La mer

Société franco-japonaise d'Océanographie

THE 16TH JAPANESE-FRENCH OCEANOGRAPHY SYMPOSIUM

"The sea under human and natural impacts: challenge of oceanography to the future Earth"

November 17-21, 2015

Tohoku/Tokyo, Japan

La Société franco-japonaise d'océanographie

（日仏海洋学会）

http://www.sfjo-lamer.org/

FONDATION FRANCO JAPONAISE SASAKAWA

FONDATION RECONNUE D'UTILITÉ PUBLIQUE

MFJ 日仏会館 90ème Anniversaire 公益財団法人 日仏会館 La Maison Franco Japonaise

FRA Fisheries Research Agency Tohoku National Fisheries Research Institute

Organizational committee

Prof. Teruhisa Komatsu (President SFJO Japan)
Prof. Hubert-Jean Ceccaldi (President SFJO France)
Prof. Shiro Imawaki (JAMSTEC)
Dr. Yves Henocque (IFREMER/SFJO France)
Dr. Patrick Prouzet (IFREMER/SFJO France)
Prof. Tsutomu Morinaga (SFJO Japan)
Prof. Jiro Yoshida (TUMSAT)
Prof. Hiroshi Kouno (TUMSAT)
Prof. Yasuyuki Koike (ex.TUMSAT)
Prof. Jota Kanda (TUMSAT)
Prof. Yuji Tanaka (TUMSAT)
Prof. Hisayuki Arakawa (TUMSAT)
Prof. Yujiro Kitade (TUMSAT)
Prof. Takeyoshi Nagai (TUMSAT)
Prof. Daigo Yanagimoto (Univ. Tokyo)
Prof. Toshiki Nakano (Tohoku Univ.)
Dr. Hiroshi Uchida (JAMSTEC)
Prof. Kaoru Ichikawa (Kyushu Univ.)
Prof. Mitsuru Hayashi (Kobe Univ.)
Prof. Tomoharu Senjyu (Kyushu Univ.)
Dr. Yutaka Okumura (FRA)
Dr. Hideki Takami (FRA)
Dr. Tetsuo Seki (SFJO Japan)
Prof. Kenji Ookoshi (Toho Univ.)

Scientific committee

Prof. Teruhisa Komatsu (President SFJO Japan)
Prof. Hubert-Jean Ceccaldi (President SFJO France)
Prof. Shiro Imawaki (JAMSTEC)
Dr. Yves Henocque (IFREMER/SFJO France)
Dr. Patrick Prouzet (IFREMER/SFJO France)
Prof. Tsutomu Morinaga (SFJO Japan)
Prof. Jiro Yoshida (TUMSAT)
Prof. Hiroshi Kouno (TUMSAT)
Prof. Yasuyuki Koike (ex.TUMSAT)
Prof. Jean-Claude Dauvin (Université Caen)
Dr. François Galgani (IFREMER/SFJO France)
Dr. Sandrine Ruitton (IFREMER)
Dr. Hervé Thébault (IRSN)

Organaizer : Société franco-japonaise d'Océanographie Japan & France
Sponser : La Maison franco-japonaise, Fondation Franco-Japonaise Sasakawa, Tohoku Nashonal Fisheries Reseach Institute
Support :The Japanese Society of Fisheries Science, Tohoku branch of the JSFS, The Oceanographic Society of Japan, The Society of Fisheries Oceanography, Miyagi Prefecture Fisheries Technology Institute, Iwate Fisheries Technology Center, Fukushima Prefectual Fisheries Experimental Station, Akita Prefectural Fisheries Promotion Center, Aomori industry technology center fisheries research institute, Fisheries Experimental Station of Ibaraki, Tohoku University (Tohoku Ecosystem –Associated Marine Sciences), Tohoku University (Graduate school of agricultural science), Alliance Francaise de Sendai, Japan Agency for Marine-Earth Science and Technology, L'Ambassade de France au Japon, Cable TV Marinet
Co-support : HUMANWEB Inc., Sanyo Techno Marine Inc., K-Engineering Co. LTD., IDEA Consaltants Inc., Kokusai Kogyo Co. LTD., Toyo Corporation, Saikai Laboratory of Aquaculture and Technology Co. LTD., JFE Advantech Co. LTD., SEA-Plus Inc.
Advertisement : Kokusai Kogyo Co. LTD., Toyo Construction Co. LTD., Amco Inc., Saikai Laboratory of Aquaculture and Technology Co. LTD., IDEA Consaltants Inc.
Exhibition : Amco Inc., The General Environmental Technos Co. LTD., Saikai Laboratory of Aquaculture and Technology Co. LTD.
Cooperation : Japan Kotsu Co. LTD., Ojima-Kamabokoten Co. LTD., Saura Co. LTD.

日仏イノベーション年

FRANCE JAPAN INNOVATION YEAR

Program

17-18 November

- **Excursion**
  Tokyo-Ichinoseki-Rikuzentakada-Ishinomaki
  Ishinomaki-Shizugawa-Shiogama

19 November, The Shiogama public hall

08h30 Registration
09h00 Opening address
09h00-09h15 Teruhisa KOMATSU President of SFJO Japan

09h15-09h30 Hubert-Jean CECCALDI President of SFJO France
Evolution and progress accomplished during previous French-Japanese Symposiums of Oceanography

Key note

Chairpersons Teruhisa KOMATSU & Hubert-Jean CECCALDI

09h30-9h50 : Key note 1-1 Hideki TAKAMI (FRA)
Challenges to revitalize the abalone *Haliotis discus hannai* fishery damaged by the 2011 mega-earthquake and tsunami in Iwate prefecture, northeastern Japan
Key note 1-2 Yutaka OKUMURA (FRA)
Influence of the tsunami on the coastal area of Miyagi Prefecture, Japan

09h50 -10h10 : Key note 2 Patrick PROUZET (IFREMER)
Ecological status of Atlantic salmon (*Salmo salar*) in France

10h10-10h30 : Key note 3 Hisayuki ARAKAWA (TUMSAT)
Explaining the reasons for the slower decrease in radioactive concentrations in some fish species after the Fukushima Daiichi Nuclear Power Plant Disaster

10h30-10h50 : Key note 4 Hubert-Jean CECCALDI (SFJO France)
Future essential orientations in marine sciences and technology and cooperations between the two Sociétés franco-japonaises d'Océanographie

Coffee break

Oral session

Session 1 Natural impacts and recovery of aquaculture

Chairpersons Yujiro KITADE (TUMSAT) & Sandrine RUITTON (Mediterranean Inst. Ocean.)

11h05-11h20 Com-01 Mitsuru HAYASHI (Kobe Univ.)
Shift of water quality in Osaka Bay by the resuspension of marine sediment caused by tsunami

11h20-11h35 Com-02 François POISSON (IFREMER)
By-catch monitoring programme of the French Bluefin tuna longline fishery.

11h35-11h50 Com-03 Shinnosuke KAGA (Iwate Fish.Tech.Ctr.)
On-site depuration of paralytic shellfish poisoning toxins accumulated in the oyster *Crassostrea gigas* in Ofunato Bay, Japan

11h50-12h05 Com-04 Patrick PROUZET (IFREMER)
The European eel (*Anguilla anguilla*) in France: An example of close cooperation among researchers and fishers to study and manage an endangered species.

12h05-12h20 Com-05 Yoshifumi TAKAHASHI (Kyushu Univ.)
An analysis of the potential success for an improved “High quality” oyster entering the existing market.

Group photograph

12h30 -14h00 Lunch

Poster session

14h00-15h00 P01-P15

Session 2 Human impacts

Chairpersons Hisayuki ARAKAWA (TUMSAT) & Yves HENOCQUE (IFREMER)

15h00-15h15 Com-06 Akira MATSUMOTO (TUMSAT)
A feasibility study of an in situ fluorescence spectroscopy system for the detection of deposited oil

15h15-15h30 Com-07 Hervé THÉBAULT (IRSN)
^{137}Cs and Tritium concentrations in seawater off the Fukushima Prefecture: Results from the SOSO 5 Rivers Cruise (October 2014)

15h30-15h45 Com-08 Jun SHOJI (Hiroshima Univ.)
Do species diversity and productivity of fisheries resources increase around submarine groundwater seepages in coastal area?: possible effects of global warming

15h45-16h00 Com-09 François GALGANI (IFREMER)
Plastic in the Mediterranean Sea

Coffee break

Session 3 Promotion of cooperative research on fisheries/oceanography between Japan and France

Chairpersons Ryo KIMURA (FRA) & Sandrine VAZ (IFREMER)

16h20-16h30 Opening address of the session: Executive Director Fuminari ITOH (FRA)

16h30-16h45 PCR-1 Yves HENOCQUE (IFREMER)
Do our ocean policies make any difference to the wellbeing of coastal communities?

16h45-17h00 PCR-2 Masahito HIROTA (FRA)
Fish and seafood value chains and the well-being for local community

17h00-17h15 PCR-3 Franck LAGARDE (IFREMER)
Synthesis of new knowledge about determinism of Pacific oysters (*Crassostrea gigas*) larval recruitment in the Mediterranean Thau Lagoon

17h15-17h30 PCR-4 Masakazu HORI (FRA)
Challenge to harmonize sustainable fishery with water-quality improvement using seagrass-oyster interaction in oligotrophic coastal ecosystems

Banquet

18h00-20h00 Ground palace Shiogama

20 November, The Shiogama public hall

08h30 Registration

Session 4 Challenge of oceanography

Chairpersons Shiro IMAWAKI (JAMSTEC) & Hervé THÉBAULT (IRSN)

09h00-09h15 Com-10 Yujiro KITADE (TUMSAT)
Recent research results and future project in Antarctic Ocean by Umitaka-Maru research group for physical oceanography

09h15-09h30 Com-11 Mathias GIRAULT (Kanagawa academy of Sci. & Tech.)
Automatic sorting system and incubation at single plankton level using microfluidic devices

09h30-09h45 Com-12 Daigo YANAGIMOTO (Univ. Tokyo)
Observation of near-bottom current on the continental shelf off Sanriku

09h45-10h00 Com-13 Jean-Claude DAUVIN (Université Caen)
The English Channel: towards a new Japanese Sea

Coffee break

Session 5 Coastal ecosystem and management

Chairpersons Yasuyuki KOIKE (SFJO Japan) & Jean-Claude DAUVIN (Université Caen)

10h15-10h30 Com-14 Sandrine RUITTON (Mediterranean Inst. Ocean.)
Japanese vs. French artificial reefs: high technology vs. design to enhance ecological services

10h30-10h45 Com-15 Satomi TAKAGI (Tohoku Univ.)
Improvement of gonad quality of the sea urchin *Mesocentrotus nudus* by short-term cage culture

10h45-11h00 Com-16 Nelly FERROU & Gérard FOURNEAU (Aquitaine Landes Récifs)
Artificial reefs installation along the Aquitaine Coast

11h15-11h30 Com-17 Sandrine VAZ (IFREMER)
Quantitative mapping of fish habitat: from knowledge to spatialised fishery management

11h30-11h45 Com-18 Kazumi WAKITA (Tokai Univ.)
Perceptions of marine ecosystem services: A case study from remote islands, Taketomi Town

11h45-12h00 Com-19 Catherine BOISNEAU (Comité Nat. Pêche Professionnelle en Eau Douce)
Amphidromous fishes management in continental waters. The need for an integrated approach

Reception at The Embassy of France in Japan (11-44, Minami Azabu-4, Minato, Tokyo**)**

21 November, The hall of Nichifutsu Kaikan (La Maison Franco-Janonaise) in Ebisu

09h30 Registration

Session 6 Aquaculture

Chairpersos Tetsuo SEKI (AFFTIS) & François GALGANI (IFREMER)

10h00-10h15 Com-20 Hirokazu ABE(FRA)
Larval and juvenile dynamics of the Manila clam *Ruditapes philippinarum* in Matsushima Bay and Mangoku-ura Inlet, northeastern Japan, following 2011 tsunami disaster

10h15-10h30 Com-21 Catherine MARIOJOULS (AgroParisTech)
Certification schemes for sustainable aquaculture and feeding

10h30-10h45 Com-22 Waka SATO-OHKOSHI (Tohoku Univ.)
Ecological impacts of the 2011 earthquake and tsunami on the subtidal macrobenthic community in Onagawa Bay, northeastern Japan

10h45-11h00 Com-23 Jean-Claude DAUVIN (Université Caen)
One year colonisation by zoobenthic species on an eco-friendly artificial reef in the English Channel intertidal zone

11h00-11h15 Com-24 Rena SHIBATA (FRA)
Retinomotor and stress responses of marbled sole *Pleuronectes yokohamae* under the LEDs

Coffee break

11h30-12h00 Summarize of Symposium
Chairpersons Presidents of SFJO Japan & France

Group photograph

Open Seminar for Public（with interpretation）

PM, 21 November, The hall of Nichifutsu Kaikan (La Maison Franco-Janonaise) in Ebisu

Historical Relationship between France and Japan on Oyster Culture, for the renovation of aquaculture in Sanriku

13h00 Registration

13h30-13h40 Opening address **Teruhisa KOMATSU (President of SFJO-J)**

13h40-14h10 History and solidarity on Oyster culture in both countries
Yasuyuki KOIKE (ex. Prof. of TUMSAT)

14h10-14h40 Situation of Oyster culture in France. Dr. Catherine MARIOJOULS (Agro.Paris.Tech)

14h40-1500 Break

15h00-15h30 Situation and new trial on Oyster culture in Japan. **Tetsuo SEKI (AFFTIS)**

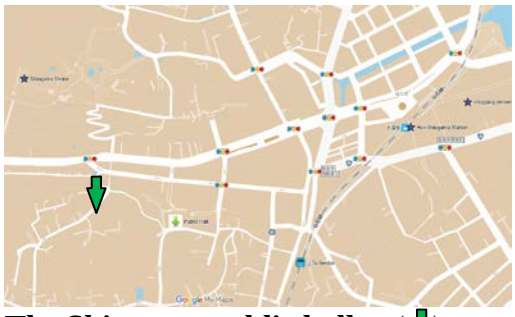
15h30-16h00 New challenge on commercialization and culture technique of Oyster in Japan:
Ms. Kyoko WASHIASHI (Oyster innovation Co. Humanweb)

16h00-16h30 Cooporation between France and Japon on Oyster culture and future prospects.
Franck LAGARDE (IFREMER)

16h30-17h00 Discussion

17h00-17 h15 Closing address **Prof. Hubert-Jean CECCALDI (President of SFJO-F)**

17h30 Cocktail (with concert of the flute)



The Shiogama public hall（⇩）

The hall of Nichifutsu Kaikan in Ebisu（●）

Poster session

P-01 Mathias GIRAULT (Kanagawa Academy Sci. & Tech.)
Development of a Microfluidic Sorting System in Oceanography

P-02 Miwa YATSUYA (FRA)
Clearance rates of Crassostrea spp. on oyster reef in temperate semi-enclosed Ariake Bay, western Japan

P-03 Hidekazu SHIRAI (Sanyo Techno Marine, Inc.)
A high-resolusion unstructured grid finite volume model for currents around narrow straits of Matsushima Bay

P-04 Toshiki NAKANO (Tohoku Univ.)
Quantitative Metabolome Profiling of Growth Hormone Transgenic Coho Salmon

P-05 Ken HIGUCHI (TUMSAT)
Development of an underwater NaI(Tl) scintillation spectrometer to monitor seabed radioactivity

P-06 Haruka SUZUKI(Tohoku Univ.)
Distributional changes in the kelp *Eisenia bicyclis* resulting from the subsidence and the landfill for breakwater restoration after the 2011 Tohoku Earthquake

P-07 Minoru TOMIYAMA (Aichi Fisheries Research Institute)
Factor analysis of upstream migrating Ayu in the Yahagi River using machine learning

P-08 Yutaka OKUMURA (FRA)
Suitable quantity of oyster culture in Oginohama Bay, Miyagi, Japan

P-09 Hikaru ENDO (Tohoku Univ.)
Combined effects of nutrient availability, light intensity, and temperature on the photosynthetic pigments and color of the brown alga *Undaria pinnatifida*

P-10 Keiichi YAMAZAKI (TUMSAT)
Amplification of near-inertial period fluctuation associated with passage of typhoon around the Tango Peninsula, Japan

P-11 Hiroyuki TOGASHI (FRA)
The use of stable isotopes for food web analyses: An example of food webs in a coastal ecosystem in Sendai Bay

P-12 Yuki KUBO (Tohoku Univ.)
Seasonal movements of the herbivorous gastropod *Omhalius rusticus*

P-13 Takuro NAKAGAWA (TUMSAT)
Relationship between patterns of fish behavior and concentration of radioactive materials after nuclear accident by the 2011 Great East Japan Earthquake.

P-14 Yoshichika IKEDA (TUMSAT)
Development of a de-oiling process for seabed sediments

P-15 Teruhisa KOMATSU (Univ. Tokyo)
Trophic cascade of seaweed forests in Sanriku Coast after the huge tsunami on 11 March 2011

P-16 Gérard FOURNEAU (Aquitaine Landes Récifs)
Implantation of artificial reefs on the French Atlantic Coast

Preface

The sea under human and natural impacts: challenge of oceanography to the future Earth

The sea is an indispensable component of Earth system. Human societies obtain great benefit from the sea. Global warming threatens the sea through seawater temperature rise, acidification, sea-level rise and huge depressions. The tsunami repeats destroying coastal zones. Increase in population and industries along the coast, especially in Asia, cause degradation of coastal ecosystems through direct and indirect manners such as reclamation, overexploitation of bioresources and pollution. We need to understand physical, chemical and biological mechanisms of the sea and threats of human and natural impacts on the sea and its ecosystems at the present day. Based on comprehensive understanding of the sea including the impacts, we can forecast the sea in the future Earth according to several scenarios of global warming. In order to prevent the sea in the future Earth from in sustainable conditions, sustainability science and education for sustainable environments concerning the sea are also needed now.
The 16th France-Japan Symposium on Marine Science focuses on progress in oceanography to understand the present sea from physical, chemical, biological and ecological aspects including fisheries science. We discuss the sea in the future Earth under different scenarios and how we establish sustainable ocean through marine science.

Teruhisa Komatsu : President of SFJO Japan
Hubert-Jean Ceccaldi : President of SFJO France

Opening address

Challenge to resolve problems in the ocean and coastal waters in future Earth with stronger cooperation between the two Sociétés franco-japonaises d'Océanographie

Teruhisa KOMATSU

Président de la Société franco-japonaise d'Océaographie de Japan, komatsu@aori.u-tokyo.ac.jp
University of Tokyo

The mankind had thought that the ocean had been an unlimited space till mid 20th century. After the World War II, rapid economic growth and explosive increase of human population have exploited the riches of the ocean and polluted the ocean till now. We are facing exhaustion of the resources and serious damages of the coastal and ocean ecosystems with direct and indirect ways with local to global scales such as pollution, illegal fishing, global warming, etc. by human activities, and now recognizing the limit of the ocean like as planetary boundaries. Because sciences are needed to adapt this situation, The Future Earth is established by the International Council for Science. The Future Earth is a global platform for international scientific collaboration, providing the knowledge required for societies in the world to face risks posed by global environmental change and to seize opportunities in a transition to global sustainability from point of view of problem-driven approach instead of discipline-oriented approach. This approach encourages interdisciplinary and/or transdisciplinary participation of social and human scientists with natural scientists to resolve the problems after reviewing past experiences on natural-science-driven approach, which has not been always successful for solution of problems. In the world, there are five secretariats of Future Earth, two of which are located in France and Japan. Since there are different philosophies on nature, there are strong possibilities to make break-through to solve problems in the ocean by co-designs and co-works with insights and inspirations brought by fruitful discussions among marine scientists and oceanographers of two countries together with social and human scientists.

Two Societés franco-japonaises d'Océanographie have provided a platform for discussions and collaborations, and promoted them since 1970s. This tradition helps to realize our final and common goal of sustainable and healthy ocean for future generations by conserving and restoring marine ecosystems through deep understanding of earth systems and human activities influencing the ecosystems in which the mankind lives. Now, we need to challenge to resolve problems in the ocean and coastal waters in future Earth with stronger cooperation between the two Sociétés franco-japonaises d'Océanographie.

Finally, two presidents of Societés franco-japonaises d'Océanographie acknowledge Maison franco-japonaise de Tokyo, Fondation franco-japonaise Sasakawa, Fisheries Research Agency of Japan, Ambassade de France au Japon and also other organizations listed in the programs for their supports.

Evolution and Progress Accomplished during Previous French-Japanese Symposiums of Oceanography

Hubert-Jean CECCALDI

Président of Société franco-japonaise d'Océanographie de France, ceccaldi.hubert@orange.fr
Member of the Academy of Marseilles

France and Japan have, in the field of marine sciences and technology, a long common past. Louis-Emile Bertin was the creator of Japanese Military Navy during Meiji Era. He founded the naval shipyards of Yokosuka, Sasebo and Kuré. Not less than 68 important warships were constructed on his plans and on his directives and this new Japanese fleet win the naval battle against Russia in May, 1905, in Tsushima Islands.

Paul Claudel, Ambassador of France in Japan, founded the Franco-Japanese Home of Tokyo, where the "Société franco-japonaise d'Océanographie" of Japan always has its seat there. Uninterrupted exchanges took place between both countries about marine and maritime problems for more than 50 years.

This amicable and efficient collaboration started with the divings of the French bathyscaphes in the course of 1960s, in the depths of Japanese waters and , then, the creation, in Japan, of the "Société franco-japonaise d'Océanographie" of Japan.

Other numerous examples of collaboration concerned shellfish farming, aquaculture of crustacea, of fish, of seaweeds, artificial reefs, development and management of the coastal zones, laws of the sea, etc.

Since 1983, 15 French-Japanese symposiums take place between Japanese and French specialists, alternately in each country, bringing new ideas to the participants. These always become enriched of different the cultural approaches by whom chosen topics are approached and treated in each of both countries.

Considering the topics treated during symposiums, it appears that the participants express similar interests in each country, on following subjects: functioning of the marine ecosystems, particularly on littoral areas, detailed processes of these ecosystems, modification of their functioning or under the effects of human activities.

A clear differentiation was made between perturbations of natural origins and perturbations created by mankind activities.

One will try to put in an obvious place the human factors that intervene in the various ways of use of the marine ecosystems richness. In this perspective, the traditional Japanese concepts of sato-yama and sato-umi have to be adapted to our new way of thinking the exploitation of natural resources.

Another clear differentiation appeared between the services obtained from natural environments and the management of the ecosystems. One will also assess necessities which it will be obvious to the mankind to recover the natural previous capacities of the ecosystems. The new concept of socio-ecosystem may open new fields in marine research, in deepen some of its content.

Finally we wish to identify more clearly now the topics which will lead necessarily to future multidisciplinary studies, including economy, sociology, traditions, religions and anthropology.

Challenges to Revitalize the Abalone *Haliotis discus hannai* Fishery Damaged by the 2011 Mega-Earthquake and Tsunami in Iwate Prefecture, Northeastern Japan

Hideki TAKAMI[1*], Toyomitsu HORII[2], Yukio MATSUMOTO[1], Takahiro SAIDO[3], Toshiaki OHMURA[3], Tadakatsu NORO[3], Tomohiko KAWAMURA[4]

[1]Tohoku National Fisheries Research Institute, Fisheries Research Agency, Japan, [*]htakami@affrc.go.jp
[2]National Research Institute of Fisheries Science, Fisheries Research Agency, Japan
[3]Iwate Fisheries Technology Center, Japan
[4]International Coastal Research Center, Atmosphere and Ocean Research Institute, The University of Tokyo, Japan

The mega-earthquake and massive tsunami on 11 March 2011 hit a wide area of the Sanriku Coast, including the coast of Iwate Prefecture, known as the highest abalone production area in Japan. The fishery and populations of the abalone *Haliotis discus hannai* in Iwate have been largely damaged by the earthquake and tsunami. Quantitative surveys comparing before and after the earthquake and tsunami at several abalone habitats along the Sanriku Coast generally revealed that juvenile abalone, especially the young-of-the-ear class at the time of the disaster, were seriously affected by the catastrophic disturbance (Goto and Ohmura 2012, Takami *et al*. 2013, Kawamura *et al*. 2014, Takami and Nakaie 2015). Since the age at first capture of abalone is at 4-5 years old, the commercial catch may again show a decrease from 4-5 years after the event. In addition, as the tsunami destroyed most of the hatcheries producing abalone seed in the area, stock enhancement activities of the abalone by reseeding hatchery-reared juveniles into wild populations have been interrupted.

Due to the above situation, the reduction of the abalone resources for the fishery is a concern at least for several years after the disaster. To avoid overfishing on the damaged populations and contribute to the rapid renovation of the destroyed hatcheries, our research challenge is to demonstrate a way of stock management allowing sustainable use of the abalone populations and establish more effective techniques for abalone seed production under the ongoing project "A Scheme to Revitalize Agriculture and Fisheries in Disaster Area through Deploying Highly Advanced Technology" of the Ministry of Agriculture, Forestry and Fisheries Japan.

We evaluated the stock abundance of the adult abalone before and after the event on the main fishery grounds in Iwate Prefecture by using the maximum likelihood estimation method of the DeLury on the basis of the catch and vessel-day data in 1989-2013. As the results, the stock abundance of the adult abalone has been relatively stable both before and after the earthquake, and there were no signs of overfishing during these years. However, the future abundance will gradually decrease with the recruits of the damaged wild year class and by the interruption of the juvenile reseeding into wild populations.

Abalone hatcheries in Iwate prefecture have been restored and restarted providing abalone seeds for reseeding since 2014. In the process of resuming the abalone seed production, we are trying to establish a new technique on larval settlement and post-larval rearing, which is based on larval and post-larval ecology (Kawamura *et al*. 2005). The combination use of green alga *Ulvella lens* for the induction of larval metamorphosis and a mono-cultured benthic diatom *Cylindrotheca closterium* for the food item of metamorphosed post-larvae enables to improve the initial survival and growth rates of the abalone (Matsumoto *et al*. 2015). Further, the reduction of labour costs is expected by introducing this new technique into hatcheries.

LITERATURE CITED

Goto, T., T. Ohmura (2012) Effects of the earthquake disaster with huge tsunami in March 2011 on marine environment and fishery resources in the coastal waters off Iwate, Pacific coast of northern Japan. Kaiyo Monthly 44: 328-335.

Kawamura, T., R.D. Roberts, H. Takami (2005) Importance of periphyton in abalone culture. Periphyton: Ecology, Exploitation and Management (eds. E. Azim et al.), 269-284, CABI Publishing, UK, 319 pp.

Kawamura, T., H. Takami, J. Hayakawa, N.I. Won, D. Muraoka, Y. Kurita (2014) Changes in abalone and sea urchin populations in rocky reef ecosystems on the Sanriku Coast damaged by the massive tsunami and other environmental changes associated with the Great East Japan Earthquake in 2011. Global Environmental Research 18: 47-56.

Matsumoto, Y., T. Noro, H. Takami, Y. Fujinami, Y. Kuji, T. Kawamura (2015) A study on the new method for larval settlement, post-larval growth and survival of abalone *Haliotis discus hannai* using a cultured benthic diatom *Cylindrotheca closterium* and a pre-grazed green alga *Ulvella lens*. Nippon Suisan Gakkaishi (accepted).

Takami, H., N.I. Won, T. Kawamura (2013) Impacts of the 2011 mega-earthquake and tsunami on abalone *Haliotis discus hannai* and sea urchin *Strongylocentrotus nudus* populations at Oshika Peninsula, Miyagi, Japan. Fisheries Oceanography 22: 113-120.

Takami, H., H. Nakaie (2015) Impacts of the 2011 Mega-earthquake and tsunami on Ezo abalone *Haliotis discus hannai* at Iwaisaki, Miyagi, Japan. Marine Productivity: Perturbations and Resilience of Socio-ecosystems (eds. H.J. Ceccaldi et al.), 17-21, Springer International Publishing Switzerland, 391pp.

Influence of the Tsunami on the Coastal Area of Miyagi Prefecture, Japan

Yutaka OKUMURA

Tohoku National Fisheries Research Institute, Fisheries Research Agency, Japan, okumura@affrc.go.jp

EARTHQUAKE AND TSUNAMI

The tsunami caused by the great earthquake (Mw 9.0) on 11 March, 2011 hit the coastal area of Tohoku, Japan. The height of the tsunami in Miyagi Prefecture ranged from 2.9 to 7.7 m.[1] The run-up height in Onagawa, which is approximately 130 km from the epicentre (38.297°N, 142.372°E), was over 30 m.[2] In this study, the influence of the tsunami is investigated.

Picture 1. After the second wave of the tsunami in Matsushima Bay (Left). A destroyed building in Onagawa on 27 August, 2014 (Right).

WASTEWATER PLANTS

The running of over 50 wastewater plants was stopped just after the tsunami.[3] In the inner part of Sendai Bay, including Matsushima Bay, two wastewater plants were destroyed. Therefore, eutrophication by the inflow of untreated water to the coastal area was a concern. The temporal change of nitrogen (N) and phosphate (P) emitted from the wastewater plant varied depending on the plant. N and P emitted from plant A showed very little change before and after the tsunami. This was because the quantity of wastewater that was unprocessed decreased due to the damage to fish processing factories near plant A. Conversely, N and P emitted from plant B increased just after the tsunami. This was because the quantity of wastewater hardly changed and the treatment potential in plant B was lost. After 2013, emissions of N and P decreased because of the recovery of the wastewater plants.

Picture 2. Wastewater plant in Ishinomaki (Left). Treatment pools were empty by drive stop. Advertisement of the can (Right). Photographs taken on 6 May, 2012.

EUTROPHICATION OR OLIGOTROPHICATION

Eutrophication caused by the destruction and the reduced function of the wastewater plants was a concern. In Sendai Bay, the dissolved inorganic nitrogen (DIN) and phosphate (DIP) were lower after compared with before the tsunami. In Matsushima Bay, DIN and DIP from 2011 to 2012 were higher than before the tsunami. However, from 2013 to 2014 the concentrations decreased to less than those before the tsunami. Two bays were thought to be oligotrophic. Furthermore, the N/P and N/Si ratios were different from the Redfield ratio, which indicates levels suitable for phytoplankton growth. We conclude that the environment was unsuitable for the growth of phytoplankton.

THE QUANTITY AND DIVERSITY OF PHYTOPLANKTON

Today, no ecological regime shift of phytoplankton is observed in the inner part of Sendai Bay. Conversely, *Alexandrium* spp., plankton that cause paralytic shellfish poisoning, increased after the tsunami.[4] The cause of the bloom was thought to be the disturbance of the sea floor by the tsunami.[5]

Picture 3. Koamikurahama on 27 May, 2011 (Left). The red tide of Noctiluca was observed on the debris. Koamikurahama on 15 April, 2013 (Right).

PERIPHYTON ON OYSTERS

Large quantities of oysters were killed by periphyton, such as Bryozoa and Hydrozoa, in Matsushima Bay in 2013. The appearance species of periphyton before the tsunami are currently investigated using filtered seawater samples from 2004 to 2005.

Picture 4. Oysters covered with Bryozoa, and Hydrozoa. Photograph by Akihiro Moriyama.

MEASURES FOR ENVIRONMENTAL CHANGE

Today, a new oyster culture trial is being carried out based on periphyton prevention methods, such as hot water or silicone treatment, aquacultural ground management, and the spread of single seed methods by collecting seedling of oyster larva in France.

REFERENCES

1. Japan Meteorological Agency 2011, http://www.jma.go.jp/jma/kishou/books/saigaiji/saigaiji_201101/saigaiji_201101_03_22.pdf p98.
2. TOHOKU UNIVERSITY 2011, http://www.town.onagawa.miyagi.jp/hukkou/pdf/iinkai/01_meeting/01_meeting_appendix3-3.pdf
3. M.L.I.T. 2012, http://www.mhlw.go.jp/topics/bukyoku/kenkou/suido/tantousya/dl/s06_a.pdf
4. MASUDA, Y. *et al.* 2014, Miyagi.Pref.Rep.Fish. Sci.14,41-56.
5. KAMIYAMA,T. *et al.* 2014, J.Oceanogr. 70,185-195.

Ecological Status of Atlantic Salmon (*Salmo salar* L.) in France
The Need for an Ecosystemic Approach

Patrick PROUZET[1], Nicolas MICHELET[2]

[1]IFREMER - SFJO, France, patrick.prouzet@ifremer.fr
[2]CNPMEM/CONAPPED, France,

Atlantic salmon (*Salmo salar* L.) is, in France, a totemic species and a symbol of the quality of aquatic environment.

Formerly, very abundant in numerous river basins entering the Channel or the Atlantic coast, this species, unfortunately, is declining since the beginning of the 20th century and particularly after the end of the 2nd World War. Presently, this anadromous fish migrates on 40 river systems located between the Belgium border and the Spanish one. The salmon is mainly exploited by rod anglers but there still exists a professional fishery in the Adour-Gaves basin (located in the South-West part of France) where the salmon catches are allowed with drift net. In all other estuaries and coastal waters where they are not prohibited, salmon catches by (professional) fishermen remain incidental and very few. The commercial salmon fishing, whether targeted or accidental, is strictly regulated in France, including a fishing licensing regime specific to diadromous fish species." The total catch is currently estimated to 10 metric tons around 3000 fish.

The decline of Atlantic salmon in France is due to multiple anthropogenic pressures that have affected the size and the quality of its freshwater habitat during the 20th century such as: edification of dams on a great number of rivers for energy production or for agricultural and domestic purposes; increase of the water pollution with a degradation of the quality of the spawning areas; impediments to free migration due to an insufficient number of fish ladders or non effective fishways that prevent salmon to reach safely and rapidly their spawning areas.

The final result is a large decrease of the productivity of salmon stocks in most part of the salmon rivers and some difficulties to maintain a professional or leisure exploitation. Despite the ban of the salmon catch in large river systems such as the Loire, Gironde, Seine, Garonne, Dordogne basins and the drastic decrease of the number of salmon fishers (presently less than 3000 for anglers and less than 30 for professional fishers), managers have some great difficulties to rebuild the population. Most of the restoration programs failed due to a too fragmented approach without a global view of the salmon needs; fishing regulations without improvement of salmon environment have limited effects on the stock restoration if the main cause of decline is the decrease of the quality of salmon habitat.

So, the future of Atlantic salmon in France lies in the implementation of an ecosystemic approach in order to have perennial and significant effects on the abundance of this population. The examples of restoration programs undertaken in the Adour-Gaves basin or in small river systems such as the Elorn river in Brittany confirm the need for management plans including not only fishing regulations but also improvement of salmon environment. On the Adour-Gaves river system for example, a restoration program including regulation of fishery, improvement of the free migration of individuals for a better access to the good spawning areas located in the upper course of the salmon tributaries, has given significant results on the stock abundance and on the percentage of large spawners in the population.

Explaining the Reasons for the Slower Decrease in Radioactive Concentrations in Some Fish Species after the Fukushima Daiichi Nuclear Power Plant Disaster

Hisayuki ARAKAWA

Department of Marine Sciences, University of Marine Science and Technology, Japan, arakawa@kaiyodai.ac.jp

INTRODUCTION

As a result of the Fukushima Daiichi Nuclear Power Plant (1FNPP) disaster, large quantities of radioactive materials were released into the ocean. The amount of Caesium-137 (hereafter referred to as Cs) released was estimated at 3.5 PBq[1]. It was reported that the release of the materials took place during a concentrated period, shorter than a month. Immediately following the accident, it is thought that a water mass that contained radioactive materials at high concentrations released from 1FNPP flowed southward with the coastal current; when it reached the Kuroshio extension, it was dispersed eastward[2-4]. Because of movement of this water mass and its diffusion, coastal seawater, seabed sediments, and many marine organisms were contaminated by the radioactive materials. After marine organisms contaminated with high radioactive concentrations were caught in April 2011, fisheries activities were banned. While radioactive concentrations in many species decreased over time, concentrations in some species of fish decreased very slowly (e.g. Japanese rockfish and others). In this study, we report changes in radioactive cesium concentrations of marine organisms over the 4 years since the accident and attempt to identify the reason for the slower decrease in radioactive concentrations observed in some fish species.

METHODS

We examined (1) the distribution and changes in radioactive Cs concentrations in individual marine organisms, (2) the dispersion of radioactive Cs attributable to fish movement, and (3) the reason for the slower decrease in the radioactive concentrations in several fish species.

Three sampling points were chosen off the coasts of Iwaki (Yotsukura and Ena) and Soma, Fukushima Prefecture. Marine organisms and seawater and seabed sediment samples were collected at the sampling points between May 2012 and May 2014. The radioactive Cs concentrations in the collected organisms and samples were measured by a germanium semiconductor detector. The ecological half-lives of the organisms were estimated from the results. Japanese rockfish and skate were selected as sample fish species. An ultrasonic pinger was inserted into the body of the fish, and the fish movements were recorded by biotelemetry for one year. Japanese rockfish were cultured in a large water tank for one year, and the biological half-lives of radioactive Cs in the fish were estimated.

RESULTS AND DISCUSSION

(1) The ecological half-lives of Cs in seaweed and seagrass, invertebrates, and fish were estimated. The ecological half-lives of Cs in seaweed and seagrass were 39–130 days, and the radioactive Cs concentrations of seaweed and seagrass indicated a clear decrease over time. There were obvious decreases in the concentrations in many species of invertebrates and fishes. The ecological half-lives of many of the fish species were 36–281 days. However, benthic and omnivorous types of fish, such as the Japanese rockfish (367 days) and a skate species (560 days), had relatively long ecological half-lives.

(2) Diffusion via the movement of various organisms within the Iwaki study area was investigated using ultrasonic biotelemetry. In open sea areas, Japanese rockfish remained within the same rocky area (within a radius of 200 m) throughout the year.

(3) To identify the reason for the slow decrease in the radioactive Cs concentrations in various fish species, including the Japanese rockfish off Iwaki, the biological half-life of the rockfish was investigated in a water tank experiment. Results show that the ecological half-life of radioactive Cs of the rockfish was ca. 270 days longer than in other marine fish[5].

CONCLUSION

Following the 1FNPP accident, many marine organisms were polluted by radioactive materials. The concentrations of radioactive materials in these organisms decreased over time. However, the concentrations in a few species of fish decreased very slowly, which reflect the slower metabolisms of these fish species. Monitoring of marine organisms off the Fukushima coast for radioactive pollution should continue in the future.

REFERENCES

1. Tsumune et al., 2012, *J. Environ. Radioact*., 111, 100-108.
2. Yoshida and Kanda, 2012, *Science*, 336, 1115-1116.
3. Kawamura et al., 2011; *J. Nuclear Sci. Tech.*, 48, 1349-1356.
4. Honda et al., 2012, *Geochemical J*., 46(1), e1-e9.
5. Matsumoto et al., 2015, *J. Environ. Radioact*. In print.

ACKNOWLEDGMENTS

This study was supported by the Environment Research and Technology Development Fund (No. 4ZD-1201) from Ministry of the Environment, Japan.

Future Essential Orientations in Marine Sciences and Technology and Cooperations between the Two Sociétés Franco-Japonaises d'Océanographie

Hubert-Jean CECCALDI

Président de la Société franco-japonaise d'Océanographie de France, ceccaldi.hubert@orange.fr

The economic and social models structuring the world in which we live are not any more adapted to the contemporary situations: they set to the humanity immense challenges.

Our final goal is quite simple: the mankind has to avoid to destroy the environment in which its evolution was born and achieved and in which he lives

The very next holding in Paris of a very large international Conference on climate change (COP 21) defined itself the same purpose.

The study of the disturbances of the natural environments has to differentiate clearly the disturbances produced by Nature, of those who depend strictly on activities of the man.

It is essential to have a better knowledge of the marine ecosystems, by using new technologies of measures *in situ*, estimated partially by oceanographic satellites by new means of techniques and integrated into a global multi-data computer system.

The problems with which we are confronted today are multiple:

- Renovation of the modes of exploitation of the littoral natural marine resources
- Importance of the fish farming in the supply of products necessary for the man
- Concrete evaluation of the consequences of the global warming and the rise of the sea level
- Real and effective protection of the Marine Protected Areas at the international level
- Better knowledge of the pelagic ecosystems and the deep oceans ecosystems
- Reasonable artificialization of sea shore marine environments by ecological engineering
- Obligation by law to create marine habitats for marine species in any construction in the sea
- Return to a good quality of sea water in particular towards wastes and plastics
- Use of the marine energies well integrated in the marine environments and their ecosystems
- Regulation of the accesses to the sea and the control of the ecotourism
- General application of the Japanese concepts of sato-umi to fishery cooperatives and
- Obligation to increase the number of specialists in management of the marine environments
- Implementation of teachings and developing really multidisciplinary researches
- Essential necessity of regulating the huge actual increase of the world population
- Study of the traditions and the religions in the exploitation of the marine resources
- General education of the populations of the developed countries and developing countries
- Detailed studies of the consequences of the increase the sizes of the littoral megalopolises
- Risks of privatization of marine spaces and of their natural resources
- Renewal of the maritime law based on relationships between Nature and Society

Our final and common goal is to integrate strongly in a very deep way the human activities into the functioning of the ecosystems in which the man lives.

The exchanges between both “Societés franco-japonaises d'Océanographie”, have to identify the ways which will allow us to progress together in the conservation and the preservation, in an optimal way, of the life into the oceans - and in the planet -.

Shift of Water Quality in Osaka Bay by the Resuspension of Marine Sediment Caused by Tsunami

Mitsuru HAYASHI[1], Satoshi NAKADA[2], Soto SUZUKI[2], Mirai MIAWAKI[3]

[1]Research Centre for Inland Seas, Kobe University, Japan, mitsuru@maritime.kobe-u.ac.jp
[2]Graduate School of Maritime Sciences, Kobe University, Japan
[3]Fuculty of Maritime Sciences, Kobe University, Japan

INTRODUCTION

The Nankai Trough Earthquake will hit within 30 years, and a huge tsunami will be caused. Marine sediment will be resuspended and transported by the tsunami[1]. The density of *Alexandrium* cysts in the western part of Sendai Bay increased after the tsunami caused by the Tohoku Region Pacific Coast Earthquake on 11 March 2011[2]. *Alexandrium spp.* is a harmful phytoplankton that causes shellfish poisoning, and appears in Osaka Bay every year[3]. Not only cysts but also heavy metals are contained in the marine sediment in the inner part of Osaka Bay. We calculated the temporal variation of concentrations of heavy metals, nutrients and so on in the water column while a tsunami caused by the Nankai Trough Earthquake attacks Osaka Bay, and discussed these characteristics.

METHODS

Resuspension flux of marine sediment (g m^{-2} s^{-1}) can calculate by using a bottom shear stress by tsunami, a moisture content of the sediment and so on. The flux of materials is obtained by multiplying it by the material concentration in the sediment. Since the horizontal velocity of tsunami which give the bottom shear stress changes constantly, the material flux also change temporally. The simulation of tsunami[4] was conducted from earthquake occurrence for 10 hours every 0.5 seconds by using the fault model of type 3 of the Nankai Trough Earthquake which gives largest influence for Osaka Bay. The Model is one dimension in vertical and has the horizontal mesh of 50 m. Then the materials (heavy metals, nutrients and so on) flux to each mesh were added up. And the concentrations in the water column 10 hours after the earthquake were obtained.

RESULTS AND DISCUSSION

Figure 1 shows the distribution of the concentration of zinc (Zn) in the water column. We assumed that the water column does not contain heavy metals before the earthquake. The environmental criteria of Zn for the seawater established by Japanese government is 0.01 mg l^{-1}. Over that is indicated by gray color. It is considered that resuspension does not occur under the low moisture content in the western part of Osaka Bay with the water depth of 30 m or more[1]. Therefore Zn concentration does not change. On the other hand, it is considered that the periphery of breakwaters, the estuary and the inside river are "hot spot" of resuspension which will occur continuously throughout the tsunami hitting due to the large moisture content[1]. The Zn concentration exceeds the criteria at not only the hot spots but also the inner part of the line which connects Kobe Airport - Izumiotsu. Since the velocity of tsunami becomes weak inside of ports, resuspension is also weak, so Zn concentration does not exceed its criteria. The distribution of Zn depend on the concentration of it in the sediment. The same tendency is seen in chromium (Cr), lead (Pb) and mercury (Hg). Cadmium (Cd) concentration in the seawater is low, furthermore the value of criteria of Cd is high. Therefore the region which exceed the criteria is small in case of Cd.

CONCLUSION

When huge tsunami caused by the Nankai Trough Earthquake attacks Osaka Bay, marine sediment will be resuspended and there is possibility that the concentrations of heavy metals exceed the environmental criteria for the seawater.

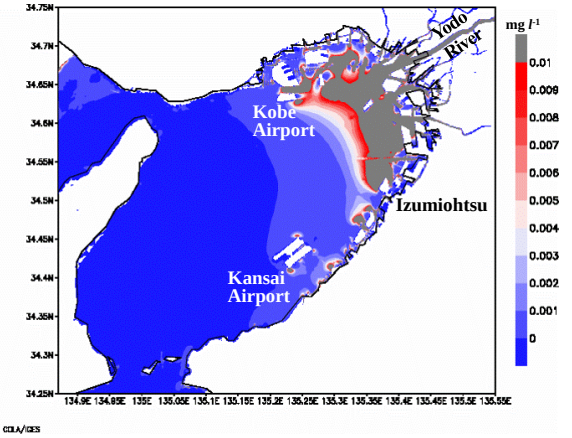


Figure 1 Distribution of the concentration of zinc (Zn) in the water column 10 hours after the earthquake by the resuspension of marine sediment.

REFERENCES

References must be numbered. Keep the same style.

1. HAYASHI, M. *et. al.* 2014, *Proc. 25th ISOPE.* pp.6(CD).
2. KAMIYAMA, T. *et. al.* 2014, *J. Oceanography.* 70(2),185-195.
3. YAMAMOTO, K. *et. al.* 2011, *Bill. Plankton Soc. Japan*. 56(1),13-24.
4. NAKADA, S. *et. al.* 2014, *Proc. 25th ISOPE.* pp.6(CD).

ACKNOWLEDGMENTS

The authors would like to thank Dr. M. Sano in Osaka Prefecture, Prof. S. Koshimura in Tohoku Univ., Prof. E. Kobayashi and Mr. Y. Taniguchi in Kobe Univ., the providing of the super computer of Kyoto Univ. and the funding support from Sumitomo Electric Industries Group CSR Foundation.

By-Catch Monitoring Programme of the French Bluefin Tuna Longline Fishery

François POISSON[1*], Sophie ARNAUD HAOND[1], Hervé DEMARQ[2], Luisa METRAL[1], Blandine BRISSET[1], Delphine CORNELLA[3], Bertrand WENDLING[3]

[1]IFREMER, France, [*]francois.poisson@ifremer.fr
[2]Institut de Recherche pour le Développement (IRD), France
[3]Agence de Médecine Préventive (AMOP), France

Pelagic longlines have often been described as a threat to elasmobranchs and endangered sea turtle and seabird populations worldwide. It is important not to generalize across fisheries when considering bycatch issues. The impact of longline fisheries by-catch varies with many factors including season and location of fishing, fishing gear and method, abundance and behavior of potential by-catch species. The SELPAL programme conducted in collaboration with the fishing industry is designed to describe the activity of the fishery, to assess the scale of fishery effects on the various taxa, to study the ecology of the blue shark (*Prionace glauca*), one of the most common elasmobranchs species by-caught and to propose mitigation measures to reduce the mortality of blue shark, pelagic sting ray (*Pteroplatytrygon violacea*) sea turtle and sea birds. The preliminary results are presented.

On-Site Depuration of Paralytic Shellfish Poisoning Toxins Accumulated in the Oyster *Crassostrea gigas* in Ofunato Bay, Japan

Shinnosuke KAGA*, Yoshimasa KAGA, Hitoshi YAMAGUCHI

Iwate Fisheries Technology Center, Kamaishi, Iwate, Japan, *s-kaga@pref.iwate.jp

INTRODUCTION

Following the Great East Japan Earthquake in 2011, paralytic shellfish poisoning (PSP) toxins accumulated almost every year in the Yesso giant scallop *Patinopecten yessoensis* and Pacific oyster *Crassostrea gigas* in Ofunato Bay via ingestion of the toxic dinoflagellate *Alexandrium tamarense*.

Determination of the detoxification rates for oysters would be useful for fishermen, enabling them to identify how long areas contaminated with PSP toxins should be closed to harvesting. Those involved in oyster farming could then negotiate with clients concerning shipment quantities following detoxification, and would be able to achieve stable income by planning annual production level.

Detoxification rates have been calculated by fitting a negative exponential function of bivalve toxicity level (derived from laboratory or field studies) against time[1]. Yamamoto et al. (2003)[2] reported a detoxification rate of 31.4%/day in *C. gigas* affected by *A. tamarense* in Hiroshima Bay, Japan.

In this study, we performed linear regression analysis between $\log_e$-toxicities and days after the maximum toxicity level, in order to obtain a detoxification rate for *C. gigas* in Ofunato Bay.

METHODS

Sampling was carried out at the Shizu station in Ofunato Bay from 1998 to 2001. Water samples for monitoring cell numbers of *Alexandrium* spp. were collected one to five times per month at 2-m depth intervals from the water surface to the bottom (12 layers). Non-toxic oyster specimens were transplanted to the sampling station (at 8 to 12 m depth) in April each year. Five oyster specimens were collected for toxicity testing each time seawater was sampled. Toxicity of whole tissues was analyzed by high-pressure liquid chromatography for PSP toxins according to Oshima[3].

We performed linear regression analysis between $\log_e$-toxicity and number of days in the detoxification period after maximum toxicity levels had been reached for all study years, on the basis of Pearson's correlation coefficient test. Using the equations obtained from this analysis, the number of days needed to reach 4 mouse units (MU)/g whole tissue, from the date of maximum toxicity (t_4) was then estimated. Normality was verified where necessary.

RESULTS AND DISCUSSION

Re-toxification based on the presence of *A. tamarense* after maximum toxicity levels in oysters had been reached was hardly observed. The abundance of *A. tamarense* reached a maximum from May to June each year, after which the bloom sharply declined. The maximum number of cells (96,200 cells/l) was observed at 10 m depth in May 1998. The maximum toxicity of *C. gigas* was observed from May to June each year and ranged from 15 to 45 MU/g whole tissue.

There was a significant reciprocal relationship between $\log_e$-toxicity and number of days into the detoxification period following the maximum toxicity level in all study years except 2001 ($P < 0.05$) (Table 1).

The observed rates of detoxification (10.8 ± 2.4%/day) were lower than those previously reported for *C. gigas* (31.4%/day for whole tissue)[2] (Figure 1). Additionally, the period required for detoxification (t_4) from the date of maximum toxicity varied from 12 to 30 days.

Table 1 Relationship between $\log_e$-toxicity and the number of days into the detoxification period following maximum toxicity level for all study years except 2001(*NS* not significant, * $0.01 \leq P < 0.05$, ** $0.001 \leq P < 0.01$).

Years	Number of data pairs (n)	Pearson's correlation coefficient (*r*)	Significance (*P*)
1998	5	−0.990	**
1999	3	−0.998	*
2000	6	−0.924	**
2001	3	−0.920	NS

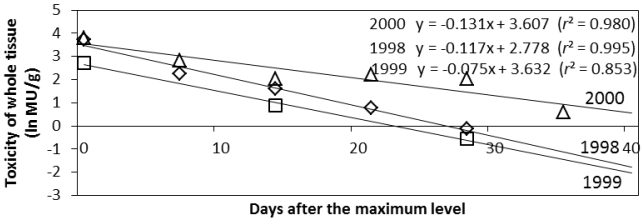


Figure 1 Rates of detoxification in whole tissue of the oyster *C.gigas* for each study year, as determined by linear regression analysis with fitted linear equation

CONCLUSION

The detoxification rate obtained in the present study will be useful for estimating the duration of detoxification in oysters in Ofunato Bay. Because the biphasic detoxification model is widely accepted in bivalves, further investigation will be needed to establish a more accurate and reasonable method for predicting detoxification in oysters.

REFERENCES

1. BRICELJ, VM. and SHUMWAY, SE. 1998, *Rev. Fish. Sci*. 6, 315-383.
2. YAMAMOTO, T., FLYNN, KJ. and TAKAYAMA, H. 2003, *Fish. Sci*. 69, 944-950.
3. OSHIMA, Y. 1995, *J. AOAC Int.*78, 528-532.

ACKNOWLEDGMENTS

This work was partially supported by the Regulatory research projects for food safety, animal health, and plant protection (no: 2602).

The European Eel (*Anguilla Anguilla*) in France: An Example of Close Cooperation among Researchers and Fishers to Study and Manage an Endangered Species

Patrick PROUZET[1], Eric FEUNTEUN[2], Philippe BOISNEAU[3], Nicolas MICHELET[4]

[1]IFREMER/SFJO, France, patrick.prouzet@orange.fr
[2]MNHN/CRESCO, France
[3]CONAPPED, France
[4]CNPMEM/CONAPPED, France

The European eel (*Anguilla Anguilla*) was a very valuable species for the economy of small scale fisheries in France either in marine or in inland waters. At the beginning of the 21st century the species was the third in value of all the species caught in the Bay of Biscay despite a strong reduction in abundance since the middle of the 20th century and especially since the seventies. Right now, there is a sharp decline of the economic value of that fishery due to some constraining fishing regulations and due to the export ban of eel outside Europe.

Due to a dramatic decrease of its abundance in all the European waters, the EU decided to define an eel management plan in 2007, in a council regulation establishing measures for the recovery of the stock of the European eel. Each member states producing eel had to identify the measures to take and the areas to be covered and had to evaluate the effectiveness of these measures. These measures constituted the basis of the national management plan defined by each member states that wish to exploit the eel resource. The objective of the eel national management plan is to reduce anthropogenic mortalities so as to permit with high probability the escapement to the sea of at least 40% of the silver eel biomass relative to the best estimate of escapement that would have existed if no anthropogenic influences had impacted the stock.

In that context, some large scientific programs such as INDICANG and EELIAD have been undertaken to improve our present knowledge on the migratory behaviour of eel at different phases of its biological cycle, to develop some methodologies to evaluate the abundance of the stock in a given river system and to assess the relative effects of both fisheries and others anthropogenic factors on the future of the stock. The most part of these studies have been made through a close cooperation between scientists and fishers in order to add their know-how and knowledge to develop some technical approaches on the field. Some examples are given to illustrate these field experiments.

An Analysis of the Potential Success for an Improved "High Quality" Oyster Entering the Existing Market

Yoshifumi TAKAHASHI[1], Tsutomu MIYATA[2], Hiroki WAKAMATSU[2]

[1]Faculty of Agriculture, Kyushu University, Japan, gibun@agr.kyushu-u.ac.jp
[2]Socioeconomic Development Group, Fisheries Research Agency, Japan

INTRODUCTION

Improving the quality of products is one way for a business to survive in a tight market. A premium can then be added to a commodity's price to gain additional revenue and the better quality product will expand the market. Therefore it is important to understand how buyers in the intermediate organizations, such as the producers, distributors and restaurant owners, who know consumers' needs, evaluate the premium product.

Evaluating taste has been well researched, but has not focused on the intermediate organizations by using questionnaires to gain their opinions on taste with analysis using weighted coefficients

For example, the relevant items for food evaluation consist of four categories: "appearance and texture", "fragrance", "taste" and "mouthfeel"[1]. These categories are such important factors that ordinary consumers cannot decide on their order of priority. In questionnaires, many consumers tend to answer "strongly important" for all categories when they evaluate each category into five levels of importance. It thus becomes impossible to discover the relative importance of each category.

Japanese Government and Miyagi prefecture has been introducing breed improvements for ordinary oysters in shells for two and a half years while reconstructing the oyster industry after damage by large earthquakes. However, the oyster famers are anxious to know how these intermediate buyers will evaluate this new improved oyster.

The aims of this paper are: 1) to discover how buyers evaluate the new oysters in shells introduced after breed improvement ("high quality oyster") compared with the ordinary oysters in shells that are easily available to buy ("ordinary oyster"), and 2) to evaluate the potential value of a "high quality oyster" on the existing market. Furthermore, we aimed to analyze the responses from our subjects using Fuzzy Analytic Hierarchy Process methodology (Fuzzy AHP).

METHODS

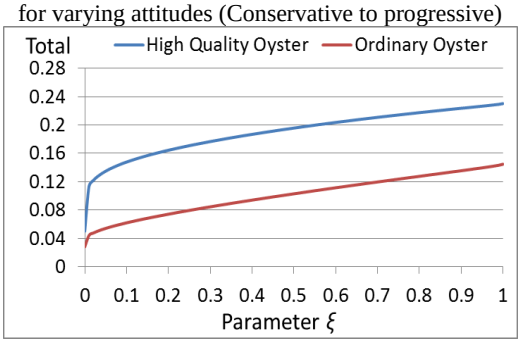
1 Data - We distributed questionnaires to delegates at an oyster symposium in Miyagi, Japan (June 2014), and received 65 responses after they had tasted a "high quality oyster". The questionnaire consisted of three sections: respondent's socio-economic data, questions comparing the two types of oyster as described earlier and how much they were willing to pay for such an oyster (WTP).

2 Fuzzy Analytic Hierarchy Process (Fuzzy AHP) - AHP is a well known analytical method to make optimal decisions based on subjective evaluations (Saaty 1997). This method has been applied in many fields of research: psychology, economics, urban engineering, military operations and education. AHP has also been developed by adopting another methodology to overcome the two limitations of "substitutability" and "complementarity". Fuzzy AHP is just such a methodology to take these two problems into account. Fuzzy AHP can evaluate continuously from a minimum weighting for conservative consumers to a maximum weighting for progressive consumers via the neutral weighting of usual AHP, so we adopted the Fuzzy AHP methodology.

RESULTS AND DISCUSSION

Figure 1 shows the comprehensive evaluation of "high quality" oysters compared with "ordinary" oysters. The symbol, ξ, in Figure 1 represents the subjective response from conservative to progressive consumers. The producers, distributors and restaurant business owners had a consistently higher evaluation for "high quality oyster" than "ordinary oyster". We also calculated their WTP for "high quality oyster" when we suggested the cost of an "ordinary oyster" as 200 yen: the mean WTP was a little higher at 215 yen.

Fig 1. Comparison of "High Quality" and "Ordinary" oysters for varying attitudes (Conservative to progressive)



CONCLUSION

Our purpose was to obtain the intermediate buyers' evaluation of a "high quality oyster" and their WTP. We concluded that the buyers preferred the "high quality oyster" to the "ordinary oyster" even as the buyers' attitude gradually shifted from conservative to progressive. We found that the "high quality oyster" commanded a premium price and would be selected by intermediate buyers.

REFERENCES

1. Takahashi, K. 2013, *Oyster Research Institute News*, 28, 9-13. (in Japanese)
2. Saaty, T. L. 1997, *Journal of Mathematical Psychology*, 15(3), 234−281.
3. Cheng, C. H. 1997, *European Journal of Operational Research*, 96(2), 343-350.

ACKNOWLEDGMENTS

This study was part of "A Scheme to Revitalize Agriculture and Fisheries in Disaster Area through Deploying Highly Advanced Technology" funded by the Ministry of Agriculture, Forestry and Fisheries, Japan.

A Feasibility Study of an *In Situ* Fluorescence Spectroscopy System for the Detection of Deposited Oil

Akira MATSUMOTO*, Xuanyu LIU, Yoshichika IKEDA, Hisayuki ARAKAWA

Tokyo University of Marine Science and Technology, Japan, *amatsu0@kaiyodai.ac.jp

INTRODUCTION

The Tōhoku earthquake and tsunami that struck on 11 March 2011 caused 22 fuel tanks around Kesennuma Bay (northern Japan) to collapse. As a consequence, a large amount of fuel oil (~11,500 kL) spilled into Kesennuma Bay. Some of the oil adhered to suspended particles and was deposited on the sea floor, polluting the bay sediments. The concentration of oil contamination in the sediments was so high that the negative influence on benthic organisms is considered ongoing. To remove the oil from the surface sediments efficiently, it is necessary to understand in detail its spatial distribution.

In our previous study, we found that sediment samples collected from Kesennuma Bay emitted fluorescence when irradiated with UV. A correlation between *n*-hexane concentrations and the fluorescence intensity was then confirmed in the laboratory. However, the detection limit of fluorescence is extremely low in highly turbid water. In this study, we developed a new measurement system that has a sediment contact-type detector. To assess the ability of this *in situ* fluorescence spectroscopy system to determine the sedimentary oil distribution, relationships between the signal-to-noise ratio and probe angle, and oil concentration in the sediment and fluorescence intensity were examined.

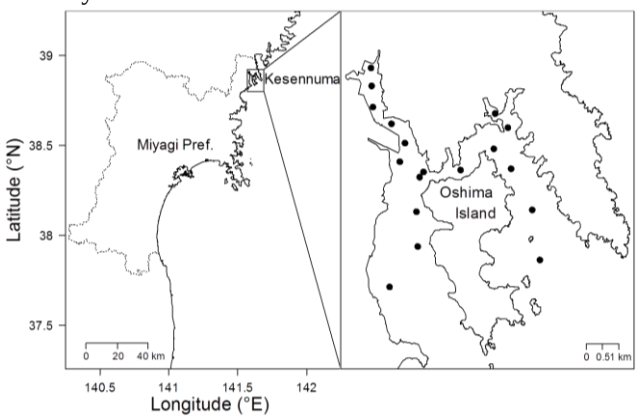


Fig. 1 Map of the 18 sampling sites around Kesennuma Bay in July 2015.

METHODS

Using an Ekman-Barge sampler, we collected surface sediment samples from 18 sites around Kesennuma Bay in July 2015 (Fig. 1). The sediment samples were divided into subsamples to measure oil concentration (*n*-hexane soluble fraction and polycyclic aromatic hydrocarbons [PAHs]) and fluorescence spectra. The fluorescence spectra were generated at one nm intervals by a "Jaz" spectrometer with a fibre optic reflection probe (Ocean Optics Inc., FL, USA). Both the light receptor on the spectrometer and the UV excitation light (365 nm) were set 3 mm above the sediment surface using the same probe. A fluorescence maximum value (550 nm) was considered to be a "signal", whereas the UV reflectance was considered to be "noise". Signal-to-noise ratios were measured at six probe angles (0°, 15°, 30°, 45°, 60°), with the vertical set as 0°. Ten spectra were measured from sediment samples of each of the 18 sites under the optimal probe angle (15° from vertical), and the spectra were averaged for each sample. Integrated signal values in the range of 490–620 nm were considered to be the fluorescence intensity from the averaged spectra. The same spectral measurements were performed using two lengths of fibre optic reflection probes (2 m and 30 m).

RESULTS AND DISCUSSION

The sediment samples showed a weak and broad (500–600 nm) fluorescence emission, which was similar to that of bunker-C oil[1]. The signal-to-noise ratio was highest at a probe angle of 15° from vertical. This probe angle may be optimal for spectral measurements. All of the following results were from this probe angle. There was a difference in the fluorescence intensity between the two fibre optic lengths. The fluorescence intensity of the 30-m fibre optic was about 28% (±13%) weaker than that of the 2-m fibre optic. Although the correlation between *n*-hexane concentration and the fluorescence intensity using the 2-m fibre optic was not significant (P=0.49), the correlation between PAH concentration and fluorescence intensity was significant (P<0.05). Because the same situation was also observed in the 30-m fibre optic, the sediment sample fluorescence may be attributable to PAHs contained in the deposited oil.

CONCLUSION

A significant positive correlation between PAH concentration and the fluorescence intensity was confirmed for both the 30-m and 2-m fibre optics. These results demonstrate the feasibility of the *in situ* fluorescence spectroscopy system for the detection of PAHs in sedimentary oil deposits.

REFERENCES

1. Measures, R. M., Houston, W. R., Stephenson, D. G. 1974, *Opt. Eng.* 13(6), 494–501.

ACKNOWLEDGMENTS

This study was supported by the research project "Tohoku Ecosystem-Associated Marine Science" from the Japan Ministry of Education, Culture, Sports, Science and Technology (MEXT).

137Cs and Tritium Concentrations in Seawater off the Fukushima Prefecture: Results from the SOSO 5 Rivers Cruise (October 2014)

Michio AOYAMA[1], Hervé THEBAULT[2*], Yasunori HAMAJIMA[3], Sabine CHARMASSON[2], Mireille ARNAUD[2], Céline DUFFA[2]

[1]Institute of Environmental Radioactivity, Fukushima University, Japan
[2]Institut de Radioprotection et de Sûreté nucléaire (IRSN), France, *herve.thebault@irsn.fr
[3]Low Level Radioactivity Laboratory, Kanazawa University, Japan

INTRODUCTION

The Fukushima Dai-ichi Nuclear Power Plant (FDNPP1) accident, which occurred in Japan on March 11, 2011, resulted in the releases of large amount of various radionuclides especially caesium isotopes (^{137}Cs half-life 30.2y and ^{134}Cs half-life 2.06y) both in the atmosphere and in the oceans. Various authors have observed that caesium have been transported from contaminated watershed to rivers[1]. Three and a half years after the accident this study has been conducted in order to investigate the river influence on coastal areas.

METHODS

In October 2014, the cruise SOSO 5 Rivers took place off the coast of the Fukushima prefecture. The sampling was targeted off the mouths of 5 coastal rivers located North of the FDNPP and whose watershed were strongly contaminated by accident fallout i.e. Mano, Nitta, Ota, Odaka and Ukedo rivers.

Seawater was sampled along radials comprising 5 stations in front of each of these 5 rivers. Seawater was sampled on surface and 1m above bottom. In addition one water sample was realised in 4 estuaries (the Ukedo estuary was not accessible at that time). All the samples were filtered on 0.45µm. An improved ammonium phosphomolybdate (AMP) procedure[2] was used to extract caesium from the samples. The weight yield of AMP/Cs compound generally exceeds 99 % for 2 litre samples as well as radiochemical yield of radiocaesium. The activities of AMP/Cs compound were measured at the Ogoya Underground Facility of the Low Level Radioactivity Laboratory of Kanazawa University using high-efficiency, well-type ultra-low background Ge-detectors. One liter of seawater underwent tritium analysis through electrolytic enrichment at the Tritium Laboratory (Miami, USA).

RESULTS AND DISCUSSION

Both ^{134}Cs and ^{137}Cs were detected in all the samples demonstrating a contamination from the FDNPP accident releases. Generally the concentrations were higher at coastal sites and decreased with distance from the coast, and were higher in the surface layer compared to the bottom layer. The relationship between ^{137}Cs and ^{134}Cs decay corrected to the date of the accident showed that pre-Fukushima ^{137}Cs activities due to global fallout from nuclear bomb testings[3] were close to 1.5 Bq.m^{-3}. The ^{137}Cs/^{134}Cs activity ratio was close to 1, a value consistent with the ratio observed nearby the release point after the accident[4].

Regarding tritium, only a part of all samples (11) were analysed (table 1). The tritium levels are quite low but higher levels always characterized estuarine waters. In seawater they ranged from 1.48±0.09 in front of the Mano river to 0.57±0.09 TU at 6.7 nautic miles off the Nita mouth (Nitta 5). These results underlined the fact that away of rivers influence, seawater tritium content is less than 1 TU which corresponds to background level in the marine environment. In rivers tritium contents ranged from 4.10±0.14 in the Ota estuary to 1.81±0.09 in the Odaka estuary. These levels are in agreement with what is known from continental freshwater, the continental tritium reservoir being higher than the marine one. In Japan, levels up to 6TU are conservative estimate of the pre-Fukushima background level[5]. Therefore our dataset does not show any influence of the tritium released by the Fukushima accident on these rivers or on coastal waters north FDNPP in October 2014.

Table 1 Tritium content (±1 sigma) in rivers and coastal rivers (SoSo5 rivers project-October 2014).

Location	Date (yymmdd)	TU	eTU
Mano Estuary	14/10/11	3.28	0.11
Mano 1 surface	14/10/09	1.48	0.09
Nitta Estuary	14/10/11	3.89	0.13
Nitta 1 surface	14/10/19	0.89	0.09
Nitta 5 surface	14/10/19	0.57	0.09
Ota Estuary	14/10/11	4.10	0.14
Odaka Estuary	14/10/11	1.81	0.09
Odaka 1 surface	14/10/18	0.99	0.09
Odaka 5 surface	14/10/18	0.68	0.10
Ukedo 1 surface	14/10/17	0.92	0.09
Ukedo 5 surface	14/10/17	0.70	0.09

REFERENCES

1. NAGAO S., KANAMORI, M. OCHIAI, S. TOMIHARA S. FUKUSHI, K and YAMAMOTO M. 2013, *Biogeosciences*, 10, 6215–6223.
2. AOYAMA, M. & HIROSE, K. 2008. In: PAVEL, P. P. (ed.) *Radioactivity in the Environment*. Elsevier.
3. AOYAMA, M., K. HIROSE, K. NEMOTO, Y. TAKATSUKI, D. TSUMUNE. 2008 *Geophysical Research Letters*, 35 (1)
4. BUESSELER K., AOYAMA M., FUKASAWA M. 2011 *Environmental Science and Technology*, 45 (23), 9931–9935
5. MATSUMOTO T., MARUOKA T, SHIMODA G., OBATA H., KAGI H., SUZUKI K., YAMAMOTO K., MITSUGUCHI T., HAGINO K., TOMIOKA N., SAMBANDAM C., BRUMMER D., MARTIN KLAUS, P. AGGARWAL, *Science of the Total environment*, 445-446, 365-370.

ACKNOWLEDGMENTS

This work was part of the AMORAD project (French National Agency for Research ANR-11-RSNR-0002). The authors thank the KANSO team for their helpful and expert assistance in field work.

Do Species Diversity and Productivity of Fisheries Resources Increase around Submarine Groundwater Seepages in Coastal Area?: Possible Effects of Global Warming

Jun SHOJI[1*], Masaki HATA[1], Masakazu HORI[2], Ryo SUGIMOTO[3], Takeshi TOMIYAMA[1]

[1]Graduate School of Biosphere Science, Hiroshima University, Japan, [*]jshoji@hiroshima-u.ac.jp
[2]Fisheries Research Agency, Japan
[3]Fukui Prefectural University, Japan

INTRODUCTION

Economic values of the ecosystem services of coastal waters have been evaluated as among the highest among those of the world's ecosystems. Recently more attentions have been paid on the mechanisms how the freshwater (including surface and submarine ground waters) contribute to the high productivity and species diversity of the coastal ecosystems. We conducted physical and biological surveys in temperate coastal waters in Hiroshima, southwest Japan in order to examine effects of submarine groundwater on species diversity and productivity of fishery resources. Submarine ground water is nutritionally rich and stable in temperature throughout the year, indicating positive effects on fishery production and species diversity under a variety of changes in environmental conditions including global warming.

MATERIALS AND METHODS

Fish sampling was conducted by the use of small seine net (2 x 1 mm, 2 mm mesh). Invertebrates (crustaceans and polychaetes, as prey for the fishes) were collected with a bottom plankton net (0.3 x 0.4 m, 1 mm mesh) and a sediment sampler (10 x 10 cm circular cylinder). In addition, underwater camera recording was conducted by four digital cameras (1 min interval, for 3 hours) to analyse abundance and species composition of fishes around each survey site. Relationships between physical parameters (water temperature, salinity and radon concentration) and biological parameters (abundance, biomass and species diversity of fish, crustaceans and polychaetes) were investigated.

RESULTS AND DISCUSSION

Significant increase in abundance and number of species of fishes and some invertebrate species were observed, indicating that submarine groundwater promotes biological production and species diversity in coastal ecosystems. The dependence of food webs on organic matters of terrestrial origin was examined by stomach contents and stable isotope analyses. In addition, effects of temperature on survival and growth of juvenile fishes were examined under laboratory conditions in order to test the possible effects of climatic changes (mainly, global warming) on fish production. Effects of increase in seawater temperature is expected to be smaller in the fish community around submarine groundwater seepage because temperature of submarine groundwater is more stable than seawater.

Com 9

Plastic in the Mediterranean Sea

François GALGANI

IFREMER, LER/PAC, France, francois.galgani@ifremer.fr

Because of large cities, rivers and shore uses, some of the largest amounts of Municipal Solid Waste are generated annually per person (208 – 760 kg/Year), because of tourism, 30% of the world's maritime traffic and a closed basin, the Mediterranean has been described as one of the most affected areas by marine litter in the world. Plastic, mainly bags and fishing equipment, is the largest part of debris and they may physically degraded into smaller fragments, the so-called microplastics. Most existing surveys of microplastics on the surface, worldwide, have found average densities lower than in the NW Mediterranean Sea (80-250000 items/km^2) and microplastics have been also found on beaches and sediments, including deep sea, reaching concentrations of 1000 pellets/m^2.

Recent studies on the deep sea floor in the Mediterranean Sea concluded that coastal submarine canyons act as conduits for the transport of marine debris into the deep sea areas where densities were evaluated from 295 samples at an average density of 179 plastics/km^2.

The balance between the increase of waste and plastic productions, reduction measures and the quantities found at the surface and on shorelines is still not answered. Recent research demonstrated (i) the importance of hydrodynamics, (ii) the impact of plastic at sea that include entanglement, physical damage and ingestion, the release of chemicals, the transport of species and the alteration of benthic community structures, and (iii) social and economic harm that also include risks to human health, threat to navigation and costs to maritime sectors.

As necessary steps, a better management will then need to (i) increase the coverage of survey sites and further development of data analysis in all regions, enabling to map hot spots an sources, (ii) develop supporting tools for larger scale assessments, including harmonized databases, (iii) a better definition of thresholds, baselines and targets, and finally (iv) a coordinated monitoring.

To support actions to be taken in order to minimize impacts on the marine environment, the European Commission included recently marine litter as one of the descriptor of the Marine Strategy Framework Directive (MSFD), establishing a framework within which Member States must take action to achieve or maintain Good Environmental Status (GES). Beside, the Barcelona convention with its Regional Action is coordinating the monitoring of marine litter and support the implementation of reduction measures. Research, supported by many institutions has then become critical and priorities include (i) a better definition of standardized/harmonized protocols, (ii) research on nanoparticles at sea, (iii) a better understanding of circulation and transport (iv) an increased knowledge of the ecology of microbial life on plastic and consequences on degradation, species dispersion and release of chemicals, and (v) a better understanding of the interactions between plastic and marine organisms. Using some examples, the process of the implementation of monitoring is described and discussed in the context of reduction measures.

Do Our Ocean Policies Make Any Difference in the Wellbeing of Coastal Communities?

Yves HENOCQUE[1, 2]

[1]IFREMER, France, yves.henocque@ifremer.fr
[2]JAMSTEC, Japan

Like many other countries, France and Japan now have their own ocean policy, though at different stage and in quite different context. On the European side, buzz words like 'Blue growth', 'Maritime spatial planning', and others, are on the forefront and could make us feel that ocean policies are primarily focused beyond the coast, in offshore waters and their corresponding human activities, with coastal communities or populations lagging behind. Through case studies, we will try to show that ocean policies should be coast-to-coast, across oceans and across regional seas towards the progressive building up of a "Blue society".

Fish and Seafood Value Chains and the Well-Being for Local Community

Masahito HIROTA[1*], Juri HORI[2], Mitsutaku MAKINO[1]

[1]NRIFS, Fisheries Research Agency Japan, Kanagawa, Japan, [*]mmhirota@affrc.go.jp
[2]College of Contemporary Psycology, Rikkyo university, Japan

INTRODUCTION

From the sight of social approach, fish and Seafood have a great meaning for people's life, social structures and even in well-being, especially for those who have seafood cultures since ancient times, such as Mediterranean and Asian people. FRA*, MAFF*, PICES[1], have been running a social study form the view point of the human's life and its well-being since 2012, that's because the social science could lead a next stage of coastal management approach in harmonizing with ecosystem services. In this study program, the research highlights the fish and seafood values as the base of local community and its life, in order to understand the well-being.

*FRA: Fisheries Research Agency Japan
*MAFF: Ministry of Agriculture, Forestry and Fisheries

METHOD

Focusing on Asian countries (Japan, Indonesia, Thailand) , the study has been putting emphasis on the issues about social utilization of fish and seafood and its well-being for local people in order to understand the balanced social values (Fig).

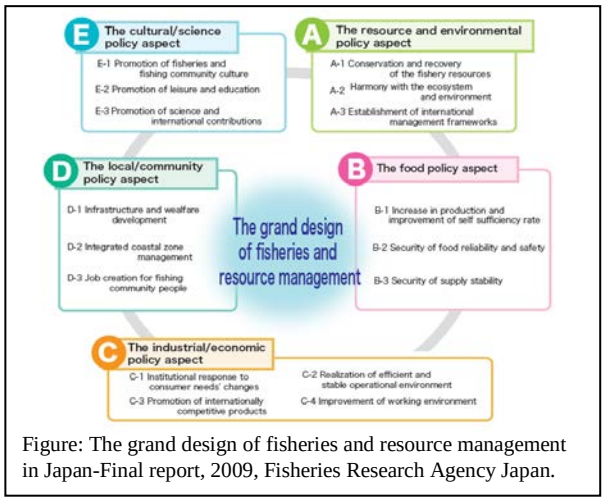


Figure: The grand design of fisheries and resource management in Japan-Final report, 2009, Fisheries Research Agency Japan.

The methods are followed; 1) to know the social value chain, the research has drawn the commodity chain and stakeholder map while running interviews (and questionnaires) survey to the local stakeholders, 2) to understand the local community structure, the survey has put the criteria[2&3] for its every-day life standard, rules and organizations, while communicating with local inhabitants. As the future step, the study hope to compare with the case of France.

RESULT AND DISUCUSSION

The research has highlighted the patterns of the fish and seafood value depending on the commodity chains and community structure types. It can classify two patterns as followed;

1. Open value chains: it is for the open markets such as global business, which standardizes fish and seafood products like an industrial materials to utilize in various countries.
2. Closed value chains: this type of activities depends on local or domestic utilities depending on local people's life standards, culture, confidence and well-being. In the closed value chain's society, fish and seafood are able to develop the wide variety of values and well-being in its life.

CONCLUSION

Fish and seafood value chains is closely connected with local community structure and its well-being. When thinking about coastal management system, at first we should pay attention whether the chain open or closed, while understanding whether the local people's every-day life are depending on community or not. And when understanding the good balanced coastal management, the program must have closely communication together with local people, to recognize the well-being of its life.

As the next step, we hope to collaborate with France to study the coastal management system from the sight of the value chains, local community structures and its well-being.

REFERENCES

1. Marine Ecosystem Health and Human Well-being, PICES: https://www.pices.int/projects/MarWeb.aspx (30/August/2015)
2. The ground design of fisheries and resource management in Japan-Final report, 2009, Fisheries Research Agency Japan.
3. OECD Better life initiative Compendium of OECD well-being indicators, 2011, OECD

Synthesis of New Knowledge about Determinism of Pacific Oysters (*Crassostrea gigas*) Larval Recruitment in the Mediterranean Thau Lagoon

Franck LAGARDE[1*], Serge MORTREUX[1], Martin UBERTINI[1], Ismael BERNARD[2], Hélène COCHET[3], Béatrice BEC[4], Cécile ROQUES[4], Delphine BONNET[4], Adeline PERIGNON[5], Claude CHIANTELLA[1], Gregory MESSIAEN[1], Erika GERVASONI[6], Patrik LE GALL[1], Jean-Louis GUILLOU[1], Marion RICHARD[1], Gilles MIRON[7], Annie FIANDRINO[1], Stéphane POUVREAU[8], Emmanuelle ROQUE D'ORBCASTEL[1]

[1]UMR MARBEC, Ifremer LER/LR, Sète, France, [*]franck.lagarde@ifremer.fr
[2]Eureka Modélisation, Lézardrieux, France
[3]Cochet-Environnement, Locoal Mendon, France
[4]UMR MARBEC, Université Montpellier, France
[5]CRCM, Mèze, France
[6]CEPRALMAR, Montpellier, France
[7]Université de Moncton, Canada
[8]LEMAR/Ifremer/PFOM/LPI, Brest, France

INTRODUCTION

Since 2008 and due to the mass mortalities of Pacific oysters *Crassostrea gigas* juveniles[1&2], Mediterranean shellfish farmers have decided, with the collaboration of the scientific community, to better understand the settlement of oyster larvae in Mediterranean lagoons. To answer this purpose, the PRONAMED 2 project based on ecological observations around the life cycle of the oyster over three consecutive years (2012, 2013 and 2014) was set up to explore the reproductive cycle including larval development and spat settlement of *C. gigas*. The recent study of the inter-annual variability of the recruitment, demonstrated the potential of pacific oyster recruitment in Mediterranean lagoons. Moreover, a characterisation of both temporal and spatial variations of spat settlement gave valuable information on the different ecological drivers of recruitment within Thau lagoon.

METHODS

The study focuses on 8 experimental stations in Thau Lagoon, South of France. The experiment was to make an ecological diagnosis (figure below) during gametogenesis and larval recruitment events[3&4]. The methodology monitors adult gametogenesis and all larval stages from spawning until spat stage.

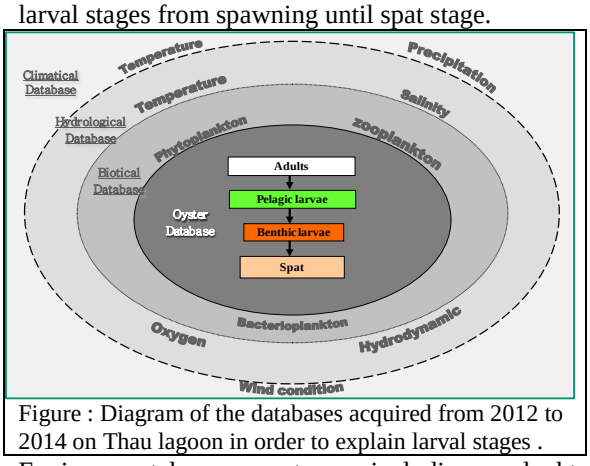


Figure : Diagram of the databases acquired from 2012 to 2014 on Thau lagoon in order to explain larval stages .

Environmental parameters including planktons (bacteria, protozooplankton, mesozooplankton, phytoplankton), temperature, salinity and oxygen were monitored every week at three stations to determine conditions under which gametogenesis, spawn, larvae and spat development occurred.

RESULTS AND DISCUSSION

This work highlights specific spawning processes and triggers[5]. Moreover, Years 2012, 2013 and 2014 have different spat recruitment profiles. Abundances of pediveliger and spat collection vary spatially at each other stations and at different time scales for survival. It appears that the number of spat on chinese hat collectors is mainly determined by :

1. the supply of pelagic then pediveliger larvae sustained by hydrodynamic activity and level of hydrologic parameters (temperature and diatom *Chaetocoeros sp.*)
2. the survival on chinese hat collectors during the metamorphosis stage relying on trophic supplies specially based on nanoparticles with size ranging from 3 to 20 micrometers.

CONCLUSION

Recent discoveries of Japanese oysters spat field in Thau lagoon open up interesting prospects for research in nanotidal system. The analyses of collected environmental parameters allow to better characterize favorable sites and periods. Spat collecting in Thau lagoon presents high spatial, small-time scale and inter-annual variabilities induced by hydrodynamic, predation, competition and trophic resource variability. These first results give highlights about explicative factors of ecological variations of the natural oyster recruitment in Thau lagoon.

REFERENCES

1. Pernet F., Lagarde F. *et al.* 2014. Spatial and temporal dynamics of mass mortalities in oysters is influenced by energetic reserves and food quality. Plos One, 9(2), e88469.Publisher'sofficial.version: http://dx.doi.org/10.1371/journal.pone.0088469
2. Pernet F. *et al.* 2012. Mass mortalities of Pacific oysters *Crassostrea gigas* reflect infectious diseases and vary with farming practices in the Mediterranean Thau lagoon, France. AEI, 2(3), 215-237. Publisher's official version : http://dx.doi.org/10.3354/aei00041
3. Auby I., Maurer D., 2004. Etude de la reproduction de l'huître creuse dans le bassin d'Arcachon, Rapport Ifremer.p203.http://archimer.ifremer.fr/doc/00040/15145/
4. Miron G., Boudreau B., Bourget E., 1995. Use of larval supply in benthic ecology - testing correlations between larval supply and larval settlement. Marine Ec.-Prog. Ser. Vol: 124, Iss.: 1-3, p 301-305.
5. Ubertini M., Lagarde F., Mortreux S., Le Gall P., Chiantella C., Fiandrino A., Roque d'Orbcastel E., Bernard I., Pouvreau S., *In Prep*. Effect of environmental variables on the reproduction of the pacific oyster *Crassostrea gigas* in the Mediterranean: A case study in the Thau lagoon.

Challenge to Harmonize Sustainable Fishery with Water-Quality Improvement Using Seagrass-Oyster Interaction in Oligotrophic Coastal Ecosystems

Masakazu HORI[1*], Masahito HIROTA[2], Mitsutaku MAKINO[2], Naoaki TEZUKA[1], Masami HAMAGUCHI[1], Masahiro NAKAOKA[3], Jun SHOJI[4] and Ryo KIMURA[5]

[1]Fisheries Research Agency, Hiroshima, Japan, [*]mhori@affrc.go.jp
[2]Fisheries Research Agency, Yokohama, Japan [4]Hiroshima University, Hiroshima, Japan
[3]Hokkaido University, Akkeshi, Japan [5]Fisheris Research Agency, headquaers, Yokohama, Japan

INTRODUCTION

Coastal environments of the world have been exposed to eutrophication with red tide for several decade[1]. Recently as public awareness of marine pollution has become higher, the quality of coastal waters has been gradually and successfully improved in some regions[2]. However, some coastal stakeholders suggest that the improvement is now causing another issue in coastal ecosystem services called "oligotrophication"[3].

It is suggested that oligotrophication has reduced pelagic productivity in coastal ecosystems, sometimes resulting in the decrease of fishery catch because the coastal fishery system in some regions has adapted to the eutrophication. In Seto Inland Sea, Japan, most of the recent fishery-target species are derived from pelagic production[4]. In addition, bivalve culture especially pacific-oyster culturing is a typical fishery has been prospering with eutrophication.

In contrast, oligotrophication with high transparency has recovered benthic primary productivity including seagrass vegetation. Seagrasses are quite important for climate change mitigation and adaptation such as carbon storage[5] and protection from sea-level rise and storm surges[6], which are welcomed by another stakeholders concerned with environmental issues.

In this presentation, we will show some of our recent studies and ideas for establishing both sustainable fishery and water-quality improvement. First is the result from our global manipulative experiment with nutrient loading into seagrass beds. Second is the result from a stable isotope analysis of oysters in two regions under oligotrophication. The last is the discussion about the interaction between seagrass beds and oyster culturing as a key factor which contributes to harmonize sustainable fishery and water-quality improvement.

METHODS

First, we participated in a global experiment spanning the northern hemisphere to demonstrate the relationship among eelgrass ecosystem functioning, the associated epifauna diversity and nutrient loading. In the experiment, we established an experimental site of seagrass bed in western Seto Inland Sea, and then conducted fertilization and epifaunal-diversity manipulation there during the same period using the same equipment as other sites of the world.

Second, we compared carbon (C) and nitrogen (N) stable isotope composition of cultured Pacific oyster between Thau Lagoon located at southern France and Hiroshima Bay in Seto Inland Sea, Japan. In Thau Lagoon, the oyster culturing is still productive even under oligotrophication, while the oyster culturing in Hiroshima Bay is suggested to be recently rather less productive than the peak period.

Lastly, we present our research on seagrass-oyster interaction along US west coast, as a possible coastal management using seagrass-oyster interaction.

RESULTS AND DISCUSSION

Total results of the global experiment revealed that higher epifauna diversity significantly affected higher eelgrass ecosystem functioning, while any significant effect of experimental fertilization was not detected. However in the individual result from Seto Inland Sea, the fertilization had a significant interactive effect on the ecosystem functioning with epifauna diversity. The fertilization decreased the ecosystem functioning when epifaunal diversity was low.

Analysis of C-N stable isotope composition clearly exhibited that the stable isotope ratio of oyster in Thau lagoon showed high seasonal variability, while the ratio of oyster in Hiroshima bay was rather fixed and did not differ among seasons. This result suggests that the growth of oyster in Thau lagoon was derived from various types of primary productions while that in Hiroshima Bay depended on a specific resource.

Our census in US west coast showed that fish species were more abundant in the seagrass bed with oyster culturing, due to massive epifaunal invertebrates, This result suggests a possibility the seagrass-oyster interaction increases the benthic productivity enough to facilitate higher trophic levels.

CONCLUSION

In oligotrophic environment, our results suggest that facilitating total productivity based on not only pelagic productivity but also various benthic production is a first step to enhance ecosystem functioning. Seagrass-oyster interaction would become the key factor. High water-transparency is also ideal for recreational use, which can interact with fishery and subsidize to the sustainability of the social community through diverse coastal ecosystem services.

REFERENCES

1. SELMAN, M. et al. 2008, *WRI Policy Note* 1: 1-6.
2. MATSUDA, O. 2015, *Yutakanaumi* 36:7-12 (in Jpn)
3. YAMAMOTO, T. and HANASATO T. 2015, in *Issues in oligotrophication, Chijinshokan* (in Jpn).
4. HORI, M. and TARUTANI K. 2015, in *Issues in oligotrophication, Chijinshokan* (in Jpn).
5. DUARTE et al. 2013, *Nature climate change* 3:961-968.
6. ARKEMA et al. 2013, *Nature climate change* 3:913-918.

Recent Research Results and Future Project in Antarctic Ocean by Umitaka-Maru Research Group for Physical Oceanography

Yujiro KITADE[1*], Keishi SHIMADA[1], Shigeru AOKI[2], Takeshi TAMURA[3],Kohei MIZOBATA[1], Yasushi FUKAMACHI[2], Kay I. OHSHIMA[2]

[1]Tokyo University of Marine Science and Technology, Japan, [*]ykitade@kaiyodai.ac.jp
[2]Institute of Low Temperature Science, Hokkaido University, Japan
[3]National Institute of Polar Research, Japan

INTRODUCTION

Antarctic Bottom Water (AABW) is the densest water in the ocean and globally significant. Historically there have been three well-known source regions in the Weddell and Ross Seas, and off Adélie Land (Fig.1 inset). In general, AABW is produced over the continental slope and rise by the mixing of cold, Dense Shelf Water (DSW) descending into warm Circumpolar Deep Water (CDW). TAMURA et al. [2008] estimated sea-ice production in the majority of coastal polynyas around Antarctica and found that the Cape Darnley Polynya is the second largest one. While the Ross and Mertz polynyas had already been connected to AABW, the Cape Darnley result was new. Thus, Cape Darnley project, including long term mooring observation, was began to clarify the connection between sea-ice production and AABW, and identify the formation area of AABW.

DISCOVERY OF NEW FORMATION REGIONS OF AABW

Detailed hydrographic observation and recover of mooring off the Cape Darnley Polynya (CDP) were carried out by TR/V Umitaka-Maru in January of 2010. OHSHIMA et al. (2013) found newly-formed AABW, Cape Darnley Bottom Water. They showed that despite its relatively narrow shelf region, the enhanced sea ice production in the CDP was forming one of the most saline varieties of DSW around Antarctica. While many of other polynya are significantly smaller than the CDP in terms of annual sea ice production [TAMURA et al., 2008], many have similar physical features.

The Vincennes Bay Polynya (VBP) forms every year in the coastal embayment southwest of Cape Poinsett (Fig. 1), which ranks it as a 'medium' class polynya relative to all polynyas around Antarctica. We carried out long term moorings and hydrographic observations off VBP and found strong evidence of AABW production from there [KITADE et al., 2014].

FRESHENING OF AABW OFF MERTZ AND VINCENNES

Long-term water mass changes during 1994-2012 have been examined from nine repeat hydrographic sections, including data from TR/V Umitaka-Maru, along 140E, off Mertz polynya, by AOKI et al. [2013]. They showed significant freshening trends detected within most of the water masses from the bottom to surface. Combined with the freshening of near-surface and Bottom Water masses in this region, these data indicate freshening of the entire water column over the continental slope. Freshening signals have also been clarified in water masses off VBP (fig.2). In addition to the freshening, warming trend is clearly found in water masses off VBP after 2011.

Such widespread freshening is broadly consistent with the enhancement of the global hydrological cycle, together with a possible acceleration of land ice melting [AOKI et al., 2013]. However, the mechanism which transports such a freshening impact from the sea surface to the seabed is not quantitatively clarified.

PROBLEM AND FUTURE PROJECT

Fluctuations of salinity signal were observed around 0℃ in recent years as shown in Fig. 2. Low salinity signal implies intrusion of water mass into the deep layer (as indicated by VBDW in Fig. 3). As these freshening and warming progresses, there is a possibility of change of the deep circulation. And it may affect significant on the climate change. To grasp the global circulation quantitatively, it is necessary to continue monitoring observation.

We will deploy a mooring this year, consisting of large numbers of CTD and T sensors. Furthermore, we plan to deploy mooring systems to grasp the meridional circulation in Southern Ocean which have never observed directly by humankind in next few years.

REFERENCES

TAMURA, T. et al., 2008, ***GRL***, 35, L07606.
OHSHIMA, K.I. et al., 2013, ***Nature Geo.***, 6, 235-240.
AOKI, S. et al., 2013, ***JGR***,118, 6046-6063.
KITADE, Y. et al., 2014, ***GRL***, 41, 3528-3534.

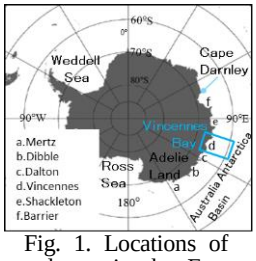


Fig. 1. Locations of polynya in the East Antarctica.

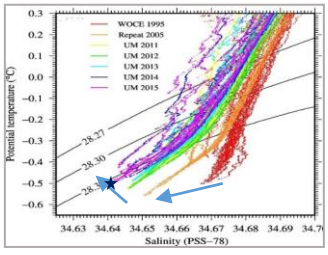


Fig. 2 θS diagram in seasonal Ice Zone along 110E, off VBP. Index 'UM' implies the data obtained by TR/V Umitaka-Maru. Star indicates VBBW obtained by mooring.

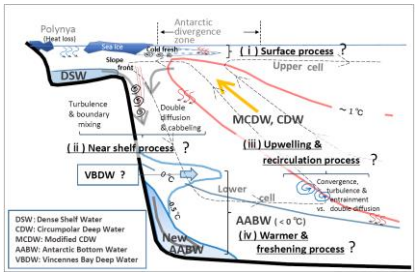


Fig. 3 Schematic view of water mass and circulation off VBP.

Automatic Sorting System and Incubation at Single Plankton Level Using Microfluidic Devices

Mathias GIRAULT[1*], Akihiro HATTORI[1], Hyonchol KIM[1,2], Kenji MATSUURA[1],
Masao ODAKA[1,2], Hideyuki TERAZONO[1,2], and Kenji YASUDA[2]

[1]Kanagawa academy of science and technology, Japan, [*]girault.bmi@gmail.com
[2]Institute of biomaterials and bioengineering, Tokyo medical and dental university, Japan

INTRODUCTION

Microfluidic is an emerging field which mainly consists in the miniaturization of complex process into a small sized device named chip. As typically the volume of sample manipulated in the chip ranged from pL to µL, the chip allows to easily monitor all the steps of an experiment in real time[1)]. Using these advantages, we developed a complete microfluidics system able to create stable and sized tuneable microenvironment for living plankton cell with a length size up to 25 µm. Then, using high speed camera and image processing system the microenvironment including the target plankton is sorted in real time and stored in passive traps. Finally, incubation can be precisely and automatically controlled in order to maintain cell alive during subsequent experiments.

METHODS

The microfluidic sorting system is based on an original chip template prepared from poly(dimethylsiloxane) (PDMS) by soft lithography. The identification of the target was performed in real time using each image captured with a high speed camera mounted on a microscope. If the target is found in the image, a pulse is sent to the high voltage amplifier. After amplification, a direct current pulse is sent to the chip and the microenvironment containing the target is sorted. Control of the incubation was performed by discrete addition of small tuneable volume to the microenvironment in order to maintain the cell osmolarity and provide nutrients.

RESULTS AND DISCUSSION

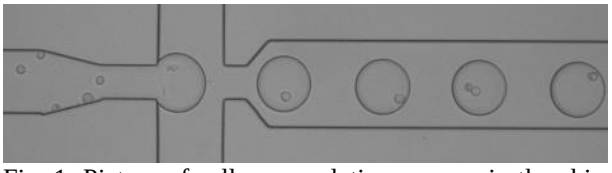


Fig. 1: Picture of cell encapsulation process in the chip (volume of microenvironment 65 pL).

Fig. 2: Examples of the living flagellates encapsulated into microenvironments (scale bars 30 µm). The right panel shows the microenvironment containing a target living dinoflagellate sorted and trapped in the chip for incubation.

We presented an efficient microfluidic sorting and incubation system based on real time image processing. By using a library of plankton pictures previously captured and learned, the target plankton in the sample was encapsulated in microenvironment and sorted depending on its morphology (Fig. 1, Fig. 2). Due to the diffusion effect through the PDMS, the volume of the microenvironment containing cell decreases of about 1.25 % per minute. To protect the cell to the osmotic choc, the size area of the microenvironment, trapped in the chip, was monitored in real-time using the imaging processing algorithm. Then, the system can automatically prevent the risk of osmotic choc by fusing an empty droplet of sample with the microenvironment. This automatic method allowed to maintain the cell alive in the chip independently of the variation of diffusion rate and without significant damage for plankton (Fig. 3).

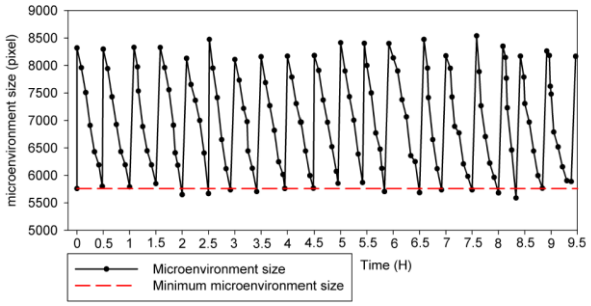


Fig. 3: Microenvironment size (pixel) depending on the incubation time (hour)

CONCLUSION

Association of image processing and microfluidic technology seems to open new perspectives in oceanography. Development of this approach can provide a powerful tool in numerous applications such as detection of toxic phytoplanktons depending on their shapes, chronobiology as well as effect of the turbulence on the plankton distribution. Our method can be an alternative approach to the classical flow cytometry and help the scientist community to investigate natural sample without any stain.

REFERENCES

1. Mazutis et al., 2013, *Nature Protocols*, **8**, 870–891.

.

ACKNOWLEDGMENTS

This work was supported by Kanagawa Prefector's local basic science funding for the On-chip Cellomics Project at the KAST, and CREST, JST for TMDU. We gratefully thank Ms. M. Hasegawa, M. S. Kawada, and Ms. H. Mikami for their helps during the experiments.

Observation of Near-Bottom Current on the Continental Shelf off Sanriku

Daigo YANAGIMOTO[1*], Kiyoshi TANAKA[1], Shinzou FUJIO[1], Hajime NISHIGAKI[2], Miho ISHIZU[1]

[1]Atmospere and Ocean Research Institute, University of Tokyo, Japan, *daigo@aori.u-tokyo.ac.jp
[2]Faculty of Education and Welfare Science, Oita University, Japan

INTRODUCTION

Bottom boundary layer on the continental shelf is thought to play an important role in water exchange between outer and coastal waters. For example, over Middle Atlantic Bight off the east coast of North America, where coastline extends north to south and coastal current flows southward like those of Sanriku coast, offshoreward bottom boundary current is indicated due to the effect of bottom friction[1]. On the other hand, massive cold water intrusion, which is thought to originate in the bottom layer over the shelf, often occurs in Otsuchi Bay, a ria bay in Sanriku coast[2]. In order to reveal the water exchange between ria bays and outer ocean, it is necessary to investigate near-bottom current distribution over the continental shelf.

We report current observation off Otsuchi Bay this summer with using a subsurface towfish mounting an acoustic Doppler current profiler (ADCP).

METHODS

Generally, ADCPs have three or four transducers which emit sound beams tilting at 10-20 degree from vertical direction. Even if downward beams reach the bottom, we cannot measure currents precisely within about 10% range from instrument to the bottom due to side lobes of the beams. That is, shipboard ADCPs cannot measure currents within 10-m range above the bottom at 100-m depth area. Because our target exists within this range, we make a subsurface towfish close to the bottom. We use V-fin mounting 500-kHz ADCP manufactured by Xylem (Sontek ADP 500) (**Photo 1**), whose pressure rating is 500 m and nominal profile range is 70-120 m.

V-fin is towed with just wire rope, and we cannot monitor pressure sensor data of ADCP in real time. We adopted a very handy acoustic telemetry system of Vemco, Canada, which is generally used in bio-logging field. A transmitter equipped with pressure sensor with a total weight of about 20g was tied to a shackle connecting the V-fin to wire rope.

Photo 1. V-fin on the deck of R/V Yayoi.

On 30 July 2015, we boarded R/V Yayoi (12 ton, 20 persons), a vessel of International Coastal Research Center in Atmosphere and Ocean Research Institute, and towed the V-fin about 50-m depth for about 2 nautical miles along 100-m isobaths off Otsuchi Bay four times: 09:05 – 10:07 (observation line L1), 10:25 – 10:59 (L2), 11:06 – 11:40 (L3), and 13:47 – 14:19 (L4). Four lines were done during flood tide at Kamaishi and Miyako from 9:00 to 16:00.

RESULTS

We succeeded in measuring near-bottom currents within 10-m range above the bottom (**Fig.1**). We can see the transition of the near-bottom current from the start and the end of flood tide. Cross-shelf currents are found especially in L3 and L4 while northward along-shelf current is dominant in L1 and L2. Unfortunately, simultaneous CTD/O_2 observation did not clearly show the bottom boundary layer through the observation. We need furthermore observations for revealing the bottom boundary current.

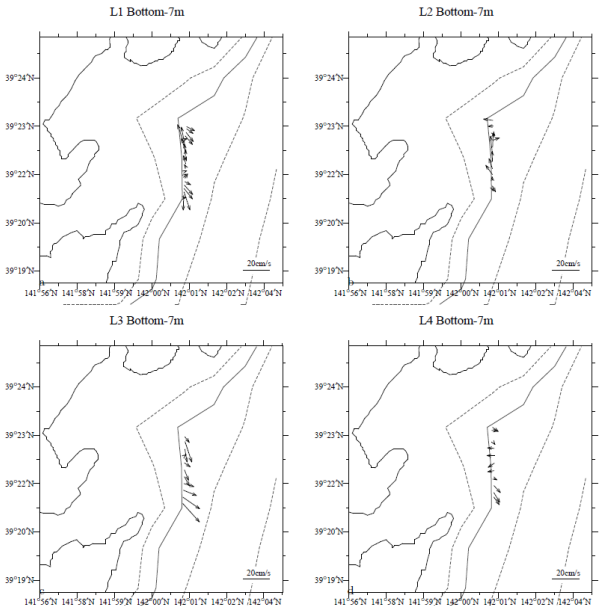


Fig.1. Current velocity distribution at 7-m height above the bottom along the four observation lines, L1 to L4. Isobaths are shown by solid line for 100-m depth and broken lines for 80-m, 120-m, and 140-m depth.

REFERENCES

1. GAWARKIEWICZ, G. and CHAPMAN, D. C. 1991, *J. Phys. Oceanogr*. 21(8), 1225-1239.
2. FURUYA, K., TAKAHASHI, K. and IIZUMI, H. 1993, *J. Oceanography*. 49, 459-475.

ACKNOWLEDGMENTS

The authors would like to thank Captain M. Hirano and his crew of R/V Yayoi. The authors would also thank the Tohoku Ecosystem-Associated Marine Sciences for providing financial support to this project.

The English Channel: Towards a New Japanese Sea

Jean-Claude DAUVIN[1,2,3]

[1]UNICAEN, Laboratoire Morphodynamique Continentale et Côtière, France, jean-claude.dauvin@unicaen.fr
[2]CREC, Station Marine de l'Université de Caen-Basse Normandie, France
[3]CNRS, France

Biological invasion s associated with the human activities are recognised as one of the main cause of the global change in marine ecosystems. The Europeans seas are known to be the recipient for several hundreds of non indigenous species from all over the worldwide ocean. In the European waters, two main origins has been evoked for the introduction of the Non-Native species (NNS), the maritime transport including ballast waters and the biofouling, and the voluntary introduction for the aquaculture. The species introduced in the English Channel a borderer sea with the England in the North and the France in the South is around > 100, which remains weak in comparison of the marine species known in this epicontinental sea (> 3,000). The main locations of introduction are the harbours especially Le Havre harbour which is the most important port at the scale of the Channel. Among the NNS, the number of species coming from the Japanese Sea is about 50; the list of these NNS is commented according to their taxonomic groups, the introduction pathways, their distributions and their dynamics in the Channel. Among them four specific cases the Bivalves *Crassostrea gigas* and *Ruditapes philippinarum* voluntary introduced and the decapods *Hemigrapsus sanguineus* and *H. takanoi* arrived via ballast waters under larvae are described in detail. In fact, these four species have changed the dynamics and the functioning of the littoral and costal ecosystems where they proliferate. But both bivalves are now key species for the French economy, while the rapid expansion of both decapods could be a trouble for the oyster and mussel aquaculture developments as predators of young bivalves. In my talk, ecological and economical issues of these introductions have been analysed.

Japanese vs French Artificial Reefs: High Technology vs Design to Enhance Ecological Services

Sandrine RUITTON[1*], Aurélie BLANFUNÉ[1], Charles-François BOUDOURESQUE[1], Pierre CRESSON[2], Mireille Harmelin-VIVIEN[1], Mélanie OURGAUD[1], Sébastien PERSONNIC[1], Hideaki TANOUE[3], Thierry THIBAUT[1], Marc VERLAQUE[1]

[1]Aix-Marseille University, Mediterranean Institute of Oceanography (MIO), Université de Toulon, CNRS/INSU, IRD, France, [*]sandrine.ruitton@mio.osupytheas.fr
[2]IFREMER, Centre Manche-Mer du Nord, Département Ressources Biologiques et Environnement Unité Halieutique, France
[3]National Fisheries University, Department of Fishery Science and Technology, Japan

Artificial reefs (ARs) worldwide are mostly used for fish production or recreational purposes. In Japan, fishermen have known this concept since the Middle Ages. Historically, fishermen used artisanal structures hand-made with traditional and natural materials to improve coastal fisheries. Nowadays, high technology assemblages optimize the operational effectiveness of artificial reefs. In France, artificial reefs are not used at the same scale as in Japan (200:1) and have been deployed since 1968 with the main objective of enhancing coastal artisanal fishing. More than half of the ARs in France have been constructed over the last 15 years. With the deployment in 2007 / 2008 of more than 400 ARs within a 200 ha zone of the Bay of Marseille (Mediterranean, France), RECIF PRADO represents the largest AR system in the French Mediterranean Sea (27 300m²). Over the last few years, in France, it has been public policy to promote the research and deployment of small ARs for environmental restoration. Generally, the enhancement of species or ecological functions is targeted with the aim of offsetting environmental degradation. For example, the earliest benthic larval stages, fish recruitment and algal assemblages could benefit from AR-based systems. As an illustration, we may consider the example of the increase in the recruitment of juveniles on artificial reefs at Marseille from 2011 to the end of 2015, using artificial and biological systems. Artificial systems consisted of floating ropes arranged on the top of the ARs. Biological systems involved the transplantation on ARs of living specimens of *Cystoseira zosteroides* C. Agardh (Phaeophyceae, Fucales), an ecosystem engineer species currently in decline in the Mediterranean Sea. A four-year *in situ* monitoring survey was carried out on and around these systems through censuses of fish juveniles and the study of the fate of *C. zosteroides* transplants using SCUBA diving. The recruitment of fish juveniles was multiplied by 4 to 10 on both systems, compared to non-equipped ARs. The fish family most concerned was the *Labridae*. *Cystoseira zosteroides* transplants survived, grew and produced fertile receptacles. The efficacy of the artificial system decreased over time because of the fouling that altered the habitat availability for the juveniles. In contrast, the biological system remained effective and even increased in efficacy over time, due to the recruitment on the ARs of offspring born of the transplanted *C. zosteroides*. During 2014, ten different species of juveniles of fishes were observed on the AR equipped with biological systems. Improved efficacy of ARs in terms of fish stock is therefore possible through the addition of special systems designed to increase the fish recruitment. Biological systems would appear to be preferable to artificial ones, especially since they are more in phase with sustainable management as they are long-lasting and do not require maintenance.

Improvement of Gonad Quality of the Sea Urchin *Mesocentrotus nudus* by Short-Term Cage Culture

Satomi TAKAGI[1*], Yuko MURATA[2], Eri INOMATA[1], Ayaka HORIKOSHI[1], Hikaru ENDO[1], Masakazu N. AOKI[1], Yukio AGATSUMA[1]

[1]Graduate School of Agricultural Science, Tohoku University, Japan, [*]satomi.takagi.q2@dc.tohoku.ac.jp
[2]National Research Institute of Fisheries Science, Japan

INTRODUCTION

Mesocentrotus nudus is a common sea urchin in northern Japan and is harvested commercially. This species inhabits barrens in subtidal rocky bottoms in high density, although the gonads from barrens are smaller and less marketable than those from kelp beds[1]. The aims of this study is to improve low gonad quality by the short-term cage culture.

METHODS

Sea urchins were collected from a barren and were cultured in a cage suspended from rope for 3 months from February to June 2014. Sea urchins were fed on the stipes inside of sporophylls and color-faded blades of the kelp *Undaria pinnatifida* for the first 2 months, then, the kelp *Saccharina japonica ad libitum* every 7−10 days until the end of culture. For 30 specimen harvested from the cage and 30 specimen from each of the barren and *Eisenia bicyclis* bed at the start and the end of the culture, their test diameter, body weight and gonad weight were measured. The gonad index (gonad weight×100/weight) was calculated. The gonad color (C.I.E.L*a*b*) and gonad firmness were also examined. Using the values of gonad color, we calculated total color difference (ΔE_{ab}*).

The content of free amino acids in each gonad was analyzed. Sensory evaluation of the gonads was carried out by fishermen.

RESULTS AND DISCUSSION

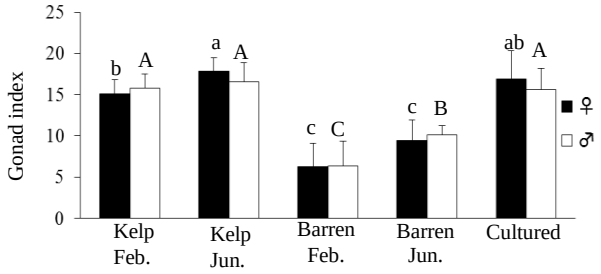


Figure 1. Gonad indices of *M. nudus* from barren, *E. bicyclis* (kelp) bed and cage culture (cultured).

"The gonad index of cultured sea urchins increased from 6.3 to 15.6, significantly higher than that from the barren (Figure 1)."

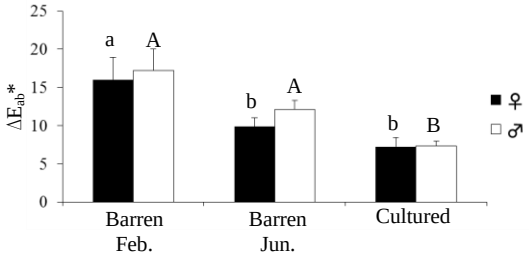


Figure 2. Value of ΔE_{ab}* in the gonad of *M. nudus* from barren and cage culture.

"The value of ΔE_{ab}* in the gonad of cultured urchins was lower than that from the barren, indicating improvement of total gonad color (Figure 2)".

The gonad firmness of the cultured urchins was closer to that from the *E. bicyclis* bed. The sweet-tasting amino acids, alanine and serine in the gonads of cultured urchins increased. In contrast, the bitter-tasting amino acids, arginine and lysine decreased significantly. The gonad of the urchins from cage culture and the *E. bicyclis* bed was evaluated highly by fishermen. We presume that extension of feeding duration would increase gonad size and further improve gonad quality.

REFERENCES

1. Agatsuma, Y, 2013, In: Lawrence, J.M. (Ed.), Sea urchins: Biology and ecology. The third edition. Elsevier, pp.449-460

Artificial Reefs Installation along the Aquitaine Coast

Florence DUFOUR, Aurélie PENNE, Nelly FERROU*, Thomas SCOURZIC, Elodie RUBIO, Aurore LABORDE, Gérard FOURNEAU

Aquitaine Landes Récifs, France, *nelly.ferrou@gmail.com

In order to fight against human pressures, as well as marine environment and resources damages over the coastline, artificial reefs have been sunken along the Aquitaine coast. The aim of the present study (led by Aquitaine Landes Récifs, a nonprofit organization) is to underline not only the steps of the colonization process on artificial reefs but also how they impact on species richness along time.

Scuba diving in situ campaigns were conducted across the 2400 m^3 sunken reefs, spread over 3 private maritime concessions ("Capbreton", "Soustons/Vieux Boucau" and "Messanges/Azur/Moliets et Mâa").

Two experimental fishing surveys were performed in fall 2007 and spring 2008 in order to complement scuba diving surveys.

Invertebrates (which are the first colonizers) represent an important part of artificial reefs diversity. In addition, vertebrates' species richness greatly increased since the first reef immersion. Although species richness is constant over time, new species are regularly appearing across the 3 sites. Furthermore, black sea bream and meagre are mainly encountered at fall, whereas Atlantic bonito and Canary drum were fished during spring surveys. Species richness was different across the 3 concessions and could be explained first by an irregular sampling effort but also by the presence Capbreton canyon, regarding reefs sunken next to it.

Quantitative Mapping of Fish Habitat: From Knowledge to Spatialized Fishery Management

Sandrine VAZ[1], Olivier LEPAPE[2]

[1]IFREMER, France, sandrine.vaz@ifremer.fr
[2]Agrocampus Ouest, France

The delineation of essential fish habitats is necessary to identify, design and prioritize efficient marine protected area (MPA) networks with fishery objectives, capable, in addition to other possible objectives and functions of MPAs, of sustaining the renewal of marine living resources. Generally, the first step to obtain maps of essential fish habitats consists in choosing one of the numerous existing statistical approaches to build robust habitat suitability models linking relevant descriptors of the marine environment to the spatial distribution of fish presence or density. When these descriptors are exhaustively known, i.e. maps are available for each of them, geo-referenced predictions from these models and their related uncertainty may be imported into Geographic Information Systems for the quantitative identification and characterization of key sites for the marine living resources. The usefulness of such quantitative maps for management purposes is endless. These maps allow for the quantitative identification of the different habitats that are required for these marine resources to complete their life cycles and enable to measure their respective importance for population renewal and conservation. The consequences of anthropogenic pressures, not only fishing but also land reclamation, aggregate extractions or degradation of habitat quality (e.g. nutrient excess or xenobiotics loadings, invasive species or global change), on living resources, may also be simulated from such habitat models. These quantitative maps may serve as input in specific spatial planning software or to spatialize population or fishery dynamics, ecosystem or trophic models that may then be used to simulate various scenarios. Fish habitat maps thus may help decision makers to select relevant protection areas and design coherent MPA networks and management levels which objectives are to sustain fishing resources and fisheries.

Marine Ecosystem Services: A View of Residents of Remote Islands, Taketomi Town

Kazumi WAKITA[1], Keiyu KOHAMA[2], Takako Masuda[3], Katsumi YOSHIDA[4], Taro OISHI[5], Zhonghua SHEN[3], Nobuyuki YAGI[3], Hisahi KUROKURA[3], Ken FURUYA[3], Yasuwo FUKUYO[3]

[1]School of Marine Science and Technology, Tokai University, Japan, kazumiw@tokai-u.jp
[2]Planning and Finance Division, Taketomi Town Government, Japan
[3]Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan
[4]LASC, Japan
[5]Faculty of Social and Environmental Studies, Fukuoka Institute of Technology, Japan

INTRODUCTION

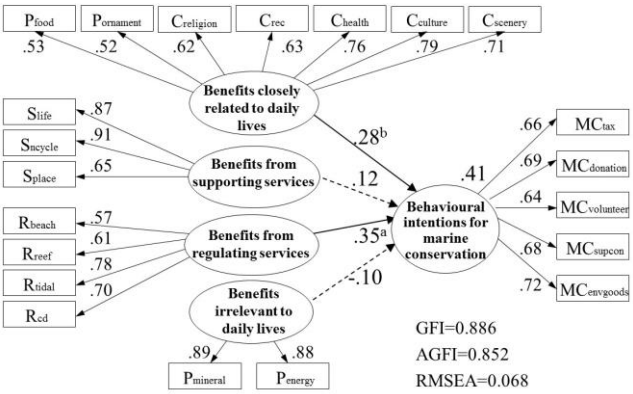
Marine ecosystem services provides various benefits to people. One of the most prevailing classifications of marine ecosystem services is the four categories provided by the Millennium Ecosystem Assessment[1], namely Provisioning Services, Regulating Services, Cultural Services, and Supporting Services. However, how the value of ecosystem is viewed varies depending on cultural norms among others[2]. However, detail analysis of differences of views of marine ecosystem services are limited. Hence, through a case study of Taketomi Town which is composed of multiple islands, this paper aims at analyzing views of marine ecosystem services by islands' residents and their influences on behavioral intentions for marine conservation.

METHODS

A questionnaire survey regarding views of marine ecosystem services and behavioral intentions for marine conservation was conducted from February 15 to March 8, 2013 with a letter from Taketomi Town asking for cooperation for the survey. The questionnaires were distributed by community leaders to all home, i.e. 2,186 family units face-to-face. Collection of responses was via postal mails. Data from the survey were analyzed in two stages. At the first stage, a factor analysis was conducted using SPPSS Statistics Ver. 21 to examine categorization of marine ecosystem services by the respondents. Then, SPSS AMOS Ver. 20 was used to assess goodness-of-fit for a proposed Structural Equation Model which hypothesizes relationships between the views of marine ecosystem services and behavioral intentions for marine conservation.

RESULTS AND DISCUSSION

A total of 393 responses were collected, and after omission of incomplete responses, 344 responses were used for the analysis. By the factor analysis, four underlying factors of perceived indispensability of marine ecosystem services were identified (Promax with Kaiser normalization, principal component analysis as the extracting method). Variables were retained if their rotated loadings were above the threshold value of 0.4. Based on the characteristics of observed variables of respective latent constructs, the authors named the four values as (i) Benefits closely related to daily lives, (ii) Benefits from supporting services, (iii) Benefits from regulating services, (iv) Benefits irrelevant to daily lives. This four categorization is different from the three categorization of marine ecosystem services perceived by residents of Tokyo, Osaka, Shizuoka, Nagano and Ishikawa, namely Indirect Benefits, Essential Benefits, and Cultural Benefits[3]. The strongest positive path coefficient (0.35) was calculated between "Benefits from regulating services" and behavioural intentions (Fig. 1), which suggests that the islands' residents would place high importance on the function of the seas to protect their lives from natural disasters.



(a) indicates significance at the 0.001 level. (b) indicates significance at the 0.01 level. Dashed line indicates path that is not significant at 0.05 or better.

Fig. 1 Standardized estimate hypothetical model

CONCLUSION

It was identified that islands' residents in Taketomi Town view marine ecosystem services in four categorized benefits, among which the most influential one for enhancing behavioral intentions for marine conservation is the "Benefits from regulating services". This suggests people's lifestyle and their connectivity with the sea would influence their value on marine ecosystem services.

REFERENCES

1. Millennium Ecosystem Assessment. 2003, *Ecosystems and human well-being: a framework for assessment.* Washington DC: Island Press.
2. Goulder and Kennedy. 1997, Valuing ecosystem services: philosophical bases and empirical methods. In: Daily GC, editor. *Nature's services: social dependence on natural ecosystems.* Washington, DC: Island Press. 23–47.
3. Wakita *et al.* 2014, *Marine Policy*. 46, 53-60.

ACKNOWLEDGMENTS

The authors thank the Taketomi Town Government and the community leaders of Taketomi Town for their kind support to conducting the questionnaire survey. Appreciation goes to Nippon Foundation for providing financial support to this research through the Ocean Alliance Initiative Project, The University of Tokyo.

Amphidromous Fishes Management in Continental Waters. The Need for an Integrated Approach

Catherine BOISNEAU[1], Philippe BOISNEAU[2]

[1]UMR CITERES, France, catherine.boisneau@univ-tours.fr
[2]Association Agréée Interdépartementale des Pêcheurs Professionnels en eau douce du Bassin de la Loire et des cours d'eau Bretons (AAIPPBLB), Comité National de la Pêche Professionnelle en Eau Douce, France

European eels (*Anguilla anguilla* L.) and Allis shads (*Alosa alosa* L.) are amphidromous species presently frequenting rivers of western Europe. Since 1850, shads abundance decreased due to impoundments, water quality problems and habitats degradations. One hundred year later, started the decline of eel, based on the same threats plus overfishing.

These two species are both subject of management plans because of decreasing populations. Eel is a critically endangered species (IUCN) and listed in annex II of the CITES, while shads are vulnerable (IUCN). Given the multiple causes of the decline of these species, only an integrated approach can act effectively for their restoration. Professional fishermen perceive globally phenomena that act on their variations of abundance, while the researchers analyze the variables in a Cartesian way. So, an extensive collaboration between researchers and fishermen can allow significant progress in understanding population dynamics. For the Allis shad in the Loire basin, such collaborations began in 1984 and continue in 2015, while for silver eels they began in 1995.

Fisheries and biometric data with scales samples of Allis shads allow researchers to elaborate indices of abundance of cohorts. The abundance of cohorts had tripled following the restoration of the ecological continuity since 1998.

For silver eels in the Loire, the fishing effort and catch data of professional fishermen, coupled with biometric measurements and quality brood stock, helped develop an annual abundance index from 1987 to 2014, the longest series available for the species in Europe for a large river, one thousand kilometers long. This collaboration also allowed fruitful contributions in several major research programs on European eel.

For example, fishermen dataset and their participation helped to build a model of prediction of starting conditions of downstream migration of silver eels from the Loire to the ocean. An application of this work is to stop hydroelectric turbines only when environmental conditions are favorable for eels, to allow their survival. This first model in the world can predict 80 % of downstream movements of silver eels with 95 % of certainty.

Fishermen and researchers together contributed to the European EELIAD program (Assessment of the Decline of European Eels in the Atlantic). Big females were selected by fishermen and then equipped of satellite transmitters and released in the gulf of Biscay. This collaborative work contributed to collect the first data on ocean migration behavior of silver eel.

Larval and Juvenile Dynamics of the Manila Clam *Ruditapes philippinarum* in Matsushima Bay and Mangoku-Ura Inlet, Northeastern Japan, Following 2011 Tsunami Disaster

Hirokazu ABE[1*], Masami HAMAGUCHI[2], Naoto KAJIHARA[2], Yuichi TANIAI[3], Akio OSHINO[3], Takashi KAMIYAMA[1]

[1]Tohoku National Fisheries Research Institute, Fisheries Research Agency, Japan, [*]hirokazuabe@affrc.go.jp
[2]National Research Institute of Fisheries and Environment of Inland Sea, Fisheries Research Agency, Japan
[3]Miyagi Prefecture Fisheries Technology Institute, Japan

INTRODUCTION

The Manila clam *Ruditapes philippinarum*, which is natively distributed along western Pacific coastlines, is one of the most commercially important bivalves in the world. The 2011 off the Pacific coast of Tohoku Earthquake that measured 9.0 on the Moment Magnitude Scale occurred off the Pacific coast of northeastern Japan on March 11, 2011. Huge tsunami waves generated by the earthquake struck a 2000-km stretch of the Pacific coastline of eastern Japan, which is thought to have seriously affected *Ruditapes philippinarum* populations in northeastern Japan. The clam has a 2- to 3-week planktonic larval stage, and it is important to understand early life ecology during this period to evaluate the reproductive potential of the clam stocks after the massive earthquake and tsunami. The earthquake also generated coseismic land subsidence up to about 1.2 m and tidal flats previously existed in Mangoku-ura Inlet were completely obliterated, even at the lowest tidal level. This habitat alteration induced by land subsidence is considered to have continuing impact on intertidal species. As a measure against such a severe land subsidence, artificial tidal flats are being constructed in Mangoku-ura Inlet. This study investigated larval and juvenile dynamics of the clam in Matsushima Bay and Mangoku-ura Inlet following 2011 tsunami disaster, including recruitment of the clam in artificial tidal flats.

METHODS

To investigate the temporal variation of the clam larval density, sampling was carried out at three stations in Matsushima Bay from 2012 to 2014, and Mangoku-ura Inlet in 2013 and 2014. Horizontal density distributions of the clam larvae were also investigated at 21 stations in Matsushima Bay on July and August, 2013. The clam larvae were collected by one vertical haul from a 2.5-m depth to the surface using Kitahara's Quantitative Plankton Net with a 22.5-cm mouth diameter and a mesh size of 75 μm. The clam larvae were identified by an indirect immunofluorescence method using an *R. philippinarum* larvae-specific mouse monoclonal antibody. The clam larvae were separated into three developmental stages (D-shaped, umbo, and fully grown) based on morphology and counted under an inverted fluorescent microscope (Olympus IX70) with 490 nm excitation light and weak transmitted light. Juvenile clams were investigated in artificial tidal flats in Mangoku-ura Inlet and natural tidal flat at Hatsutsuura in Matsushima Bay. Samples were collected using 20 cm quadrat or 3.7 cm core sampler and the samples were sieved through a 1 mm mesh. The shell length (SL) of all collected clams was measured with a digital venire caliper.

RESULTS AND DISCUSSION

Clam larvae were observed in the plankton from June to October. Their density fluctuated from 0 to 29,400 ind m^{-3} in Matsushima Bay, and from 20 to 49,800 ind m^{-3} in Mangoku-ura Inlet. The peaks of larval densities were usually observed from mid-July to early-August and second peak occasionally occurred in September. It is considered that spawning period of the clam is once a year in the summer in the northern waters of Japan, and with two peaks in spring and fall in the southern waters of Japan, due to difference of water temperature. The results of this study showed that the clams in the study area have one spawning period from late-spring to autumn with a peak in the summer.

The clam larvae continuously appeared through reproduction period and the density observed in this study was comparable to that of other major clam habitats in Japan. Therefore, reproductive potential of the clam populations in Matsushima Bay and Mangoku-ura Inlet was concluded to be high even after the large scale natural disaster. To lead abundant larval supply to efficiently increase clam production is important for post-earthquake clam fishery reconstruction and a sustainable production system.

In the horizontal larval investigation, the clam larvae were widely distributed in Matsushima Bay and tended to be distributed in higher density at the mouth and eastern parts of the bay. The clam fishing grounds were reported to spread through a wide area around islands located at the mouth part of the bay, and it was assumed to be the major source of larval supply.

In the artificial tidal flats in Mangoku-ura Inlet which were accomplished to construct in May 2014, the clam was not recruited in July 2014 and started to recruit in September 2014. The clam density increased to 600–4,300 ind m^{-2} and their shell length reached 6–8 mm in July 2015. Larval supply and the recruitment of the clam seemed to be basically favourable in Matsushima Bay and Mangoku-ura Inlet, northeastern Japan.

ACKNOWLEDGMENTS

This study was supported by a grant from the Fisheries Agency of Japan.

Certification Schemes for Sustainable Aquaculture and Feeding

Catherine MARIOJOULS

AgroParisTech, France, catherine.mariojouls@agroparistech.fr

Certification programs for aquaculture are being widely developed in the world under various forms, and for diversified purposes. In the framework of IUCN project about sustainable feed in aquaculture, we considered the main existing certification schemes for sustainable aquaculture and analysed the present criteria taken into account for aquafeeds, their raw materials, and their use.

As certification of sustainable aquaculture is a highly dynamic sector, we tried to identify the main trends in the organization of the certification schemes and in the way the certification of sustainability for feed and raw materials is defined. While there are many actors who created certification schemes where sustainability is taken into account, we focus here on schemes with international scope.

Today, there are four certification schemes with international scope, aiming at supporting responsible, or sustainable, aquaculture: Aquaculture Stewardship Council –ASC-, Global Aquaculture Alliance –GAA- through its Best Aquaculture Practices, Friend of the Sea –FoS-, Global-GAP. They are nowadays gaining importance in the number of certified farms and related companies in the value chain, and in the number of certified products in the markets, thus deserving a special attention. In addition, as a response to the difficulties created by the diversity of standards for the aquaculture companies, three of them (ASC, GAA-BAP, and GlobalGAP) have recently drafted and agreed combined checklists for farms that seek more than one certificate, in order to minimise duplication of audit points when common between schemes. Some documents published for that common work were used for the present analysis, in addition to the analysis of standards available on websites of these four bodies (1).

Feed is one of the important topics included in the standards. The four certification programs are aiming a supply of sustainable and traceable raw materials, as well as a reduction in the use of fish meal and fish oil from specialized capture fisheries.

While the standards differ by several aspects and the level of requirements, they all include the following items:

(i) Some conditions for the guarantee of traceability of ingredients (often through a certification scheme on compound feed manufacturing);

(ii) Some conditions for a responsible sourcing of marine ingredients (through different means: exclusion of endangered species – IUCN red list, IUU fisheries -; certification scheme for fish meal and fish oil -IFFO RS or ISEAL member-);

(iii) The necessity for certified farms to calculate technical indicators measuring the efficiency of feed use by fish, with imposed limits.

Until today, the question of feed in the certification schemes for sustainable aquaculture has been mainly focusing marine ingredients use, but plant ingredients begin to be taken into account. For a responsible sourcing of them, ASC rely on supplementary certification schemes, RTRS for soybean, and RTSPO for palm oil.

The picture drawn by the analysis of standards for feed in certification of sustainable –and responsible- aquaculture is complex: we observe an expected diversity of viewpoints and also a large use of supplementary certification schemes. Moreover, it is likely to evolve in a near future, through some on-going works (between concerned organizations, and inside a Feed Project of ASC).

The growing substitution rate in fish feeds of fish meal and fish oil by other raw materials is widening the issue of fish feed sustainability. Therefore, certification of sustainable aquafeed will increasingly rely on other certification schemes, elaborated by the agriculture and feed mill sectors. For the aquaculture sector itself, the present situation and the evolution of certification for sustainable aquaculture raise also numerous questions, as pointed by Bush *et al.* (2013) at a global level.

We propose to discuss some of them, related to the weight of these certification schemes in the markets and the organization of value-chains, and related to the definition and the governance of sustainability for aquaculture.

ACKNOWLEDGMENTS

To the IUCN, François Simard and Raphaella Le Gouvello, for inviting me in the discussions held in the framework of their programme about sustainable aquafeed.

REFERENCES

1. Anon., 2013 - Joint statement on requirements for the responsible sourcing of fishmeal and fish oil issued by ASC, GAA and GLOBALG.A.P.- http://www.asc-aqua.org/index.cfm?act=update.detail&uid=176&lng=1, 14/11/ 2013, 2pp.
2. Bush S.R. et al, 2013- Certify sustainable aquaculture ? Science (341) 1067-1068

Ecological Impacts of the 2011 Earthquake and Tsunami on the Subtidal Macrobenthic Community in Onagawa Bay, Northeastern Japan

Hirokazu ABE[1], Genki KOBAYASHI[2], Waka SATO-OKOSHI[3]

[1]Tohoku National Fisheries Research Institute, Fisheries Research Agency, Japan
[2]Graduate School of Frontier Sciences, The University of Tokyo, Japan
[3]Graduate School of Agricultural Science, Tohoku University, Japan, wsokoshi@bios.tohoku.ac.jp

INTRODUCTION

Physical disturbances, such as earthquakes and tsunamis, can have drastic effects on marine organisms and the marine ecosystem. These large-scale physical disturbances lead to biotic and abiotic changes within marine ecosystems. A megathrust earthquake that measured 9.0 on the Moment Magnitude Scale occurred off the Pacific coast of northeastern Japan on March 11, 2011. Onagawa Bay, located on the Pacific coast of northeastern Japan, was severely affected by the Great East Japan Earthquake and tsunami. The tsunami reached inundation heights of 20 m and destroyed the central area of Onagawa Town. It is also thought to have severely damaged the benthic community in Onagawa Bay. The aim of the present study was to discover the ecological impacts of the Great East Japan Earthquake and tsunami on the subtidal benthic polychaetes, the representative macrobenthic group of Onagawa Bay, and to examine the response of the community to a large-scale disturbance.

METHODS

Samples were taken at a station (38°26.14'N, 141°27.83'E; ca. 22 m depth) located in the innermost part of Onagawa Bay, from July 2007 to December 2013. Samples were collected once a month using grab samplers. The samples were sieved through a 1 mm mesh and all organisms were fixed with 10% neutralized formalin. Each organism was identified and counted under a stereomicroscope. The wet weight biomass of the macrobenthos was measured using an electric balance. To examine the impact of the earthquake and tsunami on the benthic polychaete community, and the subsequent recolonization, cluster analysis with the group average linkage method and two-dimensional non-metric multidimensional scaling (nMDS) was conducted based on the Bray-Curtis dissimilarity matrix calculated from the density of each polychaete family. One-way ANOSIM (analysis of similarity) with 9,999 permutations was used to test for differences in community structure among clusters, and post hoc pair-wise comparisons between clusters were performed using one-way ANOSIM. Water temperature, salinity, and dissolved oxygen concentration for the bottom layer in the water column were determined using a CTD RINKO-Profiler and HQd digital water quality meters.

RESULTS AND DISCUSSION

In total 32 polychaete families were identified. The density of the benthic polychaete community was 340–2,180 ind m^{-2} and constant in the composition before the tsunami. However, the density of polychaetes drastically decreased to 100 ind m^{-2} after the tsunami. Between November 2011 and April 2013, the density of benthic polychaetes fluctuated. Starting in May 2013, the density of polychaetes almost returned to pre-tsunami levels. The results of the cluster analysis showed a clear segmentation of the community structure before and after the tsunami. Each cluster was arranged separately in the nMDS ordination. The community structures just after the tsunami were distant and segregated from the community structures before the tsunami in the nMDS plot. In the initial recolonization, the community structure fluctuated and was dispersive in the plot. From June 2013, the community structure arranged closely each other and located near the plots of before the tsunami. However, there were no overlaps between these two groups.

Spionid and capitellid polychaetes were the most dominant macrobenthos in the fluctuated period. These groups are well known as opportunistic benthic taxa. Planktonic larvae of spionid and capitellid polychaetes were common in Onagawa Bay, and these may be able to take advantage of large-scale disturbances, by rapidly recolonizing uninhabited areas after the tsunami. On the other hand, Cirratulidae and Maldanidae, which dominated before the tsunami, have no or short planktonic larval phase seem to be more affected by large-scale disturbance. Changes in the chemical composition of the bottom sediment have been observed in Onagawa Bay after the tsunami. The overlapping effects of the natural (earthquake and tsunami) and anthropogenic (chemical pollution) disturbances are considered to have an impact on the macrobenthic community equivalent to that of a large-scale hypoxia event. The macrobenthic community in Onagawa Bay is still in the process of succession though 3 years have passed after the tsunami disturbance.

CONCLUSION

Before the earthquake and tsunami, the benthic community was stable in the species composition and dominated by cirratulid and magelonid polychaetes. The density, biomass, and diversity of polychaetes decreased after the earthquake and tsunami, and the macrobenthic community structure fluctuated for 2 years after the disturbance. In this fluctuation period, spionid and capitellid polychaetes occurred abundantly. The initial colonization was driven by larval recruitment. In June 2013, the community entered a new state, and is dominated by maldanid polychaetes. The overlapping effects of the natural and anthropogenic disturbances are considered to have an impact on the macrobenthic community equivalent to that of a large-scale hypoxia event. The macrobenthic community in Onagawa Bay is still in the process of succession though 3 years have passed after the tsunami disturbance.

One Year Colonisation by Zoobenthic Species on an Eco-friendly Artificial Reef in the English Channel Intertidal Zone

Jean-Claude DAUVIN[1*,2,3], Aurélie FOVEAU[1,2,3]

[1]UNICAEN, Laboratoire Morphodynamique Continentale et Côtière, France,
[*]jean-claude.dauvin@unicaen.fr
[2]CREC, Station Marine de l'Université de Caen-Basse Normandie, France
[3]CNRS, France

The RECIF project, an European cross-border cooperation programme INTERREG IV A between United Kingdom and France, aims to enhance the use of shellfish by-products, i.e. the queen scallop Aequipecten opercularis (L., 1758), in the elaboration of an eco-friendly material for artificial reef. In parallel of this technological development, environmental and biological monitoring have been set up. Zoobenthic species colonising three different compositions of artificial structures, eco-friendly concrete blocks (two kinds of porosity) and common concrete blocks are investigated during one year in the intertidal zone of the Luc-sur-mer Marine Station in the south of the Bay of Seine (eastern part of the English Channel). The aims of the study are to describe the short-term colonisation by zoobenthic species, to analyse the suitability for colonisation of this eco-friendly material, to highlight possible differences between the three compositions and to observe the succession of colonizing species around a complete year. A total of 75 blocks (30 blocks with eco-friendly material for each porosity and 15 blocks of common concrete) has been settled on oyster tables in March 2014. The two kinds of eco-friendly material blocks are collected each fortnight, while the concrete blocks are collected each month. Abundance and species richness of the whole community (sessile and vagile species) are recorded. Time, succession and location of settlements are also recorded parameters. Analyses between different kinds of blocks show significant temporal differences for abundances but none for species richness. Analyses reveal also differences in the settlement of species depending of the position on the blocks, i.e. the face exposed to the main tidal currents and to light, within the other faces. These differences could be explained by the environmental parameters surrounding blocks and by the larval behaviours. There are numerous results obtained by this survey strategy (one sampling per spring tide) which represents a high financial cost and which is not feasible to subtidal zone in a zone with high tidal current and high turbidity. Nevertheless, the lessons of this unique experimental study in the intertidal zone focused on all species found on the blocks show that it is important to take into account all the fauna to estimate the benthic production and the functioning role of such artificial reefs. This kind of survey is also a good start point for an observatory of Non-Native Species; nowadays, three NNS has been recorded.

Com 24

Retinomotor and Stress Responses of Marbled Sole *Pleuronectes yokohamae* under the LEDs

Rena SHIBATA[1], Yasuyuki UTO[2], Kenichi ISHIBASHI[3] and Takashi YADA[4]

[1]National Research Institute of Fisheries Engineering, Fisheries Research Agency, Japan, renas@fra.affrc.go.jp
[2]Tokyo Bay Fisheries Laboratory, Chiba Prefectural Fisheries Research Center, Japan
[3]Seed Production Research Laboratory, Chiba Prefectural Fisheries Research Center, Japan
[4]National Research Institute of Aquaculture, Fisheries Research Agency, Japan

INTRODUCTION

One of the major environmental factors that may influence fish survival and growth performance is colour in the culture system such as the tank wall and/or illumination, as reported in nile tilapia *Oreochromis niloticuss* showing lower mortality under blue light in captivity (Sabri *at al.*, 2012) and in barfin flounder *Verasper moseri* exhibiting better growth performance under both blue and green lights (Takahashi *et al.*, 2013). These findings suggest significance of colour selection in the culture system for fish culture. This also means the species-specific colour suitable for artificial production is worthy to study for better fish production. The marbled sole *Pleuronectes yokohamae* is one of the most important commercial species intensively cultured and captured in Japan. However, survivals and growth performance particularly during their juvenile stage for culture and release programs are not yet satisfied, and thus the rearing condition deserves to be improved. To grasp basis for better culture condition in terms of the colour, we examined retinomotor and stress responses of the marbled sole under different colours using LED lamps.

METHODS

Fifty five juvenile marbled sole with 55 mm average total length and 159 dph (days post hatching), artificially fertilized and reared at the Seed Production Res. Lab., Futtsu Sea Farming Section, Chiba Prefectural Fisheries Research Center, were used as the experimental animals for the analyses of both retinomotor response through histological observation of retina cells and stress response through determination of plasma cortisol concentration. They were separately exposed under different light conditions: 470 nm (blue; B), 525 nm (green; G) and 660 nm (red; R) with the illumination intensity of 10µmolm^{-2}s^{-1} as the test group, as well as complete darkness (D) and sunlight as the control (C) for the retina cell observation (RCO), while four conditions excluding D for the cortisol analysis (CA). After 3 hrs exposure under the respective conditions, they were anesthetized with benzocaine just before sampling (N=3 and 10 per condition for RCO and CA, respectively). Whole body samples for RCO were fixed in Bouin's fluid, processed for embedding in paraffin, 3 µm thick transverse sectioning and the H&E stain of retina. The section were photographed under a light microscope, and the thickness of the visual cell layer (*v*), pigment layer (*p*), and length of the cone myoid (*m*) were measured according to the method after Ali (1959). Ratios shown as *p*/*v* and *m*/v was used as the indices of retinomotor response of the retina. For CA, peripheral blood was withdrawn from caudal veins to determine the plasma cortisol concentration by ELISA.

RESULTS AND DISCUSSION

The retinal indices *p/v* and *m/v* in G were significantly higher and lower than in B and R respectively, whereas not significant different from C for both indices (Fig.1).

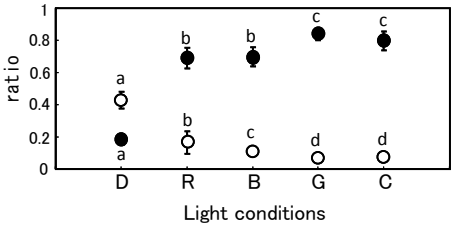


Fig. 1. Retinal indices *p/v* (●) and *m/v* (○) of the marbled fish exposed under different light conditions. The mean and S.D. were shown. Different letters indicate significant difference (One-way ANOVA with Dunnett multiple comparison test, $p<0.05$).

No difference between G and C means that the retina under G were completely light-adapted. Full acuity of vision is dependent upon the complete light adaptation of cone cells (Ali,1959), which is indispensable for fish depending a lot on vision, *e.g.* to find feed organisms and to recognize other conspecific individuals, and thus importance of green light for the marbled sole culture production were suggested through the RCO study.

Cortisol concentrations were 4.0±8.8, 2.5±2.6, 2.6±4.3, and 16.1±18.2 ngml^{-1} in C, B, G and R, respectively, suggesting significantly higher stress level under R and lower under B and G.

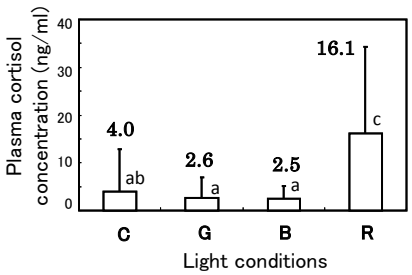


Fig.2. Plasma cortisol concentrations under different light conditions. Vertical bars show the S.D. (One-way ANOVA with Dunnett multiple comparison test, $p<0.05$).

CONCLUSION

The present study demonstrated green was most suitable for the retinal light adaptation, being equivalent to sunlight. Further, green and blue were expected to reduce stress of fish.

Development of a Microfluidic Sorting System in Oceanography

Mathias GIRAULT[1*], Akihiro HATTORI[1], Hyonchol KIM[1,2], Kenji MATSUURA[1],
Masao ODAKA[1,2], Hideyuki TERAZONO[1,2], and Kenji YASUDA[2].

[1]Kanagawa academy of science and technology, Japan, [*]girault.bmi@gmail.com
[2]Institute of biomaterials and bioengineering, Tokyo medical and dental university, Japan

INTRODUCTION

Microscopy and flow cytometry associated with stains are commonly used to investigate phytoplankton abundance. By using these methods some morphological and physiological information of organisms can be observed at the time of the analyses. Because of each plankton has its own story in the seawater column, results of these analyses show that phytoplankton can have different physiological response for a same environmental condition. To better understand this variability, development of a new method able to discriminate organisms and isolate them in some microenvironments appears to be capital. In this context, microfluidic technology seems to be an interesting approach[1)]. By using microfluidic technology, we developed a flexible method able to sort single microenvironment depending on the number and/or the morphology of particles encapsulated. This method is based on the detection of the template images performed at each frame of the camera. The latter application integrated the following steps in the same microfluidic devices: (*i*) encapsulate mixture of object in droplet; (*ii*) search the templates in each frame of the video; (*iii*) sorting the wanted object(s) using direct current pulses; (*iv*) stock the sorting microenvironment.

METHODS

The microfluidic sorting system is based on an original chip template prepared from poly(dimethylsiloxane) (PDMS) by soft lithography. The identification of the target was performed in real time using each image captured with a high speed camera mounted on a microscope. If the target is found in the image, a pulse is sent to the high voltage amplifier. After amplification, a direct current pulse is sent to the chip and the microenvironment containing the target is sorted.

RESULTS AND DISCUSSION

We presented an efficient multiple microenvironment sorting system based on real time image processing (Fig. 1). By using a library of pictures previously captured and learned, two different objects with a diameter ranged from 1µm to 25µm can be successfully detected and sorted independently on the focus point. The dual sorting experiments suggested that the processing system can discriminate and sort a mixture of small beads (4.8µm and 7.2µm) with a high efficiency 94.9±2% and 97.8±2%, respectively (Fig. 2).

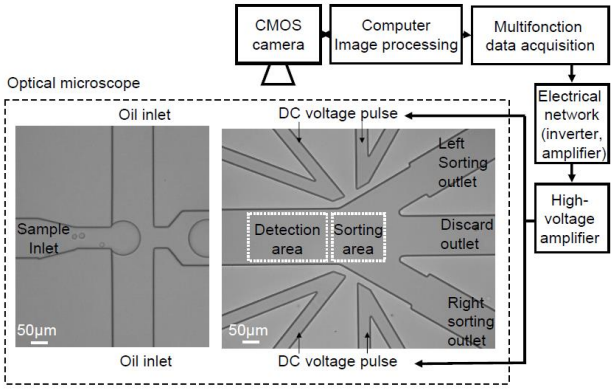


Fig. 1: Experimental set up of the microfluidics sorting devices

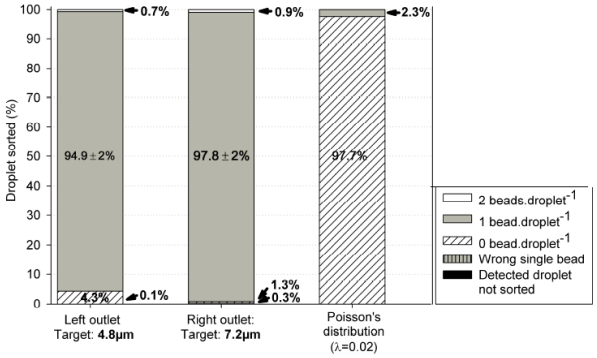


Fig. 2: Sorting efficiency (%) of the target single bead per droplet in a mixture of two different beads (4.8µm and 7.2µm, n=4, 300 droplets counted). The Poisson's distributions were calculated using a droplet volume of 65pL.

CONCLUSION

We successfully developed a new microfluidic device able to create microenvironment containing single object. Main originality of this method is the possibility to recognize and sort object depending on its shape either than fluorescence. Development of this approach can provide a powerful tool in numerous applications such as detection of toxic phytoplanktons depending on their shapes. Our method can be an alternative approach to the classical flow cytometry and help the scientist community to investigate natural sample without any stain.

REFERENCES

1. Mazutis et al., 2013, *Nature Protocols,* **8**, 870–891.

ACKNOWLEDGMENTS

This work was supported by Kanagawa Prefector's local basic science funding for the On-chip Cellomics Project at the KAST, and CREST, JST for TMDU. We gratefully thank Ms. M. Hasegawa, M. S. Kawada, and Ms. H. Mikami for their helps during the experiments.

Clearance Rates of *Crassostrea* spp. on Oyster Reef in Temperate Semi-enclosed Ariake Bay, Western Japan

Miwa YATSUYA[1], Shoji NAKANO[2], Kengo SUZUKI[3], Katsunori KIMOTO[2]

[1]Tohoku National Fisheries Research Institute, Fisheries Research Agency, Japan, ysmiwa@affrc.go.jp
[2]Seikai National Fisheries Research Institute, Fisheries Research Agency, Japan
[3]Hokkaido National Fisheries Research Institute, Fisheries Research Agency, Japan

INTRODUCTION

Oyster reefs provide important ecosystem services such as removal of suspended matter and enhancement of biological production[1]. In Ariake Bay, Japan, the area of oyster reef has decreased by 70% in the past 40 years. Hypoxia in summer is a serious problem in the bay. We established temperature- and salinity-based models of the organic matter clearance rate of 3 oyster species, *Crassostrea ariakensis* (endemic in the bay), and *C. sikamea* (semi-endemic), and *C. gigas* to estimate the potential for organic matter removal by oyster reefs.

METHODS

Oysters were collected from an oyster reef in Ariake Bay (33° 5.58' N, 130° 9.17' E). Clearance rate was measured at 4 temperatures (10, 20, 25, 30 °C at a salinity of 30 PSU) and at 2 salinities (20 and 30 PSU at 25 °C) in the laboratory. Oysters were placed individually in aquaria with 15–30 L of filtered seawater, then the phytoplankton *Chaetoceros gracilis* was added to an initial density of 2×10^4 cells mL^{-1}. Phytoplankton cell density was measured every 1 hour, and the clearance rate was calculated for each measurement:

$$CR = V\,[\ln (C_t/C_{t+\Delta t})]/\Delta t$$

where CR = clearance rate (L h^{-1}), V = volume of water in the aquarium (L), C_t, $C_{t+\Delta t}$ = cell density at the beginning and the end of the period, and Δt = duration of the time interval (t, $t+\Delta t$) (h). CR was measured hourly for 3−6 hours (i.e., CR_1, CR_2, CR_3 … was obtained), and the maximum CR value for the individual was used for later analyses. Individual maximum clearance rates and dry tissue weights were log-transformed and analysed by linear regression. Effects of temperature and salinity on clearance rates were tested by ANCOVA. Temperature- and salinity- based clearance models for each species were formulated as:

$$CR = [a - b\,(T - c)^2 + dS] \times DW^e$$

where DW = dry tissue weight (g), T = temperature (°C), S = salinity (PSU), and a−e are constants. Variables (T and S) of the model were chosen on the basis of on Akaike's information criterion (AIC).

RESULTS AND DISCUSSION

We derived allometric relationships between clearance rate and body size for each combination of temperature and salinity (Fig. 1). The effect of temperature on CR was significant for all 3 species ($P < 0.05$). The effect of salinity was significant only for *C. ariakensis* ($P < 0.05$). The following models of CR were estimated:

C. ariakensis:

$$CR = [6.78 - 0.0935(T - 22.5)^2 + 0.429\,S] \times DW^{0.55}$$

C. sikamea:

$$CR = (8.27 + 0.606\,T) \times DW^{0.86}$$

C. gigas:

$$CR = (8.80 + 0.316\,T) \times DW^{0.47}$$

CONCLUSION

The models of clearance rate for the 3 oyster species in Ariake Bay will support evaluation of the ecosystem function of oyster reefs in Ariake Bay.

REFERENCE

1. PETERSON C. H, GRABOWSKI J.H., and POWERS S.P. 2003, *Mar. Ecol. Progr. Ser.* 264: 249–264.

ACKNOWLEDGMENTS

This study was supported as a research project by the Ministry of the Environment, Japan ("Investigations for ecosystem restoration of Ariake Bay"). We thank Drs K. Nadaoka, T. Yamamoto, K. Kohata, and T. Seki for helpful advice. Ms Y. Masuda identified oyster species by the PCR method. Mr Y. Ikeda helped collect the oysters.

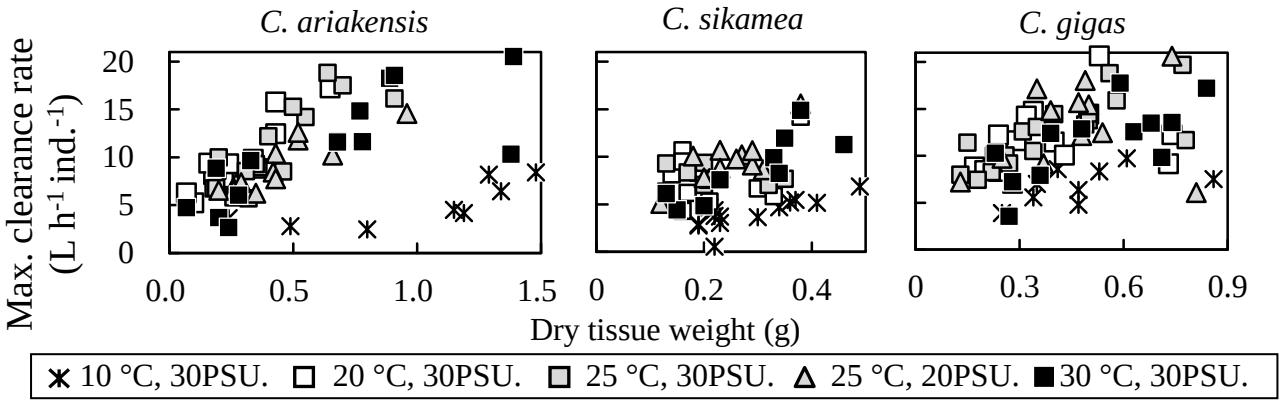


Fig. 1 Maximum clearance rates of *Crassostrea* spp. observed in different water temperature and salinity conditions.

A High-Resolusion Unstructured Grid Finite Volume Model for Currents around Narrow Straits of Matsushima Bay

Hidekazu SHIRAI[1*], Ritsuki KUNISATO[1], Shinya MAGOME[1], Teruhisa HATTORI[1], Takamasa TAKAGI[1], Katsuaki OKABE[1] Kazufumi TAKAYANAGI[1]and Shigeho KAKEHI[2]

[1]Sanyo Techno Marine, Inc., Japan, [*]shirai@stm.co.jp
[2]Tohoku National Fisheries Research Institute, Japan

INTRODUCTION

Matsushima Bay has good growing environment for oysters and is famous for cultivating oysters. However, it is reported that the seedling collection decline in 2013. It is necessary to clarify this cause in order to take a countermeasure to maintain the growing environment for them. One of the important things is to comprehend the characteristics of tidal current around Matsushima Bay which has some narrow straits. In this research, the numerical simulation of tidal currents around the Matsushima Bay is conducted for as the first step of the study to clarify their influence on environment in the bay. The results are compared with some observed data to verify the validity of the model.

NUMERICAL MODEL

Matsushima Bay has many islands of various size, which surround the inside bay. Narrow straits along them link inside and outside of the bay. It is necessary to consider these narrow straits in detail to maintain accurate reproduction of tidal current. FVCOM (ver. 3.2.2)[1)] is applied to this study field. It is based on finite volume method with unstructured grid system, which makes it possible to express narrow straits. The smallest grid size is about 10 m around these straits as shown in Figure 1. Vertical axis is specified as hybrid coordinate system with 8 layers. The tidal level, velocity, water temperature and salinity are calculated with onsideration of the influence of heat flux and wind by this model.

COMPUTATIONAL CONDITIONS

The tidal current around Matsushima Bay is simulated in the period between June 30 2014 and July 14 2014 to verify the reproduction of them by the model. The tidal levels at Sendai and Ayukawa port are calculated from nine tidal components (M_2, K_1, O_1, S_2, Sa, P_1, K_2, N_2, Q_1). Water temperature and salinity at open boundary are estimated by the relations between depth and them, which are derived from the data provided by Miyagi Prefecture Government[2)]. GPV[3)] data are used to calculate the heat flux and wind shear stress.

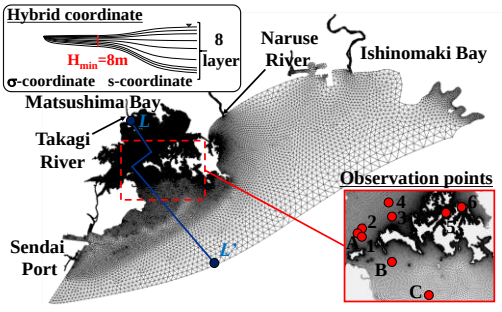


Figure 1 Computational domain

Fresh water discharge flow Takagi and Naruse River. These discharge are estimated by river basin area and rainfall.

RESULTS AND DISCUSSION

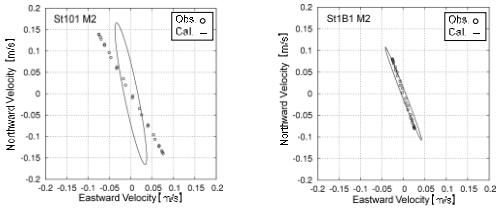
Figure 2 and Figure 3 show the tidal current ellipses and temporal changes of tidal level at St.1 which passes through the main strait. It is found that numerical results are good agreement with observed one. It indicates that the model reproduces tidal currents along the narrow straits to some degree. Spatial distributions of density during the flood (June 29 12:00～June 30 14:00) on the line *L-L'* is shown in Figure 4. It is seen that the low density water from Takagi River spread on the surface layer. On the other hand, in the normal discharge, water exchange by tidal currents becomes larger and residual current is relatively small.

CONCLUSION

In this study, the numerical simulation of tidal currents around narrow straits of Matsushima Bay was conducted and compared with observed data. It was confirmed that the model could reproduce the tidal current around the narrow straits. Numerical results showed the different characteristics from during flood and normal discharge. Further discussions about this mechanism are needed for the future.

REFERENCES

1. FVCOM @ MEDM, http://fvcom.smast.umassd.edu /, (2015.4.17)
2. Miyagi Prefecture Government, www.pref.miyagi. jp /soshiki/mtsc/kankyoutyousa.html, (2015.4.15)
3. Index of/arch/jmadata/data/gpv/original, http://data base.rish.kyoto-u.ac.jp, (2015.6.30)



(a) Surface (-1m) (b) Bottom (+1m)

Figure 2 Tidal current ellipses at St.1

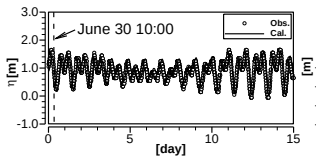


Figure 3 Comparison of tidal levels at St.1

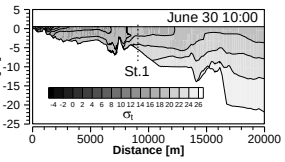


Figure 4 Distribution of σ_t in vertical cross section (*L-L'*)

Quantitative Metabolome Profiling of Growth Hormone Transgenic Coho Salmon

Toshiki NAKANO[1*], Hitoshi SHIRAKAWA[1], Toshiyasu YAMAGUCHI[1],
Yoshihiro OCHIAI[1], Giles YEO[2], Robert H. DEVLIN[3], Tomoyoshi SOGA[4]

[1]Grad. Sch. Agric. Sci., Tohoku Univ., Japan, [*]nakanot@bios.tohoku.ac.jp
[2]Inst. Metabolic Sci., Univ. Cambridge, UK
[3]West Van. Lab., Center Aqua. Environ. Res. (CAER-DFO/UBC), Fish. Oceans Canada, Canada
[4]Inst. Adv. Biosci., Keio Univ., Japan

INTRODUCTION

Growth in fish is regulated to a major extent by liver-derived insulin-like growth factor (IGF) -1 in response to pituitary-secreted growth hormone (GH) binding to GH receptors (GHR) of liver, and such a GH-IGF-1 axis plays an important role in the regulation of both growth and development[1-3]. Growth is genetically regulated and is also influenced by cellular, endocrinological, and environmental factors[1-6]. In *gh* transgenic salmon, the levels of GH and IGF-1 in plasma and mRNA expression of *igf1* and *ghr* were also observed to increase[7-10]. However, the exact mechanism of enhancement of growth in GH transgenic coho salmon (*Oncorhynchus kisutch*) is unknown and there are no details concerning the status of various metabolites which may provide clues to the growth enhancement mechanisms involved. The present study used metabolomic analysis to examine the charged metabolite levels in GH transgenic coho salmon in which GH is overexpressed.

METHODS

Fish: Triplicate groups of size (T, yearling fish, approx. 60 g)- and age (1.5 yrs old)-matched GH transgenic (construct OnMTGH1, strain M77) and non-transgenic (NT) salmon were used. Age-matched fish were pair fed a ration equivalent to the amount consumed by NT fish to maintain equivalent growth rates (ration-restricted transgenic group, RT).
Determination of metabolites: All capillary electrophoresis time-of-flight mass spectrometry (CE-TOFMS) experiments were performed using an Agilent System with an Agilent CE-electrospray ionization (ESI)-MS sprayer kit (Agilent, Palo Alto, CA, USA)[11].

RESULTS AND DISCUSSION

About 200 metabolites in both muscle and liver were quantified. The most notable difference found between transgenic and NT fish was that glycolysis metabolite levels were higher in the muscle of transgenic fish. These levels were affected by ration-restriction in transgenic fish. Furthermore, the increase in some glycolysis metabolite levels in the fasted transgenic fish muscle were also enhanced compared to those in fed transgenic fish muscle. However, there were no differences among the three groups regarding levels of muscular metabolites of the TCA cycle. These effects observed in muscle were different from effects seen in liver. Higher glucose plasma levels in GH transgenic fish than in non-transgenic fish such as coho salmon have been observed[12]. In GH transgenic animals, GH might promote gluconeogenic and lipolytic metabolism. Energy production from carbohydrates is known to be insufficient in carnivorous fish such as salmonids[13]. However, the present results suggest that GH transgenesis can improve the use of carbohydrates. In addition, these effects might depend on the level of total digestible energy intake and type of tissue in transgenic fish. Higher glycolysis in muscle is observed in growth-enhanced transgenic fish due to a higher energy requirement[14]. Several nutritional indicators (such as food intake, food conversion efficiency, carbohydrate degradation, and utilization of lipids and proteins) in GH transgenic fish are reported to be greater than those of non-transgenic fish[13,15,16]. Hence, GH transgenic fish are characterized by enhanced metabolism and energy availability owing to their high levels of circulating GH. Our finding is consistent with reports that described higher muscle glycolytic enzyme activities in GH transgenic fish compared with non-transgenic fish[13,14].

CONCLUSION

It is important to research on perturbations, recovery, and resilience processes in marine ecosystems, and management of socio-ecological system in fishing and aquaculture to take sustainable delivery of environmental benefits and food production linked to human well-being[17]. Consequently, the results of this study on GH transgenic fish can provide information that is useful for improving fish fitness and production of fishing and aquaculture. Further research regarding metabolic enzymes, energy production, and growth-related factors is needed to elucidate the exact mechanism of accelerated growth in GH transgenic fish.

REFERENCES

1. MORIYAMA, S. AYSON, F.G. KAWAUCHI, H. 2000, *Biosci. Biotech. Biochem.* 64, 1553-1562.
2. DEAN, E.E. WOO, N.Y.S. 2009, *Rev. Fish Biol. Fish.* 19, 97-120.
3. REINECK, M. 2010, *J. Fish Biol.* 76, 1233-1254.
4. NAKANO, T. 2011, *Yoshoku* 48, 64-67.
5. NAKANO, T. AFONSO, L.O. BECKMAN, B.R. IWAMA G.K. DEVLIN, R.H. 2013, *PLoS ONE* 8, e71421
6. NAKANO, T. KAMEDA, M. YAMAGUCHI, T. et al. 2015, In: CECCALDI, H.J. et al. (Eds), *Marine Productivity: Perturbations and Resilience of Socio-ecosystems.* Springer International Publishing AG, Cham, Switzerland, pp. 147-157
7. DEVLIN, R.H. YESAKI, T.Y. BIAGI, C.A. et al. 1994, *Nature* 371, 209-210.
8. DEVLIN, R.H. BIAGI, C.A. YESAKI, T.Y. et al. 2001, *Nature* 409, 781-782.
9. RAVEN, P. UH, M. SAKHRANI, D. et al. 2008, *Gen. Comp. Endocrinol.* 159, 26-37.
10. NAKANO, T. SHOJI, Y. SHIRAKAWA, H. et al. 2011, *La mer* 49, 111-117.
11. HIRAYAMA, A. KAMI, K. SUGIMOTO, M. et al. 2009, *Cancer Res.* 69, 4918-4925.
12. JHINGAN, E. DEVLIN, R.H. IWAMA, G.K. 2003, *J. Fish Biol.* 63, 806-823.
13. LEGGATT, R.A., RAVEN, P.A. MOMMSEN, T.P. et al. 2009, *Comp. Biochem. Physiol.* 154B, 121-133.
14. HILL, A.J. KIESSLING, A. DEVLIN, R.H. 2000, *Can. J. Fish. Aquatic Sci.* 57, 939-950.
15. HUANG, C.-H., HIGGS, D.A. BALFRY, S.K. DEVLIN, R.H. 2004, *Comp. Biochem. Physiol.* 139A, 199-204.
16. RAVEN, P.A., DEVLIN, R.H. HIGGS, D.A. 2006, *Aquaculture*, 254, 730-747.
17. HADJIMICHAEL, M. DELANEY, A. KAISER, M.J. EDWARDS-JONES, G. 2013, *AMBIO* 42, 1037-1046

ACKNOWLEDGMENTS

The authors thank staff at CAER and Keio Univ., and Dr. T. Fujimoto at Hokkaido Univ., Japan for assistance in lab work. TN acknowledges Dr. I. Gleadall at Tohoku Univ. for editorial assistance. This study was supported in part by KAKENHI (#23580277) from JSPS to TN.

Development of an Underwater NaI(Tl) Scintillation Spectrometer to Monitor Seabed Radioactivity

Ken HIGUCHI[1*], Hisayuki ARAKAWA[1], Akira MATSUMOTO[1], Yoshiaki MORIOKA[2]

[1]Tokyo University of Marine Science and Technology, Japan, [*]s153034@kaiyodai.ac.jp
[2]Fukushima Prefectural Fisheries Experimental Station, Japan

INTRODUCTION

As a result of the Fukushima Dai-ichi Nuclear Power Plant (FDNPP) Disaster, caused by the Great East Japan Earthquake, large quantities of radioactive materials were discharged into the Fukushima coastal area, causing radioactive pollution of the seabed[1]. It is thought that, because of its long half-life, caesium-137 (^{137}Cs) remains in marine sediments for a long time. It is therefore necessary to monitor the radioactivity levels of the coast close to the FDNPP. Generally, analysis of the sediment radioactivity is a discrete measurement in space and time, because the sediment radioactivity data is acquired by sampling the sediments. Recently, an *in situ* gamma ray spectrometer was developed for field observations; however, this equipment has a heavy and large body and cannot measure the distribution of radioactive caesium on the seabed in shallow areas[2]. To facilitate *in situ* measurements, we developed a compact, high efficiency submerged NaI(Tl) scintillation spectrometer (Seabed RadioActivity Monitor; S-RAM), based on the relationship between the gamma rays detected with the scintillator when operated in real-time and the radioactive caesium concentrations in the sediments.

METHODS

S-RAM comprises an underwater detection unit (with a 50 m cable) and a measurement unit on the deck of a ship. The detection unit that contains the NaI(TI) scintillator (diameter=5 inches, height=5 inches) is covered with an aluminium watertight housing (diameter=19 cm, height=44 cm), and mounted on a sled (length=155 cm, width=100 cm). The measurement unit can detect gamma rays across the full 3 MeV scale in 1024 channels, and the spectrum is recorded at 1 Hz during sampling.

Three different experiments were carried out as follows: First, we determined the relationship between the detected ^{137}Cs counts and the depth of sand samples collected at Iwasawa Beach, Iwaki, Fukushima. We then evaluated the effect of a shift in the peak because of a change in temperature of the NaI(Tl) scintillator. Finally, we tested the operation of the system at sea. The sea testing was carried out on board the Takusui (30 t, Fukushima Prefecture), off the coast of Nakoso, Fukushima. The vessel traversed 3 transects that were between 10 and 15 m deep. The S-RAM was lowered to the seabed, and towed at a speed of about 1 Kt. Core samples of seabed sediments were collected at both ends of each transect line, and the radioactive caesium concentrations of the sediment samples were measured with a Ge semiconductor spectrometer.

RESULTS AND DISCUSSION

Experiment 1 As the depth of the sand samples increased, the ^{137}Cs counts also increased. When the depth of the sand exceeded 13 cm, there was only a very slight increase in the ^{137}Cs counts (Fig. 1).
Experiment 2 As the temperature of the NaI(Tl) scintillator decreased, the ^{137}Cs peak shifted to a higher energy. There were no obvious changes in either the counts or the energy resolution.
Experiment 3 The detected ^{137}Cs counts were higher along the northern transect (close to the FDNPP) at Nakoso than along the southern transect; they were also higher along the offshore transect than along the onshore transect.
These results demonstrate that the S-RAM can measure the ^{137}Cs concentrations of seabed sediments.

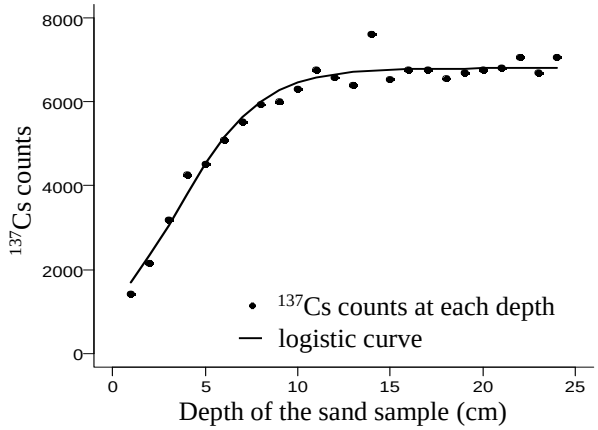


Fig. 1 Relationship between the detected ^{137}Cs counts and the depth of the sand samples from Iwasawa Beach. The solid line indicates a logistic curve fitted to the observed values.

CONCLUSION

There was a positive correlation between the ^{137}Cs counts detected with S-RAM and the radioactive caesium concentrations in sediments. The S-RAM was able to detect the *in situ* radioactive caesium distribution of in sediments in the seabed at Nakoso. The results confirm that this detector is suitable for measuring the radioactive caesium concentrations along transects on the seabed.

REFERENCES

1. KANDA, J. 2014, *Journal of Nuclear Science and Technology*. 56(4), 240–244.
2. THORNTON, B., OHNISHI, S., URA, T., ODANO, N., SASAKI, S., FUJITA, T., WATANABE, T., NAKATA, K., ONO, T., AMBE, D. 2013, *Marine Pollution Bulletin*. 74(1), 344–350

ACKNOWLEDGMENTS

We would like to thank the captain and the chief engineer of the Takusui for cooperating during the deployment of this equipment at sea.

Distributional Changes in the Kelp *Eisenia bicyclis* Resulting from the Subsidence and the Landfill for Breakwater Restoration after the 2011 Tohoku Earthquake

Haruka SUZUKI[1*], Tomoya AOKI[2], Yuki KUBO[1], Yukio AGATSUMA[1], Masakazu N AOKI[1]

[1]Graduate School of Agricultural Science, Tohoku University, Japan, [*]haruka.suzuki.p3@dc.tohoku.ac.jp
[2]Chateau Marine Survey Co., Ltd., Japan

INTRODUCTION

The 2011 earthquake caused 0.9 m of subsidence at a rocky coast of the Oshika Peninsula, northeastern Japan. Breakwater restoration in response to the subsidence is now in progress along the coastline. Offshore landfill often needs to build a higher breakwater, and the restoration work may affect kelp beds on the shallow subtidal rocky shores. According to the effects of artificial structure on rocky shore communities, previous studies have mainly focused on intertidal communities[1,2], and no reports from subtidal habitats have been available. In this study, we tried to clarify the effect of the restoration work on the dynamics of a kelp population in *Eisenia bicyclis* on the coast of the Oshika Peninsula.

METHODS

We conducted monthly monitoring surveys on a permanent study area (4 m wide x 30 m off shore from the quay, 0.5-3.0m in the depth) from July 2011 to July 2015 to describe the distributional changes of the kelp *Eisenia bicyclis* after the subsidence. Every individual of *E. bicyclis* was distinguished between juveniles and adults, tagged and mapped. Recruits were recorded at every survey.

RESULTS AND DISCUSSION

Before the subsidence, *Eisenia bicyclis* distributed 4 m to 30 m offshore along the survey line, and the shallower area (0-4 m along the line) was intertidal zone without kelp. After the subsidence, *E. bicyclis* expanded its distribution to the shallower area by many recruits. At the deeper area sank beneath the pre-earthquake lower limit of the kelp bed, though recruits were few, most of adults recruited before the earthquake survived. In September 2014, offshore landfill for the breakwater restoration destroyed the shallowest area (0-6 m along the line) and the recruits after the earthquake were buried. Due to both the destruction of shallower area population by the landfill and the scarce recruits into the deeper area, the population size of *E. bicyclis* decreased to the same level as that before the subsidence. Two months after the landfill, the number of population reached to its minimum, and then slightly increased by new recruits. Further monitoring surveys at the study site will be needed, because future environmental changes with the completion of higher breakwaters may affect the recruitment or survival of *E. bicyclis*.

CONCLUSION

The size of *Eisenia bicyclis* population expanded toward the shallower area after the subsidence, but decreased to the same level as that before the subsidence due to the landfill. Our study showed that the breakwater restoration work in response to the earthquake-caused subsidence actually had a negative impact on the kelp population dynamics at the subtidal rocky shore on the coast of the Oshika Peninsula.

REFERENCES

1. CHAPMAN, M. G. and BLOCKLEY, D. J. 2009, *Oecologia*. 161, 625-635.
2. PISTER, B. 2009, *Mar. Biol*. 156, 861-873.

ACKNOWLEDGMENTS

This work was financially supported by the project TEAMS: Tohoku Ecosystem–Associated Marine Sciences.

Factor Analysis of Upstream Migrating Ayu in the Yahagi River Using Machine Learning

Minoru TOMIYAMA

Aichi Fisheries Research Institute, Japan, minoru_tomiyama@pref.aichi.lg.jp

INTRODUCTION

Survival of ayu *Plecoglossus altivelis* after falling into the sea is thought to depend on the marine environment. As in the case, factors which influence the number of upstream migrator could be detected by mechanical learning. The monitoring investigation data for oceanographic investigation is thought to be suitable for this analysis.

METHODS

Fish were caught daily at the traps mounted on weir set 13km from the mouth of the Yahagi river from 2009 to 2015. Weight and length of the fish were measured almost every week. By a quadric curve-fitting method, daily weight of the fish were calculated. Summing the daily number of upstreaming migration, annual numbers of them were gained.

Coastal, climate, river and production of *nori* during October to February were analyzed by correlation-based feature selection method. As for software, WEKA was used for this analysis.

RESULTS AND DISCUSSION

Number of upstreaming migrator was higher in 2009 and 2015. Most affected factors which influence the number of upstreaming ayu were COD and Chlorophyll-a in December.

CONCLUSION

A possibility that an oligotrophy at a coastal region in winter influences the number of upstream migrating ayu was suggested.

Table 1 Variables for analyzing the number of upstream migrating ayu

Factors	Item
Coastal	Water temperature, Salinity, Chlorophyll-a, COD, PON, T_N, T_P, Transparency Period：October～February
Climate	Amount of global solar radiation in Nagoya Period：October～February
River	Water temperature at Nakahata Bridge (7km from river mouth) Period：October～February Water flow at Yonezu (m^3/s, 10km from river mouth) Period: October～December
Production of *nori* *(Porphyra sp.)*	Yield per farming person Price of nori (yen/sheet) Period: December～February

Suitable Quantity of Oyster Culture in Oginohama Bay, Miyagi, Japan

Yutaka OKUMURA[1], Akatsuki NAWATA[2], Hiroshi ITOH[2], Akio OSHINO[2]

[1]Tohoku National Fisheries Research Institute, Fisheries Research Agency, Japan, okumura@affrc.go.jp
[2]Miyagi Prefecture Fisheries Technology Institute, Japan

INTRODUCTION

The huge tsunami generated by the great earthquake on 11th March, 2011 caused serious damages to the aquaculture in the Tohoku coastal area. For example, the oyster harvest decreased from 40,000–60,000 tons shell weight before the tsunami to 20,000 tons afterwards (2011–2013)[1]. Although over 4 years have passed since the disaster, oyster production has not yet recovered to pre earthquake levels. Additionally, high oyster mortalities occurred in a part of aquaculture areas, as a result of either high seawater temperatures during the summer in 2012 or a large periphyton outbreak in 2013. It is hard to say if the conditions were suitable for oyster production after the tsunami. If unsuitable environmental event occur under the overcrowded culture condition of the oyster, it may cause the high oyster mortality. In this study, we aimed to calculate suitable oyster culture quantities to avoid overcrowding.

METHODS

We defined the suitable oyster culture quantity as phytoplankton quantity in the aquaculture areas minus the total filtration of phytoplankton by oysters and periphyton, such as mussel and ascidians, and that value is more than zero. To determine oyster feeding, the concentrations of chlorophyll *a* (Chl *a*), which is a phytoplankton pigment and indicator of water quality, were measured from seawater collected in Oginohama Bay, a major aquaculture area, at the intervals from once a week to once a month. After filtering the seawater by glass fiber filter (Whatmann GF/F), the phytoplankton pigments, which were extracted from the filter by methanol, were analysed by high performance liquid chromatography (HPLC)[2]. Chlorophyll (Chl) and water temperature sensors were attached to oyster longline facilities in the aquaculture areas. Temporal changes in Chl *a* were determined from Chl *a* values measured by HPLC and fluorescence values from the Chl sensors. Seawater exchange rate, which is a parameter for checking the inflow and outflow of phytoplankton across aquaculture area boundaries, was substituted with the value from a box model of Sendai Bay. To calculate filtration rate, the weight of oysters in culture nets were measured over time. An oyster culture rope with mussels, and ascidians was purchased every three months, and the weights of oyster and periphyton were also recorded for each taxa present. Oyster, mussel, and ascidian filtration rates were calculated by substituting either a modified equation[3] or published equations[4] for water temperature and weight. We interviewed members of the fisheries cooperative association to ascertain the number of oyster longline facilities, culture ropes, oysters per longline facility, and culture methods. Finally, changes in phytoplankton flux on the aquaculture areas were calculated daily.

RESULTS AND DISCUSSION

Chl *a* concentration was higher in 2014 than that in 2013, and ranged from 0.54 to 5.84 μg/L. The decrease in Chl *a* from summer to autumn recorded in 2013, was not observed in 2014.

Total oyster, mussel, and ascidian weight per oyster culture rope ranged from 22 to 69 kg in the following order, oysters > mussels > ascidians. Mussels were the predominant periphyton, accounting for 26–37% of the total weight.

Filtration occurred in the following order, mussels > oysters > ascidians. Mussels accounted for 41–87 % of the total filtration. As an oyster shell weight, which is unrelated to the filtration, is heavier than that of a mussel, mussel filtration was higher than that of oyster. Moreover mussel filtration under low water temperature is higher than to that of oysters[5], mussel filtration was higher than that of oysters in winter.

The culture ropes were attached to the oyster longline facilities at the end of May, when the supply of mussel larvae from the aquaculture areas had decreased. Therefore, mussels only attach to the culture ropes in 1 year of the 2-year oyster culture period. According to the calculation, total mussel filtration in the aquaculture areas was lower than that of the oysters from May onward. Moreover filtration of oysters attached to the quay did not even account for 10% of the total filtration of aquaculture.

CONCLUSION

Although the quantity of phytoplankton decreased with the cessation of blooming, we estimated that the number of oyster rafts (approximately 450) in the present study did not result in reduced food availability. Additionally, we believe that the number of rafts (approximately 1100) before the tsunami did not negatively impact the oyster food supply if the culture density was low.

REFERENCES

1. Ministry of Agriculture, Forestry and Fisheries. http://www.maff.go.jp/j/tokei/kouhyou/kaimen_gyosei/index.html
2. ZAPATA, M. *et al.* 2000, MEPS. 195, 29-45.
3. AKASHIGE, S. *et al.* 2005, Nippon Suisan Gakk. 71, 762-767.
4. RIISGARD, HU. *et al.* 2014, HELGOL. MAR. RES. 68, 193-198.
5. COMEAU, LA. *et al.* 2008, Can. Tech. Rep. Fish. Aqua. Sci. 2810, 1-17.

ACKNOWLEDGMENTS

Thanks also to Dr. T. Kamiyama and Dr. M. Yamasaki, for advice on this study.

Combined Effects of Nutrient Availability, Light Intensity, and Temperature on the Photosynthetic Pigments and Color of the Brown Alga *Undaria pinnatifida*

Hikaru ENDO[1*], Yutaka OKUMURA[2], Yoichi SATO[3], Yukio AGATSUMA[1]

[1]Graduate School of Agricultural Science, Tohoku University, Japan, [*]h-endo@bios.tohoku.ac.jp
[2]Tohoku National Fisheries Research Institute, Fisheries Research Agency, Japan
[3]Riken Food Co., Ltd., Japan

INTRODUCTION

The brown alga *Undaria pinnatifida* is a native to Japan, China, and Korea, and has invaded around the world. This alga has been extensively cultivated in Asian countries as one of the most important commercial seaweeds, and was also recently introduced for commercial cultivation in European countries (e.g. Peteiro and Freire 2011). In Japan, color-faded blades of this alga have been observed under cultivation during the winter, and resulted in decreased commercial value. This fading is assumed to be caused by a decreased concentration of photosynthetic pigments under nutrient-limited conditions. However, little is known about the factors influencing pigment concentrations (but see López-Figueroa 1991 and references therein) and the color of brown algae, including *U. pinnatifida*. In this study, we examined the combined effects of nutrient availability, light intensity, and seawater temperature on the pigment concentration and color of *U. pinnatifida* in a culture experiment. We addressed the following questions: (1) Do these abiotic factors significantly affect pigment concentration and color? (2) Is there a significant correlation between pigment concentration and color?

METHODS

Samples of *U. pinnatifida* were cut from the blades of six individuals (n=48). Samples were cultured in flasks for 24 days in eight treatments (n=6), as part of a fully crossed treatment design, with two nutrient levels (enriched and non-enriched seawater), two light levels (180 and 30 µE/m^2/s), and two temperature levels (15 and 5 ºC). At the start and end of the culture period, the brightness (L*), redness (a*), and yellowness (b*) of each sample was measured using a spectrophotometer. The pigment concentrations, including chlorophyll a, c1, c2, fucoxanthin, violaxanthin, and zeaxanthin, were then measured by High Performance Liquid Chromatography (HPLC). Significant effects of nutrient availability, light intensity, and temperature were analysed by a three-way ANOVA. Correlations between pigment concentrations and color values were analysed using Pearson's test.

RESULTS AND DISCUSSION

Low nutrient availability led to a decrease in all pigment concentrations and an increase in the L*, a*, and b* values of *U. pinnatifida*. There were negative correlations between these pigment concentrations and the color values. These results support the assumption that the color-faded blades of this alga, with relatively high L*, a*, and b* values, are caused by decreased photosynthetic pigment concentrations under nutrient-limited conditions. However, the present study showed light intensity and temperature also affect the pigment concentration and color of this alga. Decreased light intensity resulted in an increase in pigment concentrations, and a decrease in L* and b* values. This finding suggests that a deeper cultivation depth may decrease the color values when the color-faded blades will be observed.

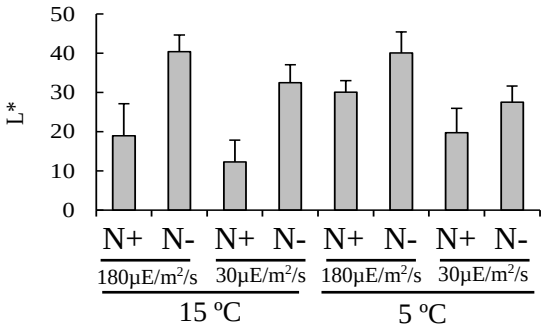


Figure 1. L* values of the brown alga, *Undaria pinnatifida*, cultured in eight treatments. N+ and N- indicate nutrient enriched and non-enriched treatments, respectively.

Moreover, reducing the temperature from 15 ºC to 5 ºC resulted in an increase in color values, although the there was no detectable effect of temperature on almost all pigment concentrations. In addition, a significant interaction was found between nutrient availability and temperature in the L* and b* values, and in almost all pigment concentrations. Nutrient enrichment had less effect on these parameters at 5 ºC than at 15 ºC. Therefore, artificial nutrient enrichment during the season when seawater temperature starts to increase may be effective in decreasing the color values, when blade color has faded.

CONCLUSION

The present study showed that the blades of *U. pinnatifida* are discolored by reductions in nutrient availability, increases in light intensity, and decreases in temperature. Further studies using whole individuals under cultivation or culture, will help us to better understand the cause and countermeasures of the color-fading phenomenon of this alga.

REFERENCES

1. PETEIRO, C. and FREIRE, Ó. 2011, *Aquaculture*. 314, 269-276.
2. LÓPEZ-FIGUEROA, F. 1991, *Z. Naturforsch*. 46c, 542-548.

Amplification of Near-Inertial Period Fluctuation Associated with Passage of Typhoon around the Tango Peninsula, Japan

Keiichi YAMAZAKI[1*], Yujiro KITADE[1], Yosuke IGETA[2], Yutaka KUMAKI[3] and Tatsuro WATANABE[4]

[1]Graduate School of Tokyo University of Marine Science and Technology, Japan, [*]d102004@kaiyodai.ac.jp
[2] Japan Sea National Fisheries Research Institute, Fisheries Research Agency, Japan
[3]Kyoto Prefectural Agriculture, Forestry and Fisheries Technology Center, Japan
[4]Fisheries Research Agency, Japan

INTRODUCTION

In the Japan Sea, near-inertial period fluctuations (NIPFs) are mainly generated by passage of typhoon. The NIPFs accompanied by strong velocity in the coastal region occasionally cause serious damage to a set-net for fishing. It is considered that strength of coastal currents induced by the NIPFs is depended on the pathway of typhoon, however, the details are not shown by observational results. Eight typhoons passed around the Japan Sea with different pathways in 2004 (Fig. 1a).We investigated the amplification of the NIPFs induced by the eight typhoons using current data obtained around the Tango Peninsula (Fig. 1b).

OBSERVATIONS AND DATA

Mooring observations using current meters (Compact-EM; JFE Advantech Co.) which were deployed at a depth of 15 m, were perfomed at ten stations around the Tango Peninsula (Fig. 1b) from June 1st to October 30th. Sampling interval is 10 minutes. Wind data obtained at 1-h interval at Mt. Taiko (Sta. MT, Fig. 1b) were used in the work.

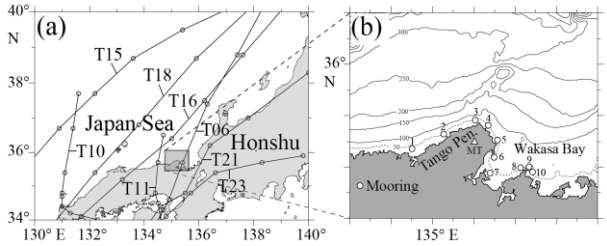


Fig. 1 (a): Location of study area and pathway of typhoons. (b): Enlargement of around the mooring sites. Open circles are indicate the mooring stations (Sta. 1 - 10). Contours indicate the isobaths.

RESULTS

NIPFs were amplified associated with passage of typhoons. Especially, the amplifications of NIPFs were remarkable at Sta. 3 – 6 where located at the tip and eastern coast of the Tango Peninsula. The energy levels of NIPFs induced by each typhoon were estimated by using current data from 12 hours before to 96 hours after the wind at Sta. MT reached maximum (Fig. 2). The difference of value of energy level of NIPFs was seen in the case of typhoons. In the case of T15 (○) and T18 (□) which center of the typhoon advanced northeastward over the central part of the Japan Sea, the energy level was high at Sta. 3 – 5 compared with the other case. In the case of T11 (●) and T16 (×) which center of the typhoon advanced northeastward near and west side of the Tango Peninsula, the energy level was lower than the above case at Sta. 3 – 5, but that was higher at Sta. 6. The energy levels were low in the case of T10 (◇) which the center of typhoon advanced northward over the western part of the Japan Sea and T06(△), T21(■), and T23(▲) which the center of typhoons advanced east side of Tango Peninsula or over the Honshu. From observational results, we roughly divided the strength of NIPFs into four cases (Case A – D) in terms of pathway of typhoons (Table 1). Eastward flows with sub-inertial period considered to be caused by coastal-trapped waves induced by wind, were also observed around the Tango Peninsula. These sub-inertial currents were amplified just after the wind speeds at Sta. MT were maximum in the case of T15 and T18 (Case A), although that amplified one day after the wind speed was maximum in the case of T10 (Case C). Phase relationships between NIPFs and sub-inertial currents were differed in the case of typhoons. In the Case A, the energy of NIPFs reached maximum after sub-inertial eastward flows were attenuated. Amplification and attenuation of NIPFs and sub-inertial eastward flows were simultaneously occurred in the case of T06 (Case D).

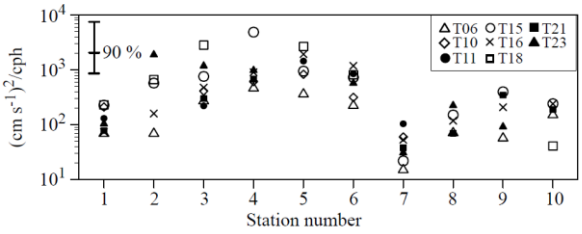


Fig. 2 Distribution of energy levels of NIPFs.

Table 1 Classification of strength of NIPFs.

Case	Typhoon	Energy level of NIPFs ($\times 10^4$ (cm s^{-1})^2/cph)
Case A	T15, T18	2.8～4.9
Case B	T11,T16	1.5～1.9
Case C	T06,T21,T23	0.5～1.9
Case D	T10	0.6～0.8

To investigate whether the difference of strength of NIPFs near the coast is depend on the pathway of typhoon, numerical experiments using a three dimensional level model were performed. Realistic coastline and bottom topography were used in the numerical experiments. Idealized wind fields associated with passage of typhoons were expressed by adopting Fujita's typhoon model. Experimental results qualitatively reproduced the observed phase relationship between NIPFs and sub-inertial eastward flows and difference of energy level of NIPFs by pathway of typhoon. The details of experimental results will be introduced in the presentation.

The Use of Stable Isotopes for Food Web Analyses: An Example of Food Webs in a Coastal Ecosystem in Sendai Bay

Hiroyuki TOGASHI[1*], Yukinori NAKANE[2], Yutaka KURITA[1]

[1*]Tohoku National Fisheries Research Institute, Japan, *htogashi@affrc.go.jp
[2]Central Research Institute of Electric Power Industry, Japan

INTRODUCTION

Food web structures are well-studied, central theme of fisheries science and ecology that depicts the pathways of energy flow up the food web, as well as the relative magnitudes of flows through, for example, plankton and benthos. Researchers have long been studied on the importance of quantitative estimation of the relative contribution of prey animals to an organism by stomach contents analysis. However, the stomach contents analysis requires experienced technique, and it only reflects recent diets of an animal. On the other hand, carbon and nitrogen stable isotope ratios representing average feeding habits and trophic position have become a powerful tool in food web analyses. In this study, we introduce the food web analyses using both approaches in coastal ecosystem in Sendai Bay.

METHODS

Sendai Bay is located the Pacific coast of northeastern Japan. We choose as the study six sites with depths <80 m in Sendai Bay. Marine products were caught by the research vessel Wakataka Maru (Fisheries Research Agency) and coastal trawl boat from Sep. 2011 to ongoing. Stomach content were identified to species level or to the level of the lowest possible taxon for each prey item and wet-weighed. For δ^{13}C and δ^{15}N measurements, each sample was packed into a tin capsule and the δ^{13}C and δ^{15}N (‰) were measured using isotope ratio mass spectrometer. The contribution rate of prey items was evaluated by mixing models for δ^{13}C and δ^{15}N values within a Bayesian framework. In this study, we used a package of R (SIAR 4.1)[1]. The enrichment factors of δ^{13}C and δ^{15}N values per trophic level were set as 0.39 ± 1.3‰ and 3.4 ± 0.98‰, respectively[2].

RESULTS AND DISCUSSION

The major 10 fish species in Sendai bay were targeted. Results show that the feeding groups were classified based on the stomach contents analysis in fish feeders, *Paralichthys olivaceus*, *Kareius bicoloratus*, *Lateolabrax japonicus*, and *Gadus macrocephalus*; crustacean feeders, *Hexagrammos otakii* and *Lepidotrigla microptera*; benthic feeders, *Pleuronectes herzensteini* and *Pleuronectes yokohamae*; plankton feeders, *Ammodytes personatus* and *Engraulis japonicus*, respectively. A dual isotope plot of δ^{13}C and δ^{15}N values showed that most of fish feeders depended on plankton feeders, and crustacean and benthic feeders depended on crustacean and/or benthos (Fig. 1). That is, there were at least two food chains in Sendai Bay based on zooplankton, crustacean and benthos. The contribution rate within a Bayesian framework of *Paralichthys olivaceus* in June 2012 in Sendai Bay was 67 % *Engraulis japonicus*, and 32 % *Ammodytes personatus*.

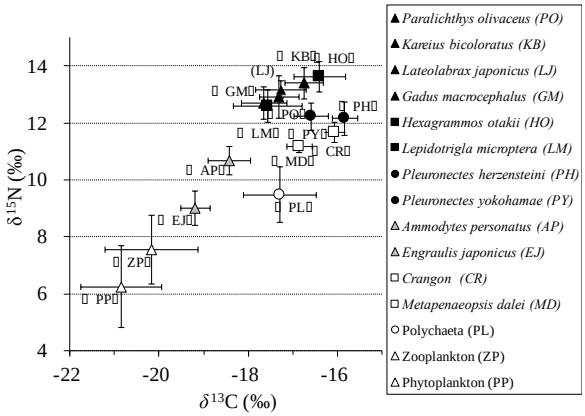


Fig. 1. Stable isotope ratios of carbon (δ^{13}C) versus nitrogen (δ^{15}N) for marine animals in Sendai Bay in June 2012. Open symbols indicate prey items (plankton, crustacean and benthos). Solid triangles; fish feeding: solid squares; crustacean feeding: solid circles; benthos feeding: and gray triangles; plankton feeding are shown, respectively.

CONCLUSION

On the whole, the results from stable isotope analysis were well consistent with those from stomach contents analysis. In the future, the data of multi-element isotopes (e.g., nitrogen stable isotopes of amino acids and radiocarbon) also can be applied to evaluate more details on the food webs in coastal ecosystem.

REFERENCES

1. PARNELL, A. C. INGER, R. BEARHOP, S. and JACKSON, A. L. 2010, *PLoS ONE*. 5, e9672.
2. POST, D. M. 2002, *Ecology*. 83, 703-718.

ACKNOWLEDGMENTS

We would like to thank the captains and crew of the Wakataka Maru, Daiei Maru and Seiko Maru for their support in sampling. We also thank T. YAMAGUCHI, S. SASAKI and J. SUZUKI of Tohoku National Fisheries Research Institute, for analysing the marine samples. This study was supported by the Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries, Japan. Partial support was also provided by CREST, JST.

Seasonal Movements of the Herbivorous Gastropod *Omhalius rusticus*

Yuki KUBO*, Haruka SUZUKI, Masakazu N. AOKI, Yukio AGATSUMA

Graduate School of Agricultural Science, Tohoku University, Japan, *yuki.kubo.t6@dc.tohoku.ac.jp

INTRODUCTION

Omphalius rusticus is the herbivorous gastropod snail dominates at subtidal rocky shores along the Sanriku Coast. Grazing activity of this densely distributed species may give high impacts on the rocky shore communities. Examination of the periodic movement of a species is essential to estimate its grazing activities[1]. Movements also have important roles both in survival and in reproduction. In this study, we aimed to clarify the seasonal patterns in the movement of *O. rusticus* with using the mark-recapture method.

METHODS (Free to use title names hereafter)

Our study was conducted at Kitsunezaki-hama (38° 21'N,141° 25'E) on the south-western coast of the Oshika Peninsula in every month from May 2013 through June 2015. A 31 m-transect line was set perpendicular to the quay. We collected 50 to 100 individuals of *Omphalius rusticus* from each of the sites along the line at intervals of 5 m. Snails collected at the sites along the line at intervals of 10 m were marked with non-toxic paint and coated with transparent glue at the outer margin of the aperture[2]. The six digits in six colors were used for the individual identification. ID mark and the site of collection were recorded for each of recaptured individuals. Within 24 hours from the collection, marked snails were released at their original site. Water temperature was monitored with 15 minutes intervals at the center of the study site.

RESULTS AND DISCUSSION

In order to detect the monthly patterns in the movement of the snail, the data after one month were used. Recapture rates ranged between 2% (July 2014) and 39% (March 2015). Throughout the study period, recapture rates were low at warmer waters (July to November) and high at colder waters (December to May). Recapture rates at the same collection site ranged from 14% (May 2015) to 100% (February to April 2015). The farthest record of the distance snail travelled was 15 m in September 2013.

Previous studies indicated that fluctuations in water temperature affect the rate of food consumption, but not on the grazing period[3]. In addition, increase of water temperature in summer can be a trigger for *Omphalius rusticus* reproduction[4]. High activity in summer may be related to the reproduction. In *O. rusticus*, temperature can be a strong controlling factor not only for its grazing activity, but for the reproductive activity. For the future studies of *O. rusticus*, it is necessary to consider the relationship between the mobility and shell size. Spatial distributions of other benthic organisms also have to be examined in the relation with the periodic activity of the snails.

CONCLUSION

Our examination on the seasonal movement of the herbivorous snail *Omphalius rusticus*, based on the individual identification by the mark-recapture method, showed that water temperature may be an important factor controlling the movement of the snail.

REFERENCES

1. HEREU, B. 2005, *Marine Ecology* 26, 54-62.
2. TAKADA, Y. 1995, *Marine ecology progress series* 117, 103-110.
3. NAKATA, K., YAMAZAKI, T., MIZUTA, H., KAWAI, T., ITO, H. and GOSHIMA, S. 2006, *Aquaculture Science* 54, 375-381.
4. LEE, J. H. 2001, *Korean Journal of Biological Sciences* 5, 37-44

ACKNOWLEDGMENTS

This work was supported by the project "Tohoku Ecosystem-Associated Marine Sciences (TEAMS)"

Relationship between Patterns of Fish Behaviour and Concentration of Radioactive Materials after Nuclear Accident by the 2011 Great East Japan Earthquake

Takuro NAKAGAWA*, Keiichi UCHIDA, Hisayuki ARAKAWA, Yoshinori MIYAMOTO, Seiji AKIYAMA, Kohei HASEGAWA, Akira MATUMOTO

Graduate School of Tokyo University of Marine Science and Technology, *nkgwaaaa820@gmail.com

INTRODUCTION

A large quantity of radioactive material was emitted into the sea as a result of the Fukushima Dai-ichi nuclear power plant (1FNPP) accident due to the Great East Japan Earthquake and tsunami On 11 March 2011.[1] Many marine organisms with the over standard levels of radioactive materials (more than 100Bq/kg) have been caught in the sea along the Fukushima Prefecture coast. Some fisheries has been pause after earthquake disaster, because some species of fish exceed the safety standards of radioactive. Why the concentration of radioactive materials is different from the species of fish? We have focused on the relationship of fish behaviour and the radiation level. Here, we investigated the behaviour by focusing on higher radiation levels fish. We chose the rockfish *Sebastes cheni* as test fish which is a high radiation level at the one of important commercial species.[2] We researched at two locations, the coastal area of Fukushima Prefecture (the open sea) and the port assumed port close to the 1FNPP (the semi closed sea). In this abstract, we introduce the research on the open sea.

METHODS (Free to use title names hereafter)

Research has been carried out from 22 Nov. 2012 to 10 May. 2014. Research locations were set at off the coast of Nakanosaku fishing port located Iwaki City (50km south from 1FNPP). Specimen fish were caught by gill net or fishing. We installed three acoustic telemetry receivers (VR2W, Vemco) and water temperature logger (Water Temp pro v2, HOBO) in research area. The transmitter (V9 (13) P, Vemco) was implanted surgically into the abdomen of the fish, and released the 20 fish. We retrieved date of receivers every several months. The method of analyse was that estimate the position of fishes from result of three receivers.

Fig. 1 shows how to estimate the position of fishes from three receivers, these rings indicate range of receiving signal of transmitter, and divided into seven areas A to G. We judged which areas are the position of fishes from result of three receivers and researched more detailed information from bathymetric chart.

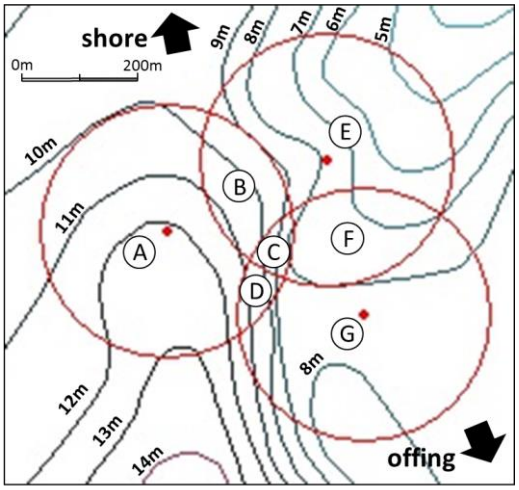


Fig. 1 Estimation of the position from three receivers

RESULTS

9 rockfishes had stayed in monitoring range until the battery of transmitter died. 7 rockfish had stayed for a very short period (less than two days), and they could have been not able to return former position due to current, physical condition, and so on. Other 4 rockfishes were missing after few months of releasing. Tow rockfishes strayed within some months strayed through the areas E and A in spring. Other two rockfishes strayed within some months were in the areas E, F, and G at last receiving in autumn.

CONCLUSION

In this research, some rockfishes have seasonal migration with varying water temperature, but many of them had stayed the same place in the range of 400 ~ 500m all the year round. This result show that rockfish like remain same place. This habit have possible making rockfish high radiation level.

REFERENCES

1. AOYAMA, M. TSUMUNE, D. and, HAMAJIMA, Y., 2013. J.Radioanal. Nucl. Chem. 296, 535-539
2. MATSUMOTO, A. SHIGEOKA, Y. ARAKAWA, H. HITAKAWA, N. MORIOKA, Y. MIZUNO, T. ,2015. Journal of Environmental Radioactivity 150 (2015) 68-74

Development of a De-Oiling Process for Seabed Sediments

Yoshichika IKEDA*, Motohiro MIKI, Hisayuki ARAKAWA, Mitsuru IZUMI

Tokyo University of Marine Science and Technology, Japan, *link-yi@kaiyodai.ac.jp

INTRODUCTION

Many fuel oil tanks in coastal northeastern Japan were destroyed by the tsunami that followed the March 2011 earthquake. In Kesennuma Bay in Miyagi Prefecture, roughly 11 kt of fuel oil were flushed into the bay[1]. Much of the spilled oil was transported outside of the bay by back waves of tsunami where the oil mixed with sand and was deposited on the seabed with suspended particles. A system of de-oiling seabed sediments was developed and its effectiveness evaluated.

METHODS

Superheated steam de-oiling: We developed a machine that removes oil from sediments particles using superheated steam and a rotary kiln that stirs the sediments. The temperature of the steam is maintained between 300°C and 700°C. The sediment throughput is 20 kg/hour (Fig. 1).

Operation of the system: The seabed sediments are collected using a type of vacuum aspiration that causes little turbidity. The collected sediments are then dried in a drying oven to ~10% water contents and injected into the system for de-oiling.

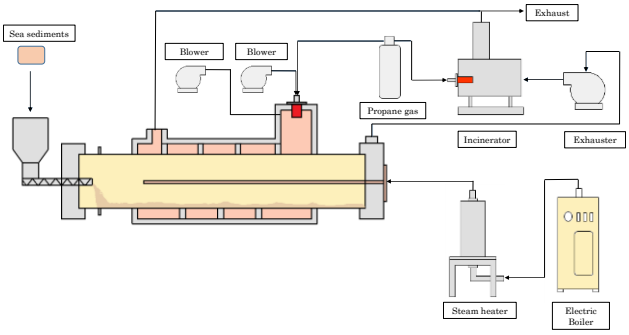


Fig. 1 The superheated steam system of de-oiling

Improvement of the system: System stability was compromised by dew condensation, unstable retort temperature and fine dust particles. The installation of a residual heat jacket, heaters and a dust collector improved the system.

RESULTS AND DISCUSSION

At temperature 450°C and more without steam, the normal hexane extract materials (n-hexane extracts) and the total petroleum hydrocarbons (TPH) from the sediment was removed from seabed sediments. The TPH remained below 400°C. However, steam at temperature 300°C or above can be used to remove oil.

Table 1 The effect of steam temperature on de-oiling

Condition	Concentration of n-hexane extracts (ppm)	Concetration of TPH (ppm)
Before treatment	3200	600
400 ℃ without steam	< 100	200
450 ℃ without steam	< 100	< 100
500 ℃ without steam	< 100	< 100
300 ℃ with steam	< 100	< 100
350 ℃ with steam	< 100	< 100
400 ℃ with steam	< 100	< 100
450 ℃ with steam	< 100	< 100
500 ℃ with steam	< 100	< 100

CONCLUSION

The superheated steam system was capable of removing oil from seabed sediments at temperatures greater than 300°C. The efficiency of the system requires further investigation.

REFERENCES

1. Sakai, K. 2013, *Nippon Suisan Gakkaishi*, **79**, 93-94. (in Japanese)

ACKNOWLEDGMENTS

This study was supported by the “Tohoku Ecosystem-Associated Marine Science” research project funds from Ministry of Education, Culture, Sports, Science and Technology in Japan.

Trophic Cascade in Seaweed Beds in Sanriku Coast Hit by the Huge Tsunami on 11 March 2011: Sato-umi Activity Serving for Increase in Marine Biodiversity

Teruhisa KOMATSU[1*], Shuji SASA[1], Hiroki MURATA[1], Shuhei SAWAYAMA[1], Masayasu HAMANA[1], Minami ASADA[1], Tetsuo YANAGI[2]

[1]Atmosphere and Ocean Research Institute, the University of Tokyo, Japan, komatsu@aori.u-tokyo.ac.jp
[2]EMECS Centre, Kobe, Japan

INTRODUCTION

Coastal ecosystems provide many ecological services to human society. In coastal ecosystems, seagrass and seaweed beds are one of the most important environments for coastal fisheries. Seaweed beds have been distributed along Sanriku Coast facing Pacific Ocean in north Honshu Island.

The Great East Japan Earthquake of which the center was situated off Sanriku Coast in Northwestern Pacific Ocean occurred on 11 March 2011 and recorded magnitude of 9.0. Huge tsunami caused by this earthquake brought catastrophic damages on Sanriku Coast. Their wave and run-up heights were about 10 m and 20-40 m along the coast. This huge tsunami should have impacted not only human societies on land, but also coastal ecosystems under the sea. A lot of broad seagrass beds and seaweed beds were distributed along Sanriku Coast with many rias-type bays which suffered serious damages on land by the tsunami. Shizugawa Bay is located in southern Sanriku Coast. Many seaweed beds were distributed in Shizugawa Bay. Seaweed beds are very important habitat for abalone and sea urchins, commercially target species in this area, especially Shizugawa Bay. Sakamoto et al. (2012)[1] reported that seaweed beds had been recovered immediately after the tsunami in 2011-2012 although seagrass beds had been greatly damaged[2]. It is very important to monitor succession of seaweed beds in Shizugawa Bay for restoration of coastal ecosystem after the huge perturbation by the tsunami.

METHODS

Observation was conducted in Shizugawa Bay in 2014 and 2015 by using underwater video camera towed from a fishing boat along the coast. We also analyzed a satellite image, GeoEye-1, taken on 12 February 2015 using ground truth data obtained by the field surveys.

RESULTS

Seaweeds were distributed along the rocky coast. Seaweed beds were classified into three types: *Laminaria*, *Sargassum* and *Eisenia bicyclis* beds. *E. bicyclis* was distributed on the rocky bottom from a bottom depth of 1 m to that of 7 m around the bay head of the Shizugawa Bay in 2011. However, *E. bicyclis* disappeared from 2014 to 2015 and many sea urchins were observed instead of seaweeds. The same disappearance of *E. bicyclis* occurred around Tsubakijima Island and Nojima Island. Satellite image analysis showed that *E. bicyclis* have completely disappeared around the bay head in 2015 from the satellite image analysis while it had been distributed in 2012.

DISCUSSION

E. bicyclis beds are important fishing ground of sea urchins. However, sea urchin fisheries were stopped after the huge tsunami in 2011 because of lack of fishing boats. The number of fishing boat wasn't recovered till 2013. Komatsu et al. (2015)[3] reported sea urchins were observed after the tsunami in rocky coast in Otsuchi Bay similar to Shizugawa Bay belonging to *Rias* type bay. Sea urchins reproduce in summer in Sanriku Coast. It is possible that sea urchins could reproduce in summer of 2011. It takes about two years for sea urchin larvae to become adult. Sea urchins might spawn not only in summer of 2011 but also in summer of 2012. The spawned sea urchins in 2011 and 2012 might be adult in 2013 and 2014, respectively. These sea urchins aren't exposed to fishing pressure during the fishing season in summer from 2011 to 2013. Moreover, adults have remained since 2011 without fishing. They have continued to feed seaweeds. Recruitments of adult sea urchins in 2013 and 2014 reinforce predation pressure on seaweeds. Eventually, *E. bicyclis* beds disappeared due to predation of sea urchins.

In California coast, giant kelp forests have been barren when sea otters disappeared. Marine biodiversity was decreased with decrease of giant kelp forests. After introduction of sea otters that predate sea urchins, giant kelp forest was recovered and also biodiversity. This phenomenon is called as a trophic cascade. Top-down control of ecosystem is very important for maintaining marine biodiversity. In Sanriku Coast, fishermen catching sea urchins play an important role of a predator which controls coastal ecosystem. Absence of sea urchin fisheries produced a trophic cascade in seaweed beds. Yanagi (2015) proposed the concept of "sato-umi" for human management of coastal seas for high productivity while maintaining high biodiversity. Therefore, fisheries of sea urchins are a sato-umi activity serving for increase in marine biodiversity.

RERENCES

1 SAKAMOTO et al., Impact of huge tsunami in March 2011 on seaweed bed distributions in Shizugawa Bay, Sanriku Coast, revealed by remote sensing. Proceedings of SPIE, 8525, 85251B-7, 2012.

2 SASA et al., Did huge tsunami on 11 March 2011 impact seagrass bed distributions in Shizugawa Bay, Sanriku Coast, Japan? Proceedings of SPIE, 8525, 85250X-6, 2012.

3 KOMATSU T. and T. YANAGI, An integrated approach for sustainable use of coastal waters, lessons from human-nature interactions during the Edo Period of eighteenth-century Japan. In Marine productivity: perturbations and resilience of socio-ecosystems, edited by Ceccaldi, H.J., Hénocque, Y., Koike, Y., Komatsu, T., Stora, G. and Tusseau-Vuillemin, M.-H., Springer International Publishing Switzerland, Cham, p. 283-290, 2015.

Implantation of artificial reefs on the French Atlantic Coast

Florence DUFOUR, Aurélie PENNE, Nelly FERROU, Thomas SCOURZIC, Elodie RUBIO, Aurore LABORDE, Gérard FOURNEAU [1]

[1] Aquitaine Landes Récifs, France, gerard.fourneau@aquitaine-landes-recifs.fr

In order to fight against human pressures, as well as marine environment and resources damages over the coastline, artificial reefs have been sunken along the Aquitaine coast. The aim of the present study (led by Aquitaine Landes Récifs, a nonprofit organization) is to underline not only the steps of the colonization process on artificial reefs but also how they impact on species richness along time.

Scuba diving in situ campaigns were conducted across the 2400 m3 sunken reefs, spread over 3 private maritime concessions ("Capbreton", "Soustons/Vieux Boucau" and "Messanges/Azur/Moliets et Mâa"). Two experimental fishing surveys were performed in fall 2007 and spring 2008 in order to complement scuba diving surveys.

Invertebrates (which are the first colonizers) represent an important part of artificial reefs diversity. In addition, vertebrates' species richness greatly increased since the first reef immersion. Although species richness is constant over time, new species are regularly appearing across the 3 sites. Furthermore, black seabream and meagre are mainly encountered at fall, whereas Atlantic bonito and Canary drum were fished during spring surveys. Species richness was different across the 3 concessions and could be explained first by an irregular sampling effort but also by the presence Capbreton canyon, regarding reefs sunken next to it.

FLUID IMAGING TECHNOLOGIES

イメージング フローサイトメータ

FlowCAM

プランクトンなどの懸濁粒子をCCDカメラで撮影し、その画像をCPUで解析することで各粒子のサイズ・面積・ESDを算出します。FlowCAMはクロロフィル蛍光や光散乱の計測データと画像データとをシームレスに関連づけられるスキャッタグラム作成機能を備えた、最新のフローサイトメータです。

仕　様

●測定レンジ

倍率	測定レンジ
1×	約10μm−3
4×	約5μm−2
10×	約2μm−0.5
20×	約1μm−0.3

●解 析

各パーティクルの長さ・幅・面積・球換算サイズ（ESD）
蛍光強度（クロロフィル・フィコエリスリン）、光散乱強度

TURNER DESIGNS
Reliable Instruments for an Unreliable World

クロロフィル測定装置

10-AU-005CE

ダイナミックレンジと安定性に優れたターナーデザイン社　多目的フィールド蛍光光度計です。クロロフィルのIn-Vivo測定と抽出測定が、手軽に、精度よく、しかも簡便に行うことができます。

●検出限界
クロロフィル-a　0.005μg/1
●光学系
デュアルビーム方式
●レンジ
3レンジ（オート、マニュアル）　0.001～999.9
●検出器
レッドセンシティブ光電子倍増管（185-870nm）

※なお、くわしい仕様に関しては科学機器部（03-3265-4265）までお問い合わせ下さい。

株式会社アムコ
科学機器部

本　社：〒102-0072　東京都千代田区飯田橋4-8-7　TEL 03（3265）4265
URL http://www.amco.co.jp/　　E-mail: kagaku@amco-inc.net

社会基盤の形成と環境保全の総合コンサルタント

当社は、社会基盤整備や環境保全にかかわる企画、調査、分析・解析、
予測評価から計画・設計、対策・管理に至る、すべての段階において、
一貫した付加価値の高いサービスを提供しています。

代表取締役会長　田　畑　日出男
代表取締役社長　細　田　昌　広

業務内容

- 河川・港湾・空港・海岸の計画・設計・管理
- 道路・橋梁・交通・都市の計画・設計・管理
- 自然及び人工災害に係る事前・事後対策調査、計画・設計
- 環境に関する現況調査、予測、解析
- 環境アセスメント（環境影響評価）、環境保全対策
- 生物の調査、分類、同定、実験、解析、育成
- 生物生息環境の保全、再生、創造
- 理化学分析、食品分析、環境リスクの評価・管理
- 気象情報配信とバイオウェザーサービス
- 海外におけるこれらに関する業務・事業


フクジュソウ(絶滅危惧種)【植物調査】


信濃川やすらぎ堤(新潟県)
【親水型堤防護岸設計】


せせらぎの道(神奈川県)
【景観道路計画・設計】

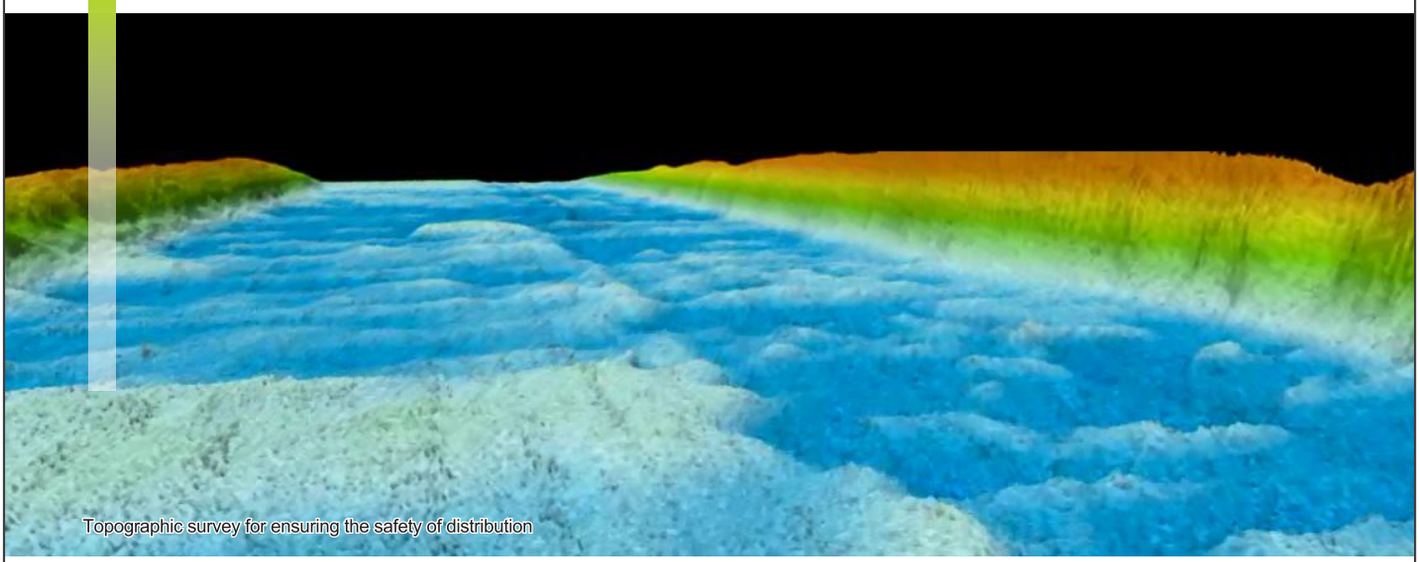

周南大橋(鋼ニールセンローゼ橋)
【臨港道路設計】


クマタカ(絶滅危惧種)【猛禽類調査】

人と地球の未来のために ——
いであ株式会社
http://ideacon.jp/

本　　社	〒154-8585	東京都世田谷区駒沢 3-15-1	電話：03-4544-7600
国土環境研究所	〒224-0025	神奈川県横浜市都筑区早渕 2-2-2	電話：045-593-7600
環境創造研究所	〒421-0212	静岡県焼津市利右衛門 1334-5	電話：054-622-9551
食品生命科学研究所 食品分析センター	〒559-8519	大阪府大阪市住之江区南港北 1-24-22	電話：06-7659-2803
亜熱帯環境研究所	〒905-1631	沖縄県名護市宇屋我 252	電話：0980-52-8588
支　　社	大阪，沖縄		
支　　店	札幌，東北，福島，北陸，名古屋，中国，四国，九州，沖縄		

Green communities
～ Towards a better future, for people and the environment ～



Topographic survey for ensuring the safety of distribution

Kokusai Kogyo, as a leading company of geospatial information technologies, has been contributing to the improvement of public services with advanced measurement technologies and a wide range of consulting technologies. Kokusai Kogyo supports the development of “Green Communities” representing the new era public concerns on “environment and energy,” “disaster prevention and mitigation” and “asset management”. Kokusai Kogyo offers advanced analysis of geospatial information consultancy for developing new government policies, maintaining and operating social infrastructures with safe and secure city planning, and building low-carbon cities.

Strata probing for the purpose of the route selection of the offshore pipeline

Tsunami observation by shortwave ocean radar (H-F RADAR)

Japan Asia Group

KOKUSAI KOGYO CO., LTD.

2 Rokubancho,Chiyoda-ku,Tokyo,Japan 102-0085
http://www.kkc.co.jp/english/ info_overseas@kk-grp.jp

Production Sales and Painting Works of the environment-friendly

"Physical Marine-growth Prevention Paint"

SAFETY PRO SERIES

Already in use as the environmental protection materials for anti-marine growth of the marine biological production systems and equipments in aqua cultural fields.

Company : Saikai Laboratory of Aquaculture and Technology Co.,TLd

Address : E2 Espoire-Ohno, 7-12 Tabaru-chou,Sasebo-City, Nagasaki 〒857-0136 Japan

Contact : Department : Research Laboratory

: U R L : hthttp://aquasafty.com

: E-mail : saikaiken@eco.ocn.ne.jp

Product Introduction

"SAFETY PRO ,the physical marine-growth-prevention Paint "

:Environment-friendly anti-marine-growth paint based on the physical repellent effect of silicone, with total absence of chemically repellent substance like medicine or heavy metals.

Making the painted surface highly lubricous, the biological surface depositing strength of the marine growth decreases.

Thus, the painted surface provides highly peelable base for long sustained marine growth prevention effect.

Specifications

Product	Target	Working			Content	Product Items
SAFETY-PRO	Mesh	1-Lquid type	Final-coat	Dipping	15kg	TC-D-M-15
					3kg	TC-D-M-3
	Boxes	2-Lquid type	Top-coat	Spray painting	15kg	TC-D-B-15
					3kg	TC-D-B-3
			Under coat		15kg	UC-D-B-15
					3kg	UC-D-B-3
SAFETY-PRO S	Mesh	1-Lquid type	Final-coat	Dipping	15kg	TC-D-M-15S
					3kg	TC-D-M-3S
SAFETY-PRO F	Boxes	2-Lquid type	Top-coat	Dipping	15kg	TC-D-B-15F
					3kg	TC-D-B-3F
		2-Lquid type	Under-coat		15kg	UC-D-B-15F
					3kg	UC-D-B-3F
SAFETY-PRO HB	Water Tanks	2-Lquid type	Top-coat	Brush painting	15kg	TC-B-T-15
					3kg	TC-B-T-3
		2-Lquid type	Under coat		15kg	UC-B-T-15
					3kg	UC-B-T-3
SAFETY-PRO Tinner	for dilution				16L	D-SS-16
					4L	D-SS-4

Product sales Performance

(incorporated Foundation) JICE: "Feasibility Study related with the Recovery of Natural Pearl and Natural Pearl Industry in the Bahrain Kingdom for the year 2013", Ministry of Economy, Trade, and Industry (METI)

"Study on Advanced Method of single Seed Oyster Culture", Advanced Agriculture-Commerce-Engineering Joint Study Project for the year 2011.

(incorporated administrative agency) The Fisheries Research Agency(FRA) ; National Research Institute of Aquaculture ; National Research Institute of Fisheries Engineering (NRIFE) ; Saikai National Fisheries Research Institute ; chuuou National Fisheries Research Institute ; Setonaikai National Fisheries Research Institute ; National Research Institute of Fisheries Science ;

(Local independent administrative corporations) Hokkiado Prefectural Research Institute ; Coast Wide area Promotion Bureau, Iwate Prefecture ; Agriculture , Forestry and Fisheries Department. Miyagi Prefecture ; Hirosima Prefectural Institute of Technology; Kyoto Prefectural Agriculture, Forestry and Fisheries Technology Center ; Kagawa Prefectural Fisheries Experiment Station ; Kumamoto Prefectural Fisheries Reserch Center ; fukuoka Prefectural Fisheries Marine Technology Center

人と地球にあたたかな技術、
ハートテクノロジー。

海の息吹、大地の鼓動、そして都市の活気。
地球の自然と快適な生活の調和こそ、私たちの願いです。
人にあたたかな技術を追求し、夢を確かなカタチに育て、
感動の明日を築いていきます。

東洋建設
〒135-0064 東京都江東区青海二丁目4番24号
Tel. 03-6361-5450
http://www.toyo-const.co.jp

Halocynthia roretzi

Haliotis discus hannai

SFJO

Society of France-Japan Oceanography
3-9-25, Ebisu , Shibuya-ku, Tokyo, 150-0013, Japan

Designed by Y. Okumura, Photographed by H. Takami