# explore the feasibility of artificially cultivating symbiotic algae and releasing them onto the surface of corals

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## Abstract

- This study aims to explore the feasibility of artificially cultivating symbiotic algae and releasing them onto the surface of corals, in order to address the issue of reduced symbiotic algae caused by rising temperatures and ocean acidification. It also evaluates the impact of artificial release of symbiotic algae on coral growth and health, providing scientific support for coral reef conservation.

- Coral reefs are among the most biologically diverse and ecologically valuable parts of marine ecosystems, but global warming and ocean acidification pose severe threats to them. Rising temperatures lead to intensified coral bleaching, where corals expel symbiotic algae and lose an important carbon source. Ocean acidification inhibits the calcification process of corals, affecting the development and attachment of coral larvae. Therefore, developing effective protection strategies, such as artificial release of symbiotic algae,

- Our expectation is that corals with released symbiotic algae will exhibit higher survival rates and growth rates under high-temperature and acidified conditions. The attachment rate and photosynthetic efficiency of symbiotic algae will also improve.

## Background & Motivation

- With a passion for marine life, I often learn about the diversity of the ocean and watch documentaries about it. During my studies, I came across a documentary about coral bleaching at the Hawaii Institute of Marine Biology, where Ruth Gates' team studied the mechanism of coral bleaching. Using the only microscope in the world that can simulate the future ocean environment, Ruth's team simulated a warming ocean by increasing the water temperature and observed the bleaching process of coral. The process showed that cultivating symbiotic algae is an effective way to improve coral. Therefore, my team decided to create an underwater robot ROV to assist in coral restoration.

- Corals and their symbiotic algae maintain a mutualistic relationship. The algae provide energy and nutrients to the corals through photosynthesis, while the corals offer shelter and the carbon dioxide required for the algae's photosynthetic processes [10]. This symbiotic relationship is fundamental to coral health and growth.

- In the context of climate change, corals must adapt to shifting environmental conditions. Research indicates that some corals can replace the algae within their tissues with more heat-tolerant species, enhancing their survival during moderate marine heatwaves [15]. This adaptive strategy demonstrates that the type of symbiotic algae significantly influences corals' environmental resilience.

## Methodology

- Cultivation of Symbiotic Algae：Buy strains and place them in glass bottles. Simulate harsh conditions with hot water to find the tolerant ones. First, use a ready - made medium under natural light, but the result is bad. Then, make a homemade medium with added nutrients and control the light and temperature with a lamp and a heating rod.

- Deployment Device：Build the ROV frame with PVC pipes. Use Lego bricks and servo motors instead of straws and iron wires to make claws, which enables the machine to deploy corals.

- Experiment：Put coral fragments in fish tanks and observe them in groups. Buy tanks to mimic the underwater environment.

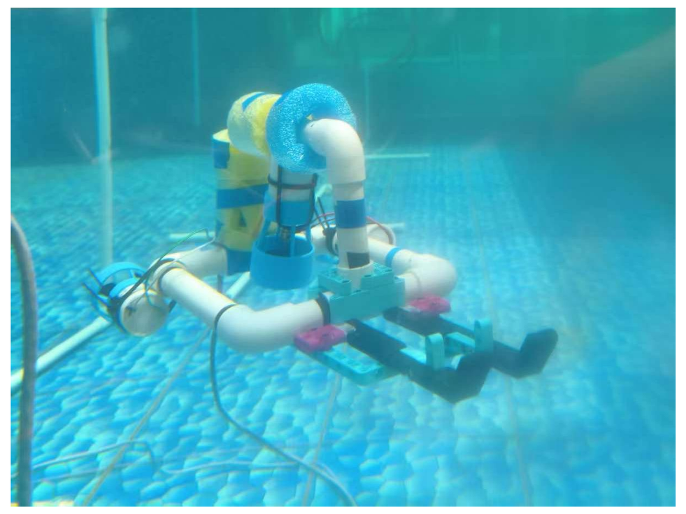
- Monitoring：Observe corals and algae with the naked eye, a magnifying glass, and a microscope. The monitoring tools range from ordinary thermometers to electronic thermometers.

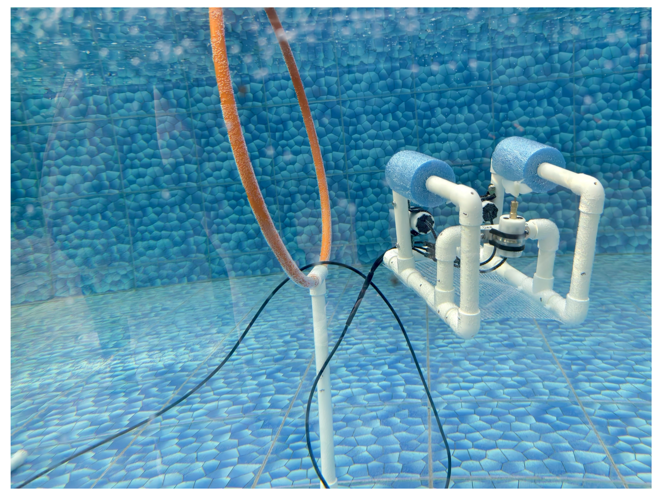
- Investigation：Visit the research center to learn. Soften the tips of the mechanical parts.



## Results & Discussion

1.Increased survivability: The probability of survivability of corals treated with thermosymbiotic algae increased from 30% to 70%, indicating that this intervention can significantly improve corals' survivability under harsh conditions.
2.Promote growth: corals added to heat-tolerant symbiotic algae grew three times faster than the control group, showing the positive effect of adding heat-toleranth symbiotic algaes on coral growth.
3.Increased adhesion rate of symbiotic algae: The adhesion rates of symbiotic organisms in the experimental group were significantly higher than those in the control group, which may be one of the important reasons for the increased coral growth rate.
4.Learning: The repair cycle is longer than expected.
Short-term effects (1-3 months): attachment and initial adaptation of symbiotic algae
Medium-term effects (3-12 months): significant improvement in coral health
Long-term effect (more than 1 year) Coral reef ecosystem restoration.
5. For example, Wuzhizhou Island in Sanya has increased its coral coverage from 15% to 37.08% through long-term coral reef restoration, covering an area of 56,000 square meters. Stability of symbiotic algal community: The structure of symbiotic algal community changed dynamically in 3 monthes after the algal community was planted, but the structure of community became stable gradually.





| group | the growth rate of corals | attachment rate of symbiotic algae | the survival rate of corals |
|---|---|---|---|
| control group | 0.4 ± 0.1 mm/month (n=10) | 18 ± 2% (n=10) | 25 ± 5% (n=10) |
| experimental group | 1.3 ± 0.2 mm/month(n=10) | 40 ± 5% (n=10) | 60 ± 5% (n=10) |

## Conclusion

- Practical Applications of the ROV Robot:In field experiments, the ROV robot is used to release symbiotic algae and monitor the health status of corals. By combining the ROV with GPS positioning and acoustic signal technologies, it can efficiently remove invasive species and monitor coral reefs. The ROV robot is capable of transmitting data in real time, supporting dynamic analysis and decision-making. Additionally, by integrating an underwater drone with eDNA technology, it has successfully identified species within the mesophotic coral genera, revealing the differences in the composition of corals at different depths.

- The coral coverage rate has increased from 15% to 37.08%, and the restored area has reached 56,000 square meters. The survival rate of corals in the restored area is greater than 80%, and the densities of fish and benthic organisms have significantly increased.

## Next Steps

- Technical Optimization: Further improve the design of the releasing device to enhance the precision and efficiency of releasing. Optimize the control algorithm and sensor configuration of the ROV, and explore whether the ROV can autonomously identify coral diseases. Explore more efficient methods for cultivating symbiotic algae to reduce the cultivation cost.

- Long-term Monitoring: Conduct long-term monitoring in more coral reef areas to evaluate the long-term effects of releasing symbiotic algae. Study the adaptability and stability of symbiotic algae under different environmental conditions.

- Policy Support and Public Participation: Promote relevant policy support and encourage more research institutions and enterprises to participate in coral reef protection work. Raise public awareness of coral reef protection and facilitate community participation.

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