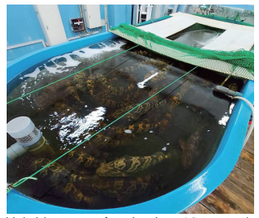
## International Initiatives Already Underway

### Success in Mongolia: The First Seawater Fish Farming Project

In 2019, we began a three-year project raising hybrid groupers in a facility in Ulaanbaatar, Mongolia. Despite the challenges of restricted travel during the COVID-19 pandemic, the fish grew to 3 kg in just two years. Productivity reached 61.5 kg per cubic meter, with a survival rate of 83%, achieving excellent results overall.



Hybrid grouper farming in a 10-ton tank.

### Saving Thailand's Shrimp Farm

Since 2016, we have partnered with Walailak University in southern Thailand to farm black tiger shrimp. Shrimp farming is a vital industry across Southeast Asia, but it is threatened by widespread infectious diseases. The Third Water is expected to help protect this industry, and new collaborative research is already underway.

Farming trial of black tiger shrimp using The Third Water.

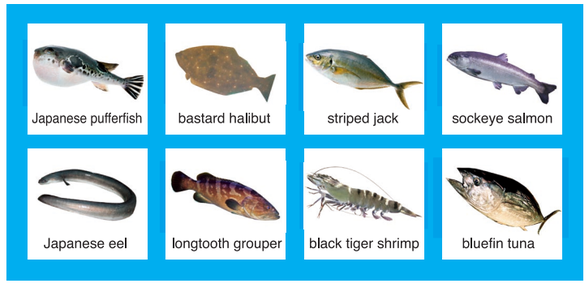
### Contributing to Cambodia's Development

As part of international projects by the Japan International Cooperation Agency (JICA), we conducted seed production trials of giant freshwater prawns—at the MARex facility in Sihanoukville in 2013, and in Takeo Province in 2014. Although securing clean, high-quality water was a challenge due to unstable electricity that required the use of solar power, the team successfully achieved the first shipment of juvenile prawns.

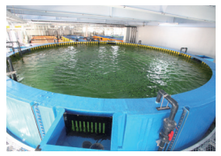
Solar panels bring light to a farmer's home for the first time.

## Species Farmed So Far

Our aquaculture projects have covered more than ten species, including Japanese pufferfish, bastard halibut, striped jack, sockeye salmon, Japanese eel, longtooth grouper, black tiger shrimp, and bluefin tuna. All have shown faster growth, high sarvival rate, and high-density farming—proving the remarkable benefits of The Third Water.




## Education and Research Center for Organisms Production



140-ton tank

35-ton tank

Lecture rooms

Seed production systems

※Note: "The Third Water" is a registered trademark.

**Inquiries for Facility Tours**

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**Tel: +81-86-256-8609** **Fax: +81-86-256-8479** **Email: kouhou@edu.kake.ac.jp**

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Sustainable Fisheries for the Future

# The Third Water

## Aquaculture's Next Frontier–Space!!

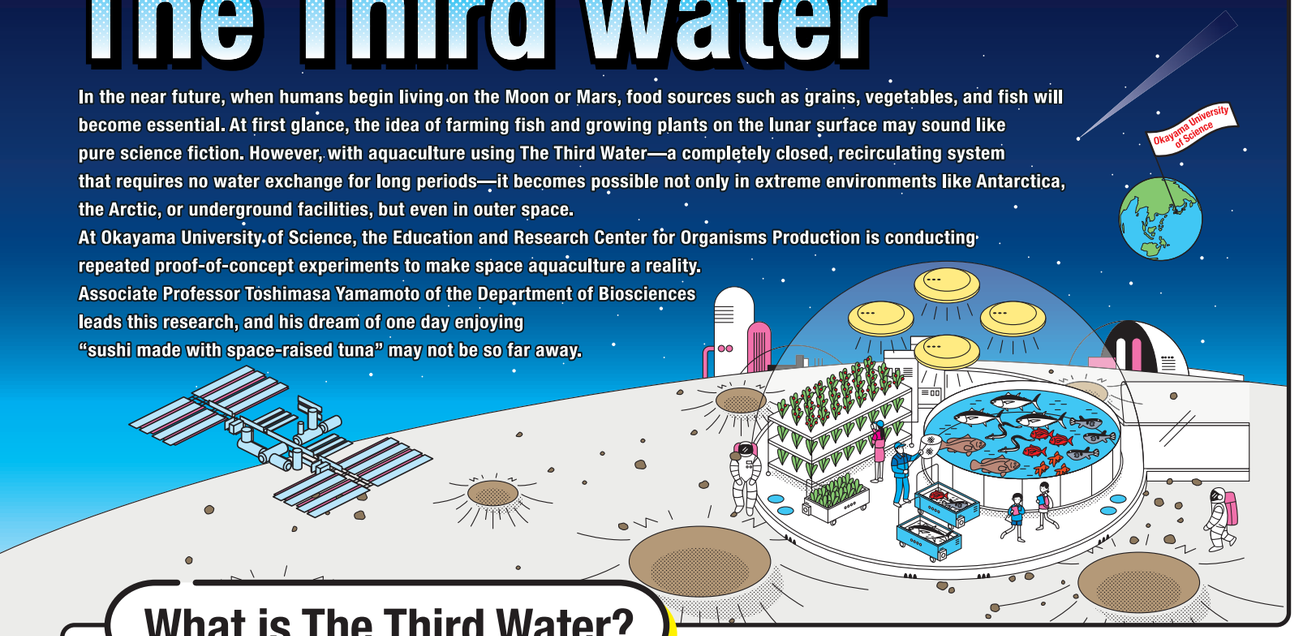
Okayama University of Science

MOON

**Okayama University of Science**

# The Third Water

**In the near future, when humans begin living on the Moon or Mars, food sources such as grains, vegetables, and fish will become essential. At first glance, the idea of farming fish and growing plants on the lunar surface may sound like pure science fiction. However, with aquaculture using The Third Water—a completely closed, recirculating system that requires no water exchange for long periods—it becomes possible not only in extreme environments like Antarctica, the Arctic, or underground facilities, but even in outer space.**
**At Okayama University of Science, the Education and Research Center for Organisms Production is conducting repeated proof-of-concept experiments to make space aquaculture a reality.**
**Associate Professor Toshimasa Yamamoto of the Department of Biosciences leads this research, and his dream of one day enjoying "sushi made with space-raised tuna" may not be so far away.**

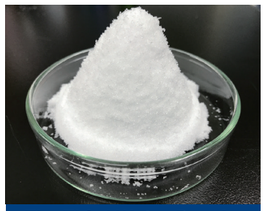



## What is The Third Water?

### Simplified rearing water

It is an artificial rearing water created by narrowing down the components of seawater to only those essential for marine fish—such as sodium, potassium, and calcium. With this water, both freshwater and marine fish can be raised together in the same tank. Research is being led by Associate Professor Toshimasa Yamamoto of the Department of Biosciences at Okayama University of Science, based at the Education and Research Center for Organisms Production.

Associate Professor **Toshimasa Yamamoto**



The Third Water Powder

## Advantages of Aquaculture with The Third Water

### Aquaculture with The Third Water has been shown to provide many benefits.

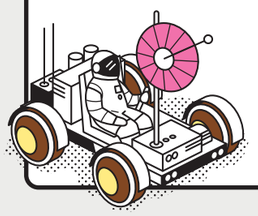
**Safe & Reliable**
Fully controlled facilities ensure food safety.

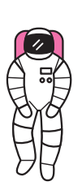
**Farm Anywhere**
With a water source, aquaculture is possible even in mountains.

**Faster Growth**
Reduced osmoregulatory stress accelerates growth.

**Disease Resistant**
Neither freshwater nor marine pathogens thrive.

**Water Recycling**
Advanced filtration allows significant water savings.





## From Research to Business

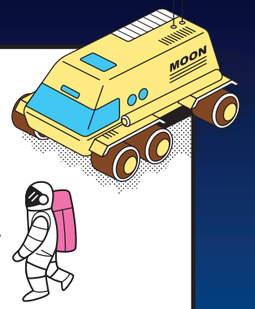
### Closed recirculating aquaculture system (CRAS) using The Third Water is steadily being commercialized across Japan.

In Tsuno Town, Miyazaki Prefecture, Okayama University of Science partnered with the town and NTT East,West,Inc. to farm Tamakai, a rare and highly prized grouper often called the "phantom luxury fish." The harvest has been used in special hot pot sets offered as gifts through hometown tax program.

In Fukushima City, OUS collaborated with the local supermarket chain Ichii Inc. and NTT East,Inc. to cultivate sockeye salmon. The salmon was well received in trial sales. Both the sockeye salmon and Giant grouper represent the world's first successful cases of land-based aquaculture for these species, and further expansion of facilities is already planned.

Meanwhile, the "OUS Eel" (Japanese eel) has become one of the signature species cultivated at OUS. It is sold grilled at supermarkets in Okayama City and served as traditional dishes such as Hitsumabushi at Wake Ugaidani Onsen Hot Springs in Wake Town, Okayama. In 2023, approximately 12,000 servings of "OUS Eel" were sold at Kura Sushi restaurants nationwide—completely selling out in just three days.

Sockeye salmon sold at supermarkets in Fukushima City




"OUS Eel" sold at supermarkets in Okayama City

OUS Eel dishes served at Wake Ugaidani Onsen Hot Springs

## The Next Frontier : Space Aquaculture

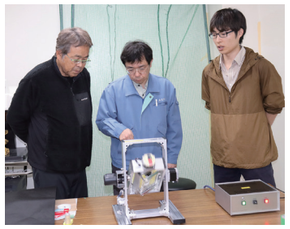
### Making Space Aquaculture a Reality

Associate Professor Toshimasa Yamamoto and his research team have long pursued the goal of achieving "space aquaculture." Believing that self-sufficiency in food production on the Moon and Mars will one day become essential, they are harnessing the unique properties of The Third Water, which allows long-term aquaculture without water exchange.

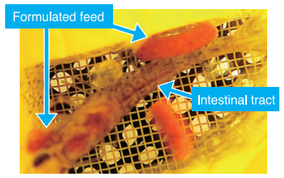
The team has already begun experiments simulating conditions on the International Space Station (ISS), exploring key questions such as:

- **Can fish eggs hatch under hypergravity conditions?**
- **Can they hatch in microgravity?**
- **Can fish feed properly in microgravity?**
- **Do bone deformities or growth defects occur in microgravity?**
- **How is bone density affected?**

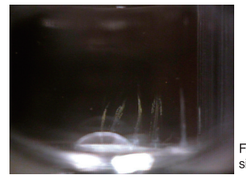
These proof-of-concept experiments are bringing the dream of space aquaculture ever closer to reality.



Analyzing genetic effects on kuruma prawn using a simulated microgravity device




Feeding experiments on kuruma shrimp under microgravity conditions



Flounder hatched under simulated microgravity

## The Third Water is Transforming Aquaculture

### Completely Closed, Recirculating Land-Based Aquaculture

Aquaculture using The Third Water is supported by advanced filtration technology.

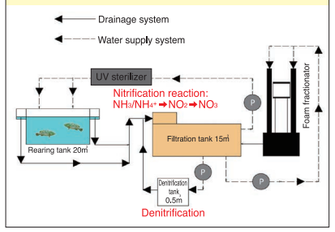
Associate Professor Toshimasa Yamamoto has been developing techniques to remove nitrogen, phosphates, and ammonia—by-products of fish waste—through improvements in filtration systems, filter media, and bacterial selection.

In 2019, his team achieved an exceptional record of 34 consecutive months without water exchange in bluefin tuna farming, a rare accomplishment both in Japan and internationally.

During this period, the tuna grew to 35 kg in body weight and 1.2 meters in length, demonstrating the remarkable potential of The Third Water system.

Bluefin tuna raised for 34 months without water exchange

**Overview of OUS Recirculating Aquaculture System (RAS)**




## Aquaponics

### A circular farming method that combines aquaculture and plant cultivation

In aquaculture using The Third Water, aquaponics has proven highly effective in removing nitrogen and phosphates derived from fish waste by growing vegetables simultaneously.

To date, more than ten types of vegetables—including cherry tomatoes, watermelons, and ice plants—have been successfully cultivated.

Associate Professor Toshimasa Yamamoto has proposed the concept of the "farmer-fisher", an integrated producer who manages both agriculture and aquaculture, and is working toward making this vision a reality.

Okayama University of Science has collaborated with Higashi-Okayama Technical High School, operated by Okayama Prefecture, on aquaponics initiatives. (Photo: banana cultivation experiment)