

# Ocean Newsletter

Selected Papers

No. **20**  
November 2016

# Director's Message

As mankind moves into the 21st century, integrated policies of ocean governance are necessary for the sustainable development and use of our oceans and their resources and for the protection of the marine environment.

Towards this end, the Ocean Policy Research Institute, Sasakawa Peace Foundation (formerly: Ocean Policy Research Foundation until March 31st, 2015) orients its research on ocean issues in line with the mission statement "Living in Harmony with the Oceans".

The Ocean Policy Research Institute, Sasakawa Peace Foundation aims to conduct cross-sectoral research in ocean related issues in order to initiate debate on marine topics and to formulate both domestic and international policy proposals.

We publish a Japanese-language newsletter titled the "Ocean Newsletter" (previously known as "Ship & Ocean Newsletter") twice a month. "Ocean Newsletter Selected Papers No.20" contains English-language versions of papers from the Japanese Newsletter edition, published from No.351(2015.3.20) to No.370(2016.1.5).

The Ocean Newsletter seeks to provide people of diverse viewpoints and backgrounds with a forum for discussion and to contribute to the formulation of maritime policies conducive to coexistence between mankind and the ocean.

Our Foundation believes that the newsletter can expand effective communication on these issues by introducing timely research abroad to an informed readership. It also welcomes responses from readers, some of which appear in the Newsletter.

It is our sincere hope that these Selected Papers will provide useful insights on policy debate in Japan and help to foster global policy dialogue on various ocean issues.

Hiroshi TERASHIMA  
President

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# Contents

## Innovative Lithium Recovery Technology from Seawater Aimed at Zero Emissions

**Tsuyoshi HOSHINO**

*Breeding Functional Materials Development Group, Sector of Fusion Research and Development, Japan Atomic Energy Agency*

4

(Ocean Newsletter No.354, May 5, 2015)

## Towards International Sharing of Accident Information

— Japan - Marine Accident Risk and Safety Information System —

**Kuniaki SHOJI**

*Member of Japan Transport Safety Board, Ministry of Land, Infrastructure, Transport and Tourism*

6

(Ocean Newsletter No.356, June 5, 2015)

## A Movement for Turning Our Thoughts toward the Ocean

**Mitsuyuki UNNO**

*Executive Director, The Nippon Foundation*

8

(Ocean Newsletter No.359, July 20, 2015)

## An Apprentice Boatbuilder in Japan

**Douglas Brooks**

*Boatbuilder*

10

(Ocean Newsletter No.359, July 20, 2015)

## Kindai University's Fish Farming Research and the A-Marine Kindai Company

**Hiroyasu TSUJI**

*President, A-Marine Kindai Company*

12

(Ocean Newsletter No.360, August 5, 2015)

## Sharing the Experiences of Sea People through "Kikigaki"

**Juichi SHIBUSAWA**

*President, Network for Coexistence with Nature (NPO)*

14

(Ocean Newsletter No.361, August 20, 2015)

## A New Pufferfish that Makes "Mystery Circles" on the Sea Floor

**Keiichi MATSUURA**

*Curator Emeritus, National Museum of Nature and Science*

16

(Ocean Newsletter No.363, September 20, 2015)

## A New Challenge by the City of Himi, a Leader in Fishing Village Culture

— Creating Community Development through the Himi Fishery Network Gallery: Totoza —

**Yujiro HONGAWA**

*Mayor, City of Himi, Toyama Prefecture*

18

(Ocean Newsletter No.365, October 20, 2015)

## On the Rearing of Organisms from Deep Sea Hydrothermal Vent Area

**Hiroshi MIYAKE**

*Kitasato University School of Marine Biosciences / Breeding Advisor, Enoshima Aquarium / Adjunct Researcher, JAMSTEC*

20

(Ocean Newsletter No.368, December 5, 2015)

## Toward a Sustainable Ocean for the Next Generation

— Address at the IMO International Maritime Prize Awarding Ceremony, London —

**Yohei SASAKAWA**

*Chairman, The Nippon Foundation*

22

(Ocean Newsletter No.370, January 5, 2016)

# Innovative Lithium Recovery Technology from Seawater Aimed at Zero Emissions

[KEYWORDS] marine resources / rare metal / resource recycling society

**Tsuyoshi HOSHINO**

Breeding Functional Materials Development Group, Sector of Fusion Research and Development, Japan Atomic Energy Agency (Ocean Newsletter No.354, May 5, 2015)

The amount of lithium in the ocean is almost infinite. As Japan is surrounded by the ocean it can be considered a lithium resource superpower, but a profitable resource recovery technology is indispensable to the creation of new domestic industries. To meet this need, the technology for selective separation and recovery of lithium from seawater has been established by using a Li ion conductive ceramics. As electricity is also generated in the separation process, a zero emission resource recovery capability is foreseen by this world's first lithium recovery technology.

## Rapidly increasing demand for lithium

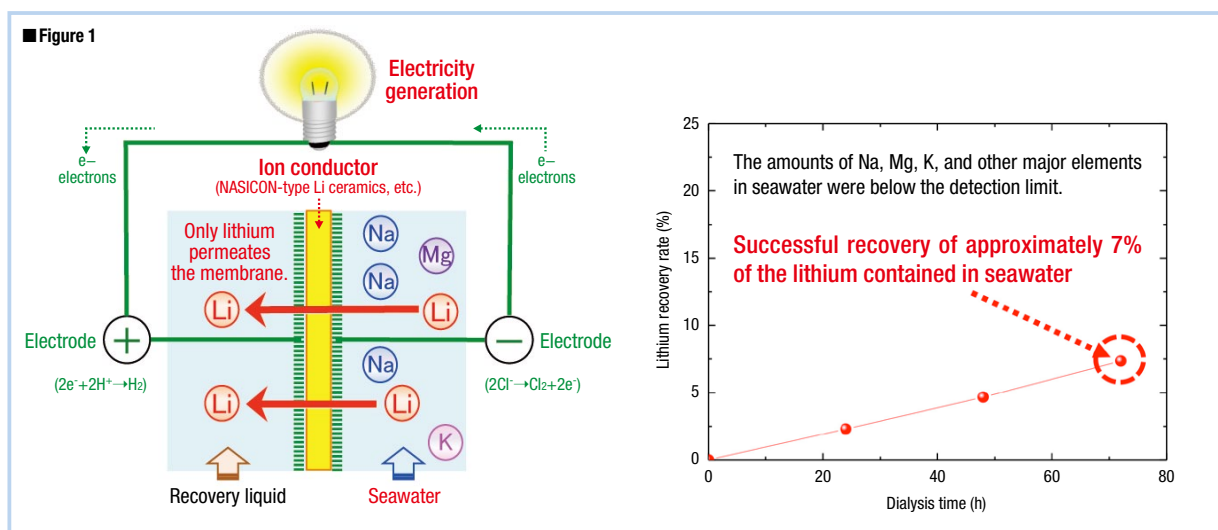
As a result of sales of electric vehicles and home storage batteries to general consumers, demand for large lithium-ion batteries is rapidly increasing. In recent years, demand for hybrid car batteries is also beginning to shift from nickel-hydrogen batteries to lightweight, large-capacity lithium-ion batteries, which has made securing lithium resources (that are used as battery materials) essential in the development of the advanced technologies of Japan, a manufacturing superpower. Lithium is also an element that is required in large quantities in order to artificially produce tritium, which is used as fuel in nuclear fusion reactors. Therefore, during and beyond the 2030s, when power generation experiments will start, demand for lithium is likely to increase at an even more rapid pace.

Japan depends exclusively on imports from Latin American countries for its supply of lithium, a rare metal increasingly in demand. Though the quantity of lithium resources is such that it will not be depleted quickly, nevertheless, lithium is recovered abroad by naturally evaporating water from salt lakes on huge tracts of land over periods of longer than a year. Given the long period of time necessary to provide a sufficient supply of lithium,

there are concerns that the supply and demand balance may be disturbed in the 2020s as a result of a rapid increase in lithium demand caused by the expansion of the lithium-ion battery market. For this reason, establishing a new resource recovery method is a top priority from a national strategic perspective.

## Innovative technology for recovering lithium from seawater without using external energy

Focusing on the fact that seawater contains a nearly unlimited amount of lithium, we started developing technology for recovering lithium from seawater. First, we began to develop a lithium recovery method that electrically transfers lithium contained in seawater to a recovery liquid by separating the seawater from the recovery liquid (devoid of lithium) with a lithium separation membrane, which is a water repellent sheet impregnated with an ionic liquid. Focusing on the fact that some ionic liquids can selectively transfer only lithium ions, we used various ionic liquids to study the transfer of lithium ions. As a result, we succeeded in recovering lithium from seawater at a 22% concentration in as short a time as 2 hours. The results of our study indicated that the recovery rates of sodium and other unneces-



sary elements contained in seawater were very low. This makes it clear that the lithium separation membrane used in our study has high promise for separating and recovering lithium. However, we were unable to completely separate lithium from all unnecessary elements. Therefore, to improve our method, we started to develop technology that uses a ceramic lithium ion conductor (selectively permeable only to lithium) as the lithium separation membrane instead of the ionic liquid membrane.

First, we conducted an experiment by replacing the ionic liquid membrane with a lithium ion conductor. In this test, however, the lithium ion conductor broke down without allowing the lithium to permeate the membrane at all. We hypothesized that the cause of this breakdown was that lithium turns into hydrated ions surrounded by water molecules when resolved into seawater. Consequently, an ion conductor that is impermeable to hydrated lithium ions could not electrically transfer the lithium.

Therefore, we started to review a new method for removing water molecules from hydrated lithium ions. After conducting a variety of tests, we developed a separation method that causes lithium contained in seawater to selectively transfer to a recovery liquid by perfectly contacting electrodes on both ends of the lithium ion conductor and by creating a difference in the lithium concentration between the seawater and recovery liquid (devoid of lithium). Moreover, we established the world's first technology for recovering lithium by capturing electrons through lithium transfer using electrodes, in the manner of a concentration cell, and also generating electricity (Figure 1).

Based on the results of material selection tests, we used an ion conductor made from ceramics with a NASICON- or Perovskite-type crystal structure as the lithium separation membrane. Resource recovery always requires external

energy. However, our technology does not consume electricity or any other external energy during the lithium separation process. Thus, it is an innovative technology that not only saves space and time compared to the conventional method, which recovers lithium from salt lakes, but also generates electricity. We used real seawater to conduct a 3-day lithium recovery experiment and succeeded in recovering a maximum of approximately 7% of the lithium contained in the seawater without allowing unnecessary elements to permeate the membrane.

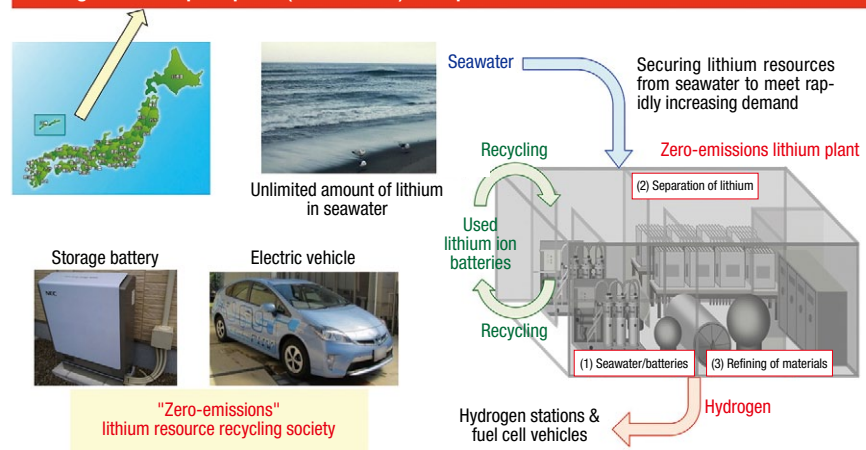
### Toward the realization of a lithium resource recycling society

Using our newly developed technology, we succeeded in recovering lithium not only from seawater but also from bittern (which has a lithium concentration 50 to 100 times that of seawater) that is used to make *tofu*. This technology has significant spin-off effects and can also be used to recover lithium from used lithium ion battery solution (in the recycling of used lithium ion batteries) as well as to efficiently recover a variety of useful minerals containing lithium from concentrated seawater, which is discarded in seawater salt manufacturing and desalination. In the future, we will accelerate research and development to realize a lithium resource recycling society. To this end, we will build a zero-emissions lithium plant, with the aim of expanding it to the size of a pilot plant, in order to secure lithium resources from seawater to meet rapidly increasing demand as well as to not only recycle used lithium ion batteries but also to generate electricity in the lithium separation process (Figure 2).

In addition, once we have significantly expanded the lithium separation and recovery system, we will also become able to manufacture the hydrogen required for fuel cell vehicles by recovering the hydrogen gas generated at the positive electrode when lithium is separated. Therefore, this technology is also likely to contribute to the development of a hydrogen society. In order to commercialize this innovative lithium resource recovery technology quickly, we must develop a lithium ion conductor with better performance. To this end, we will strive to create a nationwide system for stably supplying lithium resources through industry-university-government collaboration.

■ Figure 2

Aiming to build a pilot plant (R&D center) in Japan



# Towards International Sharing of Accident Information

## — Japan - Marine Accident Risk and Safety Information System —

[KEYWORDS] Japan Transport Safety Board / Japan-Marine Accident Risk and Safety Information System / prevention of accidents

### Kuniaki SHOJI

Member of Japan Transport Safety Board, Ministry of Land, Infrastructure, Transport and Tourism  
(Ocean Newsletter No.356, June 5, 2015)

From April of 2014, the Japan Transport Safety Board has put into operation the global version of Japan - Marine Accident Risk and Safety Information System (J-MARISIS), that allows viewing of reports made public by foreign countries' marine safety investigation authorities. With the globalization of marine casualty information, the international sharing of information concerning the causes of marine casualties and safety measures is indispensable for preventing future occurrences of marine casualties and the loss of precious lives and property, as well as environmental pollution, that accompany them.

### Introduction

The Marine Committee of the Japan Transport Safety Board handles approximately 1,000 ship accidents and incidents annually. The Marine Committee, which is comprised of a chairperson and four members, and the Marine Special Committee, which is comprised of three members, discuss the drafts of accident investigation reports; submit adopted



The author presiding over a Marine Committee meeting

reports to the Minister of Land, Infrastructure, Transport and Tourism; and release them to the public on a website and so on.

An incident is a situation with the risk of causing an accident—for example, the near collision between the car carrier Auto Banner and the training ship Shimayuki that occurred in the Kanmon passage in June 2013.

Which authority investigates a given accident varies depending on the nationalities of the ships involved and the waters where the accident occurs. The Italian authority investigated the January 2012 accident in which the passenger ship Costa Concordia ran aground and capsized in Italy, while the South Korean authority investigated the March 2014 sinking of the passenger ferry Sewol. The Japan Transport

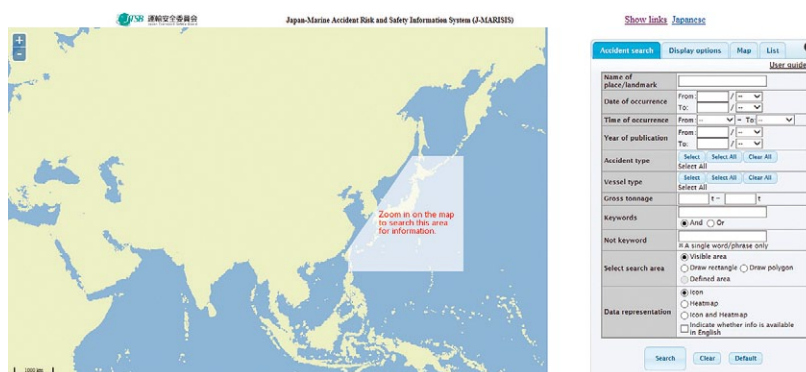
Safety Board (JTSB) investigates accidents that occur in Japan's territorial waters, including accidents involving foreign ships, as well as overseas accidents involving Japanese ships. However, the board does not handle accidents caused by intentional acts of destruction, including piracy, even if Japanese ships are damaged by such acts.

### Japan-Marine Accident Risk and Safety Information System

To help users effectively utilize published accident investigation reports, we started to provide Japan-Marine Accident Risk and Safety Information System (J-MARISIS) services via the Internet (free of charge, no registration required) in late May 2013, which show the locations of accidents on a map to enable users to access summaries and full texts of investigation reports. We also announced these services in the Ocean Newsletter No. 317 (October 20, 2013).

Provision of the English language version of these services started in September 2013. Investigation reports on marine accidents are published based on the decisions of the countries involved. In response to requests for access to information on overseas accidents that have occurred in waters on routes scheduled for overseas navigation, we put into operation the global version of J-MARISIS (Figure 1)

■ Figure 1: J-MARISIS Homepage  
Japan - Marine Accident Risk and Safety Information System (J-MARISIS)  
[http://jtsb.mlit.go.jp/hazardmap/index\\_en.html](http://jtsb.mlit.go.jp/hazardmap/index_en.html)



in April 2014 to give users access to reports published by foreign countries' marine safety investigation authorities.

## Globalization of information on marine accidents

We reported on J-MARISIS marine accident information at the 9th European Marine Accident Investigators' International Forum (EMAIF9, attended by 19 countries) held in Switzerland in September 2013 as well as the 22nd Marine Accident Investigators' International Forum (MAIF22, attended by 24 countries and territories) held in South Korea in October 2013. With the agreement of seven countries (Australia, France, the Netherlands, the United Kingdom, the United States, New Zealand, and Canada), we started the service by initially providing access to approximately 400 investigation reports.

To further publicize J-MARISIS in the international community, we also submitted a document to the first session (in July 2014) of the International Maritime Organization's Sub-Committee on Implementation of IMO Instruments to provide information on the objectives and functions of J-MARISIS as well as to discuss the globalization of marine accident information.

Subsequently, we introduced J-MARISIS at various international conferences and made requests to countries to provide data, obtaining agreements from four more countries (Germany, Indonesia, the Bahamas, and Norway). At present, we incorporate data from 11 countries into our system, thereby providing access to approximately 600 reports published by these countries' marine safety investigation authorities.

## Overview of J-MARISIS

J-MARISIS shows the location of marine accidents on a world map. Users can access information on accidents, including the name, date, summary, and investigating country, by clicking the relevant accident mark displayed on the map. The website of the report published by the relevant country's investigation authorities can be accessed by clicking on the accident name (Figure 2).

In addition to keywords, users can also search for accident information by date, time range, and accident type as well as by the type and gross tonnage of ships.

This initiative for the provision of marine accident information is the first of its kind worldwide. In response to our requests for

opinions, we received comments from maritime organizations, educational institutions, and ship companies in Japan and overseas telling us that J-MARISIS is an effective tool for improving safety for ship owners, ship operators, and ship crew. We have also received requests for providing a means of searching for information by ship nationality and ship number.

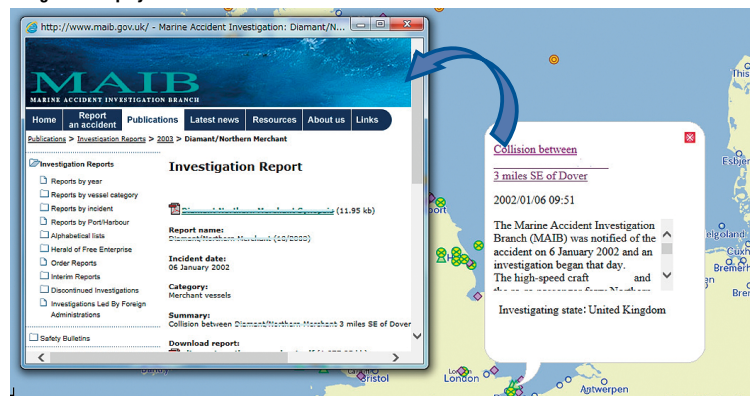
## Conclusion

Although the marine safety investigation authorities of various countries have published investigation reports in the past, sharing information on the causes of marine accidents and safety measures with the international community is indispensable in preventing marine accidents that involve the loss of precious lives and property as well as that cause environmental pollution. Therefore, in the future, we will obtain information from the marine safety investigation authorities of even more countries. In addition, with the cooperation of various international institutions and maritime associations inside and outside Japan, we must make J-MARISIS more accessible and improve its content, thereby contributing to preventing marine accidents and mitigating accident damage.

To improve J-MARISIS services, we are expanding the range of data in Japan and overseas as well as translating reports on accidents in Japan into English. In addition, given the widespread use of the Internet in recent years, we are also developing a mobile version of the map services to increase convenience for smartphone and tablet users.

To further improve the J-MARISIS services, we would like to ask you for your support and cooperation. We would also appreciate your opinions and comments about our services.

■ Figure 2: Display of accident information



● Please send your comments and requests regarding the J-MARISIS using the Comments and Inquiries page (in Japanese) on the JTSB website.

# A Movement for Turning Our Thoughts toward the Ocean

[KEYWORDS] Marine Day / diversity / curiosity

## Mitsuyuki UNNO

Executive Director, The Nippon Foundation  
(Ocean Newsletter No.359, July 20, 2015)

**As we approach the 20th anniversary of Marine Day this year, the Nippon Foundation is shining light on the various aspects of the ocean and working with the Japanese government and ocean related companies and groups to create a movement in which the thoughts of the Japanese people are turned towards the ocean. In a world of continual change, there are some things we must preserve: Oceans in which diverse forms of life can live together. With gratitude for the oceans, and involving ourselves with them in a variety of ways, universal acceptance of the idea that we humans must protect the oceans is something that must be passed on from generation to generation.**

### Twentieth anniversary of Marine Day

On July 20th of this year, we will be celebrating the 20th anniversary of Marine Day. Twenty years is the amount of time required for a newborn baby to grow into an adult (20 is the legal age of adulthood in Japan). The world's only holiday dedicated to the ocean, Marine Day was established to give thanks for the ocean's bounties and to wish for the prosperity of the maritime nation Japan. However, it is doubtful whether the Japanese people have learned to be grateful for the ocean's bounties over the past 20 years. This may be because we have not yet made serious efforts to shed light on the diverse faces of the ocean and its various charms, nor provided a broad perspective on the overall relationship between man and the ocean.

### Diversity of connections between the ocean and the people

One of the most significant events that has affected the Japanese people's attitude toward the ocean over the past 20 years is the tsunami that struck Japan during the Great East Japan Earthquake in 2011. Video of the waves engulfing local communities along the coast of Tohoku was broadcast on many news programs, planting fear of the ocean in people's minds as they saw signs of the enormous damage in the afflicted areas. There is no doubt that the ocean sometimes presents a terrible face that awes us with its overwhelming power. However, this is only one of its many faces.

Around Japan, which extends from north to south, there are various seas, ranging from one full of drifting icebergs in the north to one of coral reefs in the south, and these have different seascapes, environments, and biological species. There are quiet shores with white sand and green pine trees, beaches for swimming filled with people at leisure, and other beaches that are visited more often by sea creatures and birds than humans. Off Japan's coasts, the world stretches in all directions to the horizon, where fishing boats, cargo ships, tankers, and passenger ships navigate. Below the ocean's surface, it is no longer the human world

but instead an environment inhabited by many creatures, and deeper down, an unknown world extends where even light does not reach. The ocean has many different faces. What is your image of the ocean? The ocean's many faces also represent the diversity of relationships between man and the ocean. People involve themselves with the ocean to make a living, to enjoy leisure activities, to have adventures and take on challenges, and to gain inspiration. Different people have different relationships with the ocean. However, what all people involved with the ocean share is an interest in what may be hidden within the ocean, or in other words, curiosity about the ocean. Curiosity can drive people to action. There is no need to cite examples of astronauts and adventurers to understand that curiosity about some place far away is what drives people to use their precious time to travel. Curiosity also marks the start of involvement. As the wish to protect something or someone begins from mere curiosity, the wish to protect the ocean may also result from curiosity about the ocean and from exploring its mysterious charms—and such curiosity may be none other than the excitement that we felt as children when we gazed toward the horizon or looked into the ocean for the first time.

### An ocean network movement

This year, in which we are celebrating Marine Day's coming of age, is also the year when the World Maritime Day Parallel Event, hosted annually by one of the signatories of the International Maritime Organization (IMO), is to be held in Japan. On this occasion, the Nippon Foundation will once again shed light on various aspects of the ocean in order to create a movement to invite the Japanese people to turn their thoughts toward the ocean. To this end, the foundation is working with the Japanese government and ocean-related companies and groups to promote the Ocean Network Project<sup>1)</sup>. Our aim this summer is to arouse many people's curiosity about the ocean through a variety of initiatives we will carry out throughout Japan. For example, the Nippon Foundation will hold the Umipos Grand Prix



■ Ocean Network Project  
<http://uminohi.jp>



In addition to the project promoters, including Minister for Ocean Policy Eriko Yamatani and Nippon Foundation Chairman Yohei Sasakawa, many celebrities who support the project, such as singer and actress Umika Kawashima, appeared on stage for the July 2 kick-off event.

Contest jointly with Kazi Co., Ltd. and the Ocean Alliance, with art director Kashiwa Sato and weather forecaster Yoshizumi Ishihara serving as judges. "Umipos" is a word coined in Japanese that means "ocean posters." We will develop and make the most of apps that make it easy to produce posters in order to solicit submissions of ocean posters for the contest from all over Japan. We are accepting applications from both children and adults until the end of July. We invite everyone to take an active part in exploring the ocean's charms in their local communities and to become aware of new aspects and charms of the ocean by expressing themselves with posters.

The campaign for Tasting Seafood and Learning about the Ocean with Pride Fish, which we plan to hold jointly with JF Zengyoren, is another project organized by the Nippon Foundation. With the cooperation of food critic Yukio Hattori, we plan to provide numerous programs to help participants learn through food about traditions and culture related to the ocean. This project primarily targets parents and children, but by using food as a tool that can attract many people, we aim to create opportunities to turn our thoughts toward the ocean even without actually going there.

In addition, we also plan to use diverse approaches to organize projects, such as the Marine Day Zero Waste Action event, which aims to increase involvement in marine waste problems by simultaneously cleaning beaches all across Japan, as well as the Kaiyo Kanko University Setouchi Campus project, in which university students work with travel agencies to develop new plans for educational ocean tours and to commercialize their plans. From July to August, 56 ocean-related projects are scheduled to be implemented in collaboration with local governments,

educational organizations, NPOs, and companies throughout the country, with a total of over one million expected participants (as of June 30, 2015), especially from among children and young adults. Many and various projects are planned, each designed

to make the most of the features of its respective region. In addition to these projects, we also hold classes in schools to highlight various aspects of the oceans in different areas, as well as sports events along beaches and in the sea, where participants can experience the ocean at first hand, as well as art and cultural activities that allow people to explore and express newly discovered charms of the ocean. For details, please visit the relevant websites.

Swimming at the beach is not the only way people can enjoy the ocean in summer. By exploring and communicating the ocean's various faces and charms through the Ocean Network Project, we hope to create opportunities to awaken the curiosity of children and young adults, thereby building new bonds between the ocean and future generations. Moreover, by helping people across Japan to develop an interest not only in their own projects but also in those of other regions, we aim to generate a nationwide movement that connects people through an ocean network.

### To help future generations live in harmony with the ocean

The world is changing rapidly. Children today who grow up in environments full of IT devices and media even before they can talk will no doubt have a different worldview from that of our generation. As industries and lifestyles change, our relationship with the ocean may also change. However, even in a continuously changing world, there is something we must preserve: the ocean in which diverse forms of life can live together. Being grateful for the bounty of the ocean and sharing the idea that we humans must protect the ocean through involvement with it in a variety of ways may be one of the things that we must pass on from generation to generation.

We encourage adults to join children this summer in reminding themselves once again of the ocean's excitement. That excitement may be the surest bond between the ocean and we humans as well as the driving force required to pass on the ocean to future generations. ■

1) Ocean Network Project is a tentative translation of the project name.

# An Apprentice Boatbuilder in Japan

[KEYWORDS] “wasen” / transmitting skills / documenting traditional technologies

## Douglas Brooks

Boatbuilder

(Ocean Newsletter No.359, July 20, 2015)

The techniques of boatbuilding, like many crafts, are shrouded in secrecy and were only transmitted via an ancient apprentice system. As a boatbuilder in America working on a variety of projects, I would like to see a revival of traditional boatbuilding in Japan but the traditional apprentice system is not going to be able to save the craft. There is a need now to record a wider range of wasen designs, and offer opportunities for amateur boatbuilders to be exposed to these techniques.

### My first meeting with a traditional Japanese boatbuilder

Much of my work as a boatbuilder in the United States has involved collaborating with museums and municipalities, building replicas of traditional boats as public demonstrations. These projects involve researching traditional boat designs, teaching, as well as boatbuilding. I enjoy the varied aspects of this type of work, appreciating both working with my hands as well as engaging the public in a teaching role, and writing about my projects. I also build custom boats for clients and have been involved in restorations of wooden vessels from a Canadian skiff to a three-masted schooner.

The most significant turn in my professional life occurred in 1990 when I accepted the invitation of my college roommate to visit his native country of Japan. On that first trip I met several boatbuilders, and became exposed to a world of craft both mysterious and alluring. I met craftsmen who possessed extraordinary skills, yet also discovered the craft was only transmitted via an ancient apprentice system. Eventually one of the boatbuilders I met invited me to be his student, and in 1996 he and I built a taraibune, a unique boat still used on a small island in the Sea of Japan. In 2003 the Kodo Cultural Foundation, with funding from the Nippon Foundation, published my first book, *The Tub Boats of Sado Island; A Japanese Craftsman's Methods* (Shokumin no Gihou; Sado no Taraibune).



The Tub Boats of Sado Island: A Japanese Craftsman's Methods (Kodo Cultural Foundation)

### Documenting wooden boatbuilding techniques

Over the course of eighteen visits spanning twenty-five years I have apprenticed with five boatbuilders: in Sado-gashima, Urayasu, Tokyo, Aomori, and Okinawa. In addition I have traveled to forty-five of Japan's forty-seven pre-

fectures, meeting and interviewing over fifty boatbuilders. My teachers were in their seventies or eighties at the time I studied with them, and for each I was their sole apprentice. The last century was a pivotal time for this craft: the devastation of World War II forced one more generation to assume the work of their fathers, but the rapid recovery and ascendance of the Japanese economy starting in the 1960's pulled the sons of these men into the corporate jobs of a new Japan. In a single generation the apprentices the craft depended on disappeared.

The techniques of boatbuilding, like many crafts, is shrouded in secrecy. Most of my teachers used no drawings whatsoever, working entirely from memory. Drawings, where they did exist, were left intentionally incomplete. The goal of my work has been to document as much as I can - essentially writing the secrets down - in an effort to preserve the designs and techniques of the craft. My teachers have been willing collaborators in this process, understanding better than anyone the knowledge about to be lost.

### A revival in Sanriku

My latest research in Japan was in the tsunami zone, documenting the work of Hiroshi Murakami san, one of the last surviving traditional boatbuilders of that region. He built an isobune, the most common small fishing boat of this coast. Prior to 2011, this part of Japan (Sanriku) had the largest concentration of traditional watercraft that I have seen anywhere in Japan. Over ninety percent of the fishing fleet was destroyed or damaged in the disaster, meaning the last victim of the tsunami may be the region's culture. Currently reconstruction projects are taking place throughout the region, with even the smallest fishing harbors receiving larger and higher seawalls. The infrastructure being put in place will hopefully bring this region's important fishing industry back to full capacity. Ironically, the tsunami put Murakami san put him back in business. Since 2011 he built about twenty isobune, though this work tapered off.

Just like my previous projects, I documented as thoroughly as possible Murakami's design and dimensions (sunpo), information that only he knew. It would be impossible to record this information without working directly



left : An adze with a uniquely curved handle is used. right : Mr. Murakami and the author doing the "kikoroshi," or propping the bottom plank in place. (Photo by Angela Robins).

with him. For instance, all the crucial bevels for various plank angles on the boat were written on the walls of the shop. None of these markings were labeled; only Murakami understood their meaning. As inaccessible as this information may seem, as a boatbuilder I am fascinated with how Japanese craftsmen used their creativity to simplify the layout (sumitsuke) of their designs, a necessity when one is trying to commit to memory all the various dimensions for a boat.

Japan's last generation of boatbuilders worked through an era of incredible change and part of their genius was also an ability to adapt to the transformation of Japan in the post-War period. Murakami san was a working boatbuilder until recently and as such he developed extremely innovative ways to use modern power tools to perform traditional techniques. The pressure to produce boats as efficiently as possible was constant throughout his career. Eventually his work succumbed to competition from mass produced fiberglass (FRP) boats, yet in his techniques, particularly the use of power tools and glue, I see an opportunity to make this style of boatbuilding more accessible to amateurs.

### **Towards the transmission of wasen boatbuilding skills**

I would like to see a revival of traditional boatbuilding in Japan, like we have seen in Europe and America, but

the traditional apprentice system is not going to be able to save the craft. There is a need now to record a wider range of wasen designs, and offer opportunities for amateur boatbuilders to be exposed to these techniques. In the last three years I have built wasen in the Setouchi Festival in Takamatsu and at the Mizunoki Bijutsukan in Kameoka. I taught apprentices for both projects. Earlier this year I built two wasen with students at an American university. I hope to keep publishing my research and find more venues to build wasen and teach these techniques. It is the least I can do to honor the generosity of my own teachers, the last generation of Japanese boatbuilders. Their remarkable skills should not intimidate us, but rather inspire us to find a way to continue this legacy. ■

# Kindai University's Fish Farming Research and the A-Marine Kindai Company

[KEYWORDS] Kindai tuna / multi-generation fish farming / marine resources

## Hiroyasu TSUJI

President, A-Marine Kindai Company

(Ocean Newsletter No.360, August 5, 2015)

In recent years, as there has been much concern about the global exhaustion of marine natural resources and a strengthening of international fishing quotas, conditions for the fishing industry in Japan have changed greatly and the country itself, as a major consumer of seafood, is now being called to account. Even against such a background, I am confident that Kindai University's fish farming technology can make large contributions to resource conservation.

### Establishment of the Kindai University Aquaculture Research Institute and its research history

In 1948, under the concept of "cultivating the ocean" proposed by Koichi Seko, Kindai University's first president, who was deeply concerned about post-war Japan's food problems, the Seaside Research Facility (the current Kindai University Aquaculture Research Institute Shirahama Station) was opened in Wakayama Prefecture's Shirahama-cho. Subsequently, the Uragami Station, Shingu Station, Oshima Station, and Susami Branch were opened in Wakayama Prefecture, the Toyama Station in Toyama Prefecture's Imizu City, and the Amami Station in Kagoshima Prefecture's Setouchi-cho. At present, the Research Institute is composed of six stations and one branch.

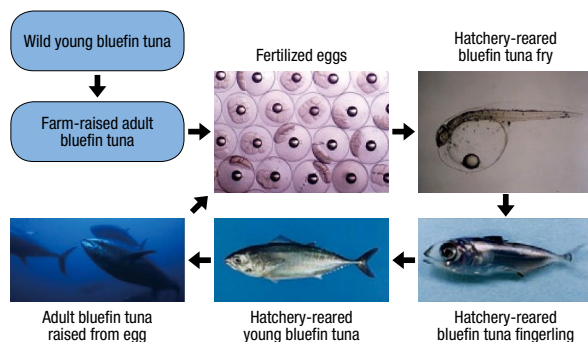
The university had no funds for the institute when it was initially established, so the institute had no choice but to sell farm-raised fish in order to maintain a self-supporting system to continue its research. Teruo Harada, who later became the institute's second director, responded to this need for funds. Through his landmark achievements, including the development of the world's first net-cage culture system, the establishment of full life-cycle culture of various marine fish species, and provision of a supply of high-quality hatchery reared juveniles through selective breeding, Harada established a management system based on self-production, thereby maintaining and continuing the institute's research without depending on funding from the university or other external organizations. Such research

activities based on a spirit of practical science have become a distinctive feature of the research institute.

Starting from yellowtail aquaculture, the institute studied the farming of various types of marine fish, including sea bream, greater amberjack, white trevally, bluefin tuna, and longtooth grouper, as well as techniques for farming freshwater fish, such as ayu sweetfish, red-spotted *masu* salmon, and sturgeon. In recent years, the institute has started to research the common Japanese conger and *masu* salmon. In addition to developing full life-cycle culture of many fish species, which is a technique for raising fish fry that have hatched from eggs into adult fish to bring up the next generation of fish, the institute has also succeeded in selective breeding, including the production of the Kindai sea bream strain, which grows faster than wild sea bream.

The institute started full-scale research on bluefin tuna in 1970, when it participated in the Fisheries Agency's research project and opened the Oshima Station. However, during the 3-year research period, it was impossible to continue to raise fish for more than a year, and all other research institutes withdrew from the project when the budget period elapsed. Only Kindai University continued the research, successfully achieving natural hatching inside cages, a world first, in 1979. However, all the tuna fry eventually died. Since the tuna laid no eggs for the 11 years from 1983 to 1993, the research on larval rearing suffered an interruption. Despite these difficult times, tuna started to lay eggs again in 1994, and in 2002, 32 years after the research started, the institute finally succeeded in achieving the world's first full life-cycle culture, when bluefin tuna that were raised from eggs under artificial condition finally laid eggs as adult fish. Kindai University's full life-cycle culture technology, which enables continuous aquaculture without the use of natural resources, is necessary for solving the global tuna resource problem and is expected to make great contributions.

#### ■ Full life-cycle culture of bluefin tuna



### Establishment of the Kindai University Aquaculture Technology and Production Center and its business history

In 1970, in order to commercialize the technology



Kindai University awards a Graduation Certificate to each raised bluefin tuna.

## Kindai University's Fish Farming Research and the A-Marine Kindai Company

developed by the Aquaculture Research Institute, the Aquaculture Technology and Production Center Shirahama Hatchery was opened in Wakayama Prefecture's Shirahama-cho to start a pilot project to mass produce farmed fish and high-quality juvenile fish for farming in collaboration with local fisheries cooperatives. Subsequently, the university opened the Susami Hatchery, Oshima Hatchery, and Uragami Hatchery in Wakayama Prefecture as well as the Amami Hatchery in Kagoshima Prefecture's Setouchi-cho.

Initially, the center raised fry into adult fish and shipped them to wholesale markets in order to generate a major source of income. However, thanks to rapidly increasing demand resulting from selective breeding of fish, especially the highly recognized red sea bream, which grow faster than ordinary sea bream, sales of fingerlings came to exceed sales of adult fish. At present, the domestic market share of juvenile sea bream is 25%, while that of white trevally is 70%. In addition to these fish, the center produces juveniles of bluefin tuna, tiger puffer, amberjack, and white trevally.

### Establishment of A-Marine Kindai Co., Ltd. and its business history

A-Marine Kindai Co., Ltd. was established in 2003 to take charge of selling products to outside organizations and to handle public relations, which had previously been performed by the Kindai University Aquaculture Research Institute and the Aquaculture Technology and Production Center. Thus, the three organizations came to engage in business together.

Since the selling of adult fish that were farmed with the aquaculture technology developed over the years in markets was not sufficient to make Kindai University's name better known to general consumers, the company changed its policy and chose business partners that advertised the Kindai brand in stores with a view to making the brand more widely known. As a result of these efforts, the business has grown to more than three billion yen in total sales.

Against the backdrop of a stagnant domestic aquaculture business due to the influence of the economic slowdown, A-Marine Kindai was reviewing what it could do to increase demand for farm-raised fish. Then, in response to a proposal by Suntory, which is knowledgeable about store management, A-Marine Kindai opened the first branch of Kindai University-raised Fish and Bounty of Kishu—

Kindai University Aquaculture Research Institute, its farm-raised fish food restaurant chain, in Osaka's Umeda district in April 2013, and the second branch in Tokyo's Ginza in December 2013. The institute's aquaculture technology has greatly improved compared to its previous level. A-Marine Kindai is striving to advertise the safety, reliability, and deliciousness of farm-raised fish by providing consumers with bluefin tuna and other fish raised by Kindai University, as well as more directly reflect consumers' evaluations in its future research and production efforts. Also, it has become widely known that Kindai University students participate in preparing the restaurant's menu and dishes. Consequently, the restaurant business boomed in FY2014, as the Osaka store was visited by 125,000 customers and the Tokyo store by 66,000 customers.

Exports are also an essential measure for bringing the aquaculture business out of the economic doldrums. Looking toward the future, A-Marine Kindai has been shipping its products to the United States on a trial basis for more than 5 years. In addition, bluefin tuna raised using the full life-cycle culture technology were listed 2 years ago in the Blue Seafood Guide published by Sailors for the Sea, an international marine environment conservation organization, and the A-Marine Kindai stores were certified as the first sustainable partner restaurant in Japan. Making the most of these circumstances, the company intends to contribute not only to promoting the aquaculture industry by advertising bluefin tuna and other fish raised by full life-cycle culture as sustainable and safe food ingredients but also to protecting the natural bluefin tuna, a species designated as endangered by the Washington Convention Conference of the Parties.

In addition, A-Marine Kindai has been collaborating with Toyota Tsusho Corporation in raising of bluefin tuna juveniles since 2010. Starting in 2015, Toyota Tsusho operates land facilities for producing juvenile tuna in order to improve production efficiency and to expand production of "Kindai tuna" by working in collaboration with Kindai University from the larval production stage.

Furthermore, A-Marine Kindai has been exercising demarcated fishing rights to participate in sea-surface aquaculture since 2013. The amount of bluefin tuna farming is increasing in Japan. As a result of stricter regulation on catching of natural fingerlings, demand for farm-raised tuna fingerlings is likely to continue to increase in the future. The company therefore aims to further expand its business operations. ■

● Kindai University Aquaculture Research Institute: <http://kindaifish.com/index.html>  
● A-Marine Kindai Co., Ltd.: <http://www.a-marine.co.jp/index.html>

# Sharing the Experiences of Sea People through “Kikigaki”

[KEYWORDS] technology cooperation / human resource development / “Itoman-uri” indentured apprenticeships

## Juichi SHIBUSAWA

President, Network for Coexistence with Nature (NPO)  
(Ocean Newsletter No.361, August 20, 2015)

“Kikigaki,” or folk narrative recording, is not only the putting of someone’s life experiences down into words, but is a process in which the interviewer empathizes with the thoughts and feelings the informants shares about their past, thus providing a vicarious experience of the informant’s life through the transcribed recording. If the sharing of marine technologies with people in other countries is accompanied by such folk narrative recordings, I believe the technologies and systems we want to impart will take a firmer root in their daily lives.

### “Kikigaki Koshien” program

Two people are talking in front of me, smiling. One is a high school student from Okayama, while the other is a 90-year-old fisherman who lives on Ishigakijima Island, one of the southernmost islands of Japan. The words coming out of their mouths differ completely from what you would expect based on their facial expressions.

“I was sold to an *Itoman-uri* (*Ichuman-ui*) (human trafficker) when I was eleven. My parents sold me because we were poor... I know many other children who were sold to human traffickers.” “My job was to drive fish into a fishing net in the drive hunt fisheries. Children who couldn’t swim were tied to ropes and thrown into the sea. I swam desperately to stay alive. On cold winter days, even if we tried to climb onto the boats, our hands were beaten with oars and we were shoved back into the sea. Drowning children were not saved; they were abandoned. On the next day, some children who had been swimming with me washed up dead on the beach.” “There was no joy in my life. I had no hope or dreams for the future. I couldn’t go to school, so I couldn’t read. I was finally released when I received a notice I had been drafted, but I was unable to read the Imperial Rescript to Soldiers and Sailors and my superior beat me. I worked hard with a fellow soldier, shaking him awake, to memorize the rescript at night while everyone else was asleep.”

This is a scene from the Kikigaki Koshien Forum. The high school student continues to nod silently, whispering, “Everything is so incredible to me. I see now what I take for granted is not necessarily so...”

This is the 14th year of the Kikigaki Koshien, in which 100 high school students record the lives of 100 senior citizens who have lived amidst nature in Japan, using their wisdom, skills, and bodies.

The senior citizens are master experts who have lived by working in forests, and on rivers, lakes, and the ocean. Thus far, the high school students have interviewed 1,300 people. They record their lives, transcribe the recordings, ask questions to obtain a better understanding, and then edit out their questions to leave only the narratives of the experts.

Students then rearrange the sentences and delete some of them to construct first-person narratives. This process may sound like a simple series of operations for putting narratives into words. However, elderly people speak a language that is difficult for high school students to understand. High school students have difficulty understanding the terms, contexts, and backgrounds of the narratives. Nevertheless, as they desperately try to transcribe the conversations again and again, the students come to share feelings with the experts—i.e., there comes a moment when they understand what is written between the lines. “At that moment, you no longer know whether you are writing down the words spoken by the expert or by yourself,” recall many high school students. That is the moment when they vicariously experience their storytellers’ lives, which their commitment to understanding others makes possible. Through Kikigaki, high school students experience a coming into contact with the minds of other generations for the first time in their lives. This experience helps them learn consideration for others. For the experts as well, the narratives constructed by the high school students provide evidence of their lives in a specific era. Thus, Kikigaki provides moments in which different generations and different individuals connect with one another.

For the elderly people who appear in the Kikigaki



A high school student and a 90-year-old fisherman



A high school student interviewing a veteran expert (photo taken by Takafumi Okuda)

Koshien, living means working. They lived in an era when moving their bodies through labor was the only way to sustain themselves. That is exactly what living meant for the man who was sold to a human trafficker and what he tried to convey with his words.

### Roles of international technical cooperation

While I was working overseas in an agricultural technical cooperation project, I often encountered situations that showed how the transfer of advanced technologies did not endure. Many advanced machines use electricity or gasoline to operate and do not function without an energy supply. Producing better agricultural products in greater quantities requires irrigation facilities as well as chemical fertilizers; it is impossible without them. I have been told that the only technology transferred from Japan that has taken root in Southeast Asia was the rice planting that Japanese soldiers taught to local residents. Asked what their occupation was, African cassava farmers answered hunting. For them, growing cassavas was not an industry called "agriculture," but rather "farming," which was just part of their daily lives. An occupation is what people do to obtain cash—for example, hunting gazelles, catching one or two per year. The mechanized farming that we teach appears useless to people who think in this way. The Japanese people have pursued economic wealth and efficiency for half a century since Japan's period of rapid economic growth, but for the people of many countries, the term "wealth" has many connotations besides economic wealth.

### Thoughts and systems

A nation's or place's present is formed by the accumulation of people's lives in the past. If the present is an extension of the past, the future is also an extension of the present. My experience in technical cooperation has taught me

that people's lives are composed of thoughts and systems. An accumulation of living has continued for thousands of years in many places where today the Japanese aim to transfer technology. My experience has made me realize the contradiction inherent in transferring only systems to such places.

Viewed as a system, *Ichuman-ui* in Okinawa was a mechanism that supported long-term employment based on advance loans rather than human trafficking. From their masters' viewpoint, children were assets and invaluable labor. They never wished to idly kill children; their aim was to achieve maximum cost efficiency without killing but without spoiling the children. Meanwhile, children were also able to acquire the work skills required to live as adult fishermen when their service contract period ended due to military service. As a system therefore it was based on a win-win relationship. However, as the old fisherman quietly tells us, *Ichuman-ui* was not merely an employment system.

If Japan is to make any contribution in the future to the people of maritime nations, including island countries, it is necessary to not just unilaterally provide systems and technologies but also to develop approaches and make efforts to understand the accumulation of life in local communities and to empathize with residents' thoughts on happiness, which continue to support their daily work. We hope Kikigaki can be used for this purpose. After all, people cannot live by systems alone. Many of the high school students who participated in the Kikigaki Koshien are already studying as university students or working as active members of society. I dream of the day when some of them will play a role in bridging thoughts between people as they work out Japan's future maritime policies. ■

# A New Pufferfish that Makes “Mystery Circles” on the Sea Floor

[KEYWORDS] fish species / spawning / Amami Ohshima

## Keiichi MATSUURA

Curator Emeritus, National Museum of Nature and Science  
(Ocean Newsletter No.363, September 20, 2015)

On the seafloor near the island of Amami-Ohshima, mysterious circles of 2 meters in diameter appear every year from April to August. The circles contain numerous grooves in an elaborate radial pattern. It has now been determined that the circles are in fact the spawning grounds of a newly discovered species of pufferfish. While 18,000 new species are discovered every year, this new pufferfish was chosen among the top 10 for 2015.

### Mystery circles on the seafloor near Amami-Ohshima Island

Some 20 years ago, mysterious circles were found on the seafloor off Amami-Ohshima Island. Made in the sand, these circles were as large as 2 m in diameter and had many grooves running in a radial pattern from the center to the periphery (Photo 1). The circles' edges had bumps that resembled double banks, with seashell pieces scattered atop. Such circles appeared from around April to August and were known among local divers as "mystery circles." How these mystery circles were created and by what remained a mystery.

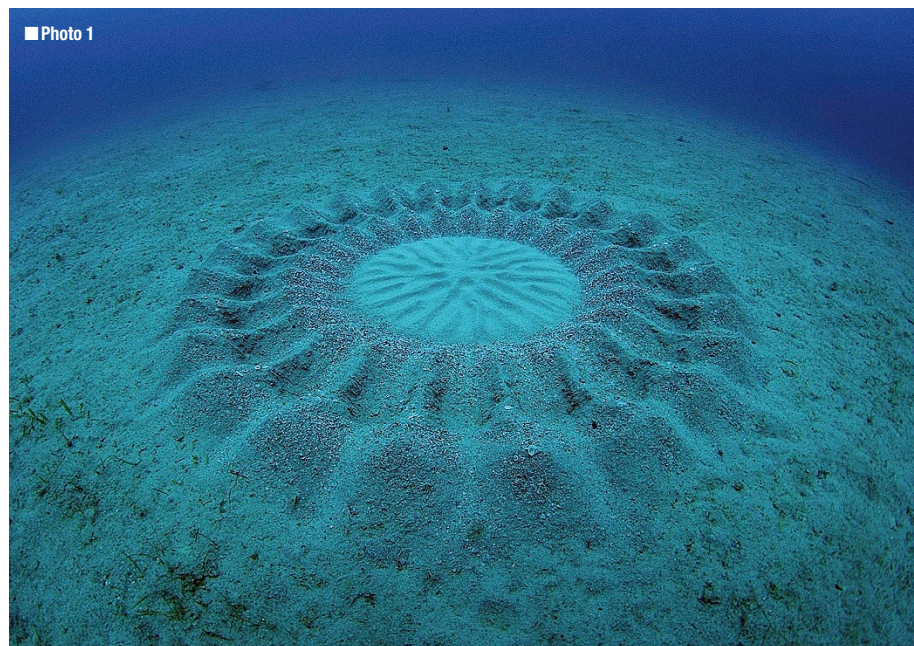
In 2011, underwater photographer Yoji Okata witnessed a small, unfamiliar pufferfish creating such a mystery circle, thus finally making clear what was creating the mystery circles. However, the species of pufferfish was unknown. I had the opportunity to observe this pufferfish in early July 2012. In the waters off Amami-Ohshima Island, I dove down to the seafloor at a depth of 25 m with Okata and a TV crew to find a mystery circle. I then saw a small pufferfish, approximately 12 cm in length, busy stirring the



An amami white-spotted pufferfish digging a groove

sand with its fins at the center of one such circle. The fish tending the circle was a male. We witnessed a female visit the circle to lay eggs in the center alongside the male; thus, the mystery circle turned out to be their spawning grounds (Photo 2).

As a result of observing the pufferfish on the seafloor and reviewing photos of it, I discovered that the pufferfish creating the mystery circles was a new species of the genus *Torquigener*. This pufferfish was shown on a TV program, soliciting many responses from the public. In addition to the fact that the pufferfish was a new species, many were surprised that such a tiny pufferfish was capable of building a spawning site with a shape as complex as that of the mystery circle. Thus, the new species of pufferfish quickly gained in popularity.



The amami white-spotted pufferfish's spawning grounds, 2 m in diameter



### Amami white-spotted pufferfish chosen as one of the world's top 10 new species

I discovered that the pufferfish that created the mystery circles was a new species. However, new species are not officially recognized until presented in an academic paper, and writing such a paper requires samples. However, it was not easy to collect samples of the pufferfish, as it had become very popular among local residents. Some people were opposed to the idea of collecting such pretty little pufferfish as samples. Therefore, I held lecture meetings on the new pufferfish species on Amami-Oshima Island in September 2013 and February 2014 to explain that samples are needed to write an academic paper on a new species. To obtain local residents' approval, I also explained that collecting several individual samples involved no risk of the species' extinction because the pufferfish were observed in those waters every year.

A research team of my museum eventually collected two individual samples of the new species in late May 2014. Fortunately, the two individuals we collected happened to be a male and a female. Based on a sample survey, I finally submitted a paper in mid-July 2014. Then, in early September, the paper on the new species was published. Since the new pufferfish had many white spots on its body, its Latin name became *Torquigener albomaculosus* (Photo 3). *Torquigener* is the Latin name of its genus, while *albomaculosus* means "white spots." In Japanese, the pufferfish was named *amami hoshizora fugu* ("amami white-spotted pufferfish"). Needless to say, it was named "amami" after the place it was initially discovered. The expression "hoshizora" (starry skies) was chosen because of the likeness of the white spots on its body to the stars in the night skies of Amami-Oshima Island. Local residents asked me to give it an inspiring name that evoked Amami-Oshima Island. Fortunately, I have been told that the Japanese name "*amami hoshizora fugu*" is popular among the locals.

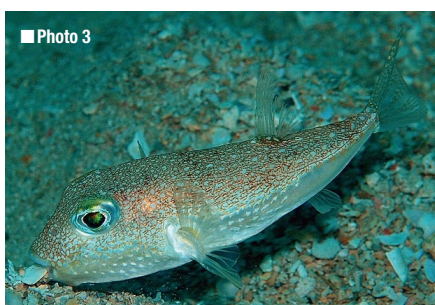
In April 2015, I received an e-mail from the International Institute for Species Exploration informing me that the amami white-spotted pufferfish was chosen as one of the world's top 10 new species. This institute is located in New

York, USA, and it is engaged in the study and preservation of biodiversity as well as provision of support for natural history museums. The world's top 10 new species are selected by a Selection Committee composed of some 10 committee members. I was informed that when choosing the top 10 new species, the committee takes great care to avoid having the selections become concentrated on a specific type of creature. According to the institute, as many as 18,000 newly discovered species are reported each year. The total number of known biological species is approximately 1.8 million. It is said that the earth is inhabited by at least 10 million biological species, including unknown species. Therefore, it is unsurprising that more than 10,000 new species are reported each year.

### Role of mystery circles

A male amami white-spotted pufferfish builds a spawning site as large as 2 m in diameter with a complex shape in 1 week. Then, a female pufferfish comes along to spawn in the center of the circle. The eggs hatch 5 days later. Why does a male pufferfish spend as much as a week building a complex structure called a mystery circle? Its spawning site has many grooves running in a radial pattern from the center to the periphery. Therefore, seawater always gathers in the center no matter which direction it flows. As a result, the seawater in the center of the circle does not become stagnant, so fresh seawater is always supplied to the eggs. Needless to say, fresh seawater containing oxygen is necessary for the eggs to grow. Thus, the radial grooves provide a comfortable environment for the eggs.

However, many fish species build spawning sites with simpler, dented shapes on the seafloor or on river or lake bottoms. The parents of such fish species often move their fins to bring fresh water to their eggs. It is easier to supply water to eggs in this way than building a spawning site with a complex shape. Why does the amami white-spotted pufferfish spend so much time and energy to build a complex spawning site? One reason for this may be that the site's shape is effective in attracting females. The amami white-spotted pufferfish builds a spawning site in sand on the seafloor, which is a monotonous landscape. A large circle with a complex shape stands out on the seafloor. A male amami white-spotted pufferfish crushes seashells and places the crushed pieces on the bank-like structure at the circle's edge to decorate it. This behavior is also considered to be useful in making the site stand out from the surrounding landscape. However, the spawning behavior of the amami white-spotted pufferfish remains a mystery, so more research is required to resolve it. ■



Amami white-spotted pufferfish putting a shellfish piece along the edge of a mystery circle (all three photos taken by Yoji Okata)

# A New Challenge by the City of Himi, a Leader in Fishing Village Culture

— Creating Community Development through the Himi Fishery Network Gallery: Totoza —

[KEYWORDS] Etchu-style fixed net / collaboration among city residents / social proposition

## Yujiro HONGAWA

Mayor, City of Himi, Toyama Prefecture

(Ocean Newsletter No.365, October 20, 2015)

Located at the base of the Noto Peninsula, Himi City faces Toyama Bay and has inherited a long history of fishing village culture. The newly opened Himi Fishery Network Gallery “Totoza” is a community center that aims to pass on fishing village culture, such as the now world-famous Etchu-style fixed net techniques, as well as bring attention to Himi’s unseen social capital and the ties among local residents.

### The City of Himi, a fishing community with a tradition of Etchu-style fixed-net fisheries

Located at the base of the Noto Peninsula and facing Toyama Bay, the City of Himi has enjoyed the ocean's rich bounties since the prehistoric Jomon period. This ocean community is frequently mentioned in ancient *Manyoshu* poems and is known as a fishing community with a storied fishing village culture. Etchu-style fixed-net fishing<sup>1)</sup> has played a pivotal role in Himi's fisheries. Commonly known as "*daiami*" in the Toyama Bay area in olden days, fixed-net fishing is believed to have started during the Tensho period (1573–1592). Then, during the Meiji period (1868–1912), fishing in Himi saw a radical change when the Hidaka-style fixed-net fishing method, used to obtain large catches in Miyazaki Prefecture, was introduced into Himi. This method was subsequently improved in Himi in various ways to develop Etchu-style large square-net fishing, which served as the prototype for present-day Etchu-style large fixed-net fishing.

Against this historical backdrop, more than 40 sets of fixed nets have been laid in the waters off Himi, where the tradition of fixed-net fishing has been maintained in order to protect marine resources. Thanks to this tradition, Himi has become one of the best-known places not just in Japan but in the world for fixed-net fishing. In fact, Himi's Etchu-style fixed-net fishing technique has spread around the world thanks to technical training conducted by JICA and other organizations in Southeast Asian and Latin American countries.

### From facilities to programs, creation of a center for city residents' collaboration

In April 2015, a new community network center, the Himi Fishery Network Gallery "Totoza," was opened in Himi, a community that is leading the development of fishing village culture with its unique tradition. This facility is intended to serve not only as a tourist facility but also as a hub for passing down fishing village culture to future generations in order to build intangible social capital and bonds between individuals. In preparation to open this facility, we have been working in collaboration with city residents.



Etchu-style fixed net



Himi's time-honored tradition of fixed-net fishing

Focused on social tourism<sup>2)</sup>, which directs visitors' attention to non-urgent but fundamental aspects of daily life, rather than on sightseeing tourism, the facility is intended to serve as a hub for leading-edge community development. As such, it will help residents actively participate in protecting local dietary customs, the traditional culture, fishing village houses, and the local landscape. Staying true to the slogan of the City of Himi administration, "From Facilities to Programs, from Programs to Hearts," the Totoza Gallery places high priority not only on creating attractive facilities but also on developing programs to promote genuine

networking among individuals in order to build bonds in the local community. From the basic design stage, we have held roundtable discussion sessions and workshops with city residents' participation and asked university students to visit village houses to collect fishing tools for exhibition, always placing high priority on working together with local residents. In addition, since opening the gallery in April, we have developed many citizen-participation projects, including a variety of seminars and symposiums as well as dialog sessions with local fishermen. For example, approximately 80 visitors from across Japan, including Himi residents, attended the opening seminar, to which we invited Hiroshi Abe, Representative of Megurinowa, a community development corporation located in Shimane Prefecture's Ama-cho that is attracting attention nationwide as a model example of community development.

More than 600 people have been involved in the *sora-ami* art project, where city residents gather together to create a large fishing net in an effort to weave a local community network through art. The completed fishing net is on display at the entrance to Totoza as the gallery's ornamental symbol. Inside, visitors can participate in weaving *sora-ami* nets even today, thereby further expanding the project's network.

Many international guests also visit the gallery, including members of Papua New Guinea's fisheries agency and the Consulate-General of Vietnam.

### Looking toward the future of Himi, a community focused on the ocean and fisheries

Totoza's most important feature is that it serves as a networking hub for solving social issues and leading the

development of fishing village culture over the long term. Residents engaged in gallery activities, including volunteers and local fishermen who visit the gallery daily, assemble to draw out new ideas. Consequently, fish dissection workshops often start unannounced in the gallery. Fishermen sometimes bring fish to the gallery in the morning, and while cooking the fish, we spontaneously spend time discussing with visitors how to dissect and cook fish. The declining percentage of fish eaters in contemporary society is raising serious concerns not only in the fishing industry but also in society at large. Promotion of fish-based diets is one of the most important programs to be developed at Totoza. Gallery visitors spontaneously discuss such issues in their daily communication—we believe this is Totoza's unique approach to social issues.

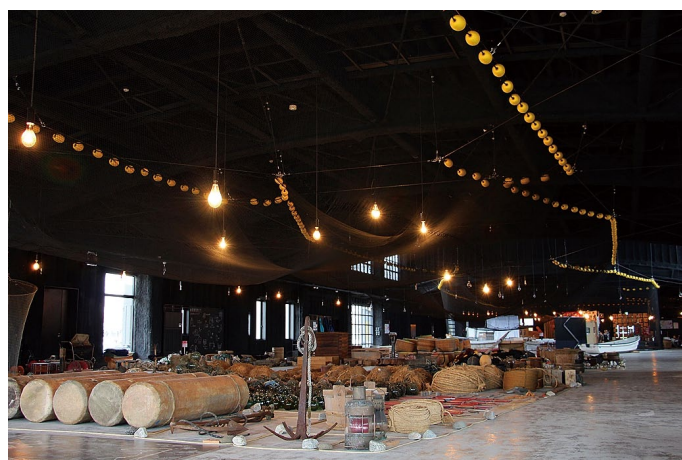
As many as 3,000 fishing tools and pieces of folk artwork are on display inside the gallery, where visitors can freely touch the exhibits. Elderly visitors from nursing care facilities who are visiting the gallery to pass the time are able to touch the folk artwork and recall old memories, which sometimes stimulates their emotions and activates their brains. Totoza is now working with other museums to develop a systematic recollection method to ameliorate dementia. Contributing to solving social issues is one important element of the future envisioned by Totoza, which aims to pass down fishing village culture to future generations.

Looking toward the future of the ocean community of Himi, we hope to continue to take on various challenges through Totoza. Please visit Totoza, a new project developed by the City of Himi, an ocean community that is leading the development of fishing village culture. ■



Himi Fishery Network Gallery Totoza: <http://himi-totoza.com/>

Items on display at Totoza Gallery



1) Himi, where Etchu-style fixed-net fishing originated [http://www.kitokihimi.com/fish\\_guide/sakana3.html](http://www.kitokihimi.com/fish_guide/sakana3.html)

2) Unlike sightseeing tourism, social tourism offers social meaning and objectives through the experience of thinking about social issues and learning about industry and local cultures.

# On the Rearing of Organisms from Deep Sea Hydrothermal Vent Area

[KEYWORDS] deep sea hydrothermal vent animals / Enoshima Aquarium / breeding

## Hiroshi MIYAKE

*Kitasato University School of Marine Biosciences / Breeding Advisor, Enoshima Aquarium / Adjunct Researcher, JAMSTEC (Ocean Newsletter No.368, December 5, 2015)*

**The bottleneck for research into hydrothermal vent organisms was that they couldn't be kept for study. In order to break through this limitation, methods for the collection and keeping of hydrothermal organisms was established. Through the raising of these organisms, I hope to clarify many aspects, from their reproduction to their ecology.**

## Introduction

Until recently, we could observe deep sea organisms only through photos of dead samples in encyclopedias. Over roughly the last 10 years, however, deep-sea organisms have become familiar species in Japan, leading to a deep-sea organism boom. One major background factor behind this boom is that deep-sea organisms we were previously unable to observe directly can now be seen live from close distances. This is thanks primarily to the efforts of aquariums in Japan, which now often exhibit deep-sea organisms. Well-known aquariums are keeping many such organisms. Japan has one of world's largest numbers of aquariums, and the Japanese people like aquariums more than any other nation. Such favorable circumstances have helped aquariums compete with one another to develop better breeding technologies. Japan continues to be the front-runner in developing technologies for keeping deep-sea organisms. Above the rest, Kitasato University School of Marine Biosciences and the Enoshima Aquarium have kept an especially large number of organisms that inhabit deep-sea hydrothermal vent environments, which can only be accessed by research submersibles.

## Why keep deep-sea hydrothermal vent animals?

One of the bottlenecks in research on deep-sea organisms has been the difficulty of keeping them. In particular, organisms living in deep-sea chemosynthetic ecosystems formed around the hydrothermal vent environments of submarine volcanoes (hydrothermal vent animals) have seldom been bred in captivity. We will be able to conduct a variety of experiments if it becomes possible to breed and keep such deep-sea organisms in facilities on land and to use them for research at any time without conducting submarine surveys.

The following introduces an effort to eliminate the aforementioned bottleneck by describing how hydrothermal vent animals can be collected and bred in captivity.

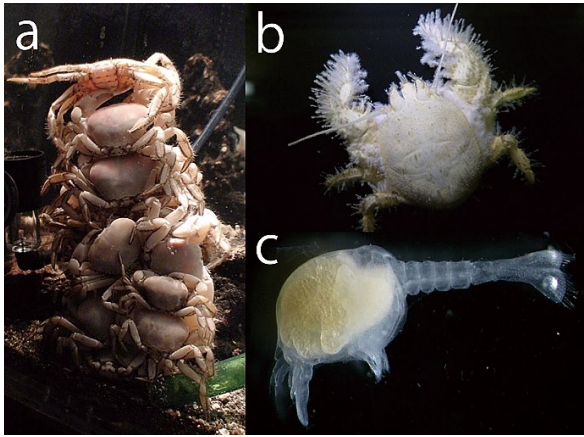
## Collecting hydrothermal vent animals

Before full-scale keeping of hydrothermal vent animals started, most hydrothermal vent animals were thought to be

unable to be kept alive in captivity after being collected by a submersible and brought aboard a ship. However, methods have been developed to keep them alive between the time of their collection on the deep seafloor and the time of bringing them aboard, thereby greatly increasing the probability that they will survive capture. The secret is to maintain the water temperature at a consistently low level. This applies not only to hydrothermal vent animals but to all deep-sea organisms. At depths exceeding 1,000 m below the surface, the water temperature drops to below 4°C. Leaving deep-sea organisms in water with a temperature close to 30°C in summer causes them to die quickly due to the water temperature being nearly eight times higher than their normal temperature. Another secret is to prevent hot water containing hydrogen sulfide from flowing into collection containers. Many people think that deep-sea organisms inhabiting areas around hot water with hydrogen sulfide will not be ill-affected by seawater containing hydrogen sulfide. However, inside a closed container, where water is not replaced, hydrogen sulfide is highly toxic. To avoid hydrogen sulfide, water must be collected at a distance from hydrothermal vents, and the water in containers must be replaced as often as necessary when gathering organisms by submersible. Even when coming up to the sea surface from the seafloor after a submarine survey, the container water must be replaced once again at a depth of 600 to 800 m, where the water temperature is 4°C to 6°C. Doing so makes it possible to bring most invertebrates alive to environments with normal air pressure. Since invertebrates do not have gas in their bladders or other organs, they do not bloat when brought to environments with normal air pressure. Also, deep-sea fish have degenerate bladders that are filled with fat, so they do not bloat excessively.

## Keeping method

Hydrothermal vent environments differ completely from everyday environments. When breeding aquatic organisms, we usually illuminate the water tank, increase the dissolved oxygen level by aeration, and maintain the water temperature at around room temperature and the pH at a level of 7 or 8. We never allow toxic hydrogen sulfide to be produced. In a hydrothermal environment, however, hot water with



a: *Gandalfus yunohana*; b: *Shinkaia crosnieri*; c: *Shinkaia crosnieri* larva (Enoshima Aquarium deep-sea chemosynthetic ecosystem tank)

a temperature exceeding 200°C comes out of vents amid seawater with a temperature below 4°C, creating a steep temperature gradient. The hot water is acidic with a pH of around 6 to 7; the dissolved oxygen level is low; and the water also contains hydrogen sulfide. This totally dark environment has a high water pressure. Thus, we must breed deep-sea organisms using a method completely contrary to ordinary breeding methods. Replicating a deep-sea environment requires various tools: to keep the dissolved oxygen level low, we aerate the water with nitrogen to remove the oxygen; we add carbon dioxide to lower the pH level; and we also add sodium sulfide solution to produce hydrogen sulfide. In addition, to generate hot water while keeping the water temperature below 4°C, water must be heated using a heater while simultaneously cooling it. This is necessary for some biological species having thermal dependence which inhabit hydrothermal environments.

In particular, yunohana crabs (*Gandalfus yunohana*), which are often found in the Izu-Ogasawara waters, tend to gather around hot water (thermal dependence). They always cluster together in warm areas (Figure 1-a). In contrast, galatheid crabs (*Shinkaia crosnieri*; Figure 1-b), which are found in the Okinawa Trough, do not have thermal dependence. The largest water tank in the Enoshima Aquarium's deep-sea section is designed to meet all these requirements. We recommend that readers view this water tank, which is the world's only deep-sea chemosynthetic ecosystem tank.

### What we have learned from breeding these organisms

The experience of breeding these organisms taught us many things that we could not discover by submarine surveys, several of which I would like to introduce here. One finding is about breeding. Thus far, one of the most notable species that we have succeeded in breeding is the galatheid

crab, *Shinkaia crosnieri*, whose larvae (Figure 1-c) we were able to observe from a close distance. *Shinkaia crosnieri* larvae are highly buoyant. Therefore, they are likely to float in water using their own buoyancy shortly after hatching from eggs, and they drift with the current until arriving in a new hydrothermal environment. Adult *Shinkaia crosnieri* has no eyes and feeds on bacteria that breed on the dense growths of bristles on their abdomens. However, larvae and juveniles have eyes and are likely to prey on other creatures.

In addition, our observation of yunohana crabs, *Gandalfus yunohana*, reveals that they do not have hydrothermal dependence when they are larvae; rather, they develop dependence as they grow into adults. A study of the activity of yunohana crab digestive enzymes reveals that the activity level increases among adults when there are hydrothermal sources, but this activity level is unaffected by the presence or absence of hydrothermal sources among small individuals. This leads us to postulate that large individuals cluster together in warm water to facilitate digestion, but small individuals are adapted to their environments so they can survive at low temperatures until they are able to reach a hydrothermal source.

### Conclusion

Breeding of deep-sea organisms has but just begun. An increasing number of aquariums are exhibiting deep-sea organisms, thereby contributing to the establishment of better breeding methods and enabling more detailed research on deep-sea organisms. Personally, I would like to establish methods for collection and keeping mid-water pelagic organisms. ■

# Toward a Sustainable Ocean for the Next Generation

— Address at the IMO International Maritime Prize Awarding Ceremony, London —

[KEYWORDS] ocean related human resource development / ocean crises / future ocean design

## Yohei SASAKAWA

Chairman, The Nippon Foundation

(Ocean Newsletter No.370, January 5, 2016)

On July 20th, the 20th anniversary of Japan's Oceans Day, as well as the following day, the Maritime Bureau of the Ministry of Land, Infrastructure, Transport and Tourism hosted the IMO World Maritime Day Parallel Site 2015, a first for the country. Over the two days, an international symposium took Maritime Education and Training as its theme, the results of which were included in the Yokohama Declaration.

### On receiving the award

I would also like to express my deepest grief and condolences to the innocent victims and the bereaved families of the recent outrageous attacks in Paris.

Now, let me express my sincere respect to the International Maritime Organization, for all its efforts for the maintenance of maritime safety and security and the prevention of marine pollution by ships. Indeed, I believe the important role played by IMO deserves to be widely recognized when we consider that maritime transport is said to account for more than 90% of global trade.

As I stand before you, I am greatly humbled and honored to accept this prestigious prize, not alone, but together with the 1,099 Sasakawa/Nippon Foundation Fellows from 131 countries and our partner institutions who have so dedicatedly provided education and guidance to their students.

### Ocean related human resource development initiatives

Looking back, we began our project for ocean related human resource development in the 1980's. At that time Grotius' principle of "freedom of the seas" had become outdated and the United Nations Convention on the Law of the Sea was adopted, which applies the common heritage of

mankind principle to the use and management of the ocean resources beyond national jurisdiction.

To support global ocean governance, and fill the gap of global human resource capacity, The Nippon Foundation began our work of "Nurturing a New Generation of Ocean Professionals", in particular, from developing countries, at institutions such as the World Maritime University and International Maritime Law Institute. We now have a network of more than one thousand fellows all over the world and we will strive to expand and strengthen this network ever more.

In recent years, we have witnessed that the problems related to our oceans arise from various interrelated causes. Therefore it has become indispensable that we have specialists who are able to apply a more comprehensive perspective that crosses disciplinary boundaries.

It is for this reason that The Nippon Foundation has also been giving importance to the ocean related human resource development of young experts who can develop holistic perspectives and knowledge. Currently, we have partnered with six universities, including Cambridge and Princeton, to establish a program that brings together experts from around the world in various fields such as climate change, ocean policy, biodiversity, fisheries, ocean resource eco-



Chairman Sasakawa's speech on receiving the IMO International Maritime Prize.



The IMO International Maritime Prize Awarding Ceremony at IMO headquarters in London.

nomics, and Law of the Sea to predict the future of our oceans. I am renewing my commitment to working for the capacity building of future generations to project a more holistic and global vision for oceans and people.

### Deepening crises of the oceans

Excellencies, ladies and gentlemen. I am however deeply concerned at the fact that the state and problems of our oceans are growing increasingly serious.

Allow me to spend few minutes to mention some of my concerns.

Overfishing has led to the destruction of ecosystem balance in different parts of the world, and it is said that about 50% of the world's marine life has been lost over the past 40 years. Climate change can increase large-scale natural disasters with significant impact on all life on Earth.

Acidification of the oceans is the cause of devastating biological damage such as to the coral reefs. Rising sea levels are threatening the lives of island nations of the South Pacific.

Legal and policy challenges confront us over the development of newly discovered deep-sea resources. There is also the issue of the management of the high seas, which cover two thirds of the oceans. The battle to win maritime rights threatens the security and stability of the principle of "common heritage of mankind."

As countries assert their rights and interests, the oceans, which are supposed to be our common heritage as one, are being split into pieces. Each of us, though we may be unaware, is involved in the deprivation of ocean resources that belong to future generations.

Crises that are challenging the oceans are becoming more and more serious. We remain ignorant of them as they silently continue to grow. Furthermore, the ever deepening crises of the oceans are left unaddressed. Unless we confront today these issues of the oceans and take effective measures without delay, a time will come when human existence itself will be threatened.

### Towards solving ocean problems

I am well aware of the major role UNCLOS has played in maintaining international order, providing a legal framework for all maritime activities. However, due to changes in society and the environment, we now face problems that could not have been imagined before. We need to recognize that it is not enough to deal with them just through existing international organizations and conventional frameworks.

Now is the time for us to seek a new framework of ocean governance that will enable us to effectively solve the problems of the oceans. This new framework will not sim-

ply solve current problems to ensure that our finite oceans are passed on to the next generations. But it will be a new framework that addresses the changes of the ocean and, "designs the future of the oceans", while providing hope for future generations. I believe this calls for a new global organization that can address the issues of ocean governance from a holistic and an integrated perspective.

I feel that many of us share these concerns and the need to take responsibility, consider the future of the oceans, and take appropriate action. But there is also a bright side to our challenges, that there are young people who are well aware of the situation of the ocean today and what it will become in the future if left unattended. It is my wish that an integrated framework of ocean governance be established and that, coupled with the abilities of the young professionals we have nurtured, will enable the crises to be overcome, leaving abundant and beautiful oceans for future generations. ■