly endangered now. Jellyfishes also act as a habitat for many types of fish larvae. In fear of the venom on the jellyfish, larger prey do not attack the small fish larvae. This provides shelter, and also food for larvae of fish (Arai, 1997).

## 1.3 Jellyfish Identification Guides

The main orders of scyphozoans, were stated in two books, Russel (1970), *The Medusae of The British Isle*, and Kramp (1961) *Synopsis of the Medusae of the World*, in spite of their restrictive name, these books reviews most of the information up to that date. Most scyphozoan enthusiasts have used this book as a bible at that time even recent researchers refer to these books for identification purposes.

Later came another compilation by Arai (1997), *A Functional Biology of Scyphozoa*, which had more findings and was a sharper and more advanced version of the earlier bible. The extent of information was so vivid that even this research refers mainly to it.

Most researches in recent times are more focused on the venom of the jellyfish and not on the diversity. The lack of knowledge on the venom has brought in researchers like Bailey et al.(2005), Nomura et al.(2005), Hawdon (1998), Fenner and Fitzpatrick (1986), Azuma (1986) and many others to study mainly on the potency of the venom and the



possible envenomation methods for it. Current researchers are also moving into extraction of new metabolites.

#### **1.4 Significance of Research**

The significance of this research is to be able to identify all the existing Scyphozoans and Cubozoans in Kota Kinabalu waters, in order to record frequent blooms according to species. Frequent blooms of these jellyfishes, caused many a problem to economical based sectors, and by knowing their bloom profile and biodiversity the extent of the problems could be controlled. A mitigation method could not be planned without knowledge of the affecting species.

#### **1.5 Objectives of Research**

The objectives of my study are :

1. To have an overview of the status of Scyphozoan and Cubozoan jellyfishes in Kota Kinabalu waters.
2. To determine the bloom occurrence of Scyphozoan and Cubozoan jellyfishes in Kota Kinabalu waters.
3. To identify the dominant species in our waters and the wideness of its distribution.

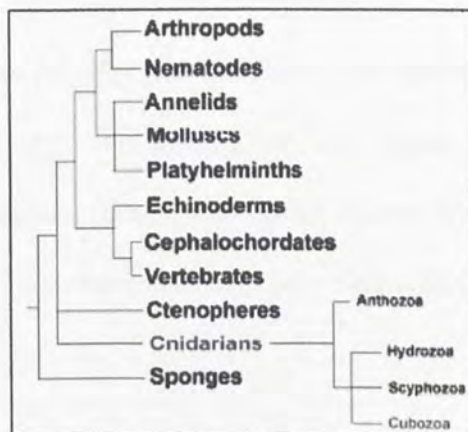


## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Overview of Jellyfish

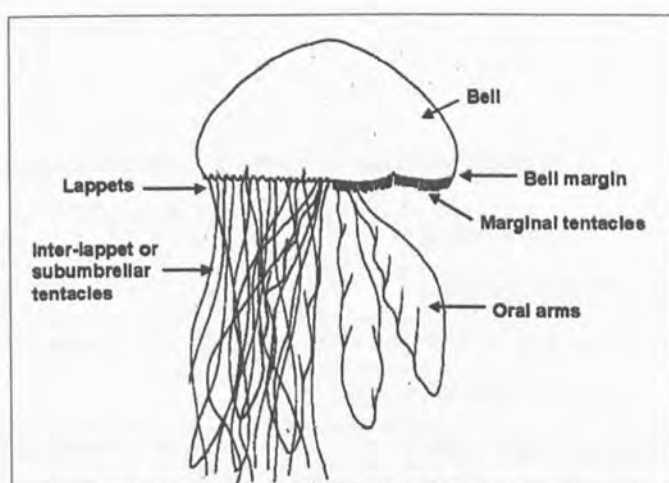
Naturally, the term ‘Jellyfish’ refers to all water creatures made of jelly-like substances. Ctenophores (comb jellies), hydrozoans, scyphozoans (true jellyfish), and cubozoans (box jellyfish) are among the common taxa referred to as jellyfish, in this study, however only two classes are considered, Class Scyphozoa (true jellyfish) and Class Cubozoa (box jellyfish). Nevertheless, both these classes belong to Phylum Cnidaria, which also includes anthozoans (corals, sea anemones and gorgonians) and hydrozoans.



**Figure 2.1** Phylogenetic standings of cubozoan and scyphozoan



Like the other cnidaria, jellyfish have no head, heart, blood, brain, and no special organs for respiration or excretion. They are made of 95% water and they do not have a rigid skeleton nor any specialised organ systems, and there are only two tissue layers, with relatively simple internal organisation. The bell extends to tentacles or oral arms, or in some species both. Depending on species, their basic anatomy differs. The basic anatomy of a regular jellyfish is shown in Figure 2.2.



**Figure 2.2** The basic anatomy of a jellyfish (Scyphozoan and Cubozoan)

For a moon jellyfish (*Aurelia aurita*) the mouth is in the centre, surrounded by four palps, or oral arms. The gonads, or sex organs, are four crescent-shaped bodies surrounding the central mouth. The broad, saucer-like bell of the jellyfish is crossed by numerous canals radiating from the center. Tentacles fringe the edge of the bell (marginal tentacles).

Most jellyfish probably live no more than a year, and many may only live a few months. In captivity, jellyfishes like the purple-stripe jelly (*Chrysaora colorata*), moon jelly and sea nettle (*Chrysaora quenquiecha*) can live for 2 to 3 years. In their natural

habitat it is generally thought that these and other larger types may live about a year, and maybe up to a year and a half. Small jellies, like the crystal and umbrella jellies probably live for 4 to 6 months at most. Generally, the smaller jellies are short-lived and may only be around for part of the year. It is difficult to know for sure the age of jellies since they cannot be tagged and tracked like fishes, and they do not have any kind of growth rings that indicate age. For comb jellies, the sea gooseberry may live 4 to 6 months, and in captivity the lobate comb jellies can live for over a year (probably a lot less than in their natural habitat) (Arai, 1997).

### 2.1.1. Difference Between Cubozoan and Scyphozoan

Cubozoan	Scyphozoan
Box shaped bell	Circular shaped bell
Umbrella margin built inwards into a velarium	Velum lacking in some, umbrella margin not built inwards
4 perradial rhopalia present	More than 4 present
Tentacles arise only from pedaliium	Tentacles arise from bell margin or oral arms
Only four pedaliiums present at corners of bell.	More or none in some

**Table 2.1** Differences of the two classes. Sources : Modified from, (Arai, 1997), (Southcott, 1982), (Bhamrah & Juneja, 1999), (Gershwin, 2002), (Seymour & Sutherland, 2001).

## 2.2 Nematocyst

Almost all cnidarians including cubozoids and scyphozoids possess a microscopic structure called nematocyst or also called stinging cells and stinging capsules. They are in fact not



capsules, but minute organ like structures that develop within a specialised cell called cnidoblast (Southcott, 1982). Within the cnidoblast lies a coiled harpoon-like structure that uncoils when it comes in contact with target. This is the main defense and feeding method of the scyphozoans and cubozoans. Zooplanktons and small fishes, being their main diet, are first injected with these nematocyst then absorbed into the stomach or velum through the manubrium. In the stomach of the jellyfish there is another form of nematocyst called the gastric cirri (Arai, 1997). The function of these structure is to prevent struggling prey from damaging the soft jelly walls of the velum.

### 2.3 Basic life cycle

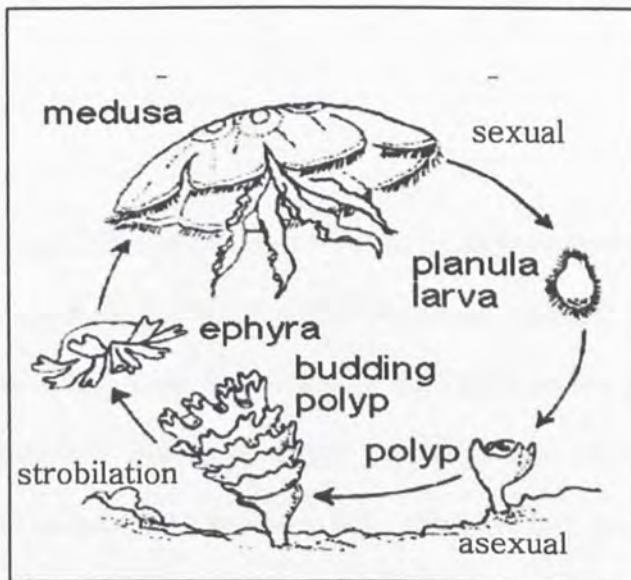
Scyphozoans and Cubozoans, with an exception of order Stauromedusae lead a double life, first as an attached polyp with tentacles stretching up, and later as drifting medusae with trailing tentacles. Order Stauromedusae however lack a medusa stage (Arai, 1997).

An adult female produces eggs and holds them around her mouth. The male jellyfish then releases sperm into the water, and the female drags in the sperms to the eggs for fertilisation with her oral arms. The fertilized eggs stay on the oral arm and grow into flat round larvae that are better known as planula. The planulae are then released into the water column. These planulae are carried by water currents until they find a perfect substrate to attach themselves to rocks. The settled planulae then metamorphosize into a polyp, resembling an anemone.



Polyps usually develop over a period of months, but may live for several years producing clones and waiting for the right time to strobilate (a process where a polyp metamorphoses into a few medusae). This asexual reproduction explains how a single pair can be the parents of millions of juveniles. The next stage is when strobilation begins, where free-swimming juvenile jellyfish or better known as ephyrae, break off from the polyp into the water. In the case of the moon jelly and most Rhizostome species this causes a bloom.

The ephyrae will start developing complete tentacles and oral arms resembling the medusae. A jellyfish in the medusae stage usually live 2 to 6 months and later perish in rough waters or get washed ashore (Arai, 1997).



**Figure 2.3** Basic Lifecycle of Scyphozoans and Cubozoans

## 2.4 Scyphozoan

Scyphozoans have attracted the attention of many types of people, from naturalist who adore their graceful movements, fishermen who dread their capability to prevent fishing, tourist who are dispelled by their painful sting to Asians who see them as a delicacy. Known better as true jellyfish, scyphozoans have been a drive in the improvement of mechanical technology for physiologists who examine them as a possible simple models for the functioning of various system.

This class of cnidarians has 200 over known species and holds four Orders, each with distinct characteristics.

## 2.5 Cubozoans

Class Cubozoa has only 1 order Cubomedusae, which houses 50 over species including the world record holder for the 'world's most venomous creature' , the *Chironex fleckeri* or better known as the sea wasp. Cubozoans or also known as box jellies got their name from their cube shaped bell. Box jellies gained popularity from increasing death among beach goers involved in stings. Cubozoans were unknown to many until the death rate in Australian waters increased to a tremendous rate without a specific known reason. As most box jellies are almost transparent and posses long tentacles, there are practically unseen in the water, which allows people to be stung unaware, and to make matters worse, the Sea wasp has a potent venom that could kill a full grown human in 30 seconds.



Another famous box jelly is the *Carukia barnesi* which was discovered by Dr. Jack Barnes around the early 1960's. This jellyfish's sting causes a condition called Irukandji syndrome, famous among the Australian natives.

## 2.6 The Dangers of Jellyfish

Both these classes of jellyfish pose a great deal of danger to humans and in major industries. While a box jelly, *Chironex fleckeri* or *Carukia barnesi* could be fatal to men, they also affect the tourism industry. Due to the painful stings of jellyfish, people refrain themselves from nearing a jellyfish infested beach.

In this case, all jellyfish blooms ward off humans, either due to their painful sting or their large quantity that clouds the water. Although the use of stinger protective net has been introduced to keep them out of the beach, the smell of decaying jellyfish is strong enough to continue the effects of warding off humans.

These blooms also pose a threat to the fisheries industry, both mariculture and the fishing industry. In the case of mariculture, blooms deplete the plankton abundance in the water, and decrease the food availability for juvenile cultures. The tentacles of the blooms could also cause fatalities to the cultured species. Furthermore, in the case of cage culture or sea pens, large blooms could clog the nets. This in return would block the water flow in the cages and obstruct the circulation, encourages the growth of microbes and depletes the dissolved oxygen in the water column. Either way, the culture would drop to a saddening level. On the other hand, fishing boats dread the occurrence of jellyfish in the water for

somewhat the same reason, whereby net clogging increases their workload and large blooms reduces their catch.

Meanwhile, for other industries that use seawater as a coolant for reducing heat in generators, mostly in power plants, the occurrence of jellyfishes either clogs their pipes or jams their filters. This consumes a great deal of energy and resources to be cleared. If the management were to know of an occurrence in advance, this can be prevented, and it would save their resources.

This brings to show that the identification of the specific species of jellyfish that roam our waters is essential in handling the problems caused by them, or at least in addressing the precautionary methods of mitigation.

## **2.7 Major Orders of Scyphozoans**

### **2.7.1 Order Stauromedusae**

The order includes all sessile or temporarily sessile polypoid medusae which attach to the substrate by an aboral disc on the exumbrella or an aboral stalk. It remains a non-free swimming medusa. The main body or calyx has a central mouth on a short quadrangular manubrium, with usually eight single primary tentacles and eight clusters of hollow, capitate secondary tentacles which in most species are borne on eight arms. The four longitudinal septa of the gastrovascular space are each indented from the exterior by a deep funnel. In sexual reproduction non-ciliated planulae larvae are formed, which develops into polyps and then directly into the mature medusae that very much resembles the polyp.



Settled planulae aggregates or polyps may also reproduce asexually by budding. (Arai, 1997; Southcott, 1982).

### **2.7.2 Order Coronatae**

This order includes mostly bathypelagic to mesopelagic (deep dwelling) medusae each of which has a deep furrow (coronal groove) dividing the aboral surface (exumbrella) into a central disc and a peripheral zone. The peripheral zone has a radial thickening (pedalia), marginal lappets with interspersed sense organs, and solid marginal tentacles. There is a single mouth with single lip, placed on a short manubrium. Radial septa fuse the subumbrella wall of the gastrovascular cavity with the exumbrella between the pedalia to form peripheral pouches. Four crescent-shaped fusions form gastric septa partially separating the stomach from the peripheral pouches (Arai, 1997).

In most cases, the life cycle is unknown. Where known, the polyps are solitary or colonial with firm periderm tubes of chitin. Ephyrae are produced by transverse fission (strobilation) and develop into adult sexual medusae. Other coronate polyp species may lack medusae, reproducing sexually within the tube (Arai, 1997)

### **2.7.3 Order Semaestomae**

This order includes Scyphomedusae with umbrella margin cleft into lappets, whereas the bell is not grooved by a coronal furrow. They lack pedaliium. Tentacles if present are hollow and marginal in position as the rhopalia. Stomach has a single central opening with frilly arms, which in some cases are in the form of four oral arms. Gonads are present in





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