

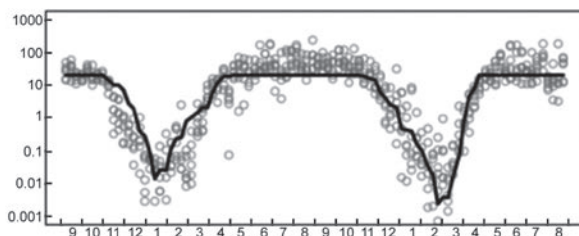
# Cutting-Edge Research at Kyoto University Facilities

## Molecular Phenology and the Seasonality of Genes

**MOL-ECOL** *Genome-wide gene expression analysis in natural plants.*



Phenology is the study of seasonal events in plants and animals. Disturbances in plant phenology due to global warming have been reported in many locations around the world. As with external phenomena, such as flowering and leaf fall, gene function is also thought to be seasonally controlled in plant cells. It is necessary, therefore, to improve the prediction methods of plant phenology by incorporating gene expression analyses. The most prominent data set from my project is a two-year seasonal transcriptome of *Arabidopsis* covering 20,000 genes. The data it provides allows us to model many genes against meteorological data. The method we have developed can be applied to various technologies, enabling early reports of plant phenology, predictions of plant responses to global warming, designed breeding of crops, and other functions.



*Arabidopsis* plants under snow cover (top left) and exposed conditions (top right) during winter, and a seasonal pattern of two-year gene expression in a gene that controls flowering time (bottom)

**Hiroshi Kudoh, PhD**

*Professor, Center for Ecological Research* 21  
[www.ecology.kyoto-u.ac.jp/~kudoh/en/index.html](http://www.ecology.kyoto-u.ac.jp/~kudoh/en/index.html)



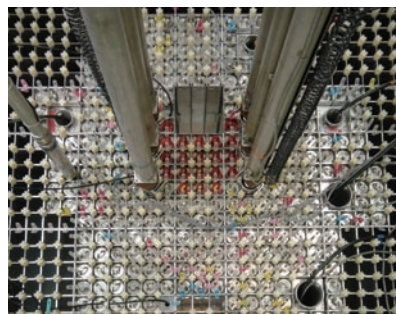
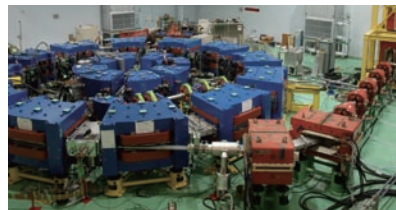
## The Challenge of Nuclear Transmutation

**REACT-PHIS** *Promising method of removing radioactive waste from power plants.*

The accelerator-driven system (ADS) is a promising potential method to achieve the nuclear transmutation of radioactive waste (minor actinides and long-lived fission products) from nuclear power plants. When applying ADS to nuclear transmutation, spallation neutrons (high-energy neutrons) obtained by an injection of high-energy protons onto a heavy metal target are employed. Among the basic research projects into ADS, at the Kyoto University Critical Assembly (KUCA), a series of reactor physics experiments coupled with the fixed-field alternating gradient (FFAG) accelerator is being carried out, and the neutron characteristics of ADS are investigated through static and kinetic analyses by means of experiments and calculations.

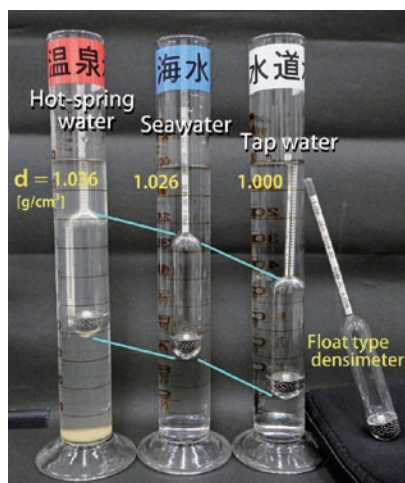
**From the Editor** For the work, He was listed in The Top 25 Most Downloaded Articles for 2011 (*Ann. Nucl. Energy*) from the Elsevier's Sciverse Sciencedirect and was awarded the JNST Most Cited Article Award for 2014 (*J. Nucl. Sci. Technol.*) from the Atomic Energy Society of Japan.

**Cheol Ho Pyeon, PhD** *Associate Professor,*  
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## Does Water Come from the Deep Earth?

*Geochemical investigation of hot-springs originating from deep fluid.*



The existence of hot-spring waters of high salinity was well known in non-volcanic regions, but their origin has been unknown for a long time. We began our geochemical investigation of hot-spring waters discharged in the non-volcanic regions of the southwestern part of Japan in 2003. Through our studies we expect to find hot-spring waters derived from deep fluid characterized by CO<sub>2</sub>-bearing saltwater, such as Arima-type thermal water, which originates from dehydrated metamorphic fluid released from the Philippine-Sea plate subducting into the interior of the earth.

◀ Density measurements for saline hot-spring water sampled from Arima, seawater, and tap water using a float type densimeter

From the Editor ▶ An oral presentation on this research was chosen as a highlight paper of the Japan Geoscience Union Meeting in 2014 (SIT40-13).

**Shinji Ohsawa, PhD**

Professor, Beppu Geothermal Research Laboratory,  
Graduate School of Science 37

[www.vgs.kyoto-u.ac.jp/japanese/personal%20page/j-ohsawa.html](http://www.vgs.kyoto-u.ac.jp/japanese/personal%20page/j-ohsawa.html)



## Improving Wheat

*Examining the genetic diversity of wheat relatives.*

Wheat is one of the most important crops in the world. Its production requires less water than rice or corn, and wheat improvement is urgently needed to respond to the increase of the world's population. This will be achieved through the introduction of novel genes into wheat. It is very important, therefore, to understand the genetic diversity of relatives of wheat. I examined the genetic diversity of wheat relatives and found that, at present, quite a limited range of diversity is employed in wheat. I also discovered that the distribution of a wild relative of wheat has been greatly affected by post glacial climate changes.



**Taihachi Kawahara, PhD**

Associate Professor, Laboratory of Crop Evolution, Graduate School of Agriculture 17  
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POINTS OF INTEREST 6

## The Laboratory of Crop Evolution 17

The Laboratory of Crop Evolution in the Plant Germ-Plasm Institute of Graduate School of Agriculture is a historic facility located in Mozume, Kyoto. The Laboratory originated as the Kihara Institute for Biological Research, founded in 1942 by Dr. Hitoshi Kihara, an internationally recognized wheat expert (See *Res. Act.* 4, no.3 [2014]: 6-9). Dr. Kihara was engaged in research on various plants, including wheat and seedless watermelons. In 1959, Kyoto University purchased the land and premises. Since then, the university has utilized the facility as an agricultural experiment laboratory affiliated with the Graduate School of Agriculture.



WEB [www2.ocn.ne.jp/~pgpinst/index\\_e.htm](http://www2.ocn.ne.jp/~pgpinst/index_e.htm)

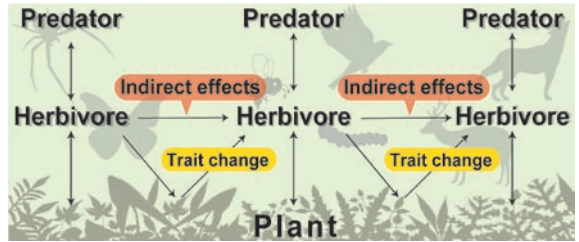
**Dr. Hitoshi Kihara (1893–1986)** was a geneticist who served as a professor in Kyoto University's Faculty of Agriculture from 1927 to 1956. He noticed that in wheat, seven chromosomes form the basic unit of inheritance and function, and named it a genome. The concept of the genome has been vital to the development of biology and genetic engineering.

## ECOL How is Biodiversity Created in Nature?

*Conceptualization of the interaction networks in ecosystems.*

Why are there so many species and interactions in nature? This has been the fundamental question in the field of Biology since the Darwin era. In this context, understanding how biodiversity is created and maintained is one of the most challenging issues in modern ecology. Food webs, based on “who eats whom,” embedded in an ecological community, have long been a basic tool to explore how biodiversity is organized in a wide range of ecosystems. However, growing evidence is that nontrophic, indirect, and mutualistic interactions, which have not been involved in the traditional food webs, are essential in forming novel interaction networks, thereby enriching biodiversity. It is critical to consider these key interactions because they are ubiquitous and widespread in nature, and they play an important role in determining species and interaction diversity.

My work has focused on the way in which nontrophic, indirect, and mutualistic interactions organize plant-based arthropod communities and alter their biodiversity. In 2005, I proposed a conceptual framework for an “indirect interaction web,” which is an interaction network that enables us to understand the components of species and interaction diversity by focusing on nontrophic, indirect, and mutualistic interactions, as well as trophic interactions. Interaction linkages caused by plant-mediated indirect effects have the potential to greatly enrich biodiversity by increasing the diversity and complexity of the network structure of interacting species. Although feeding relationships are a crucial part of the network structure, food webs provide an incomplete picture of the



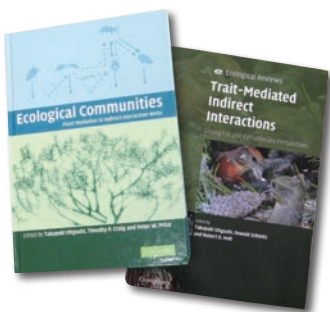
Indirect interaction web: It has been conventionally considered that food chains, or vertical species interactions, are independent of each other. However, it has recently been found that plant-mediated indirect effects, or horizontal species interactions, are closely linked to food chains. In this way, plants form the foundation of a complex ecological network, structured like a rich tapestry with interwoven horizontal and vertical threads.

forces structuring ecological communities and biodiversity because they have ignored the plant-mediated indirect effects induced by herbivores. The indirect interaction web can be utilized to improve our understanding of the complexity of a plant-based ecological community, and this knowledge will aid efforts to conserve interaction biodiversity in nature. Thus, the indirect interaction web has established a novel approach that explicitly incorporates such key interactions into the components of the traditional food webs. This approach can also provide fundamental insights into the big question of how evolution drives the organization of the ecological processes of communities and ecosystems.

**Takayuki Ohgushi, PhD**

*Professor, Center for Ecological Research* 21

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Text books on “indirect interaction webs.” Left: Ohgushi, Craig, & Price (2007). Right: Ohgushi, Schmitz, & Holt (2012).

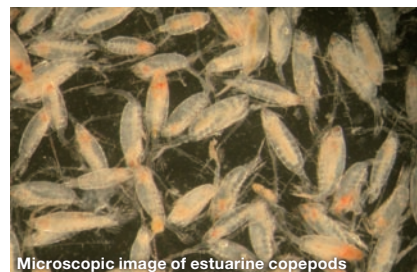
## MAR-ECOL Dynamics of Zooplankton

*Investigating links between phytoplankton and fish production.*

Defined as animals that drift with the surrounding water, zooplankton encompass all sorts of taxonomic groups and play a wide variety of ecological functions in aquatic environments. My research focuses on small crustacean groups, specifically copepods and mysids, which are essential links between phytoplankton and fish production. My interests include how copepods and mysids respond to their changing environment, how they interact with one another, and how they contribute to fish production. Using simple traditional techniques, I conduct physical and biological sampling in rivers, estuaries, and coastal waters regularly throughout the year. For me, microscopic analyses of zooplankton samples are always full of wonder, and often lead to new research questions.



▲ Dr. Suzuki, sampling in an estuary



Microscopic image of estuarine copepods

**Keita Suzuki, PhD** *Assistant professor, Maizuru Fisheries Research Station, FSERC* 13

[www.maizuru.marine.kais.kyoto-u.ac.jp/en/member-en/kyouin-en.html](http://www.maizuru.marine.kais.kyoto-u.ac.jp/en/member-en/kyouin-en.html)

## PHYS-ECO Ogasawara Islands: A Natural World Heritage Site

*Research into drought tolerance of woody plants and ecosystem conservation.*

The Ogasawara Islands are oceanic islands located 1000 km south of Tokyo. Approximately 70% of tree species in the islands are endemic. The soil is thin and of volcanic origin. The precipitation is relatively low, especially in summer, and the islands have exhibited a trend towards increased dryness over the past 100 years. As a result, extremely unique forests called “dry dwarf forests” have developed. I have examined the drought tolerance mechanisms of woody plants in such forests. The most drought-tolerant woody plants grow in the island’s extremely thin soils. Ironically, such plants have the highest risk of death because of extreme soil dryness due to prolonged drought. With the predicted future shift in global precipitation patterns, the unique forests of the Ogasawara Islands could suffer irreversible damage. I hope to conserve this rare ecosystem for our next generation.



### Atsushi Ishida, PhD

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Hahajima



Anijima

## SILVICULT Learning from Old Japanese Ways

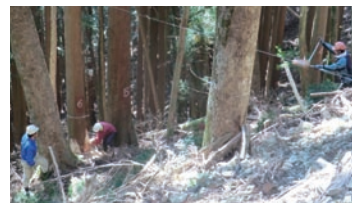
*Towards the future, with the blessings of the forest.*

Japan is a forest country. 67% of the land is covered with forests, of which 40% are plantations. Although, in the past, the Japanese developed customary practices for the sustainable use of forest resources, their traditional knowledge of “site-adapted forestry” is being lost due to social and economic changes in recent decades. I am developing a new sustainable forest utilization system suitable for modern and future societies which combines traditional methods and forefront technologies, such as Global Navigation Satellite Systems (GNSS), remote sensing, and forestry machines. This approach is called “precision forestry,” and it involves not only forestry, but also the fields of ecology, engineering, economics, and sociology. While engaged in this challenging multidisciplinary work, I am living in a community near the Wakayama Forest Research Station, where I work in collaboration with the local community.



### Hisashi Hasegawa, PhD Chief and Associate Professor,

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## New Observatory Building at Shirahama

The new building of Shirahama Oceanographic Observatory 30, DPRI was completed in the end of 2014. The facilities and the features of the observatory are renewed, and the seminar room of the observatory is used as a temporary shelter space for local residents under tsunami warning. The fundamental observed data is released on the web site (<http://refcd.dpri.kyoto-u.ac.jp/frs/shirahama/data.php>).

WEB [refcd.dpri.kyoto-u.ac.jp/frs/SOO\\_E.htm](http://refcd.dpri.kyoto-u.ac.jp/frs/SOO_E.htm)

(The Observatory web site)



## VOLCANOL Mitigation of Volcanic Hazards

*Sakurajima—the most active volcano in the world.*

I have been conducting studies on forecasting the volcanic eruptions of Sakurajima at the Sakurajima Volcano Research Center since 1981. Sakurajima is the most frequently erupting volcano in the world. This year alone, over 600 vulcanian eruptions occurred at the Showa crater of the volcano. The most effective method to detect precursory signals of eruptions is ground deformation observation using tiltmeters and strainmeters in underground tunnels. A very large eruption occurred in 1914, ejecting over 2 km<sup>3</sup> of volcanic ash and lava. After the eruption, the magma was recharged in the reservoir north of the volcano and is now back to 90% of what it was before the 1914 eruption. It is vital that we establish methods to counter such a large eruption. The first step towards mitigating volcanic hazards is obtaining an early warning of eruption by detecting precursors and evaluating the time and scale of the forthcoming eruption.



Sakurajima Volcano



**Masato Iguchi, PhD** *Professor, Sakurajima Volcano Research Center, DPRI* ④

[kyouindb.iimc.kyoto-u.ac.jp/e/rF9qW](http://kyouindb.iimc.kyoto-u.ac.jp/e/rF9qW)

## ECOL How Does Winter Climate Change Affect Forests?

*In-situ snow cover manipulation experiment in the university's forest station.*



Climate change alters winter temperature and snowfall regime, changes which are expected to affect the structure and functioning of forest ecosystems. The Hokkaido Forest Research Station of Kyoto University's Field Science Research and Education Center is located in eastern Hokkaido, where the soil is frozen due to severely cold temperature and thin snow cover in winter. In the station's natural forests, the staff members are working in cooperation with a research group led by Prof. Hideaki Shibata of Hokkaido University to undertake a large scale in-situ snow cover manipulation experiment exploring the way in which winter climate change affects soil nutrient and microbial dynamics, plant productivity and phenology, and other factors. An interdisciplinary joint research project, the experiment involves ecologists, biogeochemists, hydrologists, physiologists, microbiologists, and pedologists.



**Ryunosuke Tateno, PhD**

*Chief and Associate Professor, Hokkaido Forest Research Station, FSERC* ①②

[kyouindb.iimc.kyoto-u.ac.jp/e/cJ2sO](http://kyouindb.iimc.kyoto-u.ac.jp/e/cJ2sO) (Dr. Tateno)

## MED-SCI Attacking Cancer with Neutrons

*A study of radiation biology to enhance Boron Neutron Capture Therapy.*

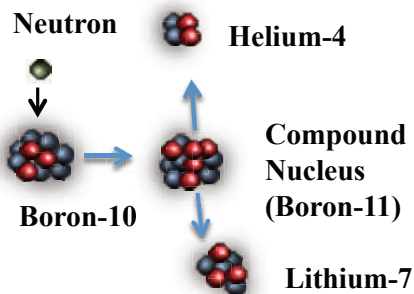
Cancer cells are surrounded by normal cells. A targeted therapy using neutrons, which kills only cancer cells, has been carried out at Kyoto University's Research Reactor Institute (KUR). Boron Neutron Capture Therapy (BNCT) uses the effect of the <sup>10</sup>B(n,α)<sup>7</sup>Li reaction to selectively destroy cancer cells injected with boron-10 compound. I have performed a study that aims to improve the effect of BNCT, and investigated DNA damage in the human body caused by neutron radiation. I found that Vitamin C is effective in protecting the human body from the effects of neutron radiation, which is has a greater effect on the human body than x-ray radiation. I aim to develop a neutron treatment for cancer with few side effects.



*From the Editor* Dr. Kinashi was awarded the Tamiko Iwasaki Award by the Japanese Radiation Research Society in October 2014.

**Yuko Kinashi, MD, PhD** *Associate Professor, Kyoto University Research Reactor Institute* ③

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The low-energy neutrons combine with <sup>10</sup>B to form <sup>11</sup>B, releasing lethal radiation (alpha particles and lithium ions) that can kill cancer cells

## Capture the Wind, Waves, and Currents

*Field observation of meteorological and oceanographic phenomena.*

Shirahama, one of the most famous hot spring resorts in Japan, is often affected by typhoons and is subject to severe wind and wave conditions. The observation tower of the Shirahama Oceanographic Observatory (SOO), Disaster Prevention Research Institute (DPRI), Kyoto University takes field measurements of meteorological and oceanographic phenomena. Such field data is crucial to understanding various phenomena in coastal regions. Field data of severe wind and wave conditions is particularly scarce because of the difficulty in obtaining it. The data gathered by the observation tower therefore has an important role to play in investigating coastal processes such as air-sea interaction. The long-term continuous measurement provided by the observatory contributes to a multidimensional understanding



of coastal processes caused by numerous factors, including the Black Current.

### Yasuyuki Baba, PhD

Associate Professor, Shirahama Oceanographic Observatory, DPRI 30  
[rfd.dpri.kyoto-u.ac.jp/frs/SOO\\_E.htm](http://rfd.dpri.kyoto-u.ac.jp/frs/SOO_E.htm)



Research vessel, *Kaishō*



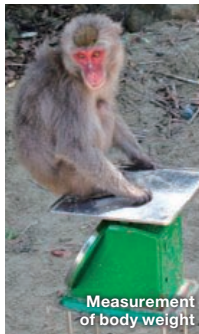
The observation tower of the SOO

## Do Infants Grown Slowly Catch Up Ones Grown Fast?

*Body weight data throughout life in Japanese Macaques in field.*



An adult female and its baby



Measurement of body weight

Koshima islet, where all the Japanese macaques have been identified for over sixty years, is well-known as birthplace of primatology in Japan. Unique data such as maternal lineage and monthly body weight data has been accumulated for long term. While body weight is one of important indexes which affect animals' survival and reproductive performance, it's almost impossible to measure it in field. In my analysis female infants grown slowly give birth to less offspring than ones grown fast due to shorter life span and longer interbirth interval. Males grown slowly also suffer disadvantage in survival and related index, lifespan and maximum body weight in whole life time. So infants which are behind in growth may be going to pay in their adulthood.



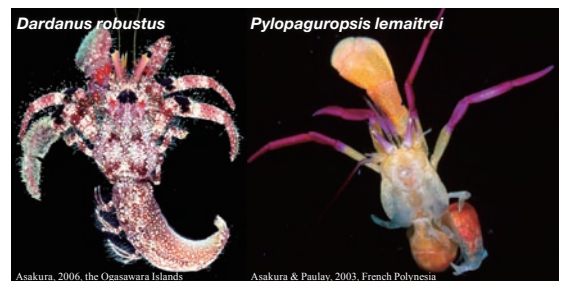
Akiko Takahashi, PhD *Researcher, Koshima Field-Station, Wildlife Research Center* 40

[www.wrc.kyoto-u.ac.jp/koshima\\_st/index\\_e.htm](http://www.wrc.kyoto-u.ac.jp/koshima_st/index_e.htm)

## Biodiversity in Marine and Freshwater Crustaceans

*New developments in marine biology studies.*

My research interests focus on marine and freshwater crustaceans and other benthic macro-invertebrates, and range broadly across animal behavior, population dynamics, community ecology, taxonomy, systematics, biogeography, phylogeography, and environmental sciences. I have been intensively studying the taxonomy of hermit crabs in the Indo-West Pacific area and found global patterns of diversity. The greatest diversity is seen in the Philippines, Malay Peninsula, and Australia, known as the Indo-Malayan center of maximum marine biodiversity, or the coral triangle, due to its large number of marine organisms. A distribution boundary of many species is found at the eastern edge of West Pacific (i.e. the East Pacific Barrier). Hotspots of speciation are found in peripheral areas of the Indo-West Pacific, including Japan, Hawaii, and the Red Sea.



Asakura, 2006, the Ogasawara Islands

Asakura & Paulay, 2003, French Polynesia

Akira Asakura, PhD *Professor, Seto Marine Biological Laboratory, FSERC* 31 [kyouindb.iime.kyoto-u.ac.jp/e/qR7vD](http://kyouindb.iime.kyoto-u.ac.jp/e/qR7vD)

## SYST-FISH Fish in the Sea of Japan

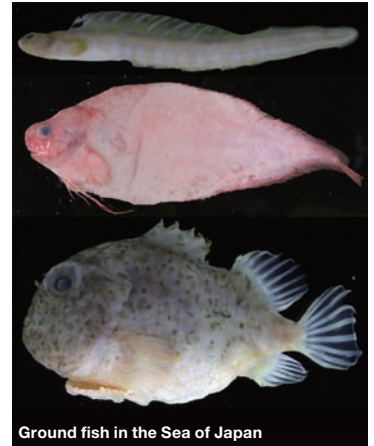
*When and where did they come from?*

The Sea of Japan, a semi-enclosed sea in the North Pacific, is joined to neighboring waters via relatively narrow shallow straits. Accordingly, sea level regressions during the glacial periods likely resulted in the isolation of the Sea of Japan and the fragmentation of many populations of marine organisms. Based on molecular genetic analyses, I have revealed the impact of historical events for ground fish in the Sea of Japan. For example, clear genetic divergences between the Sea of Japan and other geographic regions of the North Pacific were found in the *Sake-bikunin* species of snailfish. The genetic divergence suggested that colder climates from the late Pliocene epoch and the isolation of the Sea of Japan during the Pleistocene epoch may have driven its divergence. Interestingly, similar patterns of genetic divergence have been detected in some other ground fish, which suggests that they have been isolated through a common historical event.



**Yoshiaki Kai, PhD** Assistant Professor, Maizuru Fisheries Research Station, FSERC 13

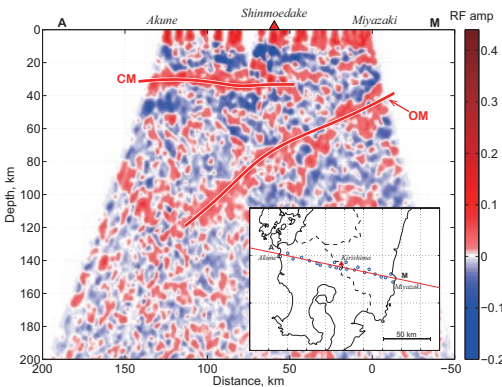
[www.maizuru.marine.kais.kyoto-u.ac.jp/en/](http://www.maizuru.marine.kais.kyoto-u.ac.jp/en/)



Ground fish in the Sea of Japan

## REG-PHYS Seeing Underground with Seismic Waves

*Imaging the Philippine Sea plate subducting beneath southern Kyushu.*



What is occurring under the ground beneath southern Kyushu, where a Nankai Trough megaquake could occur and magma is generated beneath the Sakurajima and Kirishima volcanoes? Using seismic waves, we try to see the earth's interior, through which light cannot propagate. Since 2010, we have deployed seismometers with an average spacing of 5km from Miyazaki to Akune via the Kirishima volcano. We have analyzed P waves from large earthquakes in distant regions, such as Indonesia, extracted S waves which were converted from the P waves at seismic velocity discontinuities, such as the top surface of the Philippine Sea plate, and obtained an image of the geometry of the discontinuities. We have successfully imaged the oceanic Moho (OM) in the subducting plate and the continental Moho (CM) in the western part of southern Kyushu, both of which are boundaries between the crust and the mantle.

**Takuo Shibutani, PhD**

Chief and Professor, Tottori and Miyazaki Observatories, Research Center for Earthquake Prediction, DPRI 19 39

[www1.rcp.dpri.kyoto-u.ac.jp/~shibutan/index.html](http://www1.rcp.dpri.kyoto-u.ac.jp/~shibutan/index.html)



## Japanese Cedar Wood House

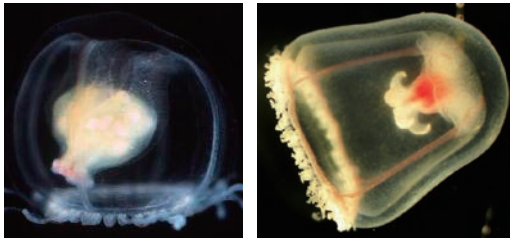
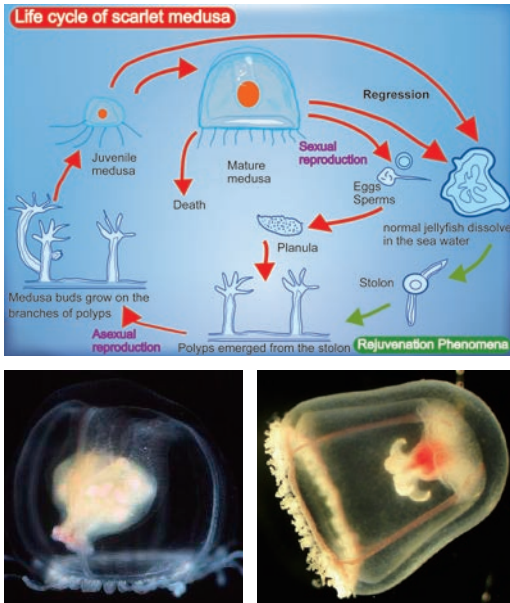
*Unique building using a method developed by the university.*

International Seminar House in Yoshida Campus, is constructed of thinned timber from Japanese cedar trees grown at the university's Wakayama Forest Research Station. The construction method used, called "j.Pod," was developed by an industry-academia collaboration group including Prof. Masami Kobayashi and Assoc. Prof. Hirohide Kobayashi from Graduate School of Global Environmental Studies. The method was also used to construct other university buildings, including parts of the Wakayama Forest Research Station and some buildings on Yoshida North Campus. Through promoting the use of the j.Pod construction method, the university seeks to contribute to local forestry and industry.



## Will Human Dreams of Immortality Come True Through Jellyfish Research?

Biological and life science studies of immortal and ephemeral jellyfishes.



From the Editor Dr. Kubota received the Award of the Biogeographical Society of Japan in 2012 for his numerous works of immortal jellyfish. His studies were reported by the *New York Times* in December 2012, resulting in his participation in Google Zeitgeist 2013 (London), Ideacity 2013 (Toronto), and other significant scientific events.

### Shin Kubota, PhD

Associate Professor, Seto Marine Biological Laboratory, FSERC 31

[www.benikurageman.com/en/index.htm?](http://www.benikurageman.com/en/index.htm?)

[www.seto.kais.kyoto-u.ac.jp/shinkubo/shinkubo\\_home/index\\_en.html](http://www.seto.kais.kyoto-u.ac.jp/shinkubo/shinkubo_home/index_en.html)



## The Kozagawa Project

A First Step for Global Restoration.

The earth is composed of three ecosystems: wild, cultural, and pseudo-cultural. The wild ecosystem originated at the time of the big bang, the cultural ecosystem evolved from the wild ecosystem with human intervention, and the pseudo-cultural ecosystem rapidly appeared in an unsustainable manner collisions and fusions of cultures between polytopic civilizations.

In modern and early modern Japan, some regions have been blessed with, or suffered chaotically from, various elements of man-made ecosystems. As a result, wild and cultural ecosystems have dwindled and become vulnerable, while pseudo-cultural ecosystems have been expanding and causing harm.

I have launched a voluntary project, the *Kozagawa Project*, comprising members from the townsmen, government, industrial, and academic sectors. The project adopts as its symbol a monolithic rock formation in the Koza River, a natural national treasure. The *Kozagawa Project* is a 50-year field program which regards the southern Kii Peninsula as a model region for applied anthropology, and aims to restore all aspects of the region's wild, cultural and pseudo-cultural ecosystems to well-balanced dynamic phases using the wisdom of cosmology regarding the interactions of the four fundamental forces (gravitational, electromagnetic, strong nuclear, and weak nuclear). The project began in 2004, and its first stage will last until the middle of the 2050s.

The data and folklore knowledge collected in this project have been documented in *The Report of the Kozagawa Project's Combined Forces: FSERC/ KOPCOM, 1-10*.

### Shinya Umemoto, PhD Director and Associate Professor, Kii-Oshima Research Station, FSERC 23

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## How Do We Calculate the Value of $\pi$ ?

*Opening new horizons with the Monte Carlo method.*



Cherenkov radiation glowing in the core of the Kyoto University Research Reactor (KURR)

How do we calculate the value of  $\pi$ , the ratio of a circle's circumference to its diameter? It is well known that this value can be calculated by using random numbers instead of arithmetic methods. This stochastic approach is known as "the Monte Carlo method," and it is now being applied to many areas of science, including neutron and light transport calculations in nuclear reactors. However, the method is not always a sufficiently versatile tool to replace other conventionally used deterministic methods. I am currently devoted to research that could expand the area of application of the Monte Carlo method. Recently, I succeeded in using the method to establish an algorithm to solve a complex-valued transport equation. I hope that this accomplishment enlarges the areas in which the Monte Carlo method can be applied, and opens the way for further developments.



### Toshiiro Yamamoto, PhD

*Associate Professor, Kyoto University Research Reactor Institute* 33

[www.ne.t.kyoto-u.ac.jp/en/information/laboratory/person/YamamotoToshiiro-fold?set\\_language=en](http://www.ne.t.kyoto-u.ac.jp/en/information/laboratory/person/YamamotoToshiiro-fold?set_language=en)

## Magic Toilet: The Future of Global Sanitation

*Alleviating water pollution and food shortage.*

A third of the seven billion people on Earth are without sanitation, which puts their water supplies at risk. Sanitary sewer systems in the developed world are effective but not sustainable. To achieve a high level of efficiency, it is generally not advisable to mix or dilute different types of waste, and yet the current toilet and sewer systems mix and dilute urine and feces—with each other and with other liquids, including water. A solution to this problem could be "diversion." Our body naturally separates urine (high in essential nutrients for plants) from feces (low in nutrients, but high in pathogens). Sewer systems which employ urine diversion have the benefit of producing waste which can be used as a fertilizer in developing countries, and in developed countries they reduce the load on nutrient removal processes. This technique is compatible with public sewer and centralized treatment systems in developed countries.



Specially designed toilet can divert (separate) urine from feces



### Yoshihisa Shimizu, PhD

*Professor, Graduate School of Engineering /*

*Research Center for Environmental Quality Management* 22

[www.eqc.kyoto-u.ac.jp](http://www.eqc.kyoto-u.ac.jp) (RCEQM web site)



## Abuyama Observatory



Established in 1930, the Abuyama Observatory 18 is located 218m above sea level at the top of the *Bijin Yama* ridge, which stretches south from the summit of Mt. Abuyama in northeast Osaka prefecture. Built on the slope of the mountain, the observatory consists of a main building and an adjoining annex on its west side. The observatory was described as a remarkable modern heritage site in the report on modern heritage produced by Osaka prefecture in 2007. The report compared the entrance hall connecting the main building and the west annex to "the interior of a modernized Greek temple." Many people visit the observatory to see

WEB [abuyama.com/top.html](http://abuyama.com/top.html)

## EVOL MORPH PR | The Evolutionary Morphology of Macaques

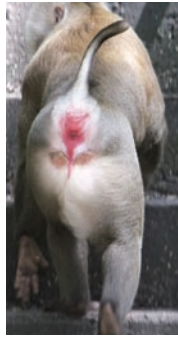
*History and mechanisms producing new species of macaques.*

Macaques, such as Japanese monkeys, are common monkeys living widely in Asia. They have diversified greatly into twenty-one living species. I am investigating their diversity, mechanisms, and the history of how their traits have evolved. By means of ecological segregation, they share common habitats, forest type, geographical conditions and life styles of terrestriality vs. arboreality. Macaques have survived climate changes in glacial periods, which likely had a great influence on their phylogeny and morphology. Macaque morphology has been shaped not only by their fundamental life activities, such as feeding or positional behavior, but also by the communication in their societies which varies greatly among species.



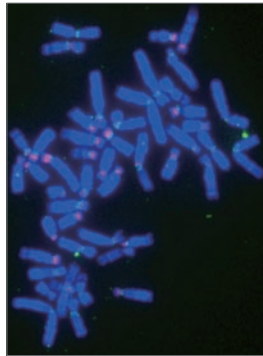
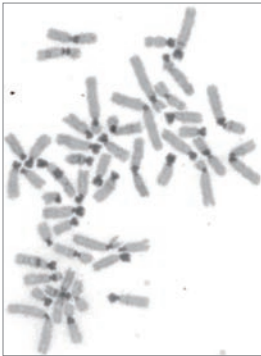
**Yuzuru Hamada, PhD** Professor, Primate Research Institute 20

[www.pri.kyoto-u.ac.jp/shinka/keitai/index.htm](http://www.pri.kyoto-u.ac.jp/shinka/keitai/index.htm)



## EVOL MORPH PR | Why are Genomic “Garbage Cans” Important?

*Seeking the pathway that Chromosome evolve from constitutive heterochromatin.*



Constitutive heterochromatin regions (black regions in fig. left) are colloquially called genomic garbage cans because they are filled with junk DNA (inert genetic material). However, these so-called ‘wastelands’ are actually quite important for the creation of chromosome changes and/or karyotype evolution. In monocentric chromosomes with a single centromere, that centromere and its vicinity provide an important apparatus for morphological differentiation among chromosomes and constituting markers for karyotype evolution. The apparatus is generally composed of multiple repetitive DNA sequences, and can be analyzed via fluorescent *in situ* hybridization

(FISH) techniques using specific DNA probes (fig. right). My work investigates the evolutionary pathways of chromosomes from the perspectives of such structural and component alterations.



**Hirohisa Hirai, PhD** Director and Professor, Primate Research Institute 20

[www.pri.kyoto-u.ac.jp/sections/molecular\\_biology/english/hirai.html](http://www.pri.kyoto-u.ac.jp/sections/molecular_biology/english/hirai.html)

the building itself, rather than the historic seismometer it houses. The upper floors, in particular, provide tremendous panoramic views of the Osaka Plain. The night view is also spectacular, with the countless lights of Osaka City seeming to spread out to the far corners of the earth. There is also an ancient tomb (*kofun* in Japanese) on the top of the *Bijin Yama* ridge. Dr. Toshi Shida, the first director of the observatory, discovered the *kofun* in 1934 while excavating a tunnel to conduct seismographs. A lacquered coffin containing a mummy was found in a stone chamber. X-ray photographs of the mummy taken by Dr. Shida using advanced radiographic technology indicated that the mummy was a person of noble rank. It is speculated that it could be the remains of Fujiwara no Kamatari, a famous figure in Japanese history. Visitors welcome. Take a taxi from either Settsu-Tonda Station or Takatsuki Station on JR line.

**Dr. Toshi Shida (1875-1936)** is famous for discovering a quadrant-type push-pull distribution of initial seismic motion (push-pull of P wave initial motion, distributed in quadrants,) predicting the existence of deep earthquakes, and the discovery of the “Shida Number” in earth tidal force (the elastic deformation of the earth due to solar and lunar attraction). Dr. Shida also established the Beppu Meteorological Research Laboratory (which later became the Research Center for Geophysics), of Department of geophysics, Kyoto University.

## MARINE-BIOLOGY Mathematics Reveals the Origin of Cooperation

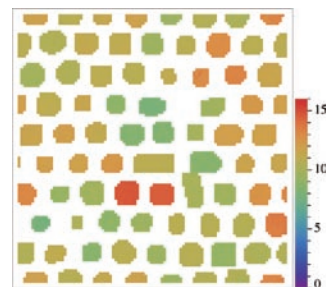
*Studying the evolution of cooperation through equation and computation.*

Cooperation is an important characteristic in some organisms, including humans, although such a behavior can be difficult to evolve and maintain. Typically, when all members of a population behave cooperatively, a defecting individual can enjoy a greater advantage by avoiding cooperative efforts. Such individuals are so-called “free rider” or “cheaters.” We are theoretically investigating the evolutionary process of cooperative interaction using mathematical modeling and computer simulation. We are currently studying three aspects of the evolution of cooperation: (1) relationships between structures of cooperation and variation of cooperation levels in a population, (2) the effects of negotiation between players on the evolution of cooperation, and (3)

the joint evolution of resource exploitation and cooperation in two-dimensional space. In the latter research project, we revealed that, in the spatial structure, the evolution of cooperation can be facilitated by the evolution of resource exploitation that is accompanied by a competition among individuals (Fig.1). This indicates a paradoxical feature in the evolution of social interaction, i.e. a positive interaction (cooperation) can be evolutionarily promoted by the simultaneous development of a negative interaction (exploitation) in a spatially structured population.

**Atsushi Yamauchi, PhD**

*Professor, Center for Ecological Research* 21  
[www.ecology.kyoto-u.ac.jp/~a-yama/main-e.html](http://www.ecology.kyoto-u.ac.jp/~a-yama/main-e.html)



Spatial distribution of individuals. Blue indicates a lower level of altruism and red represents a higher level. The white region represents empty sites.



Textbook of theoretical evolutionary ecology  
(A. Yamauchi, *Shinka-seitai-gaku-nyumon*  
[Tokyo: Kyoritsu Shuppan Co., Ltd., 2012])

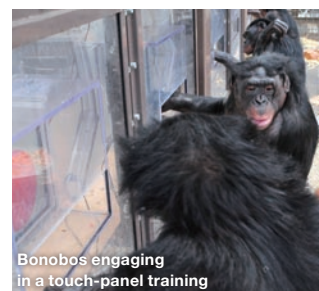


## PRIMATOLOGY Our Evolutionary Neighbors

*Comparative study of chimpanzees and bonobos.*

At Kumamoto Sanctuary, we have received bonobos from US zoos and initiated a new scientific project to study them. Currently Kumamoto Sanctuary is the only place in Japan housing bonobos, and it is also home to the largest number of chimpanzees in the country. Chimpanzees and bonobos are the closest living relatives of humans, and can thus be called our evolutionary neighbors. By conducting a comparative study

of chimpanzees and bonobos, we seek to uncover the evolutionary origins of the human mind. We are also engaged in fieldwork studies of their wild counterparts in Africa. Through these “two-by-two comparisons,” that is, chimpanzees vs. bonobos and wild vs. captivity, we aim to gain true knowledge about human nature.



Bonobos engaging in a touch-panel training



**Satoshi Hirata, PhD (right) and Naruki Morimura, PhD**

*Professor and Program-Specific Associate Professor, Kumamoto Sanctuary, WRC* 41  
[www.wrc.kyoto-u.ac.jp/kumasan/indexE.html](http://www.wrc.kyoto-u.ac.jp/kumasan/indexE.html)

## The Hakubi Project Opportunity for Outstanding Young Talent

The project was established in 2009 to foster outstanding young researchers and recruits twenty international researchers per year as associate and assistant professors. The project is open to any researcher in any academic field.

**WEB** [www.hakubi.kyoto-u.ac.jp/eng](http://www.hakubi.kyoto-u.ac.jp/eng)

## ETHOLOGY Controlling an Invasive Animal: the Cane Toad

*Using the behavior and ecology of cane toads to control their populations.*



**Takashi Haramura, PhD**

*Assistant Professor, The Hakubi Centre for Advanced Research / Seto Marine Biological Laboratory, FSERC* 31  
[www.hakubi.kyoto-u.ac.jp/eng/02\\_mem/h25\\_haramura.shtml](http://www.hakubi.kyoto-u.ac.jp/eng/02_mem/h25_haramura.shtml)

## ATMOSPHERIC Radar Atmospheric Physics for Accurate Weather Forecasts

Development of 1.3-GHz Wind Profiler Radars.



LTR



LQ-7

Observations of wind velocity profiles are crucial for studying meteorological phenomena, weather forecasting, etc. The wind profiler radar (WPR) is one of the most suitable remote sensing instruments for determining the height profiles of wind velocity vectors with high time and height resolutions. We developed the first active phased-array WPR known as the lower troposphere radar (LTR). It has a frequency of 1.3 GHz and a peak output power of 2 kW with a 4 × 4 m active phased-array antenna. The same radar system is adopted in the JMA<sup>1)</sup> wind profiler network, WINDAS.<sup>2)</sup> Next, using seven Luneberg lens antennas, we developed another 1.3-GHz WPR known as LQ-7, which has a peak output power of 2.8 kW. Recently, the JMA replaced the WPRs of WINDAS with LQ-11, which is similar to LQ-7 but uses eleven lens antennas.

1) Japan Meteorological Agency, 2) Wind Profiler Network and Data Acquisition System.

**From the Editor** For his achievements, Dr. Hashiguchi was awarded the Minister's Prize for Science and Technology of the Ministry of Education, Culture, Sports, Science and Technology of Japan and the Horiuchi Prize of the Meteorological Society of Japan.

### Hiroyuki Hashiguchi, PhD

Associate Professor, Research Institute for Sustainable Humanosphere 28  
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## RCEP-PHYS Seeking the Forerunners of Earthquakes

The differences between normal and anomalous phenomena.

Do you believe that major earthquakes are preceded by *anomalous* phenomena, such as increases in electromagnetic noise and ground deformation? There are many reports of such phenomena, but it is a great challenge to distinguish between *normal* and *anomalous* phenomena. Moreover, we have few chances to observe earthquake-related phenomena, because major earthquakes (fortunately) do not occur frequently. I am trying to define the objective differences between *normal* and *anomalous* phenomena, through precise geophysical observations, mainly around the Miyazaki Observatory near *Hyuga-Nada* in southwest Japan, where large earthquakes have repeatedly occurred, together with mathematical modeling of the obtained data.



### Ken'ichi Yamazaki, PhD Assistant Professor, Miyazaki Observatory, DPRI 39

[www1.rcep.dpri.kyoto-u.ac.jp/observatories/MYZ.html](http://www1.rcep.dpri.kyoto-u.ac.jp/observatories/MYZ.html)



Instruments housed in a tunnel to observe subtle strain of Earth's crust

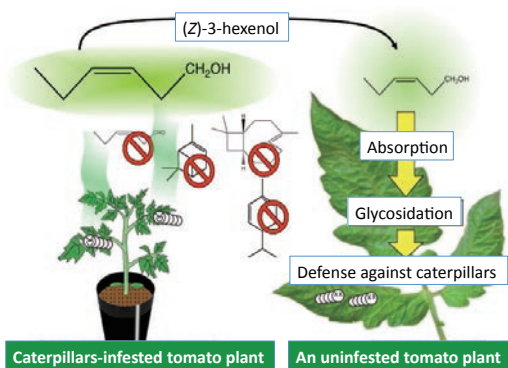
Invasive animals destroy native ecosystems, and the cane toad is one of the most harmful invasive animals in the world. Cane toads have spread to naturally beautiful Japanese islands, such as Ishigaki Island and the Ogasawara Islands. I am seeking methods to control cane toad populations on Ishigaki Island, which lies west of Okinawa, by using the toad's evolved behavior and ecology. I am currently conducting research on their mating call (males call females) and on the pheromones of tadpoles (inducing cannibalism or decreasing the survival of metamorphosis). Through this research I am seeking ways to gather many cane toads together on one site for easy collection, and to decrease the number of cane toads emerging from ponds. Cane toads have been introduced to many areas in the world. Therefore, to find methods to control invasive populations of cane toads world-wide, I am collaborating with scientists in the University of Sydney, Australia, where the cane toad is also an ecological problem.



Cane Toad on Ishigaki Island

## CHEM ECOL How Do Plants Smell Danger?

*Deciphering the mechanisms involved in plant-to-plant communication.*



involved in the volatile reception (smell) in plant-to-plant communication.

**Junji Takabayashi, PhD** *Professor, Center for Ecological Research* 21

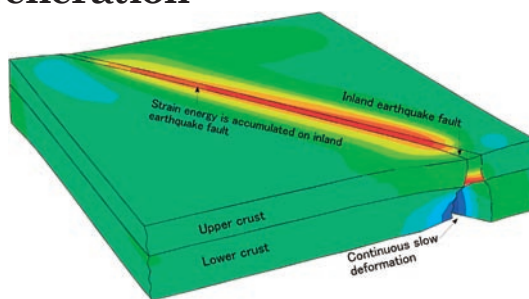
[www.ecology.kyoto-u.ac.jp/~junji/index.htm](http://www.ecology.kyoto-u.ac.jp/~junji/index.htm)



## SEISMOLOGY The Mystery of Earthquake Generation

*Why do inland earthquakes occur?*

Surprisingly, it is not known why inland earthquakes occur. In the Japanese Islands, it is believed that inland earthquakes are generated as strain energy is accumulated by the subduction of oceanic plates. However, inland earthquakes do not occur by this process alone, since the accumulated strain energy is released through the occurrence of large subduction zone earthquakes. In my research, I propose a hypothesis that continuous slow deformations beneath inland earthquake faults accumulate strain energy on the faults and I am examining this hypothesis using observation data. I have developed a new seismic observation system that enables continuous seismic recording at many stations of an order of ten thousands, which has never been done before. I have named it the Manten System, and I have installed approximately 300 stations in Japan and New Zealand. The project is based at the Abuyama observatory.



**From the Editor** This work is funded by the Grant-in-Aid for Scientific Research on Innovative Areas (2014-2018).

**Yoshihisa Iio, PhD** *Professor, Abuyama Observatory, DPRI* 18

[www1.rcep.dpri.kyoto-u.ac.jp/~iio/](http://www1.rcep.dpri.kyoto-u.ac.jp/~iio/)



## EVO-BIO When Predators Promote Speciation

*Theory of speciation processes promoted by biased predation.*

Speciation, the formation of new species, has been the “mystery of mysteries” ever since Darwin, because the first mutant of a new species has difficulty in producing offspring. A snake eating land snails recently suggested a solution to this old conundrum: biased predation on resident individuals (in this case, right-handed snails) could increase the relative fitness (survival advantage) of mutants (left-handed snails), and eventually promote speciation. By analyzing population-genetic models, I found that genetically dominant alleles are favored with predation, whereas recessive alleles are more likely to spread without predation. The speciation theory will be further examined by molecular biological studies in the near future.

**Masato Yamamichi, PhD**

*Assistant Professor, Hakubi Center for Advanced Research / Center for Ecological Research* 21

[sites.google.com/site/mstyamamichi/](http://sites.google.com/site/mstyamamichi/)



## FOREST Why are Forests Important?

*A long-term ecosystem research project based on water cycles and forest education.*



In recent years, the demand for environmental education is increasing in Japan and throughout the world as human beings obtain overwhelming power and greedily pursue more profits, with little awareness that the basis of our existence is in danger. To address this problem, I am undertaking long-term ecological-hydrological research in the Yusen-Dani natural forest covered watershed of Kyoto University Forest in Ashiu, Kyoto. I also engage in forest education activities for citizens and students in Tokuyama Experimental Forest in Shunan City, Yamaguchi. I believe that through my work I can develop an integrated concept of education, natural science, and philosophy.



**Tadashi Nakashima, PhD** *Chief and Lecturer, Tokuyama Experimental Station, FSERC* 36

[fserc.kyoto-u.ac.jp/wp/blog/topics/in\\_english/facilities\\_e](http://fserc.kyoto-u.ac.jp/wp/blog/topics/in_english/facilities_e)

## PALEONTOLOGY Searching for Primate Fossils in Southeast Asia

*Evolutionary history and differences of primate fauna in Southeast Asia.*

Since 1998, I have carried out paleontological investigations in central Myanmar with the main aim of discovering primate fossils. Myanmar is located in continental Asia, and since the 19<sup>th</sup> century it has been very well known for producing a diverse quantity of mammalian fossils, including those of primates from the Tertiary sediment (up until sixty five million years ago). In particular, fossil primates from the latest Middle Eocene Pondaung Formation are regarded as the oldest anthropoid primates in Southeast Asia (including New and Old World monkeys, apes, and humans).

I am now searching for primate fossils from the Late Miocene to Pliocene Irrawaddy sediments in Myanmar to make comparisons with the Pleistocene primate fauna in Guangxi Province, southern China. The differences in primate fauna are likely influenced by the environmental change in Southeast Asia, such as the emergence of a monsoon climate.

**From the Editor** For his work on this project, Dr. Takai received the Academic Award of the Palaeontological Society of Japan in 2008.

**Masanaru Takai, PhD**

*Professor, Primate Research Institute* 20

[www.pri.kyoto-u.ac.jp/sections/keitou/index\\_e.html](http://www.pri.kyoto-u.ac.jp/sections/keitou/index_e.html)



▲ In a water jar locally used in a north east province of Thailand



Excavation and investigation of primate fossils in Myanmar



Myanmarpithecus, a fossil discovered by Dr. Takai and his colleagues



A right-handed snail

**H**AKUBI (白眉), means 'white eyebrows' in Japanese (白: white, 眉: eyebrows). The word originates from a Three Kingdoms era (220-280 AD) Chinese legend: "Three kingdoms saga." According to the legend, one of the kingdoms, called Shu, was home to five brothers with extraordinary talents. The fourth brother; *Baryō Kijō*, who was particularly outstanding, had white hairs in his eyebrows, and so the term *Hakubi* has come to refer to particularly talented individuals.



白眉孝常 (Baryō Kijō) ©Yoshika Amanka

## MAR-SCI Exploring Underwater in Japan

*Diving surveys reveal the effects of global warming and the impact of the March 2011 tsunami.*

My hero is Jacques-Yves Cousteau, who co-invented Aqualung and pursued underwater exploration around the world. As I cannot afford to have a ship like Cousteau's famous *Calypso* to play with, I consistently dive in local waters. I have conducted twice-a-month underwater visual surveys at our research station for over thirteen years. Through those surveys, I have revealed seasonal



Lionfish *Pterois lunulata*, a subtropical species, is becoming common in the temperate Sea of Japan



Schools of rockfish *Sebastes cheni* were totally devastated by the tsunami in 2011, but have recovered in three years

and inter-annual changes in the fish community. I found that tropical fish are increasing, which suggests warming trends in the Sea of Japan. I also dive in northeast Japan once every two months. Although the entire fish community there was wiped out by the tsunami in March 2011, it has gradually recovered with increasing abundance, species richness, and larger fish.



**Reiji Masuda, PhD** Associate Professor, Maizuru Fisheries Research Station, FSERC 13

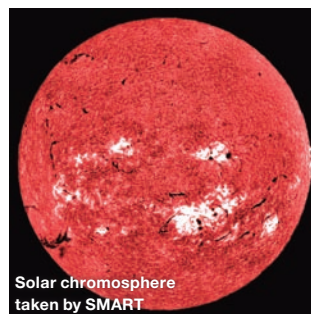
[www.maizuru.marine.kais.kyoto-u.ac.jp/en/](http://www.maizuru.marine.kais.kyoto-u.ac.jp/en/)

## SOLAR PHYS Space Weather Forecasts

*Studying the solar activity and its effects on the earth.*

It is not only light that streams towards Earth from the Sun. Firstly, there are the streams of charged particles that flow from the Sun (known as solar wind), filling the heliosphere and sometimes interacting with the Earth. When Solar flares, and other explosive phenomena, occur on the Sun, high energy photons and huge clouds of magnetised plasma (Coronal Mass Ejections; CMEs) are thrown outward. If these reach Earth, then man-made satellites and power stations that form part of society's infrastructure, and also the activities of Humankind in space are all vulnerable to damage from these phenomena. These changes to the space environment are called Space weather. As humankind extends its reach into space, the prediction of solar activity, and its impact on Earth, is becoming more and more important. At Hida Observatory, using the Solar Magnetic Activity Research Telescope (SMART) to observe the chromosphere and magnetic field across the whole solar disk, we are making great strides towards understanding the mechanism behind flares and coronal mass ejections and working towards making accurate space weather forecasts. Note that our group uses a multi-faceted approach to study the Sun; not only with observations of solar activity using both space- and ground-based telescopes, but also with simulations and theoretical analysis.

To make space weather forecasting a reality, continuous observations of the sun are necessary. Led by Kwasan and Hida Observatories, in collaboration with researchers throughout the world, the CHAIN project works to place low-cost telescopes around the world, guaranteeing that there is 24-hour coverage of solar activity. The first step of the CHAIN project was to move the Flare Monitor Telescope (FMT) from Hida Observatory to the Solar station of Ica University, Peru in 2010. The second station is at Saudi Arabia and the telescope will be in operation in 2015.



**Kazunari Shibata, PhD<sup>1)</sup>, Kiyoshi Ichimoto, PhD<sup>2)</sup>, Satru Ueno, MS<sup>3)</sup>, Shin'ichi Nagata, PhD<sup>4)</sup>**

Professor, Kwasan Observatory 11<sup>1)</sup>, and Professor<sup>2)</sup> and Assistant Professors<sup>3,4)</sup>, Hida Observatory 8, Graduate School of Science [www.kwasan.kyoto-u.ac.jp/index\\_en.html](http://www.kwasan.kyoto-u.ac.jp/index_en.html)