**JOURNAL OF TROPICAL LIFE SCIENCE**
2021, Vol. 11, No. 2, 181 – 186
http://dx.doi.org/10.11594/jtls.11.02.07

**Research Article**

# Comparative Study of Morphology and Histology on Papuan Jellyfish *Mastigias papua* in Kakaban Lake and Sea

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*Article history*:
Submission August 2020
Revised August 2020
Accepted December 2020

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**ABSTRACT**

Jellyfish are marine invertebrates belonging to the phylum Cnidaria. *Mastigias papua* is a jellyfish from the Scyphozoa class. This study investigates differences in environmental parameters, morphology, and shape of nematocyte cells using the histological method with (SEM) Scanning Electron Microscopy on *M. papua* jellyfish Kakaban Lake and Sea. Environmental parameters in Kakaban Lake and Kakaban Sea were measured for salinity, temperature, and pH. The t-test analysis results showed significant differences in environmental parameters in Kakaban Lake and Kakaban Sea ($p < 0.05$). Body diameter and length of jellyfish tentacles were measured and analyzed using SPSS 16 with a t-test. The t-test analysis showed that for *M. papua* jellyfish in Kakaban Lake and jellyfish in the Kakaban Sea showed a significant difference in the diameter and length of the body tentacles ($p < 0.05$). The SEM results of jellyfish in the Kakaban Sea showed that the tentacles of *M. papua* in the Kakaban Sea had nematocytes consisting of three forms, namely microbasic isorhiza, atrichouz isorhiza, and merotrichous isorhiza. *M. papua* in Kakaban Lake has nematocyst cells, which comprise of one type, namely Microbasic mastigophoran, where the number of nematocytes is minimal and has a smaller size than the Papuan *Mastigias* jellyfish that live in the Kakaban Sea. Nemeatocyte cells are stinging cells in jellyfish. SEM results show that the jellyfish in Kakaban Lake cannot sting because the size of the jellyfish tentacles is reduced to smaller, fewer nematocyte cells and different shape nematocytes. Based on the results of this study, it can be concluded that there are differences in environmental parameters, body dimensions, tentacle length, and the size and number of nematocytes between *M. papua* jellyfish in Dunau and in the Kakaban Sea.

*Keywords: Kakaban lake, Mastigias papua, Nematocyte cells*

## Introduction

Like other animal classes in this phylum, jellyfish have stingers (nematocytes), which are found in cnidocytes. Nematocytes are complex intracellular structures in Cnidarians [1]. Nematocytes function as a means of self-defense as well as for searching for prey, which in this cell has a kind of thorn complete with threads to attract prey so that it does not escape its grip. Jellyfish have a variety of stinging cells, ranging from those that cause mild stings to those that are deadly. The higher the sting effect level of the animal, the higher its venom content.

Commonly encountered jellyfish generally contain venom so that when humans are stung, it will cause hemolytic, cytolytic, cardiotoxic, neurotoxic, musculotoxic, clastogenic, clastogenic, and enzymatic activity effects [2 - 9]. However, there is one island in Indonesia that has its own uniqueness, namely Kakaban Island which is located in Berau, East Kalimantan, on this island there is a lake that was formed in the middle of the ocean since 2 million years ago, which is based on the assumptions and experiences of people who travel on the island of Kakaban. The jellyfish that live on the island lose the ability to sting so that people who swim and touch the jellyfish do not

*How to cite:*
Nurasmi N, Ridwan A, Awaludin A (2021) Comparative Study of Morphology and Histology on Papuan Jellyfish *Mastigias papua* in Kakaban Lake and Sea. Journal of Tropical Life Science 11 (2): 181 – 186. doi: 10.11594/jtls.11.02.07.

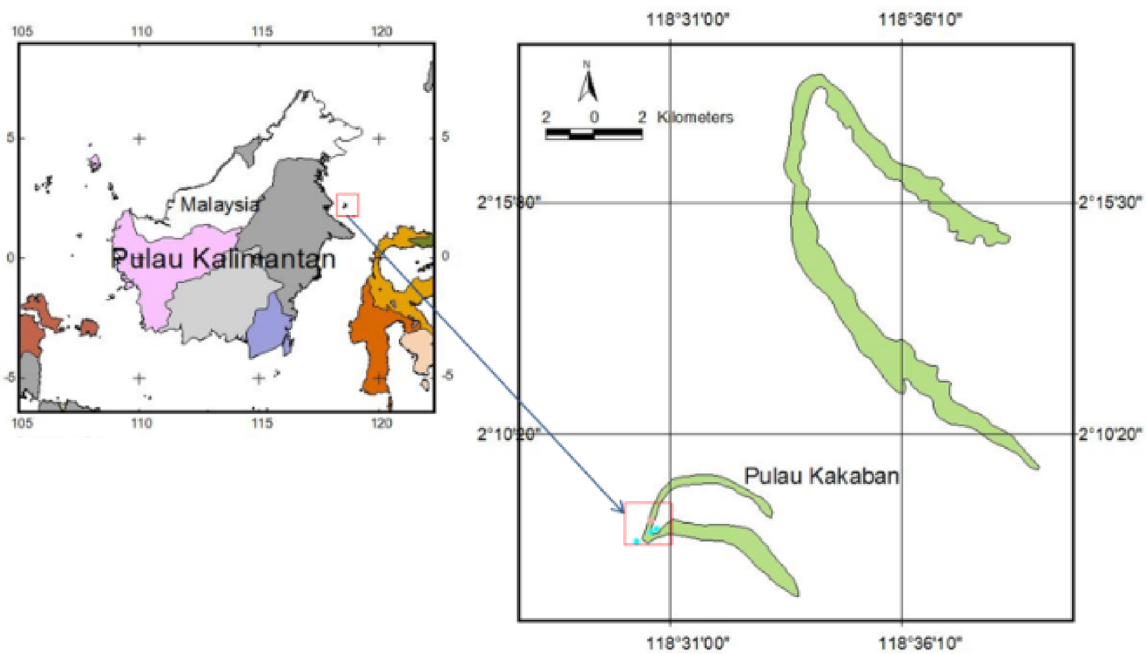


Figure 1. Sampling location

feel any symptoms of poison due to the sting of the animal. This uniqueness causes Kakaban island to be nominated as a UNESCO world heritage area. The only well-known lake that is similar to Kakaban Lake is found only in an archipelago in Micronesia, with fewer species when compared to Kakaban. In Kakaban Lake, there are species of spotted jellyfish (*Mastigias papua*). The uniqueness of the jellyfish in Kakaban Lake is interesting, so researchers are interested in studying the comparison of the morphology and structure of nematocytes with (SEM) Scanning Electron Microscopy *M. papua* in the Kakaban Lake and Sea.

## Material and Methods

### *Sampling location Kakaban Lake*

Sampling was carried out at Kakabandan Laut Kakaban Lake, Kakaban Lake located on the uninhabited Kakaban Island, administratively included in the area of Berau Regency, Derawan Islands, East Kalimantan.

### *Measurement of body diameter and tentacle length*

Jellyfish were collected in Kakaban Lake and Kakaban Sea. Immediately after collection, the body diameter and tentacle length of each type of jellyfish were measured using a stainless steel caliper. The body diameter and tentacle length of each jellyfish species were recorded. After weighing the jellyfish, samples were stored in the sample bottles.

### *Data analysis*

Body diameter and tentacle length of each jellyfish were measured and analyzed using SPSS 16 with a t-test to determine the ratio of jellyfish tentacle lengths on Kakaban Island and Kakaban Lake.

### *Analysis of nematocysts structure by SEM (Scanning Electron Microscopy)*

To obtain a picture of nematocytes, SEM was observed. The length of the jellyfish tentacles was put in PBS (phosphate buffer solution) at cold temperatures. The tentacles were isolated and immersed in a boudin solution for 24 hours. The tentacles were then dehydrated with alcohol levels ranging from 70%, 80%, 90%, and 100% each for 30 minutes, then dried with a Hot Plate (JEOL JHP 1100). The dried tentacles are cut with a diameter of 5 mm to be glued to the holder, then a Fine Coater (JEOL Ion Sputter JFC 1100) is installed with a current of 7.5 mA voltage of 1.2 KV for 4 minutes. Plating is done with gold: palladium with a concentration of 80%: 20% with a thickness of 200 – 400 Angstroms. The sample was then ins talled with an Analytical Scanning Electron Microscope Machine (JEOL Type JSM 6360 LA) to be observed.

Table 1. Profile of Kakaban lake environmental parameters

| Parameters | Unit | Mean Value ± SD |
|---|---|---|
| Salinity | Ppt | 21 ± 1.73 |
| Temperature | ˚C | 29.5 ± 0.57 |
| pH | ppm | 7.8 ± 0.20 |

Table 2. Profile of Kakaban marine environment parameters

| Parameters | Unit | Mean Value ± SD |
|---|---|---|
| Salinity | ppt | 29.6 ± 1.52 |
| Temperature | ˚C | 28.3 ± 0.577 |
| pH | ppm | 8.1 ± 0.05 |

Table 3. Mean body morphological size (± SD) of jellyfish *Mastigias papua* from Kakaban lake and sea

| Parameters | Lake | Sea |
|---|---|---|
| Body diameter (cm) | 12.8 ± 1.3 | 3.36 ± 0.35 |
| Tentacle length (cm) | 1.1 ± 0.05 | 1.1 ± 0.12 |

**Results and Discussions**

Environmental parameters at the sampling location can be seen in Table 1 and Table 2. The results of the t-test analysis on environmental parameters showed that the salinity and pH between Kakaban Lake and the Sea of Kakaban were significantly different ($p < 0.05$). Simultaneously, the temperature was not significantly different or the same ($p > 0.05$). The existence of differences in salinity and pH parameters can delay the occurrence of changes in jellyfish in Kakaban Lake so that the jellyfish can adapt to the environment to survive. Several factors influence protein formation.

One of the most influential factors is the environment. The lower pH in Kakaban Lake causes the enzyme to form protein venom not to build because the salinity does not support the formation of the enzyme. Each enzyme has a specific temperature and pH that causes the activity to reach its optimum. The jellyfish in Kakaban Lake did not have tentacles, and this indicates that the protease did not show any activity. This is possible due to the thermal denaturation of both the substrate and the enzyme. The higher temperature in Kakaban Lake also affects the formation of proteins, because higher temperatures will cause the enzymes to denaturation and break down, so they are unable to form. Organisms that grow at high temperatures require enzyme adaptation to provide molecular stability as well as structural flexibility [10]. To be able to survive, enzymes must conform to pH, temperature, and salinity. The pH condition of the jellyfish can explain their original habitat. Proteins with a high pH of 8.1 in the Kakaban Sea provide enzyme activity so that jellyfish tentacles in the Kakaban Sea can form. Conditions with high salinity, following the requirements of the place of origin of the sample from the sea, which has a salinity of 29.6 ppt.

Based on the morphological size of the body diameter, the results of the t-test analysis showed that *M. papua* in the Kakaban Lake and Sea had a significant difference ($p < 0.05$). The jellyfish in the lake have a larger size compared to those in the Kakaban Sea; this is because the energy allocation is not used much for tentacle growth. In general, jellyfish allocate some of their energy for the development of tentacles. Meanwhile, the jellyfish in the Kakaban Sea have a smaller body diameter because the energy allocation is mostly used for tentacle growth.

The t-test results on the morphological size of the tentacles showed that *M. papua* jellyfish in the lake and sea had a significant difference ($p < 0.05$). Papuan Mastigias jellyfish in the sea have tentacles and are longer in size compared to jellyfish in the lake. *M. papua* in the lake has tentacles but is reduced to be shorter when compared to those in the Kakaban Sea.

The morphological characteristics of the tentacles and nematocysts were examined using SEM. The observation by SEM (Figure 2) shows that the nematocyte cell structure found in *M. papua* in the Kakaban Sea contains three forms of nematocysts cells, namely merotrichous isorhiza, atrichouz isorhiza and anisorhiza (Figure 2). Nematocytes are the most unique structures found in cnidarians. The nematocytes enclosed inside the cell are called cnidocytes, which in most cases are subjected to a trigger such as cnidocil which is a modification of the cilia. The nematocytes secreted from the Golgi apparatus are referred to as cnidoblasts [11]. The cell structure of nematocytes varies by species, but generally consists of hollow coiled threads with spines on the surface layer. Nematocytes are concentrated in tentacles or arms [12]. A tentacle can have hundreds or thousands of nematocytes embedded in the epidermis. The severity of the sting depends on the species of jellyfish, the penetrating power of the nematocytes, the thickness of the victim's skin and the sensitivity of the victim to poison [13]. Merotrichous isorhizae,

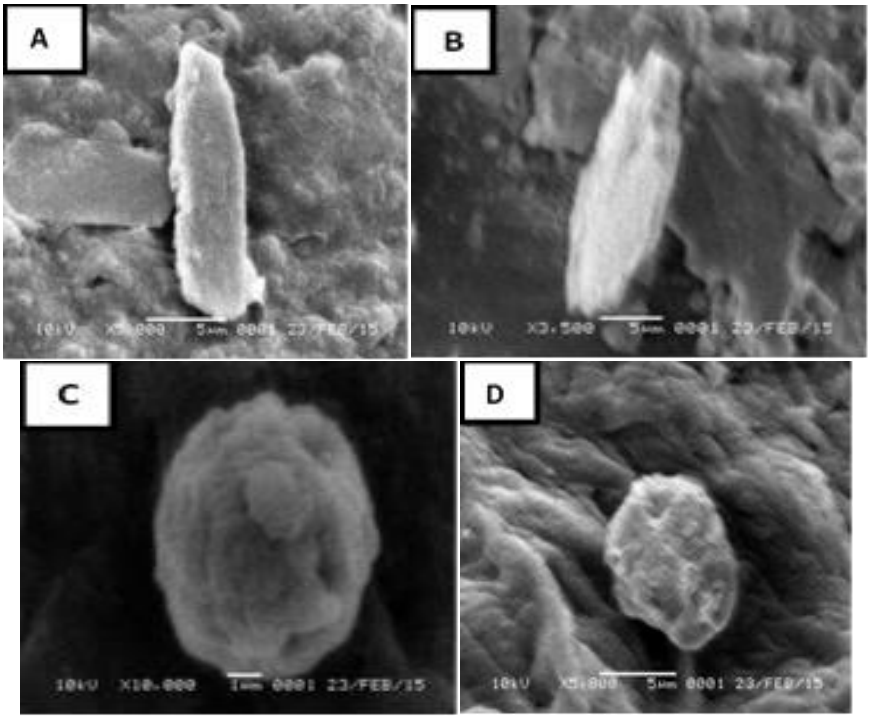


Figure 2. Nematocysts cells of *M. papua* in the Kakaban sea: Merotrichous isorhiza (A), Atrichouz isorhiza (B), and Anisorhiza (C and D)

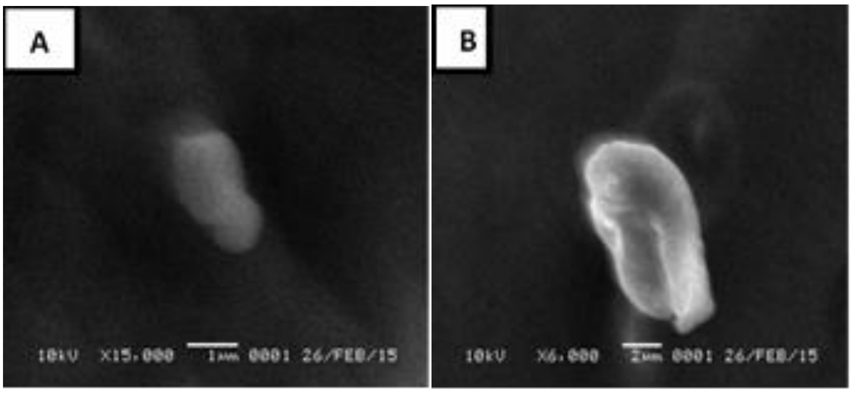


Figure 3. Nematocysts cells of *M. papua* in the Kakaban lake: micro basic mastigophoran (A and B)

a nematocyst class found in only a few species of Cnidaria, are present in the hydroid Clytia noliformis. This nematocyst type is present in the hypostome, gonangium, and hydranth body, near the base of the tentacles but is absent in the tentacles themselves [14]. Isorhiza is A type of nematocyst (= stinging organelle) without a well-defined shaft, the discharged tubule is the same diameter throughout its length, or narrowing slightly toward the distal end. Nematocysts with the tubule slightly dilated proximally are termed 'anisorhizas' [15].

In Mastigias papua in Lake Kakaban, there is one form of nematocytes, namely Microbasic mastigophoran (Figure 3). Microbasic mastigophoran is Refers to the length of the discharged shaft (or basis, or butt) on nematocysts, i.e., the thickened base of the tubule. Traditionally, 'microbasic' was defined as 3 times or less the length of the capsule, whereas 'macrobasic' was defined as 4 times or more than the length of the capsule. However, I prefer to follow the convention of Bouillon and Boero, in which a single capsule length is the critical point; thus, microbasic is herein used to mean those nematocysts in which the discharged shaft does not exceed the length of the capsule, and thus does not need to twist or fold to fit inside, and macrobasic is herein used to mean those nematocysts in which the discharged shaft is too long for the capsule, and thus is forced to twist or fold to fit inside, regardless of the number of times. Most cubozoan nematocysts are microbasic.

Based on the above results, it can be rejected that the nematocyst cells between Mastigias papua jellyfish in Kakaban Lake and Kakaban Sea have differences, where the form of nematocysts from Mastigias papua in the Kakaban Sea has three forms. In fact, the nematocyst cells in Lake Kakaban only have one route with different types. The size of Mastigias papua nematocytes in Lake Kakaban is smaller, and the number of nematocytes is less. The small size of the nematocytes and the number that regulates the number of nematocytes affect the production of toxins. Merotrichous isorrhizae are abundant in the hypostome, gonangium, and hydranth bodies, near the base of the tentacles but absent in the tentacles. The unfilled capsules are elongated. Merotrichous isoriza is a nematocytic cell that functions as a jellyfish injector, with the absence of nematocytes in jellyfish in Lake Kakaban being one of the reasons the jellyfish cannot sting and are now harmless. This is because merotrichous mycorrhizal nematocytes are cells that function as injectors which can expose humans to jellyfish venom when injured [16]. Another factor that causes the inactivity is the environmental conditions in Lake Kakaban which have changed both from salinity, pH, and temperature. The deadly effect of the jellyfish toxin is the result of death [17]. Cardiotoxic is a toxin effect from jellyfish that causes heart tissue damage [18]. The protein poison contained in the tentacles becomes non-toxic, presumably due to differences in salinity, pH and temperature in the lake, which causes when the poison is released by the jellyfish, the protein becomes inactive.

## Conclusion

Based on the results of this study, it can be concluded that there are differences in environmental parameters, body diameter, tentacle length, and size and number of nematocyte cells between *Mastigias papua* jellyfish in the Kakaban Lake and Sea.

## Acknowledgment

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