CHAPTER

27

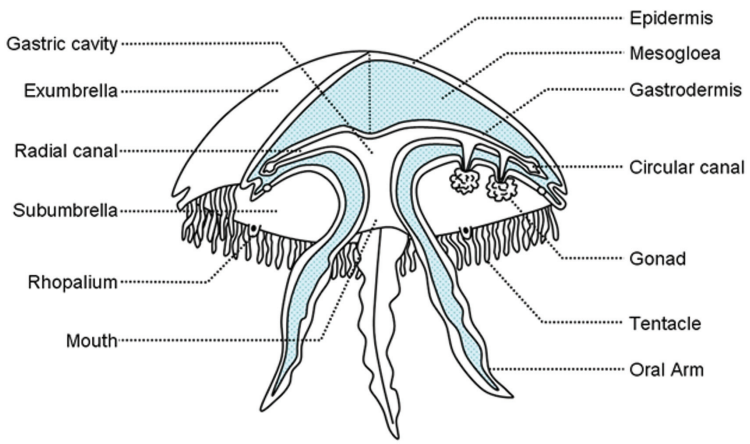
Jellyfishes-Diversity, Biology-Importance in Conservation

Dr. R. SARAVANAN
Marine Biodiversity Division
ICAR-Central Marine Fisheries Research Institute

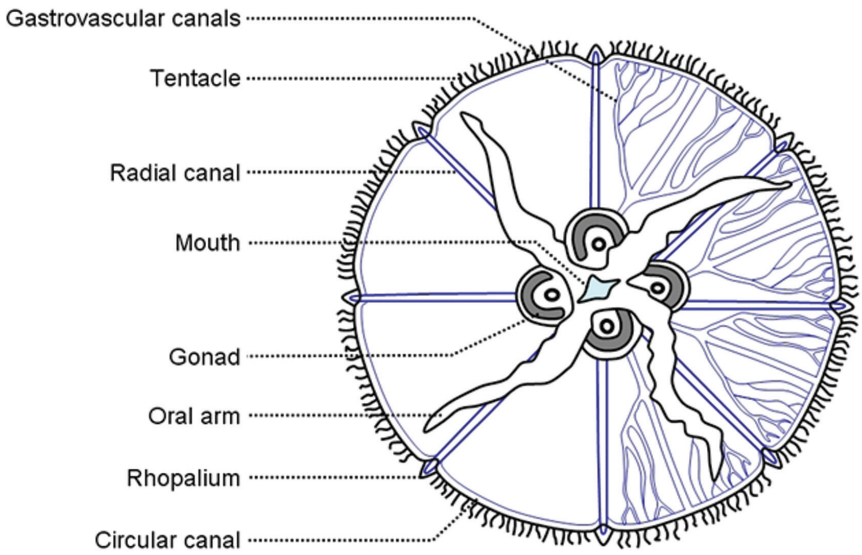
Jellyfish is a common word used for any gelatinous animal in marine waters. These include a wide variety of stinging and non-stinging jellyfishes. Jellyfishes are the oldest animal on planet earth from Pre-Cambrian period, and passed through 500 million years of natural selection. The term jellyfish generally refers to gelatinous zooplankton including medusae of the phylum Cnidaria(scyophomedusae, hydromedusae, cubomedusae and siphonohores) and planktonic members of the phylum Ctenophora, Salps and Pyrosomes etc. The true jelly fish are coming under the three Cinidarian classes *viz*., Hydrozoa, Scyphozoa and Cubozoa and seasonally swarm in the coastal waters. Among the three classes; representatives of Scyphozoan and Cubozoan are ranging in size from 2mm to 2 m bell diameter, however most of the hydrozoan jellyfishes are smaller than 2mm in bell diameter and belong to the mesoplankton. The biodiversity of the pelagic scyphozoan jellyfishes and Cubozoan jellyfishes is largely ignored in India other than a few works in this line. The first work on scyphozoan medusae was published way back in 1930, in which the scyphomedusae of Madras has been described with illustrations (Menon, 1930). Subsequent to this publication the above author has brought out scyphomedusae of Kurusadai Island (Menon, 1936). These are the two classic works which describe about the taxonomic features and distribution of scyphomedusae along the south east coast of India. Since then there is a long gap in the study of scyphomedusae in India. The scyphomedusae available in India was listed as 34 by Chakrapany (1984). The Medusae of the Travancore waters was studied by Nair (1951) and assessed the impact on fisheries.

Morphometric features of Jellyfishes

Jellyfishes are simple organisms with three layers of tissue viz., Endoderm, Ectoderm and Mesoderm. The body is composed of water over 90 percent. The umbrella shaped body which is called bell and the underside is covered with oral arms or tentacles. In jellyfishes difference in the bell margin is used as a differentiating character between different groups. The members of the order Semaeostomeae have



Aurelia medusa – cutaway diagram

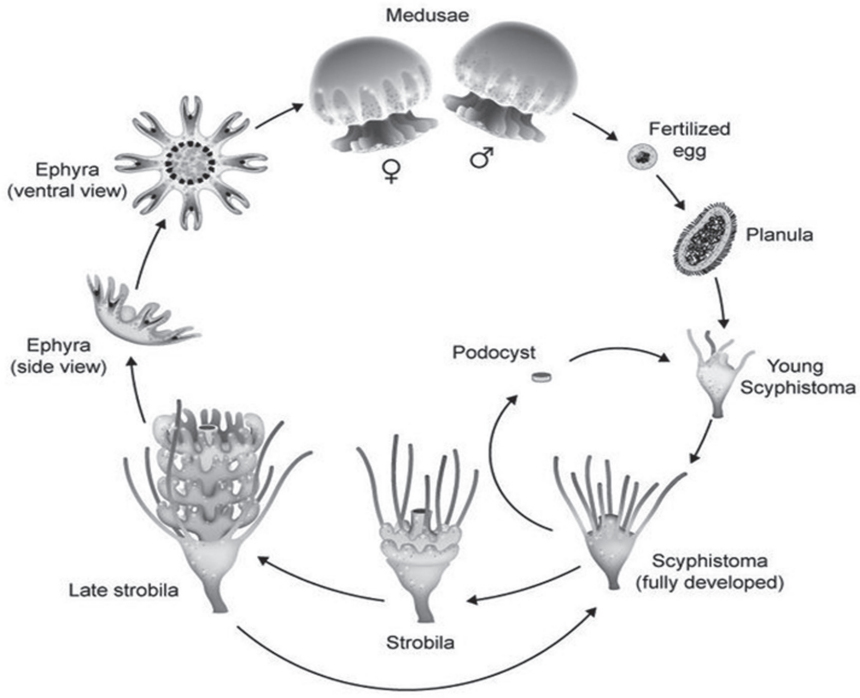


Aurelia medusa – subumbrella view

tentacles on the bell margin whereas the order Rhizostomeae have tentacles on the tip of oral arms. Jellyfish are 97% water and are semi-transparent.

Jellyfishes have two body layers, the outer layer epidermis and the inter layer gastrodermis. Between both layers is a thick layer of mesoglea which consists of fibres embedded in a hydrated matrix that contains cells. These layers of tissues make up the umbrella of the jellyfish which is usually bell shape, thus the umbrella is also known as the bell. The scyphozoan jellyfish are tetraradially symmetrical, meaning having many structures in multiples of four. It contains a simple gastrovascular cavity which acts as stomach. They are also characterized by having gastric filament in the stomach. Some scyphozoan jellyfish such as Semaestomeae contain an opening, or mouth at the subumbrella. There are four to eight oral arms near the mouth, which functions as arms to capture and transport food to the gastrovascular cavity. Jellyfish lack eyes, but possess many sensory receptors capable to detect light, pressure, temperature and gravity. These sensory receptors are concentrated in the marginal sense organ that contains the rhopalium (Nakanishi, 2015). Not all jellyfish possess tentacles. For Semaestomeae jellyfish, tentacles can be found at the margin of the bell or at the subumbrella whereas tentacles are absence from the Rhizostomeae jellyfish. Jellyfish contains network of canals that usually anestomoses with each others that formed various patterns.

Life cycle and biology: Cnidarian jellyfish, also called medusae, have complex life cycles that often involve a benthic stage: the polyp and the pelagic stage: the medusae or jellyfish. This bipartite life cycle alternates between an asexual, benthic polyp and a sexual, pelagic medusa. Medusae typically are produced asexually in abundance and grow rapidly in seasons (Russel, 1970).



Life cycle of the cannonball jellyfish *Stomolophus meleagris*; based on Calder (1982)

Diversity and distribution of jellyfishes in India:

Class Scyphozoa is ascribed with four orders, namely Stauromedusae, Coronatae, Semaeostomeae and Rhizostomeae with 65 genera and over 187 species globally. The diversity of scyphozoan jellyfishes along the Indian coastal waters has been reported as 29, however given the poor research attention given to this group, there may be more species to be recorded in the coming years.

Order Semaeostomeae:

The order Semaeostomeae composed of three families, four subfamilies, 18 genera and 56 species (Kramp, 1961). Semaestommeae jellyfish are characterized by four oral arms around the mouth. Tentacles are found at the umbrella margin. (Arai, 1997). The two important families of Semaeostomeae are Cyaneidae and Pelagiidae.

Order Rhizostomeae:

The order Rhizostomeae composed of two suborders, 10 families, 25 genera and approximately 89 species (Kramp, 1961). Rhizostomeae jellyfish are characterized by having bell margin cleft into lappet, with no tentacle on the bell margin, without a central mouth, with eight oral arms extended

from the subumbrella, where each oral arms are bear numerous secondary mouths. Network of canals are found beyond the stomach. (Kramp, 1961; Arai, 1997). The important orders of this family are Mastigiidae, Versurigidae, Lychnorhizidea, Catostylidea, Lobonematidae and Rhizostomatida.

List of Scyphozoan jellyfishes Occuring in Indian waters

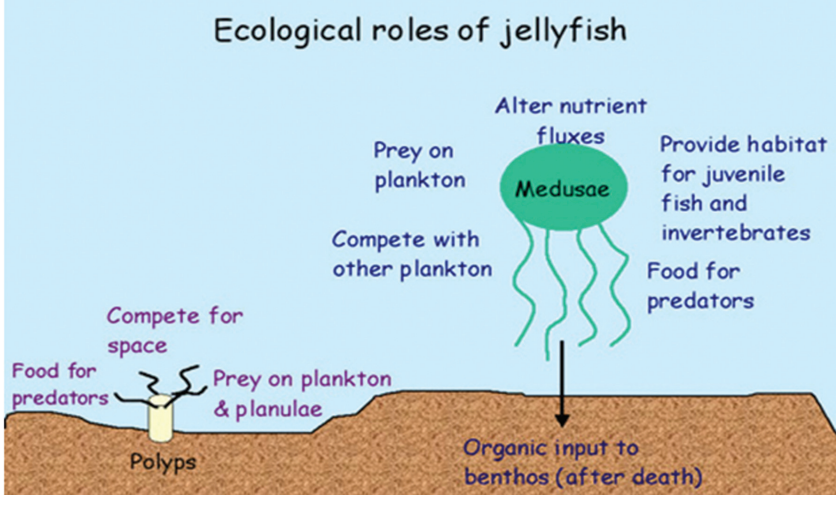
1 *Atolla wyvillei Haeckel, 1880*
2 *Nausithoe punctata Kölliker, 1853*
3 *Periphylla periphylla (Péron & Lesueur, 1810)*
4 *Cyanea nozakii Kishinouye, 1891*
5 *Chrysaora helvola Brandt, 1838*
6 *Chrysaora melanaster Brandt, 1838*
7 *Chrysaora quinquecirrha (Desor, 1848)*
8 *Pelagia noctiluca (Forsskål, 1775)*
9 *Aurelia aurita (Linnaeus, 1758)*
10 *Acromitus flagellatus (Haeckel)*
11 *Acromitus maculosus Light, 1914*
12 *Catostylus mosaicus (Quoy & Gaimard, 1824)*
13 *Crambionella stuhlmanni (Chun, 1896)*
14 *Crambionella orsini (Vanhöffen)*
15 *Lobonema smithii Mayer, 1910*
16 *Lobonemoides robustus Stiasny, 1920*
17 *Lobonemoides sewelli Rao, 1931*
18 *Lychnorhiza malayensis Stiasny, 1920*
19 *Rhopilema hispidum*
20 *Cassiopea andromeda (Forsskål, 1775)*
21 *Cephea cephea (Forskål, 1775)*
22 *Marivagia stellata Galil & Gershwin, 2010*
23 *Netrostoma coerulescens Maas, 1903*
24 *Netrostoma setouchianum (Kishinouye, 1902)*
25 *Mastigias papua (Lesson)*
26 *Versuriga anadyomene (Maas)*
27 *Phyllorhiza punctata Lendenfeld, 1884*
28 *Thysanostoma loriferum*
29 *Thysanostoma thysanura Haeckel, 1880*

List of Cubozoan Jellyfishes occurring in Indian waters

1. *Alatina alata (Reynaud, 1830)*
2. *Alatina madraspatana (Menon, 1930)*
3. *Tamoya gargantua Haeckel, 1880*
4. *Chiropsalmus quadrumanus (F. Muller, 1859)*
5. *Chiropsoides quadrigatus (Haeckel, 1880)*
6. *Chiropsoides buitendijki (van der Horst, 1907)*

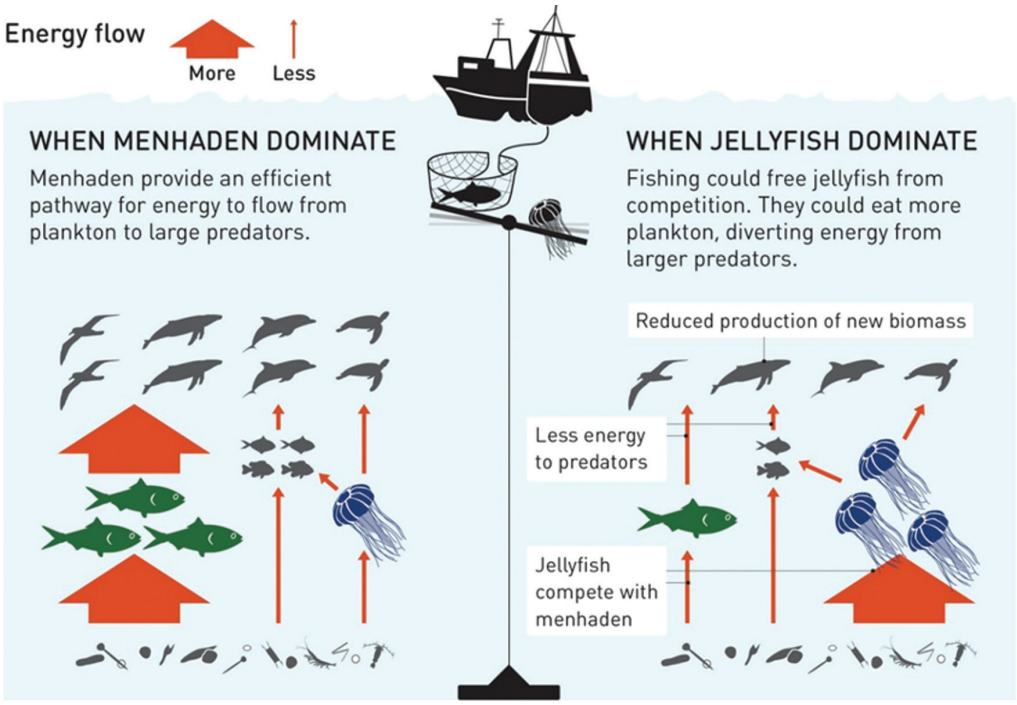
Ecosystem importance of Jellyfishes:

Jellyfishes are distributed globally and often forms swarms under favourable conditions that last for weeks to months before they collapse. Though jellyfish population swarms occur in many places at an increasing trend, but the lack of time series data on their distribution and abundance along the Indian coast prevent us from concluding their population dynamics. Establishing a time series data around the Indian subcontinent and island territories on the jellyfish abundance is difficult due the fact that in most case these jellatinous creatures get damaged in bottom trawls and zooplankton tows and not properly recorded. Jellyfish directly interfere with many human activities (reviewed by Purcell et al., 2007; Richardson et al., 2009), specifically, through stings (beach closures, tourism impacts, injuries, deaths), clogging intakes (coastal power and desalination plants, mining and military operations, shipping, aquaria), interference with fishing (clogged and split nets, spoiled catch, stung fishers, damaged gear, capsized boats), aquaculture (fish deaths, pens fouled by polyps), and marine biological surveys (interference with trawls and acoustic surveys). Jellyfish also have ecosystem impacts with indirect effects on fisheries resources that are difficult to quantify, such as their roles as predators of zooplankton, fish eggs and ichthyoplankton, as vectors for parasites, as food for fish, and as refugia and food for some species of juvenile fish.



Ecological roles of medusae and polyps. Adapted from Kingsford et al. 2000

Invasive species of jellyfish are reported in 21 of 45 LMEs. For the most part, invasive species were not responsible for the observed increases reflected in the results; however, the widespread detections demonstrate that jellyfish are truly global invaders of significant concern. Thriving populations of invasive jellyfish in systems like the Mediterranean and Black Seas should serve as warnings for other ecosystems around the globe, and it is likely that far more invasions have occurred than are reported (Holland et al., 2004). It is considered that the drivers of Change in jelly fish population, includes over-fishing, aquaculture, climate change, habitat modification, and introductions of alien species, suggest that human-caused coastal deterioration may have benefitted jellyfish and led to their increasing populations.



Potential ecosystem shift due to fishing- From fish dominated to jellyfish dominated(Robinson et al. 2015)

Potential ecosystem shift due to fishing- From fish dominated to jellyfish dominated(Robinson et al. 2015)

Gut content studies of Jellyfishes

In order to study the gut content of jellyfishes their gastric pouches are excised, opened and the contents rinsed through a 100-ìm mesh sieve. This is a common procedure for concentrating gut contents and handling samples of large medusae. The collection of jellyfish for gut content studies should be preferably done in night hours. All medusae should be studied within 35 min of collection, which is less than published prey digestion times (Arai 1997).

Global jellyfish Fisheries

Dried jellyfish is considered to be a delicacy in many Asian countries. Jellyfish are also purported to have beneficial medicinal properties and are traditionally used to treat ailments such as arthritis, hypertension and back pain (Hsieh et al. 2001). Jellyfish have been harvested off the coast of China for more than 1700 years (Omori & Nakano 2001)

Only jellyfish belonging to the Order Rhizostomeae are harvested for food. The rhizostomes are favoured because they are typically larger and have more rigid bodies than other scyphozoan orders. When processed, the rhizostomes produce a product that has the desirable, almost crunchy texture. Some species considered to be edible are:

Cepheidae	*Cephea cephea*
Catostylidae	*Catostylus mosaicus, Crambione mastigophora, Crambionella orsini*
Lobonematidae	*Lobonema smithi, Lobonemoides gracilis*
Rhizostomatidae	*Rhopilema esculentum, Rhopilema hispidum, Rhizostoma pulmo*
Stomolophidae	*Stomolophus meleagris, Stomolophus nomurai*

Indian Jellyfish fisheries

There is an active jellyfish fisheries along Kerala, Gujarat and Andhra Pradesh and four species support jellyfish fishery in India *viz*., *Crambionella stuhlmanni*, *C. orsini*, *Catostylus perezi*, *Rhopilema hispidum,* which are processed and exported to overseas markets.

Guidelines for Jellyfish studies

Preservation Method

Scyphozoans are typically preserved for morphological analyses in a solution of 4% formalin in seawater with the appropriate label (i.e. 4 parts formalin [37% w/v] and 96 parts seawater). Place the jellyfish in plastic container with a label (waterproof paper) and pour formalin until the organism is cover completely.

If you are using a plastic bag, place the organisms in a bag, fill it with formalin, twist the bag, and use a rubber band to wrap the plastic bag. When is tight enough, fold the tip of the plastic bag and with the last part of the rubber band secure the folded part of the bag. Excess 4% formalin solution is used, and it can be renewed after two weeks to ensure successful fixation.

Tissue storage for DNA studies

1. Flush the oral arms or bell margin with tapwater. Repeat several times to displace all debris.
2. Using clean forceps/scissors, cut a half-small-fingernail sized piece of tissue from the oral arm or bell margin.
3. Preserve the tissue in one vial of preservative. (Make sure there is excess preservative; guard against diluting the preservative with too much water).

4. With forceps hold a piece of oral arm and cut it with clean scissors or razor blades.
5. Place the piece of tissue in a vial with 95% ethanol

Specimen Information to be collected

Geographic location

Depth

Date (of collection)

Collector (e.g. your name)

Photograph

Whole jellyfish preserved? (yes/no; where)

Conditions

Photograph of the following features

Bell: Differences in the bell margin can be useful to distinguish orders of medusae.For example, the Semaeostomeae, in contrast to the Rhizostomeae, have tentacles on the bell margin.

Canal: Canal structure inside the bell

Cnidae: In Jelly fish, most cnidae are located in and around the tentacles and/or oral arms. Their shape is used in identification.

Mouth-arms: Differences in the form of the mouths distinguish orders of scyphomedusae. The Rhizostomeae have many small mouths distributed over their oral arms in contrast to semaeostomes, for example, which have a single, much larger, central mouth. The form and distribution of mouths over the oral arms can also be useful for distinguishing taxa within the Rhizostomeae.

Rhopalia: Rhopalia (singular rhopalium) are the most obvious sensory structures of scyphozoan jellyfish. They include specialized structures for sensing light (eyespots) and movement or direction with respect to gravity (statoliths).

Checklist to study the Morphological features of Scyphozoan and Cubozoan Jellyfishes

1	Tentacles present on umbrella (on margin or underside) (or) Tentacles lacking on umbrella	
2	Umbrella almost spherical (or) Umbrella not spherical	
3	Umbrella without prominent white spots (or) umbrella with numerous prominent white spots	

4	Mouth-arms with stout finger-like appendages (or) Mouth-arms with long and slender fi laments basally	
5	Tentacles on underside of umbrella (or) Tentacles on margin of umbrella	
6	Tentacles in a wide band around underside of umbrella; medusae large (or) Tentacles in 8 U-shaped clusters on underside of umbrella	
7	Colour of the Umbrella	
8	Umbrella cuboid or not cuboid	
9	Umbrella higher than a hemisphere (or) Umbrella decidedly fl attened.	
10	Tentacles round noodles like or pasta like flattened	