Exploring the Factors Affecting the Status of *Cassiopea andromeda* (Upside-down jellyfish) under Environmental Change

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Abstract

We have seen many reports that Lin-yuan Wetland Park(Jellyfish Lake) is the only lake in Taiwan where Upside-down jellyfish can be found. This sparked numerous questions in our minds, and we wanted to understand the relationship between the survival of Upside-down jellyfish and environmental changes. This study is addressed in four parts: (1)Observation of Upside-down jellyfish in its inverted state revealed that its tissue and mucus contain Zooxanthellae, and the cnidocytes in its tentacles are easily affected by the environment. (2)The water quality investigation of the lake where Upside-down jellyfish lives weakly alkaline water and has a high tolerance to the environment. (3)An experiment investigating the effect of light on Upside-down jellyfish's contraction behavior found that smaller Upside-down jellyfish contract more frequently than larger ones. (4)In the experiment where Upside-down jellyfish was deprived of nutrients, we discovered that lightless module, Upside-down jellyfish consumes their own nutrients, resulting in significant shrinkage in its size. We found that the growth of Upside-down jellyfish is affected by water quality and environmental changes.

Research purposes

01

Observation of Upside-down jellyfish posture

02

Investigation of water quality in the jellyfish lake

03

Effect of light on the contraction behavior of Upside-down jellyfish

04

Effect of nutrient deprivation on Upside-down jellyfish

Research methods

1. Introduction to Upside-down jellyfish

2. Observation of Upside-down jellyfish

3. Investigation of water quality in the habitat of Upside-down jellyfish

4. Method for calculating jellyfish quantity

5. Influence of light on Upside-down jellyfish contraction behavior

6. The effect of no nutrient source on Upside-down jellyfish

Fig. 1,The point of the four points （A, B, C, D）
(The yellow arrow indicates the direction of the water flow.)

Result

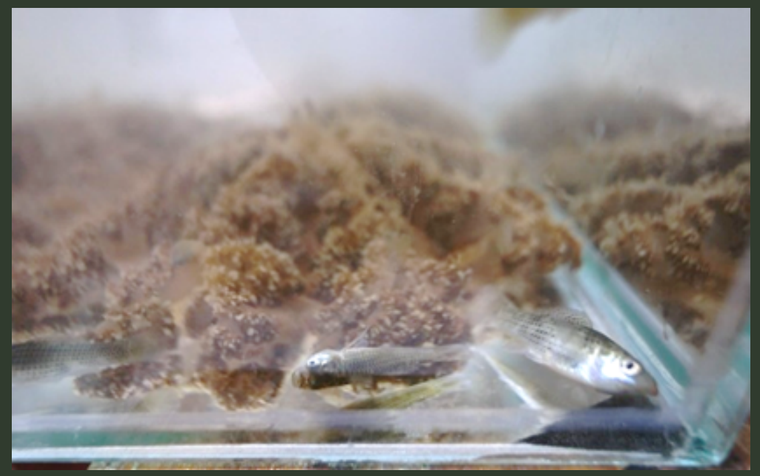


Fig. 2a, Upside-down jellyfish causing the death of a Moorish fish

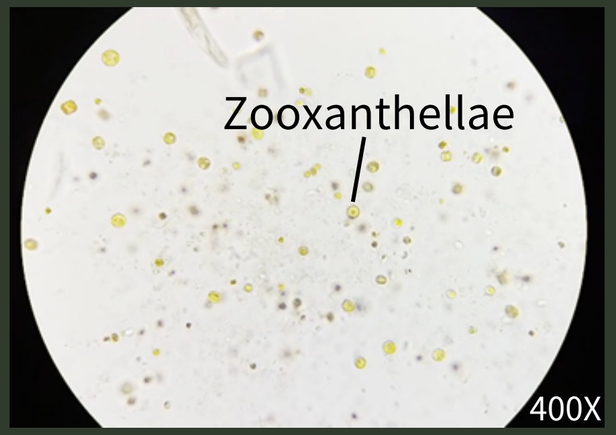


Fig. 2b, Observation Zooxanthellae in the mucus

1. Observation of Upside-down jellyfish state

1-1 Experiment on the isolation of symbiotic Zooxanthellae from Upside-down jellyfish tissue.

1-2 Results of Microscopic Measurements
Size of cnidocytes: approximately 5 to 10.5 micrometers
Size of Zooxanthellae: approximately 7.5 to 10 micrometer （Fig. 3）

1-3 Observation of mucus secretion after Upside-down jellyfish prey on Mollyfish
Upside-down jellyfish secrets a large amount of mucus that enveloped the Mollyfish, as shown in Figure 2.

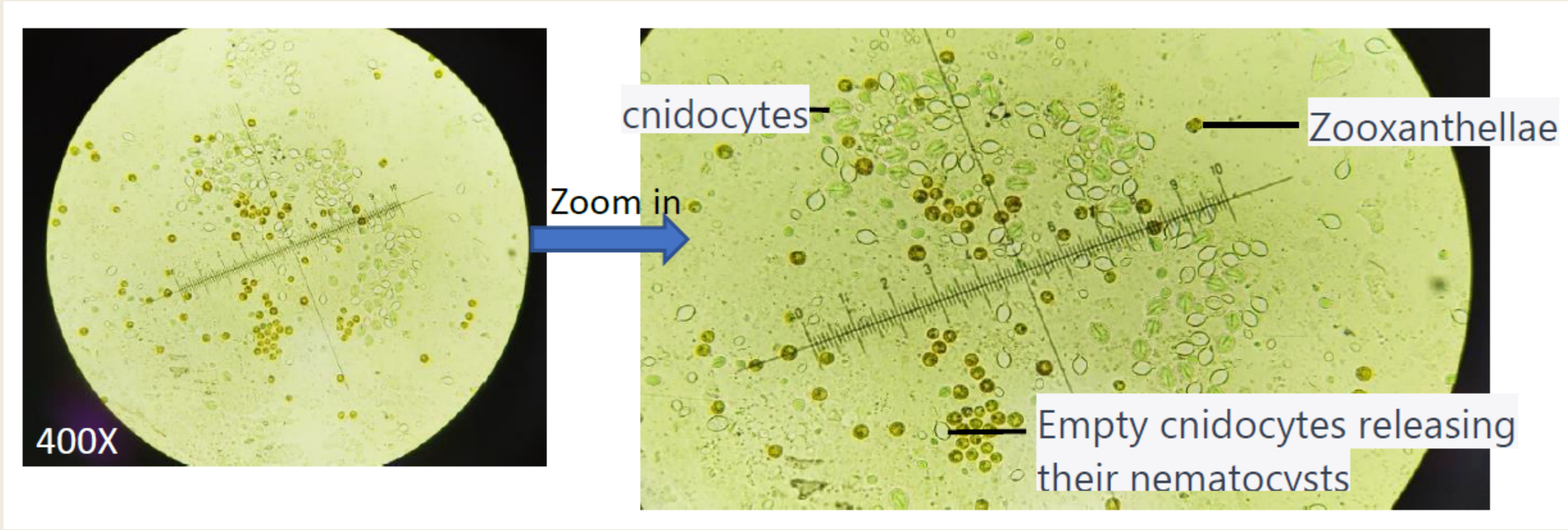
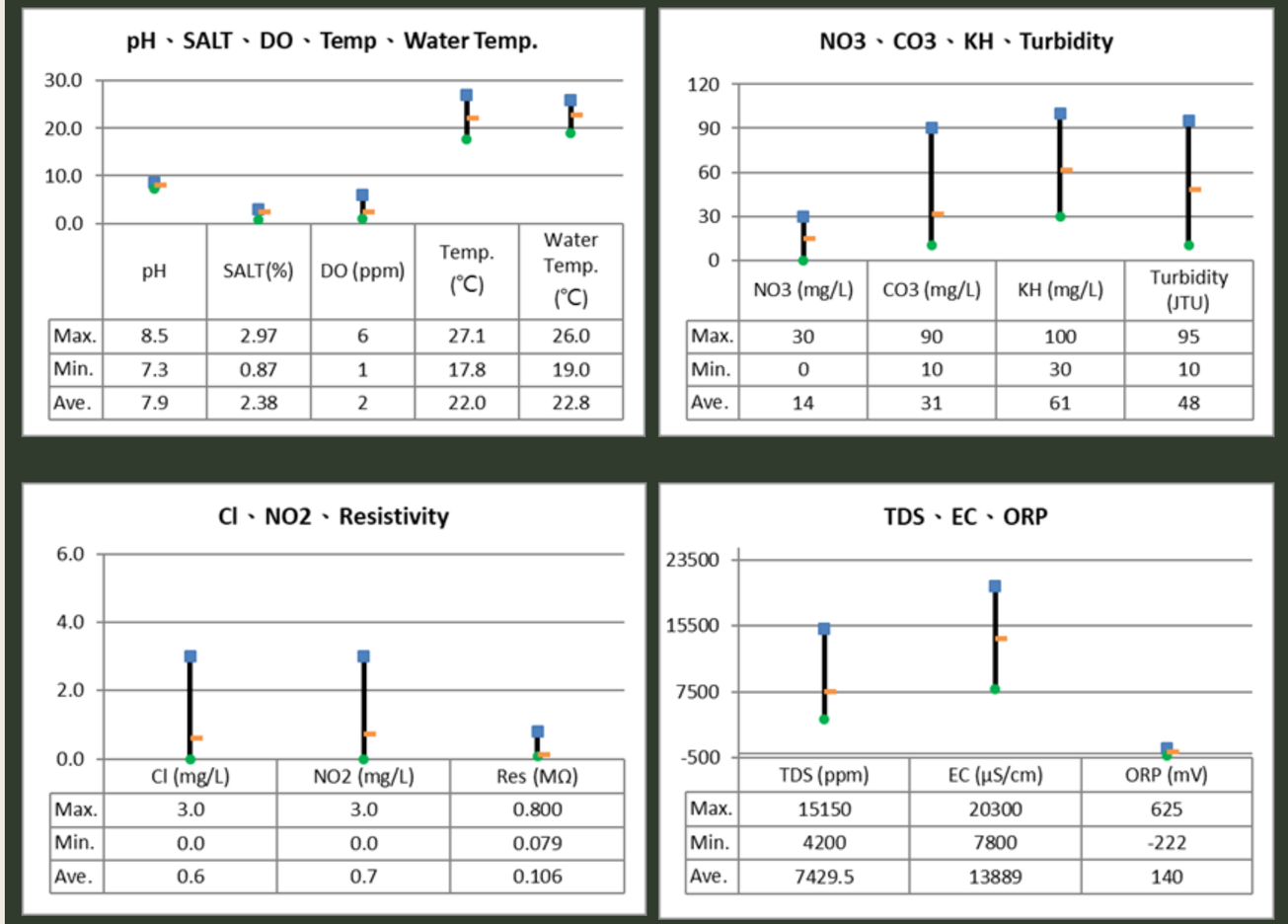


Fig. 3, After 10-15 minutes, the proportion of empty nematocysts increase

2. Investigation of Water Quality in jellyfish lake

From figure 4 ,jellyfish thrive in alkaline pH levels(pH7.3~8.5), and water temperature at average 22.8 degrees Celsius. While there is difference between the highest and lowest turbidity values(10~48JTU), we cannot determine whether it is a result of jellyfish-induced changes or other factors. The average value of ORP (oxidation-reduction potential) is positive, indicating a lower concentration of organic pollutants and good water quality, and higher visibility.



	pH	SALT(%)	DO (ppm)	Temp. (℃)	Water Temp. (℃)
Max.	8.5	2.97	6	27.1	26.0
Min.	7.3	0.87	1	17.8	19.0
Ave.	7.9	2.38	2	22.0	22.8

	NO3 (mg/L)	CO3 (mg/L)	KH (mg/L)	Turbidity (JTU)
Max.	30	90	100	95
Min.	0	10	30	10
Ave.	14	31	61	48

	Cl (mg/L)	NO2 (mg/L)	Res (MΩ)
Max.	3.0	3.0	0.800
Min.	0.0	0.0	0.079
Ave.	0.6	0.7	0.106

	TDS (ppm)	EC (µS/cm)	ORP (mV)
Max.	15150	20300	625
Min.	4200	7800	-222
Ave.	7429.5	13889	140

Fig. 4, Investigation of environmental factors in Jellyfish Lake from December 30th, 2022 to February 22nd, 2023.

3. Distribution and Characteristics of Upside-down jellyfish in Different Points

The point of jellyfish growth is also essential for their survival. For example, a rough and uneven terrain place is not suitable for jellyfish as it may cause them injury or even death. Therefore, they tend to choose areas with smoother terrain and smoother water flow.

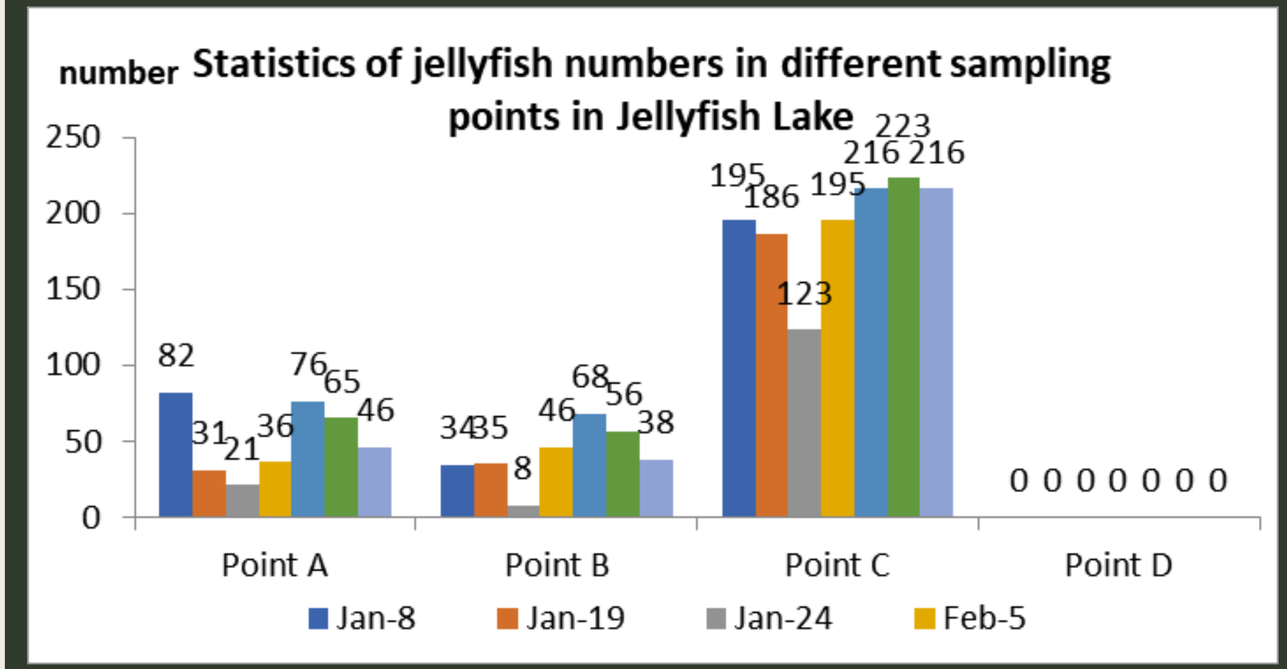


Fig. 5, the numbers of jellyfish at points A, B, C, and D recorded during the period from December 30, 2022, to February 22, 2023.

If the temperature is too high, not only will Zooxanthellae leave, but the jellyfish's body cells will also not be able to withstand the heat.

Jellyfish quantity statistics are calculated by counting the number of Upside-down jellyfish in photos, as showen in Figure 6.

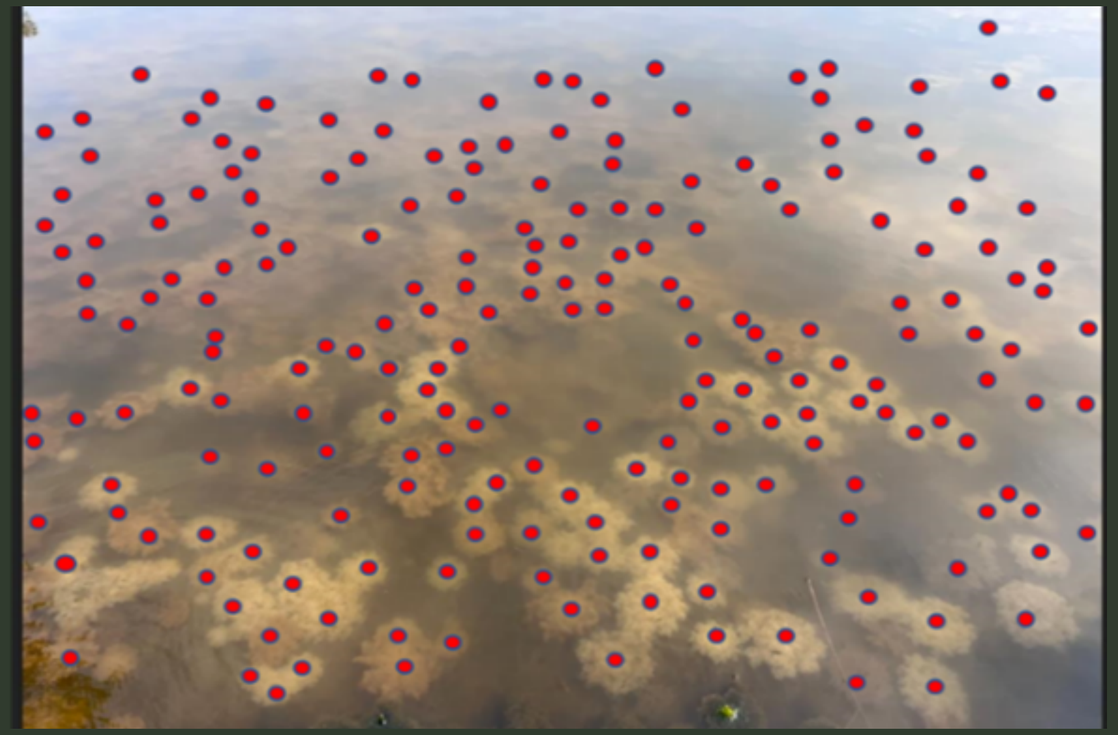


Fig. 6, Calculation Method of Jellyfish Abundance

4. Analysis of Spatial Distribution of Environmental Factors

Among the factors that affect the environment, for jellyfish, water quality is the most direct.

Average pH values at points A, B, C, and D in Jellyfish Lake range from 7.8 to 8.0 (Figure 7), indicating an alkaline pH in Jellyfish Lake.

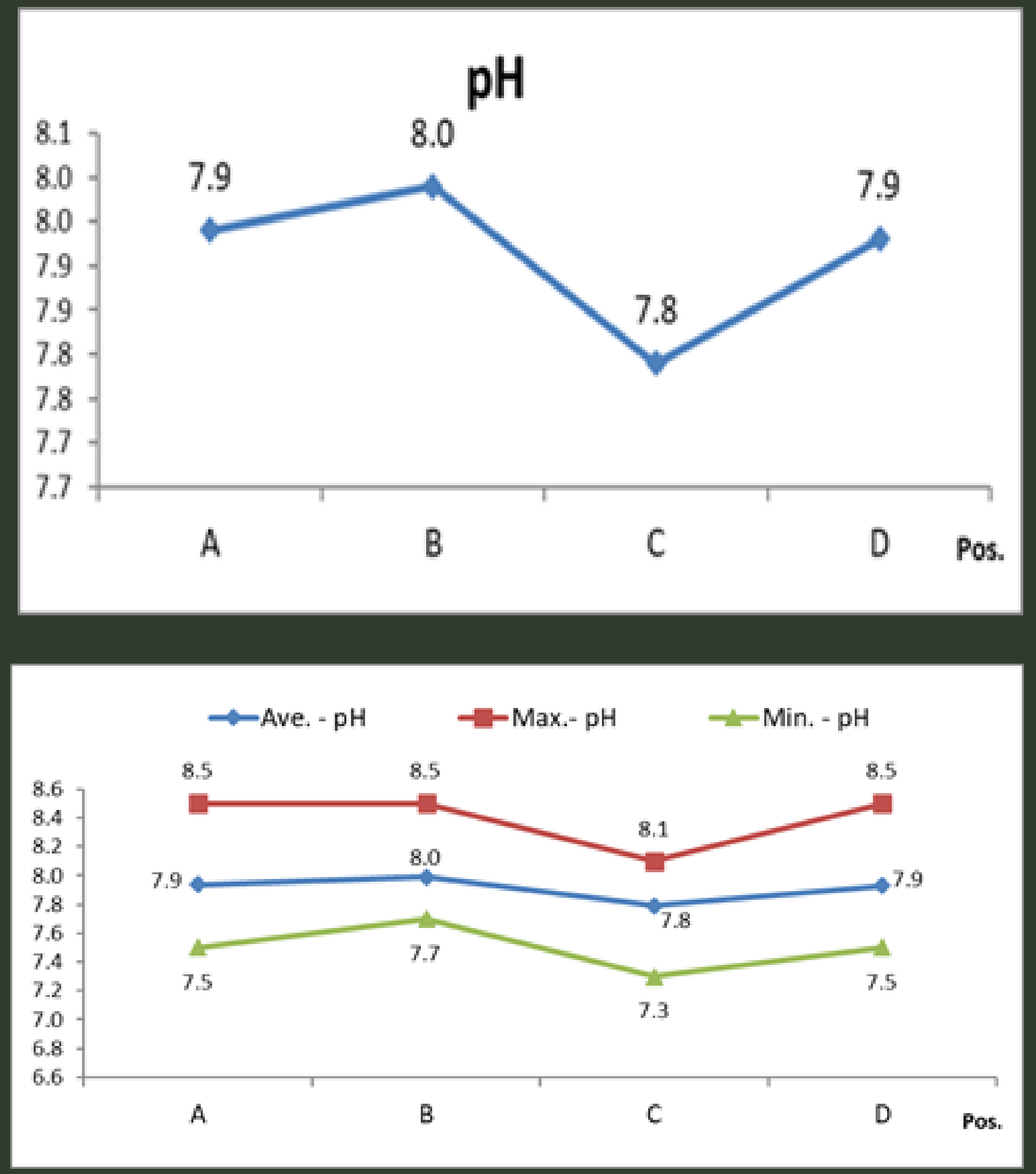


Fig. 7, Distribution of pH values at different points.

5-1. Effects of Different Light Modules on the Contraction Behavior of Upside-down jellyfish.

Under different colored lights and intensities, small Upside-down jellyfish (9cm) show a higher frequency of contractions than large ones.(12cm)

Of both sizes, the highest contraction frequency occurrs under magenta light (10), while the lowest is under blue light (5).

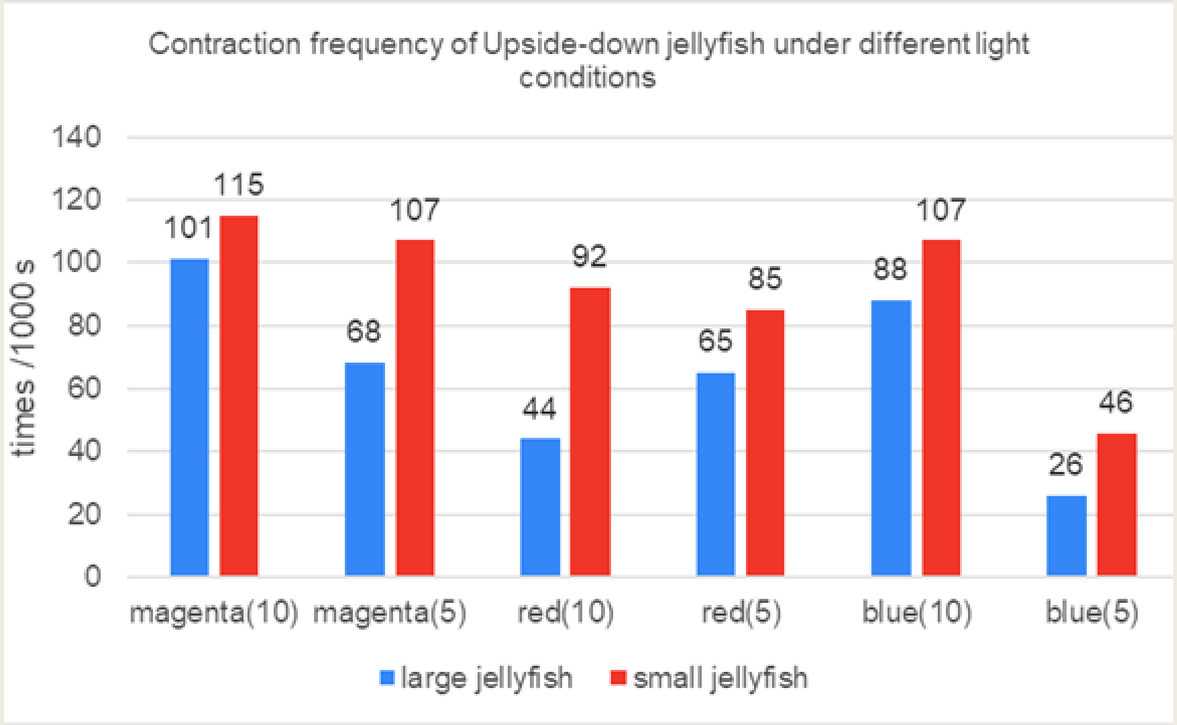


Fig. 8, Contraction frequency of Upside-down jellyfish under different colored lights

5-2 The effect of time on Upside-down jellyfish contraction behavior

We found that the contraction frequency of a jellyfish varies at different times of a day, as shown in Figure 9.

According to Figure 9, the order of single-cycle activity from high to low is 16:30~18:30, 08:00~10:30, 12:00~14:30, 20:00~10:30.

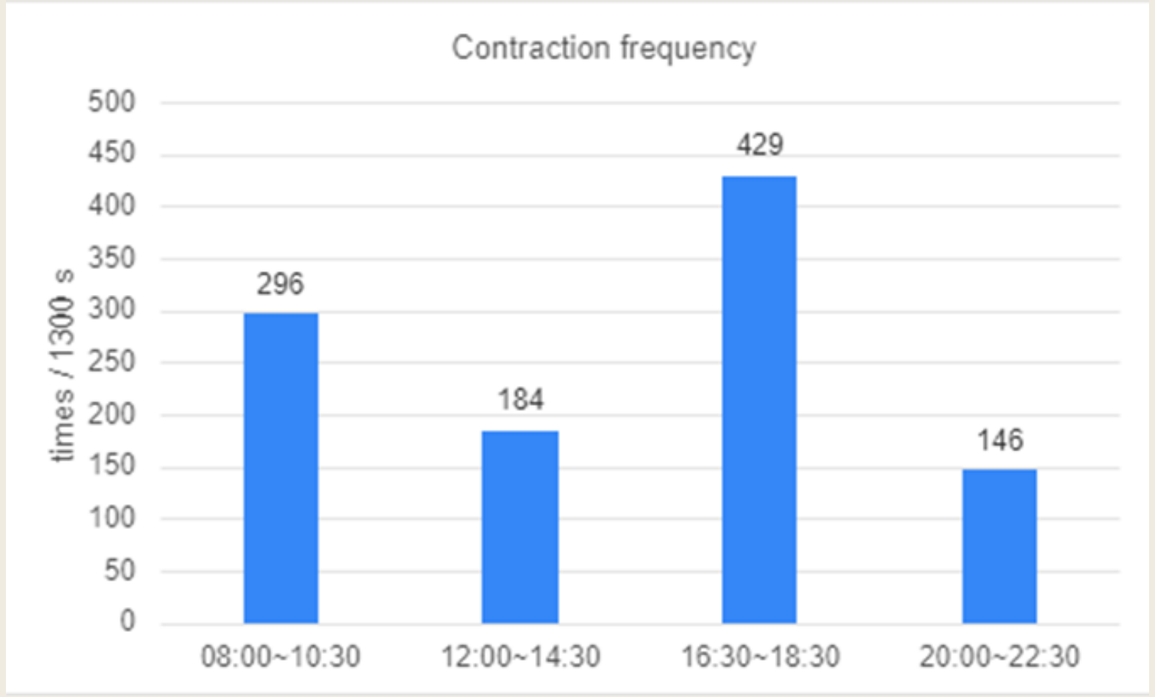


Fig. 9, the numbers of Upside-down jellyfish contraction at different times.

6-1 Lightless Module

	initial diameter lenth (cm)	diameter lenth after 6 days (cm)	difference (cm)
jellyfish A (large)	12	10	-2
jellyfish B (large)	12	10	-2
jellyfish C (small)	9	7.5	-1.5
jellyfish D (small)	9	8	-1

Table 1, Length of the diameter of the flattened bell of Upside-down jellyfish under lightless module

Large Upside-down jellyfish showed more reduction in size than small ones. According to literature, when the nutrients in the water become scarce and when the ciliates cannot provide all the nutrients, Upside-down jellyfish will start to consume their own nutrients, resulting in a reduction in size.

6-2 magenta light module

Comparing the magenta light module (Table 3) with the lightless module, the jellyfish in the magenta light module tend to have less shrinkage, that's because the module light can support Zooxanthellae photosynthesis ,and provides nutrients for the jellyfish.

	initial diameter lenth (cm)	diameter lenth after 6 days (cm)	difference (cm)
jellyfish A	10	9	-1
jellyfish B	10	10	0
jellyfish C	7.5	6.5	-1
jellyfish D	8	7	-1
jellyfish E	5	4	-1
jellyfish F	4.5	4.5	0

Table 2, Length of the diameter of the flattened bell of Upside-down jellyfish under magenta light module

Conclusion

1. Upside-down jellyfish's tissues and mucus contain Zooxanthellae, and after 10-15 minutes, the proportion of intact cnidocytes decreases from 33.9% to 13%, indicating that cnidocytes can be triggered by environmental factors such as temperature and evaporation.

2. Upside-down jellyfish thrive in alkaline water(pH value about 7.8)and a temperature of around 22.4 degree Celsius. The water should have low organic pollution levels, good water quality, and high visibility.

3. Small Upside-down jellyfish contract more frequently than large ones under different colors light and light intensities. The contraction frequency is highest under magenta light(10) and lowest under blue light (5).

4. Upside-down jellyfish contract most frequently between 16:30 to 18:30 and least frequently between 20:00 to 10:30, indicating Upside-down jellyfish‘s circadian rhythm is more active at 20:00 to 10:30.

5. Larger Upside-down jellyfish shrink more than small ones. In the absence of food and light sources, Upside-down jellyfish in the water with decreasing nutrients and without enough nutrition from Zooxanthellae will consume their own nutrients and shrink in diameter length. The large ones will shrink more noticeably.

6. Based on Upside-down jellyfish population development throughout the year, the temperature in Kaohsiung, and the government's planned wetland cultivation projects, it can be preliminarily concluded that there is a certain correlation between jellyfish growth, climate, and project planning. This study focuses on exploring the environment's impact on jellyfish development, with water quality and environmental climate being the most direct factors.

References

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