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# Effects of pH and Air on the Transformation of Podocysts in Edible Cephalopods

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## Abstract

*Rhopilema esculentum* is one of the edible cephalopods, a traditional Chinese fishery resource and an important economic aquaculture species. However, given the current natural resource depletion and frequent disease problems in breeding populations, the quantity and quality of seedlings in artificial propagation cannot meet market demand. Temperature and salinity have been hypothesized to play important roles in regulating asexual reproduction in *R. esculentum*. In this study, we investigated the combined effects of exposure to R after preservation. esculentum podocysts (stored at 2 ± 1 °C for more than 12 months) to three variable temperatures (14.5 °C on April 1, 18 °C on May 1, and 23.2 °C on July 1). simulated temperature obtained from the start date), corresponding to natural levels) and three salinities (20, 25, and 30). We tested podocyst excystation, strobilation onset time, strobilization duration, and cumulative number of efia over 45 days, and analyzed the rate of migration from podiatric to efia to determine the optimal combination of temperature and salinity. Results showed that popodocyst excystation and ephia production occurred with all treatments. Higher temperature and lower salinity significantly accelerated postcyst excystation and accelerated the onset of strobilation ($p<0.05$). Lower salinity (20 and 25) produced significantly larger ephyra numbers when the temperature increased from 18 °C on May 1 to natural values ($p<0.05$). There was a significant interaction between temperature and salinity in cumulative ephyra counts and podocyst-to-ephyra transmission rates ($p<0.05$). These results suggest that *R. esculentum* podocysts can be recycled for long-term cryopreservation. Temperature and salinity adjustments can influence the number and timing of *R. esculentum* seedlings to achieve high production and meet market demand for real-time seedling supply. This conclusion provides a scientific basis for innovative methods for sustainable utilization of edible cephalopod (*R. esculentum*) resources.

**Keywords:** Economic cephalopods; Experimental ecology; Control technology; Polyps; Asexual reproduction; Resource utilization

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## Introduction

*Rhopilema esculentum* is one of the most important species for Chinese traditional fisheries, artificial improvement and pond aquaculture, with an annual production value of over 10 billion yuan. *R. esculentum* medusae are nutritious, low in fat, tasty and play a healthy role in disease prevention. In recent years, it has also developed into cosmetics and health products, increasing its economic value and broad market prospects. Compared to other farmed species such as fish, shrimp and crabs, *R. esculentum* medusae is a fast growing, short breeding cycle, low cost, fast results and high profit [1]. In some provinces of China (Liaoning, Shandong, Jiangsu, etc.), the release of pond-improved *R. esculentum* medusae has become a distinctive industry. Related industries such as fisheries, aquaculture, processing and trade, especially seedling breeding, which is an important base for his entire *R. esculentum* industry, have significant social, economic and environmental benefits. In the current traditional seedling cultivation, a large amount of polyps has been obtained by capturing adult jellyfish in batches in a tank of a breeding facility in autumn. These polyps were then fed to grow by overwintering and began releasing efia as temperatures rose in the spring.Once strobilation is complete, these polyps and their popodocysts are discarded. Podocist breeding was therefore not used in the breeding process. However, giant cephalopod podocysts play an important role in the proliferation of polyps, and even in ephyrial populations [2]. Nemopilema nomurai podocysts can remain dormant for at least six years. Aurelia aurita s.l. podocysts can live up to 3.2 years. *R. esculentum* polyps can replenish the population through podocyst reproduction in their natural life cycle. R esculentum podocysts can be further developed and used, and the breeding process conserves bioresources and reduces negative environmental impacts. Therefore, we investigated whether *R. esculentum* podocysts could be recycled after long-term storage at low temperature [3]. If popodocysts can be recycled, how can polyps and ephyra propagate in different months with natural water temperatures and appropriate salinity?

In contrast, popodocyst reproduction increased from 18 to 26 with increasing salinity. Conclusions regarding the effect of salinity on popodocyst reproduction are therefore conflicting and warrant further investigation [4]. Moreover, previous studies focused only on constant temperature effects. Due to seasonal features of local climate variability, *R. esculentum* popodysts can experience seasonal increases in seawater temperature after wintering [5]. The combined effects of fluctuating temperature and salinity on popodocyst excystation and strobilation could significantly modulate the abundance of ephia following, and thus were worth investigating. This study was conducted to test the effects of variable temperature (T1 was simulated water temperature in the local hatchery from 14.5°C on April 1st to 19°C on May 15th). T2 is the simulated water temperature in the local hatchery from 18 April). 22 °C from 1 May to 14 June, and T3 is the natural temperature of the laboratory (23.2 °C from 1 July to 25.1 °C from 14 August) and salinity in the recycling of podocysts (20, 25, and 30) were control groups. *R. esculentum* not reported in the literature [6]. In contrast to most previous studies done at the individual level and testing material in which postcysts were produced by polyps for short periods of time or hibernated at low temperatures for short periods of time, approximately 2–3 months, our Experiments were performed at the whole colony level using triplicate runs of at least 400 popodocysts at each of nine combinations of temperature and salinity, postocysts testing material stored at low temperatures for more than 12 months [7]. Did. The purpose of this study is to determine the recycling probability of *R. esculentum* podocysts under long-term cryopreservation and to reveal specific regulatory effects of temperature and salinity that simulate seasonal variations. The findings have important implications for improving the quality and efficiency of cephalopod (*R. esculentum*) reproduction, advancing and recycling bioresources, and promoting and accelerating industrial transformation [8].

## Materials and Methods

### Origin of Podocysts

Population for seedling production provided by the *R. esculentum* seedling breeding farm when production ended in spring 2020. These polyps are derived from sexual reproduction by Medusa obtained from a *R. esculentum* aquaculture pond in August 2019 [9]. During the previous seedling rising period, these polyps were fixed on a 30 × 40 cm polyethylene sheet. Twenty polyethylene sheets were connected with a rope at intervals of 10 cm, and 10 strings were hung horizontally from bamboo. He placed 10 bamboo sticks in tank (4m x 4m x 1.5 m) containing freshly filtered seawater. Artemia salina nauplius just hatched into a polyp (body length:

200 µm) per day, a cumulative number of popodocysts (average 10–20 popodocysts per polyp) is produced, which then stabilizes in the spring. Many polyethylene sheets with post- and strobed polyps attached are typically discarded after production is complete [10].

## Discussion

Esculentum consists of alternating generations of sexually reproducing planktonic cephalopods and asexually reproducing benthic polyps. The life cycle stage used for release into natural sea or coastal waters is the plankton ephyra stage. It takes only about two months to grow to the mature Medusa stage, ready for processing and sale. Therefore, large amounts of efia were required, and the process of growing seedlings has created a separate industry. Ephyrae derive from polyps only by strobilizing, but polyps arise in two ways. One is derived from sexual reproduction of mature jellyfish and the other from asexual reproduction of polyps by producing popodocysts. Thus, popodocyst propagation and polyp strobilization are important processes affecting seedling yield.

Polyps and popodocysts are too small to be found in natural water bodies. Few studies on *R. esculentum* podocysts indicate a wide suitable temperature and salinity range. It can survive the winter at low temperatures (-1.6 to 3.2°C) for about 3 months and has a survival rate of 100%. However, R Do Esculentum podocysts survive at low temperatures? Our experiments show that all treatments resulted in popodocyst excystation followed by strobilization, with cumulative popodocyst excystation ranging from 7.84% to 22.01%, and the progression from foot disease to ephyreal. Showed infection rates ranging from 4.16% to 35.08% the results fully demonstrated that *R. esculentum* podocysts stored at 1–3 °C for more than 12 months have the ability to excyst and can be recycled and cultured under appropriate environmental conditions.

## Conclusions

Podocyst excystation and ephyra formation occurred with all test treatments. Higher temperature and lower salinity significantly accelerated postcyst excystation and accelerated the onset of strobilation ($p<0.05$). Increasing salinity and temperature from 18°C on May 1 to natural values produced significantly more ephyra ($p<0.05$). There was a significant interaction between temperature and salinity ($p<0.05$) on cumulative ephyra numbers and podocyst-to-ephyra transfer rates. Esculentum podocysts that have been stored at low temperatures for long periods of time can be recycled. Modulating temperature and salinity can affect the number of *R. esculentum* seedlings and the time to achieve high production and meet market demand for real-time seedling delivery. This conclusion provides a scientific basis for innovative methods for sustainable utilization of edible cephalopod.

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