Mie University
National University Corporation

Graduate School of Bioresources
Faculty of Bioresources

Pamphlet on Introduction of University Staff

Version in academic year 2015

Welcome to Faculty of Bioresources

Mie high school of Agriculture & Forestry, established in 1921, has become the mother organization of Faculty of Bioresources. In 1949 it became as Faculty of Agriculture and in 1987 Japan's first Faculty of Bioresources was established. We have developed talented people with great abilities of flexible and wide practical application strength on fundamentals and comprehensive knowledge related to the Bioresource sciences so far.

Hereafter also we continue to work with the aim of contribution to the education, the research, and to the society through contribution to the regional and social developments by exploring agriculture that supports to the survival of human being such production of food, conservation of ecology, and exploitation of biological resources, etc. under climate and healthy natural conditions of Tokai region.

In particular, Faculty of Bioresources plays a major role in development of human resources equipped with advanced ultramodern specialized capabilities, broad knowledge, and with broad views by exploring theories & technologies related to the Bioresource Sciences for food production, conservation and restoration of natural environments, symbiosis relationship of nature & human being, biomass energy, utilization of biological functions of bioresources etc.

Please be sure of the wonderful approaches of the Faculty of Bioresources by all means through the contents of introduction of faculty members and academic staff.

Hayato Umekawa
The dean
Graduate School of Bioresources
Mie University

Department of Sustainable Resource Sciences

Department of Environmental Science and Technology

Department of Life Sciences

Kii-Kuroshio Bio-Regional Field Science Center (Affiliated Facilities Administration Division)

Team of Graduate School of Bioresource

Department of Sustainable Resource Sciences

We aim to build a harmonious balanced recycling-oriented society by developing talented people who have abilities to design novel societies and explore technologies for cyclic utilization through environmentally friendly measures which make efficient utilization of bioresources.

Course of Biology for Agriculture and Forestry

This course offers many opportunities to study on various approaches for exploitation of bioresources such as substances useful for food etc. through thorough studying of mechanism of organisms such as crops, animals, trees & micro-organisms and their relationship with the surrounding environment and also about the biodiversity. Based on that, specialized expert knowledge and practical skills that enables new sustainable productions in communities to be acquired.

Course of International Resources & Development

In this course, students can acquire the specialized expert knowledge and practical skills that can play an active role in global society by studying various approaches for exploitation of bioresources for the production & circulation of food and exploitation of utilizable materials in Japan & Asia from international perspectives through lectures in English and overseas studies. (A special course in English for the improvement of language proficiency is offered throughout the year.)

Keywords

Agricultural production science, Forest science, International agro-forestry and resource sciences, Regional development science

Acquirable qualifications (scheduled)

High school teacher, as a kind of license (science, agriculture), assistant specialist in trees, curator

Assumed place of employment

Civil servants, Agriculture, Forestry and Fisheries related companies (food, etc.), Agriculture, Forestry and Fisheries-related organizations (such as JA), research institutions, and academic staff of the faculty

P11～P38

Department of Environmental Science and Technology

In this department students can learn & understand on the complex global ecological systems that work in Earth's biosphere which holds a variety of ecosystems (terrestrial, marine environments, atmosphere) in the field level, with the aim of realizing the importance of harmonious coexistence of human beings, organisms and the natural environment & sustainable biological production system by mathematical and systematic analysis.

Course of Earth System Science

This course offers opportunities to learn on conjugation of human activities with the causes of changes in the global environment, such as climate changes and extreme weather events occur in the atmosphere, ocean, soil, vegetation, inland waters, and in the biosphere. And also ecological type smart biological production technology sciences can be acquired.

Course of Rural and Environmental Design

This course offers opportunities to learn about the essential biological fundamentals for the utilization of natural energy and stable supply of food by thinking towards the constructing of a recycling-oriented society, which can be corresponding to the environment & climate changes. In this course, students also can study on major restoration and conservation technologies for local climate and environment.

Keywords

Meteorology, Global environmental studies, Environmental information systems engineering, Environmental science, Earth conservation engineering

Acquirable qualifications (scheduled)

As a kind of license for theories (science, agriculture) for high school teachers
Soil surveying inspector, curator

Assumed place of employment

Civil servants, research institutions, information communication, automobile, food industry, house companies, railway companies

P41～P68

Department of Life Sciences

This department develops talented people with a wide range of knowledge and technology sciences that combines the expertise and creativity on life sciences and also it is intended to contribute to the promotion of living standards by understanding the mechanisms of biological functions.

Course of Applied Biological Chemistry and Biotechnology

In this course, it can provide all to acquire higher thinking ability and wide-ranged knowledge on lives, health and food through the development of animal and plant functional foods, pharmaceuticals, cosmetics etc. and development of methods for effective utilization of under-utilized materials, and structure and function of natural substances relating to biological responses & mechanisms.

Course of Marine Biological Science

In this course, by studying on the procedures of resource management such as protection & conservation of the marine environment, multiple functions of marine ecology, production maintenance & breeding of fishes and shellfishes, it can provide all to acquire knowledge and tenacious thinking ability on management and conservation of marine resources.

Keywords

Applied Life Sciences, Marine life sciences, Marine circulation sciences, Marine resources conservation science, Aquaculture

Acquirable qualifications (scheduled)

As a kind of license for theories (science, agriculture, fisheries) for high school teachers
Food sanitation supervisor, food sanitation inspectors, curator

Assumed place of employment

Food companies, cosmetics companies, pharmaceutical companies, civil servants, teachers, research institutes

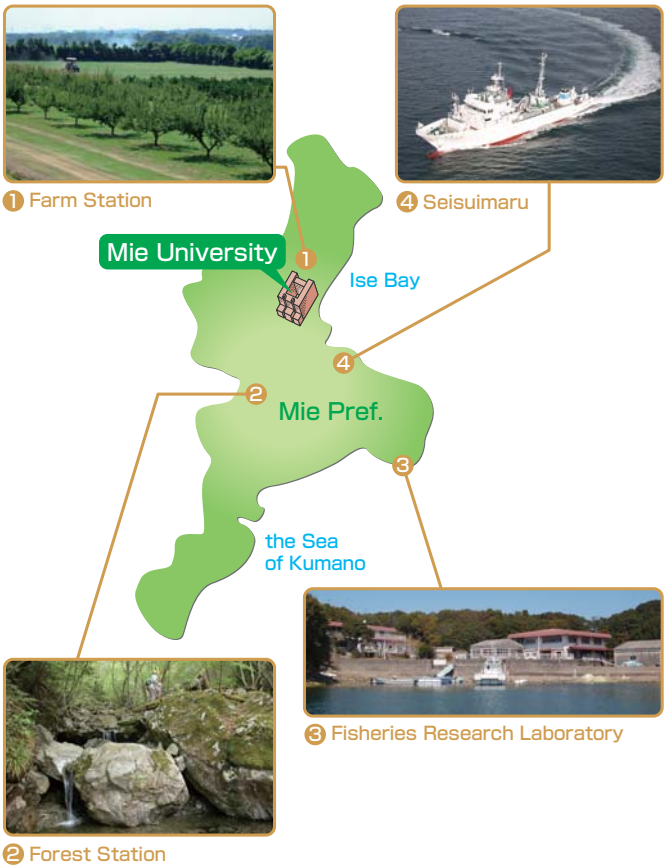
P71～P110

Kii-Kuroshio Bio-Regional Field Science Center (Affiliated Facilities Administration Division)

Each facility of field science center is an educational research facility that was established in order to study a wide range of complex fields. And it plays a very important role as a field to implement the educational researches on various agricultural & marine products, environment and natural energy etc.

❶ Farm Station

❹ Seisuimaru



❸ Fisheries Research Laboratory

❷ Forest Station

P113～P120

Team of Graduate School of Bioresource

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Department of Sustainable Resource Sciences

Department of Sustainable Resource Sciences

Research on genes for the improvement of crop species

Keywords

Agriculture, plants, general biology, particularly knowledge on genes is important.

Professor
Yoshiyuki Kakeda, Ph.D.

Improvement of crop species

In long history, human beings could make various crops by cultivating wild plants. In a broad sense, all history of crops ranging from such past to current situation is promising improvements in crop species. However, methods for species improvements have been sophisticated over the last few decades and the new species are borne that give high yield and delicious taste much more than the past. In simple words, screening the excellent individual crop species after looking for the hereditary changes to some extent and combine them by cross breeding is called as crop species improvement.

Genetically modified crops are not the sole output of genetic researches

On the other hand, genes are removed in the form of DNA and transferred into plants. By using so-called genetic engineering, crop species having resistance to herbicides & pests have been developed by using microbial genes that are not transferred by cross-breeding. Now it is being applied for the large scale cultivation of soybean and corn mainly. However, the characteristics of the crops that can be improved by gene recombinant technology are intended to be limited. Moreover, the feeling over recombinant crops is differ, according to the individual person and it is unable to say that it was universally accepted under the present situation.

Species improvement is used for DNA and genome level researches

Genome of many diverse crop has been sequenced now due to the remarkable advancement in genetic analytical technologies. Important characteristics of each individual crop is explained on the level of DNA or genome and it is intentionally combined using the units of genes. By doing so, even without using of recombinant technology, it is possible to support greatly to the genetic researches on species improvement. It is good to have a chance to do the researches with students who have high concern about agriculture or plants rather than the students who just say vaguely that they want to do researches on DNA. Moreover, in order to explain to the public after summarizing the research information, the skill of national language and English is also required.

Department of Sustainable Resource Sciences

To understand plant reproduction mechanisms, at molecular, genetic and genic levels.

Associate Professor
Keita Suwabe, Ph.D.

Keywords

Genes, DNA, genome

Subjects required to this research

plant biology, molecular genetics, molecular biology, cell biology, epigenetics

Biology to support the food production

Plants, such as rice and vegetables, are important to us for our sustainable living. To produce them sufficiently and effectively, first of all, we must understand what a plant is. My research objective is to elucidate genes that responsible for controlling the functions of plants, particularly focusing on an understanding of the molecular mechanisms underlying plant reproduction, from blooming flowers to forming seeds.

A key for the evolution to self-fertilization from outcrossing is in the mutation of the male specificity gene in pollen.

How does a plant leave it's off springs while achieving both of reproductive assurance and genetic diversity? One of the hints which solve that puzzle is self-incompatibility (SI) recognition system. SI is the mechanism to prevent self-pollination (selfing) and promote outcrossing with pollens from another individual of the same species to form seeds (offspring), and, in the Brassicaceae, it is controlled by *SRK* and *SCR*, encoding the female and male SI specificity determinants, respectively, at the *S*-locus. Genetic diversity in plants is maintained by this. *Arabidopsis thaliana* is a model organism for plant science and has lost its SI system in the process of evolution. What is the reason for that? The answer had been hidden in the genome. From our research, it was cleared that, about 400,000 years ago during the glacial period in central Europe, a mutation in pollen gene *SCR* has occurred due some unknown reason. By retrieving that mutation, transgenic *A. thaliana* plants were successful to be re-evolved into SI. This result is an evidence that support the theory of "under the conditions of scarce partners for cross-pollination, selfing is advantageous for reproductive assurance" that Darwin has proposed in 1876.

Study and elucidate on molecular mechanism of plants to leave their offspring

The next questions are how they reject their own pollen? And how they extend the pollen tube correctly into the pistil, in order to form a seed successfully? To find out solutions for these questions, we are conducting researches at the molecular, genetic and genic levels.

Department of Sustainable Resource Sciences

Soybeans save human lives!

Keywords
Food production, Japanese-style diet (Japanese), plant type, breeding, vegetable proteins, biology

Professor
Teruhisa Umezaki, Ph.D.

An impending food crisis due to population growth

World's population has exceeded 7.2 billion people in this year. Currently also the population has continued to increase and around one billion people become suffering from nutritional deficiencies. Biological researchers around the world are conducting researches on cereals, legumes and tuber crops in order to increase the staple food production. Researches on rice, wheat and corn were gradually developed and among these 3 major nutritional sources carbohydrates has been started to produce quite efficiently. It's possible to synthesize fat from carbohydrates inside the body. That secures the proteins and that become a solution to avoid the food crisis.

Soybean is a source of high-quality vegetable proteins

Rice and soybean are the basic for the Japanese-style diet and the world evaluation for that is high due to its good balance and often healthy and is also registered in the energy intangible cultural heritage. Soybeans contain a large amount of sulfur-containing amino acid which is deficient in rice when it take as a staple food. Soybean is greatly compatible with rice since soybean is excellent as a vegetable protein source. Japanese history of soybean cultivation is long and many varieties have existed. We are incorporating in improvement of varieties and development of cultivation techniques by clearly identifying the characteristics of these varieties and studying on cultivation conditions of each variety which illustrate its maximum capabilities.

New plant types and colorful soybeans to enrich eating habits.

After clearly identifying the soybean growth pattern, it is possible to make an efficient production by controlling the plant type. In addition, it was able to produce short plant types (dwarf) that do not fall (lodging) even if the plants are heavy with fruits and the food products including the functional pigments such as not only yellow color but also red, black, green & brown colors. In the near future, these soybeans will make food more appetizing & healthy for human beings.

Normal and dwarf plant types in soybean

Colorful seeds in soybean

Department of Sustainable Resource Sciences

Realization of the sustainable society using organic waste under the Win-Win relationships in agriculture

Keywords

Whole subjects learn in high school are required, because agriculture is a practical science.

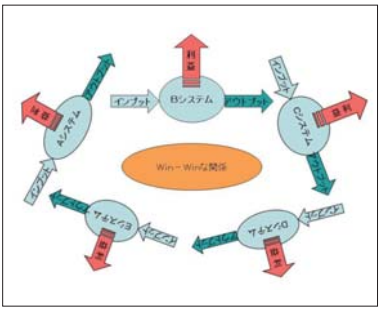
Associate Professor
Yuichi Nagaya, Ph.D.

There is a superb diet and a large amount of disposals

Our survival depends mostly on agricultural products. We can buy the various kinds of fresh food, processed food and frozen food and so on in convenience stores and supermarkets. On the other hand, a large quantity of food waste is occurred by process of manufacture, the disposal at the time of sale and the leftover after eating. I think this is 'mottainai' in Japanese, a great waste!

Let's practice the win-win agriculture

Crops that become the food, feed, fuel, fiber and industrial raw materials are cultivated in the field.



Win-Win relationships by the connection of sub-system.

Improvement of crop production (yield) is possible by fertilizer, chemical materials, soil management and cultivation techniques. By using chemical fertilizer, the yield of the crops increases easily, but soil fertility decreases gradually. Organic material, such as compost and manure, maintain and improve soil fertility. It has an effect of soil conditioner and fertilizer. But it is a heavy load and time-consuming, therefore the amount of its application is decreased annually for population aging of farmers. Compost is produced from food waste resources by disposal treatment manufacturer by Food Recycling Law. The price of this compost is cheap, mass production compared with farmer's ones. We research cooperation business model using compost management with different types of industries and business conditions to conserve agricultural land and ecosystem.

Utilize the cyclical function of nature in agriculture

Agriculture is a key industry of biomass conversion and environmental conservation using the cyclical function of nature. We stably cultivate various crops such as field crops, garden crops, food crops, industrial crops, forage crops, cereal crops, pulse crops, tuber and root crops, fiber crops, oil crops, aromatic crops and so on. There is a need to develop new agricultural techniques according to a preventive principle and appropriate technology. We can create a sustainable society.

Department of Sustainable Resource Sciences

Fruits are from marrying with favorite opposite sexes

Keywords
Biology, physiological functions, food, genetics

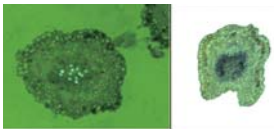
Professor
Hiratsuka Shin, Ph.D.

Fruit trees find their favorite partner selectively

Pear flowers.

Sometimes, even one tree is planted, it does not produce fruits, because the tree has the likes and dislikes against the opposite sex. Pistil of the flower refuses to accept self- pollen and does not create children (seeds). When a seed isn't form, a fruit can't be born, and this phenomenon is called self-incompatibility. Self-incompatibility is a phenomenon that is governed genetically and proteins included in pistil & pollen have become a causative agent to determine the likes and dislikes. We are doing researches on characteristics of these proteins & how to eliminate this likes and dislikes among the fruit plants.

Pistil proteins attack the pollen genes



Transverse section of pear style.
Left:Fluorescent stain of pollen tube (Luminous spots are pollen tubes).
Right:Immunocytochemical stain of RNase (Blue pigments are RNases).

Transverse section of pear fruit.
Left:Seedless fruit induced by Bordeaux mixture containing Cu^{++}.
Right:Seeded fruit induced by artificial pollination.

The pistil of the fruit tree contains different kinds of ribonucleic acid (RNA) degrading enzymes (RNase), and they cause self-incompatibility since the RNases degrade the RNA of offensive pollen. We are aiming to impart self-incompatibility partly to the plant and establish cultivation method that does not need artificial pollination and fruit thinning (The work of removing the unwanted fruits, 95% of bloomed flowers are unnecessary). On the other hand, in recent years, , we found that copper & ferrous ions sprayed onto the developing flowers can produce seedless fruits in the pear. We are conducting researches on why these ions make seedless fruits.

Research is carrying out by gathering multiple fields of academic knowledge together

Our attempt is to utilize the plants' indigenous functions to human life and conduct the researches by making the best use of genetics, biochemistry, physiology & cultivation science, and then return the results to our society. Since it is a challenge that can approach from various points of view, we want to proceed this research with everyone who are interested in plant physiology and cultivation science with enjoying.

Department of Sustainable Resource Sciences

Potassium is effective to produce the tomato fruits with high lycopene & high sugar contents

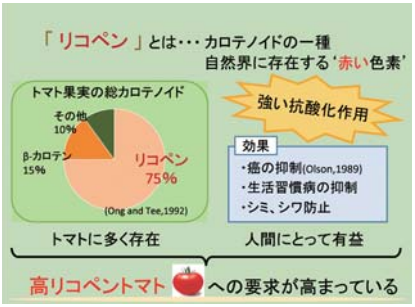
Keywords

Organisms, analytical chemistry, plant physiology, metabolical physiology and those who like plants and vegetables (including eating also)

Associate professor
Katsuyoshi Nada、Ph.D.

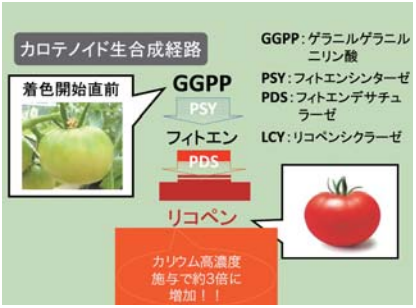
Demand for high lycopene tomatoes has increased

Lycopene is a major component in red color fruits of tomatoes and it is a kind of carotenoid. It has been reduced carcinogenic risk by capturing active enzymes efficiently and having high antioxidant activity. In recent years, due to the growing health consciousness of the consumers, demand for tomatoes with high lycopene content is increasing.



It was cleared that the application of high concentrated potassium to the tomato fruits increases the sugar content & lycopene amount

It is found that the lycopene content of the fruits has increased three times when conducting the hydroponic cultivation of normal breed of "house Momotaro" in the cultivation medium containing potassium concentration five times higher than the normal concentration. In addition, at the same time fruit sugar content also becomes about 1.5 times higher and as a result of that delicious healthy tomato fruits can be produced.



For practical application for high sugar content & high-lycopene tomato cultivation

In hydroponic cultivation of such model experiments, even though it has been found that it is possible to produce high-quality tomatoes in cultivations which have applied potassium in high concentrations, there are several problems in practical use of this fruits. Determination of exact time to apply the high concentrated potassium is the main challenge to establish a way to avoid physiological disorders due to the application of high concentrated potassium. If these critical points are resolved, it will be able to do sustainable production of value added tomatoes with high antioxidant activity.

Department of Sustainable Resource Sciences

We are not alone

Keywords
Organisms, microorganisms, gastrointestinal tract, animals

Professor
Hiroki Matsui, Ph.D.

Workers in the gastrointestinal tract

More than 1000 species of microorganisms are living in the gastrointestinal tract of animals and those forms a microbial ecosystem. In the case of human, the weight of the microorganisms of the gastrointestinal tract is consider as 1 kg but in larger livestock will have more weight. Presence of microorganisms in the gastrointestinal tract is useful to the health and nutrition of the host animal and it is an essential to maintain the body functions properly. On the other hand, microorganisms that produce methane, a greenhouse gas also inhabit in gastrointestinal tract. Since there are much more methanogens in the gastrointestinal tract of cattle, a large amount of methane is release from cattle. (For cattle, this is the matter of course, but cattle are not guilty for that at all …)

What kind of microorganism do exist? Let's examine

The results obtained from the researches on what kind of microorganisms do exist in the gastrointestinal tract of livestock such as cattle, sheep, pig, and ostrich have indicated that there are a lot of microorganisms with very interesting functions live in the gastrointestinal tract. For example, microorganisms useful for industries and microorganisms useful in feeding of livestock. Each of individual microorganisms shows particular function, but I'm also studying on the functions as a microbial ecosystem. I have also discovered that utilizing the familiar rice bran, it is possible to reduce the amount of methane emitted from cattle.

I want to manipulate microorganisms as a supervisor!

We want to develop a method for feeding livestock in such a way that reduce the environmental impact & help in feeding of livestock by controlling the microbial community in the gastrointestinal tract. I suppose it should be possible to handle microorganisms as a conductor who invents a beautiful performance by handling the orchestra.

Department of Sustainable Resource Sciences

Feed resources to support the production of milk and meat

Keywords
Chemistry, biology, plants, animals, microorganisms

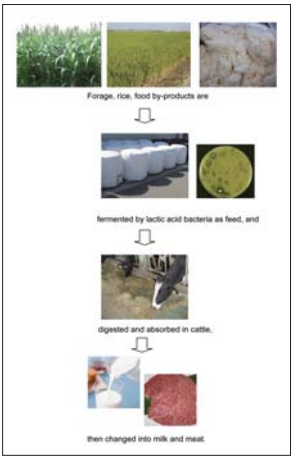
Associate Professor
Makoto Kondo, Ph.D.

Is feed not enough?

In Japan, feed self-sufficiency rate is about 25% and for most of feed raw materials Japan is depended on overseas. For example, even though about one hundred million tons of corn has been exported for food & feed in the world, 12% from that has been supplied to livestock in Japan since Japan is the world's largest importer of corn. Due to population growth in the world and economic development in developing countries, the demand for milk and meat has increased, as a result of that there is a growing demand for feed raw materials. Furthermore, in recent years, due to the sudden increase of bio-ethanol production, using of cereals became competitive among food, feed and fuel. In this way, since the stable supply of feed raw materials to Japan is apprehensive, the importance of feed production inside the country has increased.

Pasture, rice straw, okara too are fermented to use as feed

Pasture can only harvest several times per year but cattle eat food every day. Therefore, it is necessary to preserve the pasture. It is possible to proceed the anaerobic fermentation after sealing the pasture and then it becomes possible for long-term storage & can use as food in the periods with no grasses. Such fermented feed (silage) is the feed that is essential to milk & meat production not only in Japan but also around the world. In addition, since the food by-products which are discharged in production of tofu and beer are fermented in the same manner and are stored without using energy for dehydration and then it becomes possible to use as feed. We are evaluating the technologies for storing of fermented feed produced from pastures and food by-products and increase the availability of nutrients for cattle.



Focus on improvement of rate of feed self-sufficiency

The potential to produce feed remains still in Japan, from rice & wheat grown in the excess paddy fields and from by-products have come up in the process of agricultural production and food manufacturing. By effective utilization of such resources as livestock feed, we aim to improve the rate of domestic feed self-sufficiency & make stable the domestic production of milk and meat.

Department of Sustainable Resource Sciences

Study on evolution of life based on DNA sequences

Professor
Susumu Takamatsu, Ph.D.

Keywords

Keyword is 'evolution of life'. Students who are interested in living organisms and their evolution are welcome. Please study on biology ⅡB in high school, if possible.

All of life on the Earth have evolved from a single ancestor

All organisms that currently exist on the Earth are believed to have evolved from a single ancestor. Organisms have been inherited DNA from common ancestor from generation to generation. Thus, DNA sequences are just like living fossil records to study evolution of life. We are studying evolutionary history of powdery mildew fungi, obligate biotrophs of plants, using DNA sequences, especially from the aspects of host-parasite interactions, biogeography, and morphological evolution.

Drama of evolution of life on the Earth

Powdery mildew fungi have evolved from a single ancestor and currently distributed worldwide except the Antarctica. Number of known species of this fungal group is around 900. They occur on approximately 10,000 angiosperm species. This fungal group is obligate biotrph of plants that can survive only on living plants. When were powdery mildews born on the Earth? How have they diverged by expanding geographical distributions and host ranges? We are doing our best efforts to address these questions everyday.

Fig. 1 Field trip to a tropical forest of Malaysia

Fig. 2 Field trip to Argentina

Network with scientists of all over the world

To promote our study, we constructed international research network with scientists of the world. Our dream is to construct a big tree including all powdery mildew species occurring in the world.

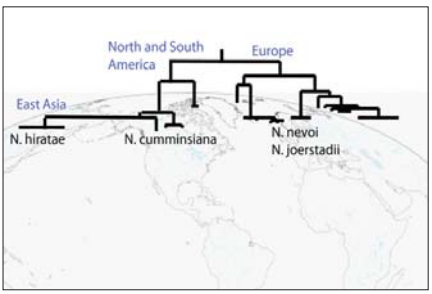


Fig. 3 Evolutionary biogeography of powdery mildew fungi

Department of Sustainable Resource Sciences

As the University hospital of plants

Keywords

Though beforehand studies in particular are not necessary, it is necessary to have an attitude that consider a wide range of information without limiting to natural sciences & social sciences.

Associate Professor
Chiharu Nakashima, Ph.D.

Support to the site of the plant disease control

The most plant diseases (about 80%) are caused by parasitic filamentous fungi (mold). To suppress the damages due to the disease, it is necessary to diagnose the fungus that cause the disease accurately. By providing background information to the site about the plant diseases cause by filamentous fungus using electron microscope or light microscope or DNA base sequence information, we are playing a role as the University hospital to support controlling of plant diseases.

Systematics of plant parasitic fungi

The taxonomic information on causal fungi is absolutely essential for controling of the plant diseases. On the other hand, the systematics of filamentous fungi which cause plant diseases has been drastically changed with the introduction of molecular phylogeny. We are conducting researches in collaboration with researchers around the world, especially the studies on the taxonomy of plant parasitic fungi called Cercospora-complex including around 5000 species. Graduate students are responsible for the special taxonomic researches on particular groups of fungi inhabiting Asian countries in addition to the diagnosis of plant diseases above mentioned.

Active place is the whole world

There is a higher diversity of plants in Asian region and parasitic fungi also rich in diversity there. Researches on diversity of parasitic fungi as organisms is also an important theme that researchers of Asian countries. By developing the human resources involved in controlling of plant diseases in the future, we continue to conduct researches under the research field of taxonomy of plant parasitic fungi, with the aim of becoming one of the research center in the Asian region.

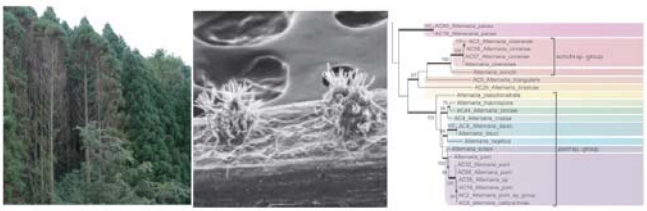


Fig.1. Towards an understanding of the Systematics of plant parasitic fungi and an accurate diagnosis of plant disease.

Department of Sustainable Resource Sciences

All individuals of all organisms want to leave their own genes

Keywords

parasitoid, paper wasp, natural enemy, biological control, behavioral ecology, social insect

Professor
Yoshihiro Yamada, Ph.D.

Selfish organisms and seemingly altruistic workers

Anthropomorphically speaking, all individuals of all organisms make efforts to leave as many of their own genes as possible. In other words, living organisms are the descendants of such individuals. Therefore, organisms are quite selfish under most situations. In social insects, however, some individuals or workers seem to give up their reproduction and work for other members in their colony. I present a true picture of it below.

Infanticidal parasitoids and workers that do not work

Oviposition on/in a host already parasitized by the same species is called superparasitism. Many parasitoids often kill the first progeny when superparasitizing. So do most dryinid species, including ones parasitic on plant hoppers, major pest insects in paddy fields. Although infanticide is undesirable in terms of the persistence of the species and/or population, it is quite desirable in terms of leaving as many of the infanticiders' own genes as possible. How selfish they are!

A dryinid parasitoid (*Haplogonatopus atratus*), ovipositing in a plant hopper (*Laodelphax striatellus*).

Colony of a paper wasp, *Polistes japonicus*: founding queen, non-marked, located center on the nest. Photoed by Y. Ishikawa.

The society of paper wasps is usually composed of one queen, her daughters and sons. Don't you think that all workers work hard for their colonies? It is usually false. No clear morphological difference is present between the queen and workers in paper wasps: workers have a potential to become queens. Workers, females emerging at the prophase and metaphase in colony development, have some alterative options: working as workers, or staying still on the nest to preserve their physiological vividness and aiming to become the successor to the present queen or to hibernate. They are considered to change their options according to future fitness returns, which depend on their physiological conditions, colony size, and so on.

Thinking parasitoids and social insects

While searching for hosts, parasitoids must often make decisions on some items; which patch to search in, how long to search in a patch, whether to accept a low-valued host, or whether to lay a male or female egg (they can regulate the sex of eggs). How do parasitoids make such decisions? The investigation of mechanisms for it is useful for efficient biological control by parasitoids.

If you are well paid, you will usually work hard, even if the company imposes hard work on you. However, if it is not so, you may leave the company. Indeed, this is similar to phenomena that are happening in the society of paper wasps, isn't it? Human being is a kind of animal. For deeper understanding of the human society, we should elucidate animal societies in various taxonomic groups.

Department of Sustainable Resource Sciences

A little-known relationships between flowers and insects

Keywords
Behavior, flower, insect, ecology, chemistry

Associate Professor
Morio Tsukada, Ph.D.

Pollination systems that do not depend on bees and butterflies are ancestral.

Well-known flower visitors are bees and butterflies. However, the flowering plants appeared on the earth more than 100 million years ago. There were no honey bees nor butterflies on the earth at that time. Then, who did pollinate flowers and how did they do that? By making this mystery clear, we can also expect to improve the productivity of the fruits of ancestral taxon.

The flowers attract insects using their odor by deceit.

Cherimoya and atemoya are tropical fruits though you may be not so familiar with them. They belong to the family Annonaceae, with relatively ancient characters in which one flower changes from female to male functionally. It does not receive visitation by bees and butterflies. We have examined flower visitors, and it was clarified that a variety of small beetles of the family Nitidulidae were attracted to the odor and found that they pollinate (Figure 1). It seems that the plants emit odor of ripe fruits which is the food of the beetles at the time when the plant wants to attract the insects (Figure 2). Although these plants have been considered to be primitive, we have found that they have evolved apparently very sophisticated pollen transferring system.

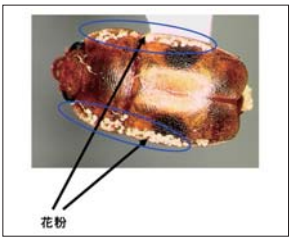


Figure 1. The sap beetle Haptoncus ocularis, with pollen of Cherimoya on the body.

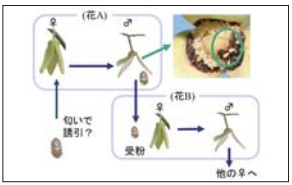


Figure 2. Hypothesis of attraction of beetles by Annona flowers with temporally changing sexual stages.

The mysterious behavior of insects

However, there are various aspects which we have not yet understood. Even though the flower emits the odor only at specific time points, whether the insects enter to the flower at that time point and stay in there for a long time or stay in the flower only when the flower emits its odor is unknown. In addition, as it is difficult to look in the flower, and as insects enter flowers usually in night, their behavior is not easy to observe. Synchronization of circadian rhythm of insects and timing of flowering rhythm is also interesting future research theme. We would like to clarify the ancient pollen transferring mechanism by studying them with you in near future.

Department of Sustainable Resource Sciences

Interaction between trees and diverse organisms in forest ecosystems

Professor
Hiromitsu Kisanuki, Dr.

Keywords
Vegetation, Ecological conservation

Subjects in high school required for the research
Fundamental Biology (diversity and distribution of vegetation, ecological conservation)
Biology (ecology and environment)

Trees as foundation in forest ecosystems

There are a lot of organisms living in forests, among which the most fundamental one is trees by far. Even if you just say a tree, the shapes and sizes of leaves & trees are various. Moreover, some tree species use wind for pollination, while some other species use insects such as bees and butterflies. Seeds of some species will disperse in wind, while others via birds & small mammals. In this way, trees live having mutual influences with surrounding natural environment as well as biological environment.

Interactions among organisms are strange now

The large herbivores have been quite increased at the domestic forests now (Figure 1). By increasing of large grazing mammals such as deer, species richness and abundance of plants have reduced and the connection among organisms that have been used plants as food and habitats have become strange (Figure 2). On the other hand, it seems to be quite difficult to restore them to former healthy & thriving forests only by decreasing the number of animals increased too many, because that treatment will derive the increment of different plants in number such as dwarf bamboo. Even if bamboo grass will be pruned, they will recover in a year. In this way, it is very difficult to control the natural vegetation by human beings and also it takes very long time to restore the declined forests.

Figure 1. Overabundant deer

Figure 2. Declined forest in Mt. Ohdaigahara, Kii peninsula

Let's see trees well to restore the declined forests

By spending time and using our physical toughness, let's try to reveal the unknown interaction of trees with organisms in forests after diligent observation and study the flora and fauna both in primeval forests and declined forests. After that, hints that can be used for effective restoration of the declined forests might be found.

Department of Sustainable Resource Sciences

Understanding the life-history of trees

Associate Professor
Takeshi Torimaru, Ph.D.

Keywords

We directly observed organisms in forests (field work), and it is pre-requested to have overall knowledge of biological sciences. Rather than visiting to a flat locations such as parks of the city, we have to climb mountains in the forest. Therefore it is also necessary to have a basic physical fitness.

The way a tree lives

Even the term biodiversity has been widely recognized, it's happened to see the people are explaining on how this diversity make influences on to the natural world and to the human societies only considering an image. In particular, although trees that make up the forest are lager in size (Figure 1) and spend longer life than human beings, we determine the life history traits of such organisms within the range that we usually work around and sensing on time and then don't people think about its protection & conservation? I have been conducting researches with the aim of leading to sustainable ecological conservation by revealing the life history traits of various tree species based on the follow-up studies on seedling of trees, trees' growth, reproduction and motility (Figure 2).

Figure 1 A big beech tree (Shirakami mountains in Aomori Prefecture)

Figure 2 Measuring the tree size (girth) at breast height

Scale of vast time & space of trees

Typhoon is not just destroying the forest, but being destroyed by the typhoon, the forest interior become lighter and therefore it is an important event that establishes new seedlings. The results obtained by monitoring the trees in a large area over a long period of time up to now, have been revealed that the tendency to be dead due to the typhoon is different in different tree species depending on the strength of the typhoon and the frequency that occurs. Moreover, by performing the parentage analyses by using the DNA extracted from seeds, it has been revealed that they have fertilized from the pollens coming from distant places.

Climatic changes and forests

As a measure for conservation of the natural environment, the forest has become an increasingly important field, when considering on how trees get adapted to face rapid climatic changes represented by global warming. Don't you try to touch with life history of trees somewhat different from human beings?

Department of Sustainable Resource Sciences

Mycorrhizal fungal network to support the life of the forests

Keywords
Biology, ecology, English language, microorganism (fungi)

Associate Professor
Yosuke Matsuda, Ph.D.

The mushroom is a child of the tree, a universal symbiotic relationship, fungal-root association

The relationship between plant roots and fungi such as mold or mushrooms is ancient and it has started 400 million years before the advancement of the plants to the land. This relationship is referred as mycorrhizal association and it can be seen in more than 80% of the plants currently. There are no root hairs in woody root tips of pine and acorn, because they are covered with this fungal mantle completely (Figure 1). These symbiotic fungi obtain photosynthetic products from trees while passing nutrients & water to the host plant that had absorbed from the fungal hyphae have spread in soil.

Fig1 White and black mycorrhizas (arrow head) formed on trees roots with a inset of cross section of mycorrhiza (the most outer parts in blue are fungal covers)

Visualization of mycorrhizal association reveals the real world in forests

It is possible to identify the symbiotic mycorrhizal fungi from molecular analysis, even in the seasons when there are no occurrences of mushrooms. I found that the fungal symbionts of some green or non-green plants are the same taxonomic members with those of trees grown in surrounding areas. In addition, I also found that these plants depend on their carbon source which is usually obtained via autotrophic photosynthesis with fungal symbionts partially or completely. Among pure-white (achlorophyllous) plants and green (chlorophyllous) plants with low height, there are unique companions who are getting the carbon with the help of the fungus (Figure 2). Large trees that grow in ample light & small grasses live in the forest floor under shady condition share the same type of fungus and pass the photosynthetic products through the mycorrhizal fungal network according to the various intensities of light in the environment.

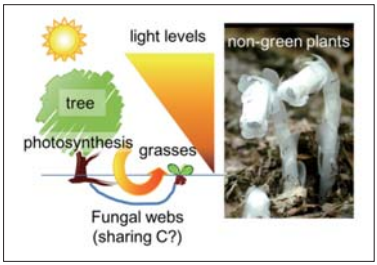


Fig 2 Mycorrhizal fungal network

Thriving forests are being supported from belowground

Even though they are green plants, they rely on symbiotic fungi to absorb nutrients using the hyphae instead of root hairs, without carrying photosynthesis process. Plants which can't move when taking roots have learned the techniques how to associates perfectly with the surrounding fungi over very long years. The fungal-root symbiosis relationship does a thankless task which supports thriving forest ecosystems. Jumping into the forests, why not continue to unravel and make clear these strange mysteries together.

Department of Sustainable Resource Sciences

Researches on mysterious plants accumulating metals

Keywords

Plant, environmental cleanup, biodiversity, chemicals, (inorganic chemistry)

Associate Professor
Takafumi Mizuno, Ph.D.

Plants and soil

Plants spend its whole lifetime at the place where seeds fell and germinated. For example even land contaminated with toxic metals, plants will attempt to adapt to its environment using a variety of mechanisms. In such plants actively accumulate metals in the body and there are some plants that intend to acquire favorable growing conditions by having resistance for that type of environments.

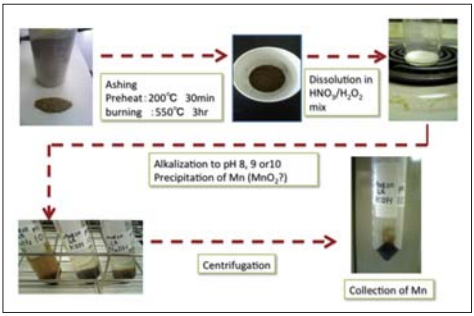
Discovery and uses of metal hyper-accumulating plants

The plants with higher accumulation ability with respect to the metals in the soil are called hyper-accumulating plants. Among them there are some plants that accumulate harmful metals of cadmium & lead and some other metals which have industrial value such as gold, nickel & manganese. In our laboratory we conduct researches on plant adaptations to its environment using a model plant that accumulates metals such as nickel & manganese and on the special vegetation (ecology) creates based on those results. Other than that we are studying about using that special ability of plants for environmental cleanup, metal resources and inorganic metal fertilizers.

Abilities of plants for environmental remediation

We are currently conducting research on plant called 'Koshiabura' (Chengiopanax sciadophyllodes) that accumulates high concentrations of manganese. But after the nuclear accident in Fukushima it has come to be reported that this plant exhibit the ability to accumulate the high radioactive cesium. We are conducting researches to elucidate this mechanism currently in collaboration with other Universities and I believe that this will link to the development of radioactive cesium removal technology by plants in the future.

Koshiabura
(Chengiopanax sciadophylloides)



Manganese phytomining from Koshiabura leaves

Department of Sustainable Resource Sciences

Researches to protect human lives and assets from Sediment-related disaster

Keywords
Physics, geology, biology, mathematics, geography

Professor
Takashi Yamada. Ph.D.

Methods required for mitigation of sediment-related disaster in near future?

Debris flow, landslide cause due to the heavy rains & earthquakes, deep-seated slope failure, blockages of rivers, landslide, snow avalanche slide and mud flow, pyroclastic flow, lava flow due to volcano eruptions have occurred around 1000-1500 cases every year in Japan. It is necessary to construct the effective measures & techniques in order to create safe & relief foundation for community by protecting human lives & assets from various types of sediment discharge. On the other hand, problems such as large-scale climatic changes in recent years; increase of risk of sediment-related disaster due to the movement of earth's plates, lowering of collaboration power of communities due to aging & population decline in mountainous areas have occurred abundantly which have to be solved by thinking & implementing measures properly. Our objective is to propose new approaches for self-defense system by self-assistance & mutual assistance or create a collaborative system with control technologies including developments, public assistance, mutual assistance & self assistance as a resolution of sediment discharge on the basis of prediction of future changes in communities.

Once in the occurrence of debris flow, how is it possible to predict?

Occurrence of debris flow that results in catastrophic disaster and its mechanism is still not known enough even in the world. Therefore focusing on Mount Fujiwara dake in Inabe city Mie Prefecture, one of the high frequency of debris flow occurrences worldwide and we are intensively studying with the aim of proposal of its occurrence prediction method and countermeasures techniques by observing the site how this debis flow occurs.

土石流発生予測のための研究イメージ

Research on sediment-related disaster mitigation which responsible for national land conservation of

Conservation of (human lives) and (assets) is being treated one of the most important research tasks. As as long as human society continues, conducting researches on steady developments for erosion control to ensure the safety. Therefore we are responsible to return more effective & efficient measures to the human society I would like to advance this research along with everyone who feels the interest & sense of mission against the mitigation of sediment-related disaster.

Department of Sustainable Resource Sciences

Make a profit on forestry

Keywords
Mathematics (statistics), work analysis, economics

Professor
Tomoaki Ishikawa, Ph.D.

The current state of forests & forestry in Japan?

About 70 percent of land area of the country Japan is covered with forests, it is also one of the country blessed with forests worldwide. For Japan that scares in resources, timber produced from forests is valuable resource and it is important to continue to utilize them effectively.

Forestry is unprofitable?

However, global timber prices are sluggish. On the other hand, the expenses to cut down a tree that grows in the forest, cut into logs & carry up to timber factory has soared. For this reason, the current state of forestry that produces timber is unprofitable & cannot take advantages from abundant resources in the country.

In order to make money from the forestry

The unprofitable forestry indicates inability to do necessary management of forests due to the indefinite funds and that will lead to increase of unhealthy forests. Unhealthy forests cause landslides in guerrilla heavy rains & it will lead to reduction of biodiversity. Therefore, keeping reduction of expenses as the main objective, we are investigating and researching on the effects of the cost reduction when introducing the forestry machines with higher labor productivity (high-performance forestry machine).

Fig-1 Logging Operation using High-Performance Forestry Machine

Fig-2 Logging Operation using High-Performance Forestry Machine

Department of Sustainable Resource Sciences

Monitoring forests from the sky like a bird

Associate Professor
Akemi Itaya, Ph.D.

Keywords

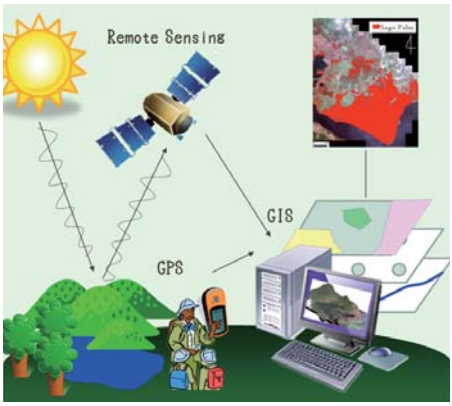
Forest, GIS, remote sensing

Subjects required for researches

Biology, Mathematics, English

Forest covers a wide area

Forest covers a very wide area. Two third of land area in Japan is covered with forests. Therefore, it takes a very long time when investigating conditions of the entire forest and its changes. In order to obtain the information of the forest, remote sensing data such as aerial photographs and satellite images have been taken from higher levels are very effective. In Japan, aerial photographs of the entire country have been taken in about every five years from around 1950s. If these the time series aerial photographs are analyzed using GIS with data from GPS and other information, it's possible to be in clear on long-term changes in the wide area of forest, for example, the growth trees and development of forests.



Forest monitoring and management using GIS and remote sensing data

Deforestation in SATOYAMA

In the past, the SATOYAMA landscape, which is the traditional rural landscape in Japan, was able to be easily found in all over Japan. The SATOYAMA is consist of forests, reservoirs for irrigation, streams, ponds, rice paddy fields and grasslands. They are connected by the water system along natural topographical features. However, those landscapes have been lost by developments recently. We analyzed the part of Tsu city using aerial photographs and topographic maps. Our results showed that the SATOYAMA landscape had been able to see around the Tsu station until the 1960's. From the 1960's to the present, about 50% of the forest area had been lost by building residence. Topographical features also had been changed, and it had become flat. These changes might impact on the event of a natural disaster as well as biodiversity.

Like a bird!

In order to understand the natural environment and live symbiotically with them, it is important to monitor large forest areas over time. We can find the tipping point of change by monitoring forests over time. These tipping point make people think how to live symbiotically with the natural environment. In our laboratory, we would like to continue to monitor large forest areas like as a bird.

Department of Sustainable Resource Sciences

Utilization of environmentally friendly wood

Keywords

Mathematics, physics (mechanics) biology (plant), English

Assistant Professor
Takayuki Uchisako, Ph.D.

Protecting forests by using woods

Wood is possible to recycle and is the excellent material for various uses. In Japan especially blessed with forest resources and it has been used as a material in close contact with the life from ancient times. Although the production of wood requires several decades, after the world war artificial forests of cedar and cypress have been developed actively. Now these trees have grown up to the size which can be used for construction of wooden buildings. Even though it is said Japan is poor in resources, using this valuable resource as harvest (deforesting) and promote again as a forest plantation (reforestation) lead to the protection of Japanese forests.

Take advantages from unique raw materials

Wood is durable and light in weight compared to the iron and concrete, but can be easily processed. In other words it saves energy. On the other hand wood is unique biological material and strength also differ according to the tree species, processed location & season. Therefore it cannot be controlled easily in the production process. Therefore, when using wood for buildings and furniture, special consideration is required depending on characteristics of the wood used, wood bonding method and maintenance management after manufacturing, but that do not necessary to the other materials. In our laboratory, I am conducting researches to improve the safety and reliability of the structures made up of wood by revealing the mechanical properties of the wood itself and wooden jointed structures after understanding the individuality of such woods.

Future of wood use

While there is a growing interest in health, environmental protection and safety of food, clothing & shelter etc., wood as a recyclable raw material, now it is reconsidered as important resource more than ever. Wood is not only a structural material; it is a raw material for extremely wide applications. There are research reports have shown the effects on safety and health maintenance of mind & body because of using wood in floors and walls of homes. I'd like to consider new utilization methods of wood with you together by elucidating the unique & unknown possibilities hidden in wood.

Department of Sustainable Resource Sciences

Open up biomass societies!

Keywords
Plant, biomass, forest, wood, environment, material, energy, chemistry

Associate Professor
Hiroshi Nonaka, Ph.D.

An era of biomass will come in near future!

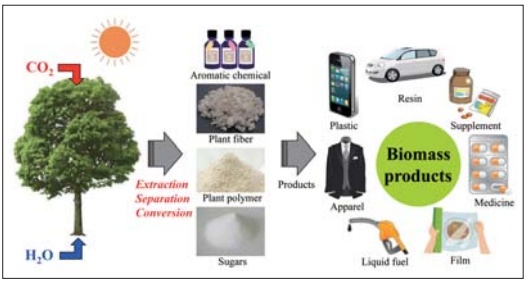
We can't continue to depend on fossil fuels which will eventually dry up. Electricity can be generated from sunlight, wind power and geothermal power. But it does not create 'materials'. Plants produce their own plant bodies by photosynthesis using carbon dioxide (CO_2) from the atmosphere and water from the soil (H_2O). While we are eating a variety of plants such as rice & wheat, vegetables & fruits, it is necessary to utilize plants in multiple applications as "biomass resources" in near future.

Tree is the top target, only burning is nonsense!

Forests occupy the 30% of land area on the earth surface and 2/3 of land area of Japan. Therefore, it is important to use the trees effectively especially in Japan. Wood is made up of polymers called cellulose, hemicellulose and lignin and small amounts of odor components. The stems of bamboo and cereal are also subjected to research. Wood can be used as an alternative fuel because it burns very well. However, it is just wasteful to burn the organic compounds that plants synthesized from CO_2 and H_2O. Isn't it?

Extraction, separation and conversion of plant components

Aromatic chemicals & antibacterial substances can be isolated relatively easily by extraction of odor components with solvents. The resultant wood is a complex composite material consisting of cellulose, hemicellulose and lignin. Separation of theses polymers is very difficult under current situation, but if successful, they can be applied to resins & film, fiber, functional foods and medicines. Production of a variety of raw chemicals and liquid fuels also becomes possible along with development of conversion technologies. Searching on high value-added trees like *Eucommia ulmoides* is also an interesting challenge because even bark and leaves could be useful as a Chinese medicine and tea. Conducting researches on extraction, separation and conversion of plant components, let's open up "biomass societies" relying on plants!



Unlimited potential of wood

Department of Sustainable Resource Sciences

In order to keep eating fruits and vegetables hereafter also

Keywords

Fruit and vegetables, agricultural products distribution, globalization

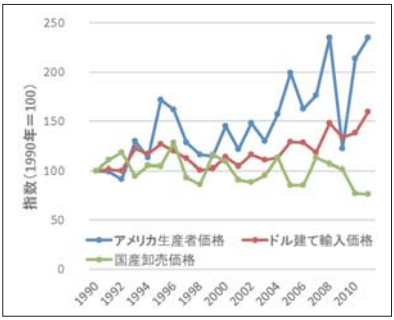
Professor
Hiromi Tokuda, Ph.D.

Fruits and vegetables supply is in increasing danger

Vegetables and fruits are one of our important food. The fruits and vegetables may not be eaten hereafter in the same way as up to now. Currently, food supply and demand of the world, is thought to be hard due to the increasing of world population and economic growth in developing countries. Fruits and vegetables are also in the same situation. On the other hand, there is growing apprehension that the decreasing of domestic production.

Real situation of uncertainty about the supply related to both domestic production and imports

Since the production of fruits and vegetables require manpower even among the various agro industrial sectors, aging of farmers in recent years and their reduction in numbers cause serious influences than in other agricultural sectors. On the other hand imports of vegetables and fruits from developing countries are increased recently and that creates severe import competition and consequently international prices are also increasing. As a result of that, Japan no longer be able to import as before. There was a hot news on the marine products few years ago (buying at a loss) and same situation is continue to occur to the fruits and vegetables as well.



さくらんぼに関する日本の交易条件の変化

Plans to support the fruit and vegetables production so far

Domestic production becomes the basis for stable supply of vegetables and fruits. It is necessary to create a mechanism that enables efficient production with less labor in order to expand the domestic production. For that, it is important to design a mechanism for the fruit and vegetable production, by taking the best uses of agricultural practices such as preparation of ground floor for orchards, making the machineries easy to use, advancing the cooperative usages of machineries in vegetable farming and also developing new technologies.

基盤整備された果樹園

Department of Sustainable Resource Sciences

What is needed to sustain the organic farming?

Keywords

Organic products, TEIKEI, CSA, food recycling, modern society, politics and economics, Ethics

Professor
Takeshi Hatano, Ph.D.

Environmental problems & food safety issues due to the separation of food and agriculture

At present society, many problems such as food safety crisis can be seen in large numbers due to the fact that food and agriculture have separated. When considering worldwide situation, does food reach accurately to the necessary person? Should trash garbage be burnt? Toward future, in order to continue the sound agriculture, it is necessary to shift to the cultivation methods that are reasonable to the environment and to the crops. Practicing of organic farming ensures the sustainability of production and safety of agricultural products.

The children who learn the composting method of garbage by the organic farmer

Extension of organic farming in the world but stagnation in Japan

For this, organic farming has spread to all over the world. Percentage of extension progress in Western Europe is about from 5% to 10%. But in Japan it has become less than 1% and that is the least among developed countries. While many people realized that organic is good, why doesn't it extend? As one of the reason, even if a consumer requests for safety, he does not demand for higher prices than ordinary agricultural products. Furthermore there are some problems with the present circulation and distribution systems. It has been found that mechanisms required to support the organic farming are missing from the society.

Recovery of food & agriculture relationship and future local communities

We attempt to create a new distribution system which enable to purchase organic agricultural products that could not treat by the conventional market. For that, it is necessary to decide by ourselves the prices, distribution methods and finding a partner for each of person who makes the products and who buys that products. However, as in the original meaning of farmers market and CSA (community supported agriculture), the number of people who do the complicated and difficult works with enjoying are increasing now. From the viewpoint of recovery of food and agriculture relationship, it is necessary to reconsider the production, distribution and consumption systems. When considering about our future model, the research on organic farming can show useful suggestions.

The organic farmers market in Nagoya

Department of Sustainable Resource Sciences

Do you eat fish?

Keywords

Supply and demand of marine products, distribution of marine products, food system, food culture.

Professor
Qingxiu Chang, Ph.D.

The role of fisheries in food supply

Per capita supply of edible seafood for Japanese citizen has become the top of the countries which have population 1 million people or more. Seafood is an important food that is essential in supporting the health and diet of the Japanese. However, fisheries & marine industry which are responsible for the supply of these food, have various problems currently such as decreasing the fish yield, fishermen's aging, the decreasing of marine products consumption and the prices of fish.

Reconstruction of marine food system

We capture the entire process as one of the system from production of marine products (marine food), distribution, processing up to consumption and in such a way that the system become more efficient & can reasonably function we conduct surveys on needs of consumers and actual situation of management of fishermen, distribution & sales together with undergraduates & graduate students with in a large field area from fishing village to sectional meeting and thereby rediscovery of these problems and the countermeasures for these are being asked.

Management of primary industry is much important.

To take the maximum advantages from the limited marine resources to the full capacity, it is necessary to manage the marine processed products. We are conducting steady survey researches day to day in order to be able to propose a comprehensive system including methods for distribution, sales and consumption, based on the concept of individual marine processed product, focusing on ensure the safety of marine processed products, conservation of natural environment and effective utilization of marine resources.

A study by observation of Owase fish market in Mie Prefecture

Department of Sustainable Resource Sciences

Why cannot the overfishing be prevented?

Associate Professor
Matsui Takahiro, Ph.D.

Keywords

Research contents are included in the economy in a broad sense, but as a method, (statistics) and (differentiation, integration in microeconomics) and you can use the combination of them such as econometrics.

Drastic fish reduction due to irrational fishing

In recent years, reduction of marine resources and decline in fisheries industry have become a major social concern. The problem of fisheries industry of Japan caused such a situation is often express simply as 'irrational fishing' and in general, price fluctuations due to the yield of fish catch, over-investment, over-fishing and catching of small fishes also refer to a variety of problems. Through these irrational catch, fisheries industry has become unprofitable and the problem of 'consumers will not have fishes to eat' is approaching.

Is the irrational fishing irrational?

Although much of such problems (enter profit in fisheries, sharing influences on resources) are explained tentatively from the viewpoint of the most ideal behavior of individual fishermen. But only from that, a part of the problem can be explained. In particular, even there are large scale fisherman organizations, there are some cases of overfishing and fishing of small fishes. Under such situations it is impossible to explain from the above viewpoint.

However, is such fishing really irrational? Some of the problems as described above have been made explanation once, for the other problems, I suppose that there is some rationality. We are conducting researches on rationality behind the irrational fishing by examining whether there are differences in the characters of the members (fishermen) of the places where the resource management is going well and the places which isn't so and the differences of characters of fishermen who have high consciousness on resource management and fishermen who do not as such.

To sustainable use of marine resources～

Finally, we aim to obtain sustainable utilization of marine resources by designing specifically how to plan a system which make possible to suppress the occurrences of irrational fishing as a result of the rational behavior of fishermen.

Department of Sustainable Resource Sciences

Milk can be produced from grasses

Keywords

Cattle, bio-resource utilization, forage chemistry & feeding technology, milk & meat production

Professor
Masakazu Goto, Ph.D.

Hats off to the cattle and sheep

Herbivores

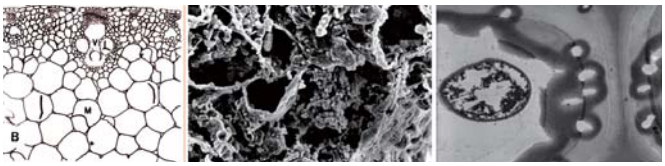
Do you feel deliciousness of milk because you feel the blessings of nature? or because of mellow aroma & sweetness? Even though, there may be many reasons why people like milk, the fat contained in the milk has a great relationship to its taste.

Fraction of fat in this milk is synthesized by acetic acid-one of the short chain fatty acids produced by the microorganisms live in the rumen of cattle and sheep, after decomposing the feed. Also because of this acetic acid is generated during the process of grasses decomposition (digestion) that cattle has consumed, even if cereals are fully given, it does not become delicious milk. Cow is one of the companion of herbivores and it grows & develops by eating grasses and straw and be able to bring up its children naturally.

My research theme is to provide milk & meat indispensable to our lives through the development of nutrient-rich grasses and fodder preferred by cattle and sheep.

Various uses from various grasses

As there are big differences in economic characteristics of rice & vegetable varieties such as the yield performance, disease resistance and earliness etc., the palatability and nutritive values of the pastures have been developed and greatly influenced by grass species and variety, growth stage at harvest, and agronomic resume etc. While investigating on the relationship of such nutritional characteristics to the anatomical structure of forage plant and its chemical structure, we have found how to be processed the by-products of agriculture, forestry, fisheries and food processing in order to expect to obtain the same effect as the forage plants.



Forage plant structure (Light-, scanning electron-, and transmission electron microscopy)

Starting point of the human survival in 21st century

The 20th century era was successful in providing staple food to the increased population of 7 billion people from 1.6 billion people, but a remarkable population growth is predicted in this century. Continuation of utilizing some under-utilized resources surrounds us and some national lands which are difficult to use by manpower, become more important thing to countries which have low rate of self-sufficiency like Japan. For that by understanding plants deeply in material chemistry, it is necessary to continue to develop food production technologies that depend on resource recycling.

Department of Sustainable Resource Sciences

To keep clean sea forever

Assistant Professor
Fukuji Yamada, Ph.D.

Keywords

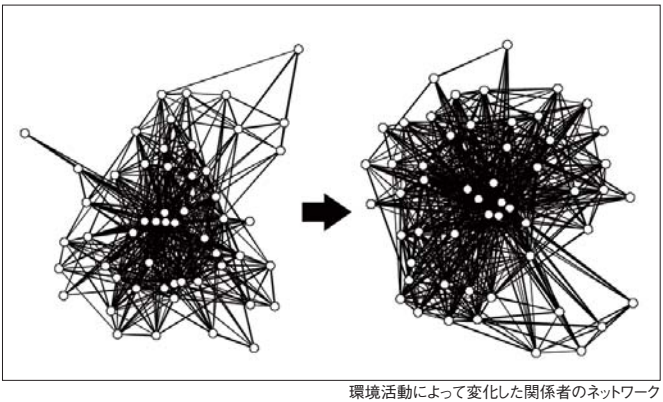
It is necessary to have knowledge of science in general, on issues related to environment. In addition, you will need to understand the structure of society. Also requires mathematical knowledge when performing the analysis of the numerical data such as questionnaires.

Sea also has many problems

Consequences of human activities and environmental issues are getting more intensified. In order to solve the environmental problems, not only the improvement of technologies but also it is necessary to continue to change our consciousness of environmental problems, life style, policies and management systems as participants to the environmental problems. In addition, deterioration of the environment is not only in lands that we are living, that extends to marine water bodies as well. Marine water body is not always a place for food production, it has been used in various ways such as tourism & leisure etc. In order to sustainable use of the marine water bodies, it is necessary to solve these environmental issues.

Know the system and consciousness of people

In order to solve the environmental problems occurring in coastal areas currently, it is necessary to know the way of thinking of related people & whether there is any defects in the system. For that, by performing interviews & giving questionnaires to those who related, can understand the actual situation. Moreover, not only the extraction of problems, but also we evaluate environmental activities & environmental education carried out in particular areas by giving excellent points. The problematic points and reasons for success are examined by analyzing the data obtained.



環境活動によって変化した関係者のネットワーク

Want to contribute to the solving of environmental problems related to marine waters.

I hope that the marine environment is improved through researches. We wish to exert ourselves together with you to do researches in such a way that improves the regional environments.

Department of Environmental Science and Technology

Department of Environmental Science and Technology

Weather and Climate Dynamics Meteorology and atmosphere-ocean-land interaction

Keywords

Prediction of extreme weather, Climatic changes, North Pole & South Pole, atmospheric observation, typhoon and heat waves

Professor
Yoshihiro Tachibana, Ph.D.

Meteorology and global warming

The people who understand global warming and global environment precisely are the ones those with high meteorological abilities. The typhoons which bring catastrophes. What will happen to the typhoons that occur in the age of global warming? Though the recent winter seasons are much cold winters, why do these cold winters continue? Summer seasons those have continuous intense heat and does it cause by global warming only? Thanks to the global warming, the damages due to cold weather which brings a shock to the agriculture do not occur any longer? Actually a safe answer to the question, why such abnormal meteorological conditions occur, is not yet find out by the human begins.

Love the Earth and exciting meteorology

When people acquired the meteorological, they become the persons who excite to the mysteries of the earth, who love the Earth, and who friendly with the earth. There are a lot of mysteries and unknowns in this earth we love. There are many mysteries in the climate and the weather also. It's better to increase the number of people who love the earth and being loved by the earth, in other words the persons with the high meteorological abilities. When having made a major breakthrough in a research, sharing the delight with students is the most excited moment and the most cheerful time.

Land-ocean-atmosphere interaction is a key to climatic change

Abnormal weather and climatic changes are directly connected with agriculture and staple food problem and also it makes influence on changes in aquatic resources. Changes in vegetation change the global climate and weather. And also change the climate and weather of oceans such as Kuroshio currents. You must know the climate and weather in order to properly understand the biosphere on Earth.

Meteorology guides global point of view

When increasing the meteorological abilities, it gives the habit of seeing globally. The atmosphere covers the whole earth. It is necessary to consider the whole earth to understand the meteorological conditions there. By such view points, it is possible to acquire a cosmopolitan outlook naturally, which is effective to apply solutions for international political issues and social problems. Don't you like to study science while enjoying with those who aim to be Earth scientists, government officers and weather casters?

図1　練習船勢水丸からバルーンを上空に飛ばして、上空の気流や気温湿度を観測しています。

図2　スーパーコンピューターを駆使して地球全体の大気の流れや気温の変化のシミュレーションを行っています。日本の気象はもとより、北極南極の海氷と気象、アフリカの干ばつなど、地球規模での気象・気候研究を行っています。

Department of Environmental Science and Technology

Let's touch the real ocean deep water and observe the world in 4000m depth

Keywords

Kuroshio Current, parent lakes, tsunami, sea & meteorology

Professor
Yoshihiko Sekine

What is physical oceanography?

When viewed on a large scale, ocean is the extremely thin membrane that covers about 70% of the Earth's surface. However, for human beings who are much smaller compare to the earth, the ocean is broad and deep. High tides can be seen during typhoon and tsunami is caused along with the occurrences of earthquakes too. On the other hand, there is also a thankful side of the ocean that is it makes the climate milder than continents. Academic studies required to conduct researches on the oceans as such is known as physical oceanography. Physical oceanography is the academic study of understanding the physics fundamentally on the basic properties of ocean water from the activities of waves such as wind air currents, rolling waves & water flows like tidal current, sea flow, distribution of water temperature & water salinity and their fluctuation processes.

Judging the global warming by physical oceanography

Due to the higher thermal capacity of the ocean water than the atmosphere, even if the atmospheric temperature rises 10℃ than the ocean water, when the atmosphere cools, seawater in 30m depth from the surface, the increment is 1℃ and if it cools in 300m depth ocean water layer takes only a little warming like 0.1℃. But the reality is not so simple, Due to the various causes such as presence of cold seawater in deep places, blowing wind over the ocean make the ocean system complex and it leads to become close to the global warming. Based on the understanding of entire global warming, quantitative understanding of influences cause by these oceans also become important. Moreover, what kind of effects to the entire marine ecosystem receive due to the influences of human activities change every moment, have been attracting attention from many aspects.

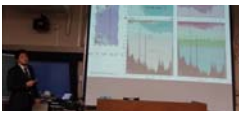
Understand the sea in ocean observations and numerical experiments

In our laboratory, starting from the ocean observations using a training ship 'Zeisuimaru' owned to the Mie University and researches using the numerical simulations also have been conducted. Using the instrument for oceanographic observation that has been installed in the 'Zeisuimaru', the density of the ocean, water temperature and salinity can be observed. Thereby the detailed facts about the water flow of the ocean currents and its origin can be revealed. Moreover, after recreating the tsunami occurrences in Ise Bay by the computer and also to examine these information, researches are conducted.

To those who want to understand the global environment

The atmosphere and the ocean have a difference, because of the gas and the liquid, but they are common in terms of fluid. By considering both of them collectively as 'geophysical fluids' and together with its dynamics, as 'geophysical fluid dynamics', lectures, debates & discussions are performed. Everyone who are major in the fields related to marine environment & the atmosphere and would like to take the qualifications for weather forecasters, Furthermore, those who would think to obtain the job related to oceanic & atmospheric environments in the future, I should be very much appreciated if you can learn the fundamentals that reflect the measures and solutions for global environmental problems which becomes problematic at present days in various ways, after understanding the nature & the details of the physical oceanography and atmospheric dynamics.

勢水丸を用いた海洋観測の様子。測器を海に沈めることで“海を測る”



自分で観測した結果を解析し、研究した結果を発表する様子。

Department of Environmental Science and Technology

Protect the lives from natural disasters by using GEOSCIENCE and CIVIL ENGINEERING

Professor
Yasuhisa Kuzuha, Ph.D.

Keywords

In order to explore the mechanism of natural phenomenon, knowledge of mathematics, physics, earth science is compulsory and chemistry as well. However, the number of students who have done the Earth science would be few. I think there are many students who have not done the physics in high school. All will be taught from the fundamentals at the university. We will study natural disasters by using GEOSCIENCE and CIVIL ENGINEERING.

Explore the mechanism of natural disasters

Japan has a high probability to be hit by natural disasters such as earthquakes, tsunami & typhoon and also it is one of the main countries that natural disasters occur even in the world. The cause of each respective natural disasters, there are some parts completely different in its character and there are some parts which are common. Rather than thinking to face the natural disasters, it important to let it past in a way that it makes less damages, after thorough understanding of its nature or properties.

Meteorological disasters and the water disasters are the sides of one dice

If exclude such things as recent climatic changes, meteorological disasters, water disaster are not only a result of rolling the dice by the god. It is the image that the torrential downpours occur in years the number six is appeared. For example, this figure is line diagram for single torrential downpour (daily precipitation) occurs once per 120 years. As shown in this figure, precipitation occurs once in 120 years. However, because it is a dice, if there is possibility to appear in next year also (once every 120 years), it's necessary to pay an attention, that it may appear in two consecutive years.

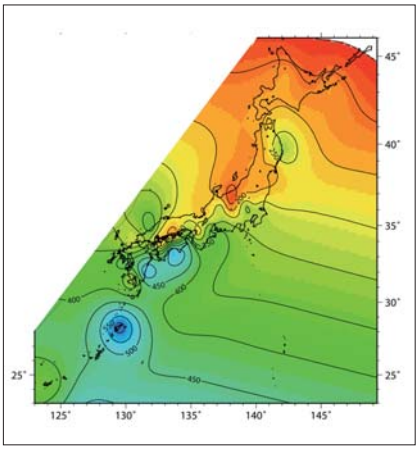


Figure 120-year daily precipitation

From floods to earthquakes

Even though on meteorological disasters and water disasters were written mainly up to here, the most fearful disaster in Japan might be the earthquakes. Considering that also as one reason, we have just begun the researches in our laboratory on the earthquakes occur due to southern ocean trough recently. Those who would like to explore the mechanism of typhoon, floods and of course the earthquakes, don't you like to conduct research together?

Department of Environmental Science and Technology

Research on mathematical principles imply in natural phenomena

Keywords

Mathematics (calculus, probability statistics), Physics (mechanics, thermodynamics, fluid dynamics, wave action), Earth science (earth, natural environment)

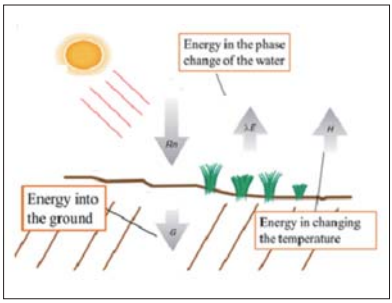
Associate Professor
Hideki Kiyosawa, Ph.D.

Familiar phenomena that occurs in soils of continents, oceans and the atmosphere

Leaves of trees which fluttering & falling during the sunlight in autumn have elegant appearance, doesn't it? But it is not easy to predict and analyze this action. Similar thing can be said to the flow of air, water and energy, and their transition which continuously available around us. Even if a phenomenon of homogeneous field in the laboratory could show by a simple theorem, it does not prove that the natural phenomenon can understand. In order to deal with the serious environmental problems that affect to the survival of the human beings, I would like to find out the mathematical theories which can imply for the each type of phenomena occurring in the atmosphere, river basins & the lithosphere in continents.

Theories of moisture variations in the soil and energy distribution at land surface

Water in the soil is in the condition that it adheres to soil particles. It's well known that the water moves from a place that the binding force is weak to where it is strong. It was difficult to handle the variations under the natural conditions due to the diversity of the properties of pore spaces in the soil. Therefore, we proposed the novel potential for adsorption force including the permeability effects of the soil pores too, and its distribution was expressed in the process of drying & wetting following a simple theorem. Moreover, when in the case of targeting the large area of the lithosphere, explanation on infiltration rate distribution to the earth surface has been attempted in terms of information entropy. Further, we also attempted to predict the entropy generation velocity in terms of extreme values related to the distribution of the sun energy on the surface of the earth.



Are there any hidden rules of the distribution of the sun energy on the surface of the earth?

Theories which lies in hydrological phenomena

Phenomena that occur on the Earth's surface receiving the rainfall and solar energy are called the hydrological processes. In order to deal with hydrological phenomena, not only the normal differential and integral calculus, but also non-integer order differential calculus and differential equations are necessary and also it is necessary to apply probability theory. Because this does not follow-up the predecessors, there are many cases that experiments do not work properly, but this field does not lack with the problems to be challenged and I think it directly links to important issues such as natural disasters and water resources.

Department of Environmental Science and Technology

Water-saving by the smart-phone

Assistant Professor
Ryoei Ito, Ph.D.

Keywords

Since it is often in contact with the farmers, communication ability with the different generations is required. Mathematics, physics, biology, information and English, etc. are required.

Which industry uses the water most?

Do you know the agriculture uses the water most? According to the FAO, about 70% of the world's water resources have been used as agricultural water. United Nations predicts that the world's population is currently about 7 billion people and it seems to exceed 10 billion people at the end of this century. 20th century was considered as the era that how to secure the petroleum oil, but it's said that the water resources replace the petroleum oil in the 21st century. Agro-industry has a low profit compared with other industries such as technological industries. Therefore it is impossible to invest much money for agriculture. (Try to calculate how many bags of rice required buying one Prius car) However, if water can be saved in agriculture, it becomes possible to support more population.

Advanced farming using ICT such as Smart Phone

Observation survey at orange farm in Kumano

These days 90% of university freshmen use smart-phones. Smartphone is small portable computer that equipped with sensors such as GPS and a camera and easy to connect to the Internet. We are trying to measure agriculture and visualize agriculture by using these technologies. The former agriculture in Japan was thought that experienced aged men and women went around small paddy fields briskly and cultivated many crops. Therefore, people must look after their fields with fewer people in a wider area. There is a problem how to bring up those who want to be farmers and who have little agricultural experience. We propose to install many sensors in the paddy fields and agricultural plot. Information coming from these sensors can provide useful advices such as (which paddy field is short of water) or (because water has supplied too much, save the water for a moment).

Item development that can be purchased at KOMERI

From the technological point of view, sensors which measure the water level of paddy field can be easily made as long as much money is spent. However, it is meaningless unless farmers buy and use these devices supposing these are convenient items. No one would spend tens of thousands of yen to buy such items even though these sensors have high performance. Our target is to develop items that can line up in the DIY shop where many agricultural materials are available.

Department of Environmental Science and Technology

What is forest management planning?

Professor
Naoto Matsumura, Ph.D.

Keywords

Biology, physics & mathematics. You may be surprised to know that these mathematical methods are required to understand the current situation of forests. In order to predict the future trend and to make forest planning, it is important to apply mathematical models based on biological knowledge.

Not to reduce the world's forests

Forests are available resources familiar to us. We have developed our economical situation by using the forest in our hands. Today the forest has exceedingly overused, so that the land area covered by forests has drastically reduced in some regions, and in some other regions available forests currently have become qualitatively very poor. Forests also show us multilateral appearances, such as a forest having abundance in water resource, a healthy and thriving forest which make us feel refreshed. We are working to properly recognize the current situation of the forests, and to make systems for maintaining sustainable healthy forests in the future.

Evaluation of forest growth and proper layout to the region

We figure out forest resources in a region properly to evaluate the amount of growth of the forest. Forest stock can be maintained, if the forest is not used more than the amount of its growth. For plantation forests, we set permanent sampling plots and derive yield prediction according to the thinning plan (Figure 1). For natural forests, we evaluate the healthiness of the forest, monitor such that the forest will be able to continue to survive in the future and create the forest management plan in the region. In addition, focusing on some indicators, we prepare a forest layout plan appropriate for the specific region. Together with the local residents, we consider how to maintain the forests. (Figure 2).

Fig.1 Snap shot of forest inventory in Sugi plantation forest

Fig.2 Forest cover in a town and available area by 200m distance from roads

Development of forest score in forest management to leave the healthy forest to next generation

Using a common scale, we evaluate whether the maintenance levels and management conditions of forests are appropriate or not and develop the forest score which can judge the forest management of world standard and then the mutual evaluation of forest management is carried out objectively. Considering such theories and the real conditions to practice the forestation, we aim to maintain the healthy thriving forests and leave the forests to the next generation.

Department of Environmental Science and Technology

Admiring the dryland vegetation, visit the desert

Keywords
Plant physiological ecology

Lecturer
Matsuo Naoko, Ph.D.

Now, what is going on in dryland ecosystems in Asia and Africa?

Ecosystem degradation by desertification is one of the serious problems in the dryland regions of Asia and Africa. I would like to understand how the dryland plants survive in severe environments and respond to the environmental changes to restore/conserve the dryland ecosystems. I would also like to evaluate the role of dryland ecosystems.

Reveal the survival strategies of dryland plants using the stable isotopes

The Kyzylkum Desert in Central Asia has much larger temperature fluctuations in summer and winter and almost no precipitation in a year. In addition, the salts have accumulated on the soil surface. However, plants survive in such environment (Fig. 1). By analyzing the stable isotope ratios of leaf organic matter and stem water, survival strategies of some dominant species were cleared as follows: Some species reduce their salt uptake by decreasing transpiration and by absorbing water with low salinity in the deeper soil layer. Others depend on water with low salinity in the shallower soil layer only during the short rainy season.

Fig.1 Brown but living plants in a desert in Uzbekistan. I love them.

Want to know the survival strategies of various plants from drylands to tropical rainforests

The methods that we propose can be applied to plants in various ecosystems including tropical rainforests and monsoon forests (Fig. 2). I would like to restore and maintain the collapsing ecosystems. At the same time, I believe that we can learn many things from diverse life styles of plants.

Fig.2 Observation tower in a tropical deciduous forest in northern Thailand.

Department of Environmental Science and Technology

Health diagnosis of agricultural crops - Measuring the field environment and plants' vigor

Professor
Takaharu Kameoka, Ph.D.

Keywords

Crops, meteorological measurements, plant physiology, ICT, soil moisture

Subjects required to the research

Mathematics, physics, biology, chemistry, earth science, technology, domestic science

Background of the research and motivation

The use of ICT (information-communication technology) on an agricultural field is thought to be a leading source for the science-based farming to achieve sustainable staple food supplying system. Here, the studies based on the measurement of growth environment of plants and plants' vigor, using ICT, such as the movement of various substances and water through the fruits and plants grown under the sun, penetration of sun light with optical information from stem to roots, and growth of roots in the soil, are introduced.

ICT is the leading source of the "Smart Agriculture"

We've developed a monitoring method of meteorological environment and soil moisture in the agricultural fields using ICT. (Figure 1) However, for the cultivation management of agricultural products, it is necessary to have new measurements for the conditions of agricultural products based on the plant physiology, in addition to the growth environment measurements. Therefore, we study on measurements of water and mineral flow in the plants (sap flow and transpiration), flow of energy substances (sugar and amino acids) in plant bodies starting from canopy photosynthate (translocation). (Figure 2)

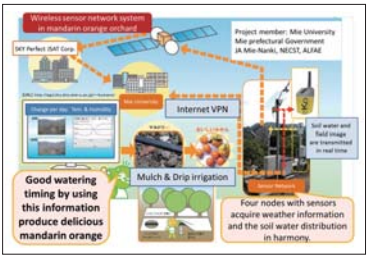


Figure 1. WSN in Mandarin Orange Orchard

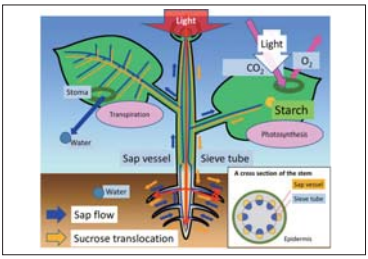


Figure 2. Water, sugar and light transport of plant

Expected real time high speed sensing

Since, recently, low-cost sensors for plant measurements, that can be used even in the farm and the basic technologies have appeared, an expectation to measure the agricultural products at the field is increasing. Crops information would be sent from the new sensors at the agricultural fields in the near future. However, what the farmers really need is the agriculture information service for the optimum cultivation. By creating knowledge based on the information obtained from the farm; it is required to achieve the agricultural information service.

Department of Environmental Science and Technology

Frozen

Associate Professor
Kunio Watanabe, Ph.D.

Keywords

To consider water, heat and solute transport in soil, general knowledge of physics, chemistry, earth science, biology and mathematics is important.

Frozen soils

It's fun to step on needle ice. Soil freezing is estimated to occur in almost 70 percent of the Earth's land surface. Soil water flow during soil freezing causes changes in soil structure and microbial activity, and closely relates to frost damage, permafrost degradation and climate change. Frozen soil has considerable strength and impermeability. In order to promote the utilization of cold regions and frozen soils, it is necessary to understand the soil freezing mechanism.

Figure 1. Needle ice - ice formation in soil.

Behavior of water in the frozen soils

In soil, some water do not freeze when cooled below 0℃. We measure this unfrozen water by various techniques. We recently developed a method that enable direct measurement of unfrozen water pressure. We conduct column experiments and measure the soil temperature, the unfrozen water and ice contents, solutes concentrations during soil freezing. For example, it has revealed that when water infiltrate to the frozen soils it undergoes three phases and the infiltration rate and the duration of each phase depend on soil water content before freezing. We also use numerical calculation to predict environmental phenomena related to soil freezing.

What lies ahead

Frozen soils and water flow in the frozen soil have not properly understood yet. There are a lot of themes in frozen soils. For instance, emission of greenhouse gases from frozen soils, uneven thawing of permafrost and the relationship to the recharge of groundwater and nitrogen-carbon cycles, are awaited to be analyzed. Understanding of frozen soils might lead to new material development, food production, and space developments such as agriculture in Mars. Wouldn't you like to bump your hot feelings against these frozen soils?

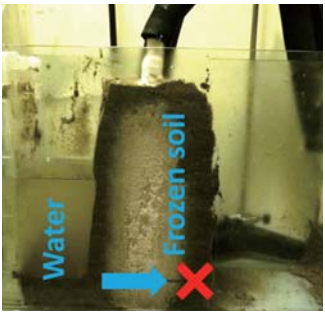


Figure 2. Frozen soil shields water flow.

Department of Environmental Science and Technology

The past and Future Earth: research for evolution of earth and sustainable earth system

Keywords

Earth system, the evolution of the Earth, a sustainable earth system, natural energy, self-sustaining energy and ecological system, geo-science

Professor
Tatsuhiko Sakamoto, Ph.D.

"To see a world in a grain of sand", understanding the earth evolution

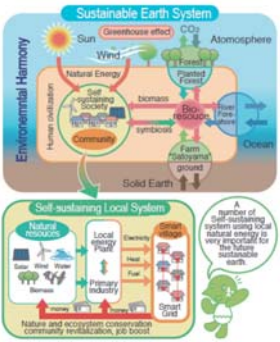
One of my researches is studying on evolution of the earth system. The present environment is a product of 4.6 billion years of earth evolution. For that we investigate geological material such as deep sea ocean sediments and terrestrial sedimentary rocks all over the world which are records of climate, ocean, and terrestrial environmental changes in the past. Especially, we focus geological times such as interglacial periods and the Cretaceous period that are the past greenhouse (warm) earth. The knowledge of the past earth is a key for predicting the future warming of the earth.

Understanding Earth system today as "Limits of growth"

When learning the history of Earth, the earth is a system that has been evolving as one life form keeping the exquisite balance. Oxygen we breathe is produced by the photosynthetic microorganisms over billions of years. The fossil fuels that we use are the fossils of the past plants that were existed several hundred million to several billion years ago. However, the human beings is going to drying up to use the fossil fuels within a short time period of 200 years. Burning of a fossil fuels are lead to increase of the carbon dioxide amount in the atmosphere, and there is fear of global warming in near future. We need to understand that the present is a turning point of growth of our history together with the earth.

How to create the sustainable earth system

Our another study is about "green innovation" to practically achieve the sustainable Earth system. In particular, it is the specific vision and strategy for sustainable society using natural energy. By achieving the self sufficiency of natural energy from familiar Earth's natural energy sources (solar, wind, water, life), self-sustaining system in a small and local region conjugate with primary industry and make activate the local economy, promoting the participation of local people from small scale municipal level. There is a future vision of a sustainable society. Why not create a feasible future vision together by keeping the earth level wide vision, studying on research and developments for new natural energy, regional recycling system with small scale distribution type and the society linked with that functionally, view of the sustainable society that harmonized with nature and living together with the earth, in the future. The prediction of the future by scientific way is not enough for the future sustainable earth system. It is necessary to "think globally and to act locally".



Department of Environmental Science and Technology

Want to treat the environment somehow

Professor
Kunio Sato, Ph.D.

Subjects required to the research

As long as focus on the things in real world, physics, biology, chemistry etc. every thing will important.

After the environmental measurement, how to do the improvements

To incorporate with the environmental issues world wide, firstly it is necessary to know the past, present and the future situations. In that sense, environmental measurement is important, but when trying to actually improve the environmental issues, truly it is necessary to develop new technologies which make few negative impacts to the environment.

After all, energy is important/ the effective use of natural energy such as solar and biomass

太陽光発電システム

First of all, due to the act of combustion that human beings began to use in primitive age, large amount of carbon dioxide emits to the atmosphere. Initially that was done for light and something to warm up and to do cooking, but then it started to be used as the help power to make and remodel things for the next generation. In other words, major combustions are being used as energy. Then should consumption of energy be stopped as a remedy for environmental problems? Edo era that consumed not more than the minimum energy requirement for the living, Japan's population was constant at nearly 30 million people. In other words, quality of life than it is now (this includes the quality of health and life) is in fairly poor condition, in the national land of Japan, it will not be able to feed the 120 million people of the population if there is no energy.

バイオマス混焼ボイラー

Is it already hopeless? No, no, we have brains and it's possible to think on that. This thinking power use to improve the person's life is the technology (engineering). Of course non-essential energy consumption is suppressed as much as possible (This is also a technology) and then energy requirement still is believed that rely on the effective use of natural energy such as solar and biomass. Japan is advancing recycle technologies originally. Recently the technologies using even municipal wastewater as the capital of energy and resources are also beginning to develop.

For the development of environmental technologies

If there are people who shout the promotion of natural energy use, some people say that just only that is not enough. In other words, this research field is never easy, when saying conversely; it's also the field quite worthwhile to do. Don't you like to try to develop environmental technologies joining with us?

Department of Environmental Science and Technology

Agricultural robots

Associate Professor
Takashi Fukushima, Ph.D.

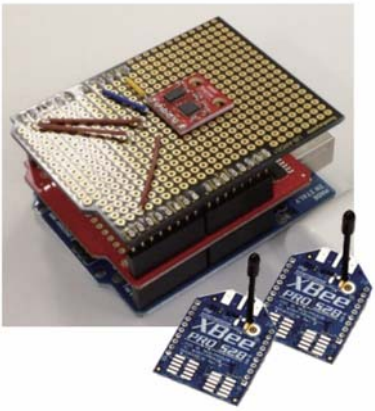
Subjects required for the research

Mathematics (all you learnt in high school), physics (mechanics, electricity, thermodynamics, waves) biology (plants)

Location + motion = locomotion

Only manpower is not enough to stably supply many foods. Agricultural robot can work automatically regardless of the day and night in order to assist farmers. Human beings get various information (positions and postures) unconsciously and work, but robots are controlled, just as a program. It's important to control robots while grasping the condition of the robot in detail. In my research, sensors to grasp the information such as where the agricultural robot staying by now? and in what kind of posture robot is moving? have been developed.

Engineering to support food production



The agricultural robots are various from big harvesters & tractors to small robots for worker's support & for the monitoring. In my research, a system using MEMS sensors (micro sensors developed by nano technology) those are small in size, inexpensive & light in weight have been developed. In order to develop sensors for agricultural robots, mechanical dynamics to inform how the robot works, electricity for designing of circuit in the robot, programming to organize the sensor information are necessary. But the most important is the knowledge concerning agriculture.

Innovation of agriculture in the future

Have you seen the products to be sold as tomatoes of Mr. Xxxx at the supermarket? Alternatively, tomatoes of (Agri-robo Mie - number 3) may be sold in the future.

The small light-weight sensor unit is necessary not only for any kind of agricultural robots. Farmers install it by themselves; it is useful to manage the business very closely by recording the work history in every successive days. Also can be utilized to monitor the activity of wild animals (bio-logging) for prediction & prevention of animal damages and for preservation of ecosystems.

Department of Environmental Science and Technology

Condition diagnosis technology for facility safety

Professor
Ho Jinyama, Ph.D.

Subjects required for the research

Mathematics, physics, English

Why condition diagnosis technology for facility is necessary?

The facilities referred here are the machines that use in production sites such as agriculture & power plants and also equipment and other things use in bridges and tunnels like social infrastructure facilities. Because of the facilities also age like the same way of human begins, troubles occur here & there and also they get sudden sicknesses (abnormal) due to various reasons. The important facilities in the nuclear power plants and the chemical factories and serious accidents in infrastructure facilities like a bridge and tunnels make not only economic & human losses, but also sometimes bring harmful influences to the global environment. In this research, development of sustainable, safe & secured society, by being able to contribute to the factory & agricultural production, by establishing smart diagnosis technology that enable to implement health diagnosis of various facilities automatically.

Condition diagnosis technology for facility

Research on basic theories and applications of intelligent condition diagnosis technology for plant machinery and society infrastructure

In this laboratory by conducting basic researches & applied researches on facility diagnosis technologies, conservation & diagnosis technology for petroleum oil & chemical plants, steel, business & office establishments, manufacturing, electricity generation and rivers & dams and also technologies for early detection of abnormalities in aircraft hydraulics & air-conditioning systems have been conducting related to the machine tool safety technologies as joint researches with companies. In addition to that, to judge the health condition of the facility by observing, many types of smart diagnosis devices were developed in collaboration with companies. These diagnosis devices are much helpful for safety & security of production facilities in the production sites.

Functions of automatic condition diagnosis and self- restoration in the future facilities

In the future, failures or accidents of facilities will be prevented by early detection and proving the abnormalities occurred. Also, when minor failures occurred in the facility, such abnormalities be able to be repaired by facility it self, having its own self-healing strength and it becomes indispensible to human life & production and these facilities become more safe and secure to use.

Department of Environmental Science and Technology

Self-feeding system for fishes, friendly toward sea & fishes

Keywords

Fish cultivation, feeding method, environmental technology, biology, ecology, physics

Assistant Professor
Mitsushi Yamashita,

Seeking a new feeding method that does not generate wasted feed

In the fish cultivation of the yellow tail & red sea bream a lot of feed is used. The typical conventional method is that a person estimated the amount of feed that seems to be eaten by fishes per day and gives it to fishes. Then, the estimated feed becomes insufficient or it becomes excess in most of the time. It becomes waste when it is excess in amount and it caused the sea contamination. Then changing the way of feeding fundamentally, a new feeding method that does not generate wastes is requested by giving appropriately the necessary amount for fishes. One of the methods is self-feeding system designed by using the learning capabilities of fishes.

In self-feeding system, fishes decide time and the amount of feed by themselves

Most of fishes show behavior having many other things without fish feed and trying to touch them. Because of that if fishes are given experience to receive the feed in several times, fishes can learn about by moving towards to those that are not feed they can receive their feed & keep that in mind. Then, when the fish demands feed, the fish tend to feed necessary amount voluntarily. Self-feeding method is a feeding method that uses the learning capabilities of fishes. Self-feeding system provides experience to fishes to catch their feed and strengthen the learning capabilities of fishes. It is a mechanism that fish can voluntarily receive feed that is necessary when it needs. A fish holds or contacts a demand sensor of the system in its mouth and the signal comes out from the sensor and then a small amount of feed as a reward is served from the feeder. Using this self-feeding method in the practical scale (preserve 10,000 fishes) sea culture (Figure 1) of red sea bream, it was proved that the system is able to reduce about 10 percent in feed without inferiority in growth as compared with the conventional feeder from the result of the experiment in one year or more.

Fig 1 the practical scale (preserve 10,000 fishes) sea culture of red sea bream

Future prospects

Demand sensor is very important in self-feeding system and it must be one that matches with the characteristics of the fish cultivated. In the research, a variety of demand sensors are developed that are suitable for various fishes and then application test for the practical scale and also on the relationship between the cultivation environment and the fish's behavior are investigated. In the future, it is expected to improve the self-feeding system by combining much more experiments and that it will spread as a practical feeding method in many fish species.

Department of Environmental Science and Technology

Plant cultivation in artificial light

Professor
Katsusuke Murakami, Ph.D.

Invention of artificial light

Incandescent lamp was invented by Edison in 1879 and lighting through the use of electricity began at that time. It is not a so long period since then, if it says from the history of human being for 130 years or more. After that approximately 60 years later the fluorescent lamp and another 60 years later an LED were appeared; lightning has evolved.

The difference between the lightning for human life and lightning for plants cultivation

Because the human eye has an iris (aperture) correspond to the brightness, can receive the visual information in response to a wide range of brightness (luminance). Humans use light as sole information source. But for plants light is one of the main energy source used in photosynthesis. (Also use as information) Therefore, illumination necessary for human activities and the illumination used for the plant cultivation are greatly different, for plants at least about ten times of illumination in a room is needed. Then, the source of light with good efficiency is especially needed. In terms of the quality of the light, since the wavelength used for the plant photosynthesis is almost the same as eye sight of the humans,' the plant can be grown by using the source of light use for the rooms.

Why plants are grown under artificial light?

In the plant cultivation experiment, if it does in the outdoors, the results are different according to the temperature and humidity, day light, carbon dioxide concentration and soil moisture etc. After the practical use of florescent lamp, artificial environment control device has achieved and by that device, light and other conditions can be arranged as possible and highly accurate repeated experiments that cannot be conducted in natural environment can be conducted. Vegetable production method by cultivating homogeneous seedlings in artificial environment and then plant them in open fields has become more popular. Recently, plant factories to grow soft leaf vegetable types mainly such as lettuce, baby leaf until up to the final harvest under completely artificial light have also been operated. (Figure 1) Artificial light cultivation can provide a secure environment instead of natural light with a lot of changes.

Fig. 1 Plant factory with artificial light source

By applying the technology that Japan takes pride

It's possible to control the vegetable cultivation environment by using the industrial technologies such as electric machineries, machines, information, measurement, control systems and conservation of energy made in Japan. Especially, the measurement apparatus that is appropriate for agriculture can be made in the laboratory. It's also necessary to study the features of the plants that is different from humans. Based on that, the artificial environment that is appropriate for the plants is achieved. Recently, we are investigating on light environment control related to the fisheries such as sea urchin larvae and algae plants.

Department of Environmental Science and Technology

Develop cameras proposing an attentive behavior

Keywords

Subjects required in the research basically are the mathematics, information science and Brain science and psychology also very important subjects in order to explain the expression mechanism and effects of an attentive behavior.

Associate Professor
Yoshinori Morio, Ph.D.

Attentive behavior to make people happy

People having attentive behavior rush into the action before the people get noticed and make the people happy. Because an attentive behavior works as the lubricant for surrounding people to act smoothly, the working environment makes happily and early. Moreover, at times, I feel an attentive behavior get decreased in the society recently, though it is indispensable to our lives. In our laboratory, in order to offer a regaining consciousness which makes sure that considering of attentive behavior even a little more, to those who do same work in the same space together and to the machines or robots that move along with the people, we want to develop a special camera if you peep at the finder of the camera, it will propose some actions for attentive behavior

The camera that track the person while rotating the camera head by itself up and down, right and left, was developed

The developed pan-tilt-zoom camera, if it find a person wearing a special suit having red & blue color markers, automatically start to track by recognizing the human posture & actions such as turning, bending & moving arms and have the ability to understand the human behavior. The developed camera is introduced into the fields if the farmer is in trouble because of heavy labor, I succeeded to develop a camera that follow up the location of the farmer and his movements automatically in the 40 m distance away from the camera.

Pan-tilt-zoom camera

The artificial intelligence that can propose an attentive behavior is developed

The function to think about help the working person to be pleased and the function which makes camera formulate assistance request menus are still under developing. I want to develop the function having ability to predict the reaction of the person being helped by using the knowledge of brain science and psychology. Because thinking about an attentive behavior can be freely designed and it is worth to challenge and it is interesting.

Example of working behavior pattern

Department of Environmental Science and Technology

Utilization of agricultural straw as renewable biomass materials

Keywords

Knowledge of Mathematics and physics are necessary but the basic knowledge of plants is also desirable.

Professor
Xiulun Wang, Ph.D.

Why straw from agricultural products use?

The limited fossil fuel resources eventually deplete. In order to achieve the sustainable developments of human society, utilization and application of renewable bio-resources is essential. Plant biomass as bio-resources is unlimited from the seaweed & sea grasses in the oceans to the plant on land and the trees in mountains. Straw as a byproduct in food production process also is a splendid plant biomass, but many of which have discarded without been effectively utilized. In this study, we physically macerate the straw and isolate the fibers and then re-combine fibers under the water to form plated material.

Rice straw

Development of environmentally friendly approaches

For the straws from agricultural products, as shown in below, the series of processes such as rutting, soaking, refining, forming and the fiber isolation treatment is done under flowing water and pulp is made. After that, pulp is filled to the mold and then compression and heating are done simultaneously with a hot press machine. By removing the moisture, fibers are bound again mutually and board material bio-board is made. During the production process, additives or adhesions are not used at all.

Bioboard made from rice straw

Recyclable raw materials

Raw materials of bio-board which was prepared by the method of this present study, is the biomass in the by-product of agricultural products. In preparation of straw fiber pulp, straw is converted into the pulp and all ingredients in the straw were used. Moreover, the additives are not added. Therefore, bio-board that was produced is pure biomass and is a completely biodegradable bio material. It can be reused as fuels in composts. Bio-board which was developed in this study is expected to be used in future as wrapping material, agricultural materials and as insulators in buildings. After using the bio-board as a raw material, it is decomposed naturally and return to the soil and it generates the carbon dioxide. But it is absorbed in new agricultural products and then it enters to the carbon cycle and it recycles.

Department of Environmental Science and Technology

Let's harvest delicious fruits easily

Associated Professor
Koji Kito, Ph.D.

Subjects required to the research

Mathematics (For logical description, mathematics is essential), Physics (especially mechanics & electromagnetism to the understand the machines and sensors), organisms (without knowing the characteristics of the target organisms machine does not create a sensor), chemistry (to elucidate the microscopic world within an organism using sensors), English (because this is the era of internationalization)

In order to free from hard labor by identifying the delicious fruits

Harvesting of fruit has mostly been done by hand. The reason is that the maturity condition of fruit is different for each individual fruit and because the places that bear fruit distributed over space widely. Because of that, it is difficult to harvest together as reaping rice with a machine. Based on the long time experience, farmers judge level of maturity in every single fruit and fruits on the tall trees are hard to harvest. Such harvests rely on human hands some time make reduction in fruit quality. Therefore in order to mechanize the harvesting work, it is necessary to have functions that determine maturity and harvest without damages to the fruits.

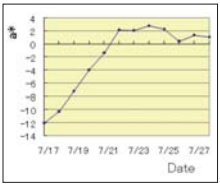
Determination of maturity of peaches by fruit color & odor and harvest with no damages to the fruits

By determining the maturity level of fruits, peaches in physiological maturity is harvested during the days that carried out manual harvesting. After that the harvesting device that becomes farmer's support is developed. Targeted fruit is the peach and damages to the quality is considerable and is one of the vulnerable fruit type. The harvesting device is made in the manner of a person use it in his hands and press the switch after putting the device to the peach and measure the maturity by the sensor. If the sensor determines as the fruit is in physiological maturity and the device automatically harvest fruits with no damages. We aim to develop this type of machine. In this case although it is the very difficult to determine the maturity, estimating the color, size & odor by the sensor, trying to evaluate using overall information. For that, by measuring these information from the trees that actually grow up & bear fruits, I try to reveal the relationship with the maturity. In addition, we are exploring a challenge of adapting a mechanism of diaphragm which can open & closer to the mechanism of harvesting which doesn't make damages to peaches.

Necessity of automation of the sensor

Decision of maturity of peach is based on the information in the sensor. Recent developments in sensor technology is remarkable, but some of them are exceed the human abilities and some are still having a long way to go. Of course the brain power that judges based on the overall information is also much important. In particular, since it is used outdoors in agriculture sector, without receiving the influences from rapidly changing environment, the sensors that estimate the color & odor correctly is also required.

Peach harvester



Variation in color of peach

Department of Environmental Science and Technology

Discover the environment of Monsoon Asia

Keywords

Environmental change, Holocene, Physical Geography, Geomorphology, land use change

Professor
Shigeko Haruyama, Ph.D.

Observe from space, think and understanding

Monsoon Asia seen from the satellite image is much beautiful and contains high diversity. It is possible to realize that a long environmental range and the range of a short term environmental changes are compacted together. The land cover changes are so intense in an Asian region and there is a large impact of human activities on environmental changes. These are related with changes in surface of the oceans. (Figure 1) What things have generated in this region? What kinds of environmental problems occur in this region? Think personally, inspect at the site, and conduct researches to find out methods to solve problems.

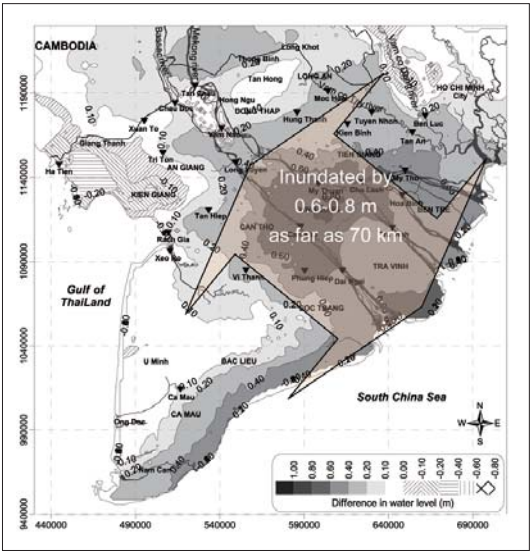


Fig. 1 Expansion of inundation in Mekong Delta under the climate change

Assessment of impacts due to land use change

Natural environmental changes in flood plain of South East Asia and related with developments, assessments of impacts to the society due to the land use changes and zoning method for disaster risks are carried out.

Elucidation of Holocene environmental change

By understanding Holocene environmental changes, where the index of the monsoon is different in Africa region from Asia region. The fluctuations from human history also will be considered.

Department of Environmental Science and Technology

Doctor of the ground soil

Keywords

Mathematics, physics (mechanics), geoscience, English

Professor
Toshinori Sakai, Ph.D.

Properties of the ground soil are diverse

If you look at the soil in a playground, you will notice that the soil conditions are different in rainy days and sunny days. In addition, the soils of Tsu city and Okinawa are different both in the color and the hardness. Similar to the differences in characters of individual person, the soils also greatly different in character, depending on the location and the condition. Soil which forms the earth's crust does not exist in the same property even it covers the single world.

Disasters occur on the ground soil are diseases of the ground soil

Disasters occur on the ground weakens the top soil and when the unexpected power is received, the soil get disturbed and collapsed. This is same as people get ill health condition or injure in an accidents. Before being sick, if people expose to the medical inspections & follow some preventative measures, no need to take care of them. Also the ground soil would not have to face serious disasters if the proper inspections and treatments had done before they become major disasters. To the same way as doctors inspect and give treatments to their patients, thinking about the treatment of ground soils having diverse properties is very important in order to make a safe and comfortable life.

Methods and devices for preventing the diseases of the earth's crust have developed

Considering about taking precautions and appropriate treatment methods against the sicknesses in the ground soil generated by various natural disasters such as Nankai Trough massive earthquake expected to occur in near future and the Kii Peninsula disaster caused by typhoon No. 12 of September 2011, is much important to lead the safe and comfortable life. In our laboratory, we are conducting researches on how to treat the illnesses of the ground soil as a doctor of the ground. Our main researches are considering about the method to prevent the slope failure and to improve the strength for soft and weak ground.

Device of evaluating slope stability (SAAM system)

Device of improvement of permeability in the ground (ECOGEO method)

Department of Environmental Science and Technology

Science for the soil contamination

Keywords
Soil contamination, simulation, nitrogen & carbon cycling, cesium contamination

Professor
Nobuo Toride, Ph.D.

Soil buffering capacity for contamination

Soils have been sustainably used by the human beings while receiving the blessings of the earth. Soils have incorporated variety of wastes in the material recycling using the soil buffering capacity. However, introduction of excessive amount of wastes above the allowable range of the soil and radioactive materials that do not exist in the nature, have resulted in a variety of soil contamination that was not seen in the history of human beings up to now.

Nitrogen & carbon cycling with the decomposition of soil organic matter

The vadose zone, also termed the unsaturated zone, is the part of earth between the soil surface and the position of the groundwater, which generally corresponds to the plant root zone. Unsaturated water flow such as infiltration and evaporation continuously occurs in the vadose zone. We are conducting researches on unsaturated water flow and solute transport in soils. Most of solutes are adsorbed to the soil particles and the soil buffering capacity is related to the interactions between the chemicals and the soil particles. When solutes move in a soil, abrupt changes in the solute concentration and pH are moderated by the soil buffering capacity. In addition, gaseous chemicals also move in a gas phase through the soil air. For example, organic materials in the soil are mineralized after the decomposition. Gaseous carbon dioxide is used by the plant photosynthesis and the mineralized nitrogen components in a solution phase are also taken up by the plants again as nutrients. We are working on the prediction of nitrate pollution of groundwater due to excessive organic matter input to the soil by coupling the nitrogen & carbon cycling model and the water flow and solute transport simulation model.

Cesium transport in a soil

Research on chemical transport in a soil, has also been applied to the prediction of cesium transport in the agricultural field of Fukushima area. We believe that it is our mission to aim the prediction of pollutants movement with higher accuracy in order to minimize the negative inheritance of soil contamination.

Department of Environmental Science and Technology

Soil, water and plants

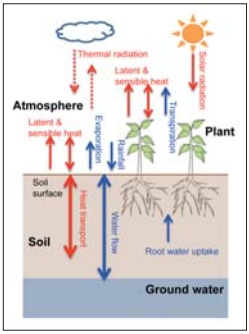
Keywords

In order to predict and understand the natural phenomena, science (physics, biology, chemistry) and mathematics (differential calculus, integral calculus) are important as fundamental subjects.

Lecturer
Masaru Sakai, Ph.D.

Water cycle in soils and role of plants

Soil is indispensable material as the place for biological production such as agricultural crops. Most plants grown in towns and mountain forests rooted to soils as well as plants grown in agricultural fields. Water that infiltrated into soils during raining, is stored in soils and absorbed to plants by its root system. Then it will be back into the atmosphere by transpiration from leaves. It is possible to say soil & plants play a major role in water cycle that occurs in natural surroundings where we live. In order to unveil this water cycle and to aim efficient water & fertilization management with less environmental stress, I want to clarify the root water uptake mechanism in soils.



Water and thermal cycles in the soil-plant-atmosphere system.

From where in soil do plant roots absorb water?

From which depth of soil do plant roots absorb water? Simply, some fraction of soil water is easy to use for plants while the other fraction is difficult since that water is held strongly to the soil. It has been reported that plants selectively uptake water that is easier to use. And there are some other reports on water that has absorbed in deeper layers will be released to upper layer close to the soil surface. By monitoring changes of soil water content in field or laboratory experiments, it is possible to understand root water uptake phenomenon. In addition, we're trying to elucidate phenomena and predict of water cycle in soils by numerical simulations using models.

Field monitoring of soil water contents and soil temperatures.

Soil, water and plants and their future

It is expected that precipitation amount will increase and soil temperature will be higher in the future due to effects of global warming. Since the relationship between soil, water and plants in those conditions may be different from the current situation, prediction about how the change occurs is much important. I would like to reveal the relationship between soil, water and plants together with you for the future.

Department of Environmental Science and Technology

Countermeasures to disasters and environmental protection
From the local region to the whole world

Professor
Zakaria Hossain, Ph.D.

Keywords

Mathematics (all in high school level) science (physics, statistics, geology, chemistry, biology), English

To prevent from disasters

For disaster prevention, environmental issues are noted worldwide from recent years and the research on cement composite which recycle the construction wastes is progressing. Our research objective is to develop the porous cement composite which can be used to grow plants with excellent in all aspects such as quality of material, level of strength, economically feasible and burdens to the environment and to develop the frontier technologies for levees that withstand the disasters and protection of glued surface (figure 1).

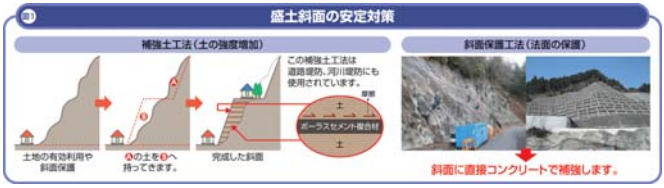


Fig.1 Slope reinforcement and protection

Three birds with one stone - recyclable material, environment, economy - outstanding great effects on disaster countermeasures

The porous cement composite material possible to grow plants that we have contrived has been used effectively in many places domestically and in overseas. Since it uses the recyclable material it is environmentally friendly and much effective to the landslides. Since it has used waste materials it is economical with low price and it is suitable as the sediment disaster countermeasures. In addition, it is also suitable for environmental protection due to the possibility of cultivating plants. By three synergistic materials such as mesh, mortar & recyclable materials, to compensate the tensile force, giving a friction force to the soil surface, a foundation which is strong enough to landslides is built up.

Technologies beyond the borders ～measures appropriate for the environment

In our research group, we are conducting researches on levee destruction and reuse of industrial wastes in developing countries and investigating on disaster countermeasures that are appropriate for the environment. Here after also we would like to conduct the researches that can support to the countermeasures for disasters faced by each country and each region and then contribute to international community. Disaster countermeasures in consideration of environmental conservation are still developing. Looking for safety of people's lives it is essential to conduct researches on new potential raw materials and on novel technologies every day.

Department of Environmental Science and Technology

This is also a research of water

Professor
Takamitsu Kajisa, Ph.D.

Keywords

Main point is the areas relevant to this research are so wide. Mathematics, Japanese language, English, science and social studies are required.

We would like to make an artificial improvement and settle a problem

In our laboratory, incorporation of the chelating agent was confirmed effective in acidic water turbidity problems in Hyogo Prefecture recently. Reservoirs of Mie Prefecture were observed and discussed the improvement of the water quality after sufficient drying the bottom mud.

Not making an artificial improvement is also important?

Besides that, in Tokushima Prefecture, we have proposed the method that divide the waterways into two kinds of sections of the waterway efficiently. One of the sections should be checked the water leakages and another section be left without checking. Moreover, in Mie Prefecture, about digging up the hot spring, a method of distinguishing the improper digging place was discussed. These are the proposals of graduate students.

Overall view

Around you, aren't there some people saying the natural conditions are the best and hating to walk on the muddy road? There are people saying both. From them, we should make the dam reservoir empty because of the heavy rains while we should store water because of the dry season (Figure 1). In some countries, rice planting is done in all inside of the field. In another countries, rice planting is not so (Figure 2). We are looking for the answers of the problems shown in the very complex situations. Therefore, I welcome the students who have ability to think comprehensively to our University firstly. Public working office that is not very businesslike is expected as a working place after the graduation.

Figure 1 Dam reservoir
(Selection of the water-surface level)

Figure 2 Experimental paddy field
(See water-surface where is not planted)

Department of Environmental Science and Technology

Protect the aquatic environment carefully

Assistant Professor
Masaaki Kondo, Ph.D.

Keywords

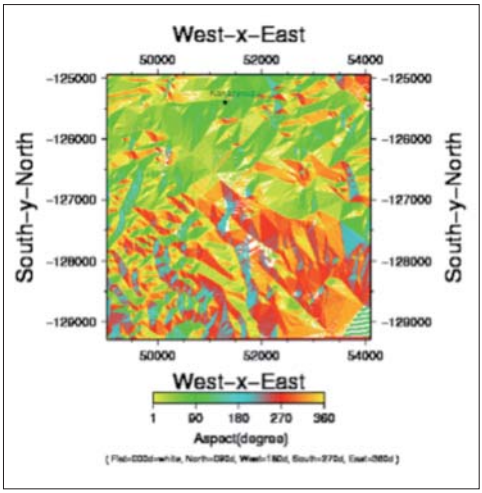
As subjects mathematics (in general, especially differential calculus & integral calculus), general science, information, physical education, industrial arts are required. I think basics have studied in the high school though it is necessary to do most of studies at the university. And I think there are no ideas that physical education and industrial arts are disregard and these are also important.

Even if you say as water

Even though we say as water using one word, it includes in a wide range. It has properties such as rainy, dynamic and might be qualitative and the places are also different such as lakes, water reservoirs, waterways, rivers, bays, etc. I also have to consider the biological factors in recent years. It is important to read and to understand the phenomenon of physical environment that brings up living things such as plants & animals. One of the themes in recent years is a salt marsh environment and surrounding environment.

Think quantitatively

The micro topography chart was made after surveying the salt marsh. GIS data etc. were used to understand the geography and topography of the salt marsh surroundings. The inflow water model was made after establishing the triangular dam and carrying out the measurements. If the surrounding environment has changed due to some factors such as urbanization, how much amount of inflow water would be changed was found out quantitatively.



Slope analysis for an object region

From impermanence of all things, here after ….

There are a lot of problems with the necessity for elucidating the physical environment as the biological environment of the surroundings including the salt marshes. For instance, it is an environment of the aquatic life. Moreover, when asking from the senior citizens live in the local area, it has been understood that the environment has changed much. Because still home and road constructions in urbanization are undergoing, in the future the problems along with this would be changed too.

Department of Environmental Science and Technology

Soil is a living thing Are blood vessels over there?

Professor
Hajime NARIOKA, Ph.D.

Keywords

All subjects which rouse your imagination.

Are there blood vessels seem to be in the soil?

We gradually came to understand that, as there are many tubes in the bodies of flora and fauna, the tubes that similar in appearance to those (called as "Tubular Macropores") are located in the soils as well. When the soil structure was observed through the special electromagnetic waves with longer wavelength called as "Soft X-rays", not only the three-dimensional structure of the internal soil, the condition of water, gas, solutes and soil organisms also have observed like a shadowgraph. This research method has been developed in Japan (Figures 1 and 2).

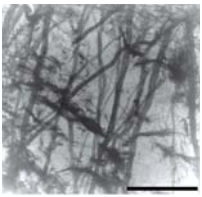


Figure 1: Soft X-ray imaging of the paddy soil. Black streaky shade is the tube in the soil. Downward is underground direction. Scale length of the lower right is 10mm.

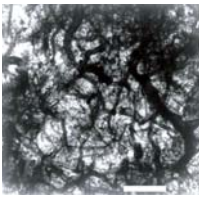


Figure 2: Soft X-ray imaging of the upland field soil. Direction and scale is the same as Figure 1.

It took 30 years from the first step of the beginning until now, in fact, it has not been yet fully elucidated

Because, as the bodies of flora and fauna maintain their health by displaying the overall organizations, the soil also possible to support the organisms to maintain their health condition when only the soil have the soil environment called as organization. But that mechanism is not well understood yet.

From now onwards…

This research is connected with the research topic as follows:

(1) Amelioration in degraded soils and barren lands: Devised and considered on the amelioration methods for the degraded soils & barren lands from the viewpoint of soil science & agricultural land engineering.

(2) Agriculture and Rural Improvement: We are involve in elucidation of problems related to the agricultural land engineering occurring in rural areas and researches on agricultural land & rural improvement.

(3) Making a special production from regional agricultural products: We are investigating on the relationship between the soil and crop growth. Recently, we are working on making of special production of functional tomatoes.

(4) A natural disaster restoration technology: We are working on reconstruction, maintenance of the farmlands after the natural disaster occurrences.

(5) Soil pollution problems: Soil degradation of agricultural lands that has abandoned the cultivations, conservation of coastal environment: we are dealing with "Problem Soils" (The soil where the productivity does not rise easily because very unique chemical, physical and biological properties of matter exist or even the soils that crops growth is difficult). In recent years, we have applied some measures to the practical agricultural fields for acid sulfate soils and saline soils (Figure.3).

Figure 3: "Problem Soil" (Ground surface of Acid Sulfate Soil, Negara Brunei Darussalam)

Department of Environmental Science and Technology

Diagnose the building structures in non-destructive inspection

Keywords
Close relationship to the physics

Professor
Satoru Ishiguro, Ph.D.

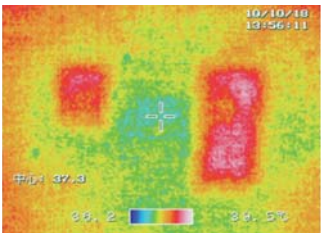
The building structures which get aged are increasing

Aging is also proceeding with building structures similar to the human society. Many of the facilities that have been constructed in the period of high economic growth in Japan such as bridges, roads, railroads, water and sewage facilities are approaching their aging time. Also in the agricultural infrastructure, dams, head works, drainage machineries, waterways, irrigation facilities that secure and distribute the agricultural water have been aging. Regarding to the waterway, there is an extension approximately 400,000 km and it becomes approximately ten laps of the earth. Currently, we are investigating on expansion of life span by checking and judging the condition of the main irrigation facilities and by applying measures such as repair or reinforcement if necessary.

Inspection of concrete waterways by thermography

Many methods are use in Non Destructive Inspection and are used to diagnose the internal situation without breaking the structure. The thermography method also is often used in non-destructive inspection. Photograph 1, showing the condition of open concrete channel that the abraded surface has repaired and it is the thermal surface image of wall of the water channel taken by thermography. When there are voids or detachments presence inside the concrete, after receiving the sun light it creates temperature difference on the surface and then that difference of temperature was measured using thermography. After that the internal situation is inspected. The red part of the thermal surface image shows the part which is higher in temperature than the surrounding and existence of voids or detachments inside the concrete was estimated.

Photograph 1 Open concrete channel that the abraded surface has repaired



Photograph 2 Thermal surface image of wall of the water channel

It is important to expand the life by health diagnosis similar to humans

Because it costs a large amount of expense to re-construct the superannuated structures newly, while reinforcing and repairing the structures the life expectancy is extended when it is necessary. It is necessary to re-construct the structures gradually according to the priority. Non Destructive Inspection is helpful to do the medical examination of structures. In the laboratory, the construction of the Non Destructive Inspection method that is effective for the diagnosis of various waterways including open water channels and the water transporting pipe lines are investigated.

Department of Environmental Science and Technology

Technologies to build stone walls and protect the traditions

Associate Professor
Kenji Okajima, Ph.D.

Keywords

For manufacturing the objects and to do the evaluation of them mathematics and physics are used. Here it is interesting if you know the physical geography since we are dealing with stones. Even though the arrangements of stones in particular region is much diverse, it requires knowledge on history because it requires the understanding of traditions & cultures also.

The fact that there will not be mason craftsmen any longer!

We can see very commonly the stone walls around us as obstacle wells. But it is hard to find a craftsman (Stone mason) who can make this stone walls now. The civil engineering technologies have evolved very much in Japan after the world war. The technology that makes the wall has moved from the stone wall to the concrete wall and It becomes impossible to make the walls for normal roadways only from the stone as a rule however. Then, the technology that cross the stones and build the stone wall becomes unnecessary and stone masons disappeared steadily from Japan. Then, the stone wall has come to be repaired with concrete.

Is the stone wall weak when it is built only from the stones?

Which of the stone wall is strongest comparing the concrete wall and the wall made only from the stones? In fact, about such a simple question, it has not been wrestled seriously until now. During the long history of stone wall, there are various methods on how to compose the stones to build a stone wall. There are some methods of composing the stones that have been considered as prohibited strategies too. How weak the various methods of composing stones as such and the methods of composing stones considered as prohibited strategies compare to the concrete walls? By clarifying these questions, it is possible to say that, in fact the stone wall was better than concrete.

I want to leave the scenery of home town in my mind

Even though the stone walls not so famous they have built in most of the places where we feel good sceneries. Techniques and traditions use to construct the stone walls are becoming continue to lost, but many people do not yet notice the crisis. Neither the technology nor the tradition lost once return to the original condition easily. After the techniques to make stone walls were lost, it is too late, even if you notice the changes in the places where you feel good sceneries. It is necessary to hand down the traditional technologies that build the stone walls in order to leave the stone walls for the future. It is necessary to create a job position for the mason who has the technology can work in order to leave the technology that builds the stone walls. By understanding the mysteries of strength and beauty of stone walls I'd like to create new job positions to make stone walls once again and protect the sceneries of home town remaining my heart.

A concrete wall in stone-wall rice terraces scenery

A model experiment to measure the strength of a stone wall

Department Of Life Sciences

Department of Life Sciences

Epigenetics and ON / OFF of the genetic switch

Keywords

Animal cells, genes, food functions, epigenome, epigenetics, lifestyle-related diseases, agricultural chemistry, biochemistry, molecular and cellular biology, molecular biosciences

Professor
Okumura Katsuzumi, Ph.D.

Genes in all human cells are same. Then why there are various cells?

Our basic unit is the cell and the DNA sequence of all cells is same. Then why will we have different cells such as skin, heart and the liver without having a lump of the same cells? It is because ON/OFF of the genetic switch varies according to the cell. When receiving the modification called methylation even if the DNA sequence is same, the gene is turned off. Such modifications are referred to as epigenome and the research field relevant to control that mechanism is called epigenetics. Although the epigenome state has been maintained in our individual cell very well, what will happen when it is altered?

When DNA becomes the hypo-methylation state, DNA damages are induced!

We have found that when DNA becomes the hypo-methylation state, the DNA is cleaved as well as a gene turns ON. Currently, we try to clarify the molecular mechanism by the gene knock down method and by the proprietary technology that visualizes DNA replication forks on the DNA one molecule under the fluorescent microscope. (Fig.1 and Fig.2) When DNA is cut, it got repaired, but if it is not complete, it will cause chromosomal abnormalities such as abnormalities in gene ON/OFF and various abnormal functions in cells. In other words, abnormalities in DNA epigenome → DNA damage → chromosomal abnormalities & abnomal ON/OFF of genes → functional abnormalities in cells → it will lead to disorders (diseases)

Fig.1 Visualization of the intranuclear world via fluorescence microscopy (some results were printed as cover illustration of various journals)

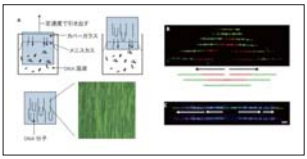


Fig.2 The proprietary technology that visualizes DNA replication forks on the DNA one molecule under the fluorescent microscope.

The unbalanced eating habits might trigger the DNA damage and lead to lifestyle-related diseases!?

When some nutrients such as the folic acid (vitamin) and methionine (amino acid) are insufficient, it causes the Hypo-methylation of DNA, that is, there is a possibility to occur according to the following flow: lack of nutrients → abnormalities in epigenome → lifestyle-related diseases such as cancers. In our research group, we expect to expand the research on the relationship between epigenetics as such and lifestyle-related diseases, including effects of environmental factors & functional ingredient derived from natural resources in a broad view.

Department of Life Sciences

Potential power of Vitamin

Keywords
Vitamin, nutritional science, biochemistry, food, health

Assistant Professor
Shin Ogata, Ph.D.

What is Vitamin?

What do you imagine by hearing the word of 'Vitamin'? Probably, do you have positive image that it would be good for our health? However, do you know what functions of 'Vitamin' have concretely? Vitamin is one of nutrients for us. In other words, we cannot live if we do not take 'Vitamin' as food similar to sugar, lipid, protein and mineral. In addition, when vitamins are deficient, we will get various diseases and finally go to death. Unfortunately, many people were dead since the cause was not cleared just 100 years before. After that, the provided situation of food was improved in the world. And nutritional science was deeply studied and was understood. As a result, many deficiency diseases of vitamins were hardly seen in the modern society. But, from recent researches, it is becoming evident that there are still many unclear points and some unknown processes on what kind of molecular mechanism that leads to the deficiency diseases due to the vitamin deficiency. Furthermore, in the case of taking nutrients in necessary quantity or more, there are some vitamins showing the function (pharmacologic function) that is different from the original function (physiological function). Pharmacologic functions are also being recognized by public interests until now.

Targeting Vitamin, nicotinic acid and nicotinamide are one of water-soluble vitamin.

Vitamin is classified based on the solubility in a solvent as water-soluble vitamin and fat-soluble vitamin. In addition, water-soluble vitamin contains mainly vitamin B group and vitamin C. In particular, nicotinic acid and nicotinamide belong to vitamin B group. These compounds are nearly similar to nicotine (in the tobacco) in name, but these physiological functions are completely different. Specifically, nicotinic acid and nicotinamide are converted into nicotinamide adenine dinucleotide (NAD) in our body. In all living organisms such as animals, plants and microorganisms, NAD is used in oxidation-reduction reaction as a driving force (coenzyme). As a result, energy molecules (ATP) are synthesized via some processes. In other words, NAD is an essential factor for life phenomenon. Furthermore, NAD can also be used as the source of some enzyme (substrate) on processes involved in control of gene expression, stability of chromosomal structure and control of aging. I would like to expand the research for the purpose of the effective use of nicotinic acid and nicotinamide to improve the health condition after deeper understanding of pharmacologic functions of these vitamins.

Effective use of a variety of factors contained in various foods

Eating is an essential behavior for the maintenance of our life activities. I aim to utilize vitamins and many other factors contained in various foods eating from routine life cycle effectively by verifying scientifically further on relationship of health enhancement.

Department of Life Sciences

Production of liquid fuels from biomass

Assistant Professor
Miyake Hideo, Ph.D.

Keywords
Genome, DNA, RNA, proteins, and microorganisms

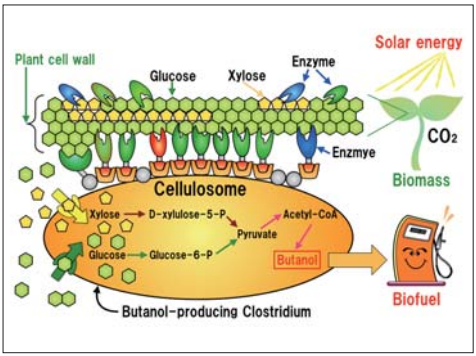
Related subjects
Chemistry, biology, physics, mathematics

Use of biomass and carbon neutral

Biomass is an organic resource derived from organisms and it is the sustainable recyclable resource as far as the life and sun energy are exist. Furthermore, biomass has a characteristic called carbon neutral which does not increase CO_2 in the atmosphere. It is possible to contribute for the reduction of CO_2 emission caused by the global warming by substituting to fuel and the material produced from biomass instead of raw materials of fossil fuel and chemical products.

Production of super microorganisms

So far we have been studying on *Clostridium cellulovorans* that has ability to hydrolyse the non-edible parts, such as rice and sugar cane. It was found that this bacterium can degrade biomass into sugars such as glucose efficiently by enzyme-protein complex called "cellulosome" on the surface of the bacterium. On the other hand, it is possible to produce butanol with almost same energy as gasoline by metabolizing sugars though *Clostridium beijerinckii* but this bacterium can not degrade biomass into sugars. Therefore by recombinant the cellulosome of *Clostridium cellulovorans* into *Clostridium beijerinckii*, a super-microorganism that can produce butanol directly from unused biomass is made.



Invention of super microorganisms

Investigation of catalytic mechanism of enzyme from the world at the nano level

Various types of enzymes have involved in biomass degradation and butanol production. These are like a very well-made machines and the size is a very small size of one-billionth of one meter (nanometers). Let's study on energy and environmental issues through research of nano level size?

Department of Life Sciences

Studying the mechanism of infection of phage

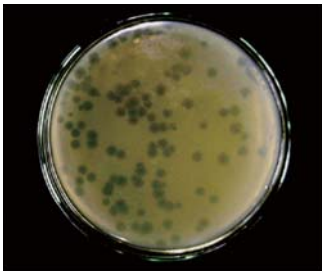
Professor
Minoru Inagaki, Ph.D.

Keywords

As a research method to capture the life of the organism as a life of molecules, comprehensive knowledge on chemistry (organic chemistry, analytical chemistry), physics (thermodynamics) and basic mathematics (functions) are required.

Still there are mysteries for just even a small virus

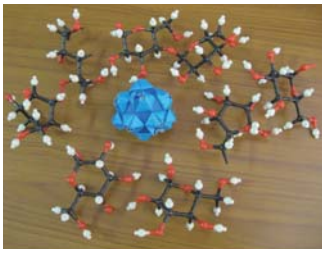
ϕX174 phage is one of the smallest icosahedral virus among all DNA viruses. At 12 vertex points of the icosahedron, it has spike projections which are made up of two types of proteins (G & H) and using this spikes, adsorbs the surface of host *E. coli* cell and causes infection by injecting the genetic materials, but detail mechanistic information is still unknown.



Emerged Praques on the *E. coli* lawn on agar plate

Decomposition of organisms into components and check their functions in vitro

By making two kinds of proteins constituting spikes with genetically-engineed technique, the sugar chain which is covered the surface of *E. coli* bacteria is purely taken out and confirm weather they have really bonded together in every single test tube. That result has shown that proteins and lipopolysaccharides have bounded individually and one of the proteins, G that bind to sugar chains of *E. coli* are100-fold stronger than the other proteins, H.



Phage binds Bacterial Saccharide

Pursue the infection mechanism of viruses

Firstly phage is bound to the surface of *E. coli* using the spikes. Then the phage invade into bacterial cell since protein are strongly bound to the carbohydrate chain and then, it is thought that the spikes open and the genes dash out. In order to ascertain whether it is a really true? It is necessary to make many components in the future and repeat the experiment for evidence *in vitro*. And finally, I want to buld up the component parts again and to reconstruct them to original state.

Department of Life Sciences

Sesame-The potential as dietary supplement

Keywords

Chemical analysis; food; health; organic compounds

Associate Professor
Hirotaka Katsuzaki, Ph.D

About efficacy of sesame

It has been considered that sesame is good for health from ancient China. However, there are many unknown parts about scientifically evidence. Research on dietary efficacy of sesame and other food has just begun recently. We are trying to make it clear scientifically.

Chemical components with the sesame

We purified the chemical compounds from sesame seeds, and analyzed it using an advanced equipment. From these results, we found a trigger and timer that turn on the function of the component that make a man healthy.

About other foods

Functional food, like sesame, may support our health scientifically. Let's try researching about wonder of food and other organisms using advanced equipment.

Department of Life Sciences

Mechanism of glowing organisms

Professor
Katsunori Teranishi, Ph.D.

Keywords

It needs basic learning knowledge of biology and biochemistry because research is carried out on mechanism of life from a molecular point of view.

Beautiful light _ wonder of glowing organisms

On the earth, the number of light-emitting species exceeds our imagination. In animal 2000 or more. And many of the light-emitting species exist in other bacteria and mush-rooms. Currently, the light have been found to be produced by a chemical reaction, how-ever, species that mechanism has been elucidated is only a few. The mechanism has been applied to space development and the state-of-the-art development of life science such as medicine and pharmacy. To elucidate the mechanisms of life luminescent organisms, is one of the important themes in the future science.

At the molecular level

We've researched about the light-emitting mechanism of jellyfish and squid and devel-oped a technique to visualize the luminous phenomenon, by reproducing the molecular mechanisms artificially. One of the emission organisms of which the mechanisms have not yet been elucidated is fungi (mushrooms). I've attracted to this photo and researched about this.

Bioluminescent Fungus used in Research

Leave the name in history

Discoverer of Boyle's law, Robert Boyle (1627-91), and Benjamin Franklin, who discovered that lightning is an electric, researched about light-emitting species. In recent 100 years, the light-emitting organisms have been investigated in molecular biology, however, there remains a lot of mystery. Using the creativity and your young imagination, please great research and leave your name in history.

Department of Life Sciences

Tasting by optical (infrared spectroscopic) sensing

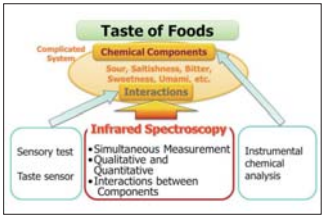
Keywords

The taste of food is very complex. It is relevant to knowledge of science (physics, chemistry and biology). Moreover, mathematics, informatics and even cultural aspects are equally important as well.

Professor
Atsushi Hashimoto, Ph.D.

The importance of taste

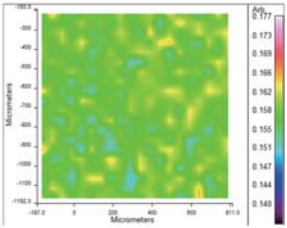
Taste food has distinctive quality for each brand, and there are significant differences in consumer preferences. Therefore, making the taste to meet the needs of consumers is an important issue. Most of processed foods are made from agricultural products, which are greatly affected by the climate of the agricultural fields. And the food processing is very complicated. Therefore, usually, quality evaluation of the food is performed based on the qualitative and subjective sensory test by tasters. So it is important to research on the method to objectively test food.



Infrared spectroscopic evaluation of food quality (taste).

Infrared Spectroscopic Measurement

We are conducting research on the method to taste of alcohol (such as wine), coffee, ice cream, and tea, using infrared spectroscopy. The developed methods have been applied to flavor evaluation. The method could be simple, easy and rapid without chemical treat-ments.



Sugar component distributions in coffee beverage

Future of optical sensing technology

Research on infrared spectroscopic measurement, is still inadequate, however, it may have great potential as objective indicator of taste. It will work effectively when consider-ing the relationship between the taste and flavor, or obtaining information about the health food ingredients and food brand.

Department of Life Sciences

Bioprocess measurement and control based on optical sensing

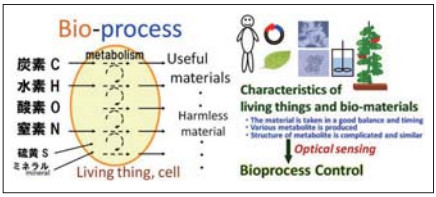
Keywords

Science; (Physics; Chemistry; biology); Mathematics; Information Science; Electric circuit (sensor); Optical sensing

Associate Professor
Ken-ichiro Suehara, Ph.D.

The working of living things is worked by bioprocess

Our active life has a lot of bioprocess using a bio-chemical reaction, for example, fermented food and useful material production, composting and waste water treatment, etc. The bio-reaction is carried out in various levels including animal and plant cell, microorganism, enzyme reaction and gene expression. For the bioprocess control, measurement of the process variables is very important. Therefore, I focused on optical sensing which has a relatively small influence on living things. In particular, Infrared spectroscopic method and color image analysis are used for the measurement, control and simulation of the bio-process.

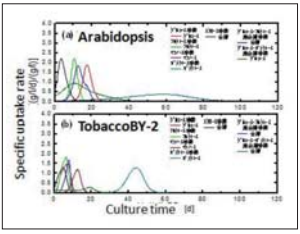


Characteristics of bioprocess and optical sensing

Can we create a food and a useful material from waste?

Sugar (carbohydrate) becoming the starting point of the metabolism is reconstructed by plant grown on the field. We can eat the sugar but unfortunately the kind of the sugar that food for us is limited.

I have studied a plant cell cultivation using sugar which is hard to use (xylose) and is fun-damental metabolic researches (glucose metabolism analysis of the plant cell, bioreactor design, measurement control) to connect this with feed and food processing as a raw materials, biofuel, useful material production.



Kinetic analysis of sugar metabolism
(plant cell cultivation)

The future of the optical sensing

Optical sensing using various light can applied to various fields. Various scenes concerned with the bio reaction are a target of the application, for example, waste treatment, food processing, agriculture, healthcare and medical consulting network, etc.

Department of Life Sciences

Making healthy carbohydrates

Keywords
Carbohydrate; Dietary fiber; Polysaccharide; Oligosaccharide; Enzyme; Food; Health

Associate Professor
Naoto Isono, Ph.D.

Healthy carbohydrates.

What kind of image do you have of carbohydrates? "Sweet", "calorie source" or "getting fat"? In fact, there are bitter or non-caloric carbohydrates. Moreover, some oligosaccharides have a good effect on intestinal disorders, and some dietary fibers enhance immunity; these are used as functional food or medicine. Healthy carbohydrates are sometimes obtained from natural food; however, their effect would not be sufficient in case of small quantity or low purity. Therefore, it is useful to produce healthy carbohydrate using microorganisms or enzymes.

Enzymatic synthesis of functional carbohydrates.

We investigate properties of various enzymes from microorganisms and plant to develop methods to synthesize healthy carbohydrates. Recently, we have developed the world-first practical method to synthesize beta-glucan, a dietary fiber, in vitro. In this method, high-purity beta-glucan is easily obtained by incubating the mixture of glucose, sucrose, and enzymes. The cost of synthesis is low. This fiber has ability to enhance immunity and cure cancer, and is expected to be used as functional food and medicine. We are now making various other useful carbohydrates.

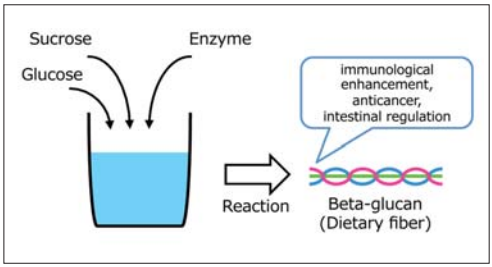


Fig.1 Synthesis of healthy carbohydrates

Department of Life Sciences

Genetic analysis on microbial plant cell wall degrading enzymes

Keywords

Microbiology; Protein; Enzymology, Biochemistry; Biomass conversion

Professor
Shuichi Karita, Ph.D.

Sustainable production of bioresources

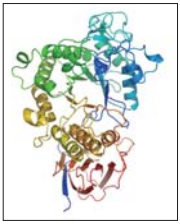
A plant cell wall contains a variety of polysaccharides which are the most in the organic matters produced on the earth. It is produced by photosynthesis and is produced continuously every year. I would like to utilize enormous living resources like a fallen leaf and dead grass for food production, biofuel production, and so on. Polysaccharides in plant cell walls are sustainable and renewable resources and one of the carbon neutral materials, meaning less contribution to greenhouse effect gas production in their utilization.

Mystery of the plant cell wall degrading enzymes

A lot of polysaccharide is contained in plant cell walls. Unfortunately, it is difficult to be saccharified for sugars. But the herbivore which has straws and grasses can break down this and change it to sugars. This reason is because enteron microorganisms which live in symbiosis with the herbivore produce plant cell wall degrading enzymes. There are many microorganisms which secrete digestive enzymes and break down fallen leaves and dead grasses in the soil. So we study about the plant cell wall degrading enzymes such microorganisms produce. We found a lot of plant cell wall degrading enzyme genes from these microorganisms and analyzed the structure and ability of enzymes to break down plant cell walls into sugars. Therefore, it is being analyzed how many enzymes need to digest plant cell walls and where such degrading enzymes bind to plant cell walls.

Papers consist of polysaccharides from plant cell walls. Microorganisms can readily degrade papers to sugars. The right electron micrograph shows microorganisms on rice straw surfaces in rumen, a digestive tract of cattle. Many microorganisms attack rice straws to digest or degrade polysaccharides in herbivore digestive tracts.

Schematic models of plant cell wall surfaces with enzymes (Better binding, better catalysis)



A protein structure of the plant cell wall degrading enzyme from cellulolytic microorganisms

Fermentation conversion of microorganisms

The purpose of this advanced study is to make an enzyme cocktail for every kind of plant residues, such as agricultural wastes, which will saccharify them into sugars by biochemical mechanisms and resulting the sugars can be converted into biofuels by microbial fermentation process. We dream of cars which will run on fuels derived from grass or straw. Let's challenge with us for the future environment of this planet.

Department of Life Sciences

Enzymatic decomposition of cellulosic biomass

Keywords

Microbiology; Biochemistry; Molecular Biology; Genetic Engineering; Protein Engineering; Bioengineering

Professor
Kazuo Sakka, Ph.D.

Global Warming and Biomass

As described by the IPCC report (2014), we are required to use more low-carbon energy such as renewable energy to reduce global warming. Conversion of biomass into fuel is an important issue for global warming suppression, and study of biomass-degrading enzymes is very important and also scientifically interesting.

Biomass, Cellulase, Cellulosome

Unused plant biomass including agricultural waste and construction waste is derived from plant cell wall. Since plant cell wall consists of lignin, cellulose and hemicellulose, many types of biomass-degrading enzymes are required in order to degrade these materials. Various microorganisms produce various types of biomass-degrading enzymes and some anaerobic bacteria form a multienzyme complex called "cellulosome". To develop tech-nology for efficiently degrading the biomass, it is necessary to understand individual cellu-lases and cellulosomes at gene or protein level and to improve these enzymes. I am inter-ested in biomass-degrading enzymes such as cellulase and xylanase that play an important role in biomass utilization.

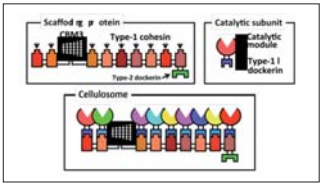


Fig. 1. Cellulosome is formed by highly specific interaction of a cohesin of scaffolding pro-tein and a dockerin of catalytic subunit

Roles of enzymes and substances other than hydrolytic enzymes

Cellulase and hemicellulase are glycoside hydrolases like starch-degrading enzymes such as amylase. Recently, aerobic microorganisms have been reported to produce enzymes capable of cleaving cellulose chains with oxidation of various carbons in the presence of molecular oxygen. I expect that there may be a novel mechanism of biomass decomposi-tion specific to anaerobic bacteria that grow under anoxic condition. It is possible that yel-low affinity substance (YAS) of Ruminiclostridium thermocellum is a chemical compound capable of enhancing cellulolytic activity of cellulosome. The function of YAS in enzymatic decomposition of cellulose is now under investigations.

Fig. 2. Production of YAS and cellulose decomposition by R. thermocellum.

Department of Life Sciences

Hydrogen gas production by the force of microorganisms

Keywords

Biology; Chemistry; Gene; Enzyme; Microorganism, Plant

Professor
Tetsuya Kimura, Ph.D.

You can solve the energy problem if you use the ability of microorganisms

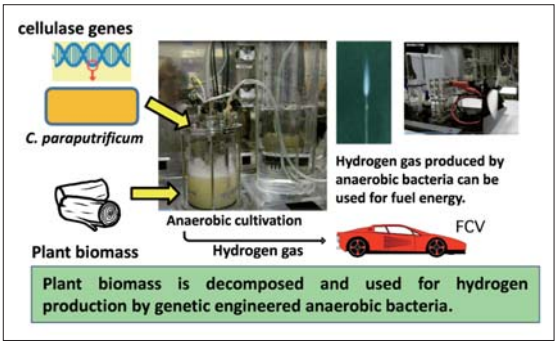
Since nuclear accident, greenhouse gas reduction and safe energy security has been more important. Microorganisms have potential power that we do not know yet. We challenge to resolve the human energy problems by using anaerobic bacteria that grow in oxygen-free environment and produce a large amount of hydrogen gas.

To breed super bacteria by using the power of genetic engineering

Anaerobic bacterium *Clostridium paraputrificum* M21 was isolated from soil of Mie University campus. This bacterium is able to make a large amount of hydrogen gas by decomposing the shells of crabs and shrimps. Unfortunately, this bacterium cannot decompose and utilize plant fibers (cellulose). On the other hand, there are some anaerobic bacteria which can efficiently decompose cellulose and utilize it as energy source. We have been studying genes encoding enzymes responsible for cellulose degradation in these bacteria. We are trying to molecular breed hydrogen producing *C. paraputrificum* that is able to decompose a portion of the plant cellulose component by introducing cellulase genes into *C. paraputrificum*. We will be able to realize dream that you can produce hydrogen gas from the garbage by anaerobic bacteria during night and charge your electric car in the morning.

Genetic engineering of microorganisms as a key technology for the future energy

Genetic engineering is a technology that has the potential to produce more powerful microorganisms with a good nature. However, it is hard just to improve one of the genes. Therefore, it is very hard to molecular breed a bacterium that is able to decompose a complex plant cell wall fiber completely because decomposition of plant cell wall requires many cellulolytic enzymes. We are trying to develop a new genetic engineering technology to breed a super microorganism.



Department of Life Sciences

Reuse of food waste to functional food

Keywords

Health; Food; Unused food resources; Chemistry; Biology

Professor
Hayato Umekawa , Ph.D.

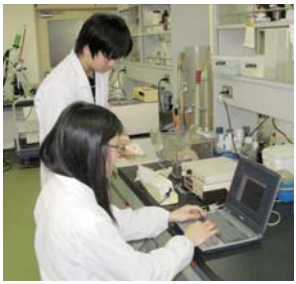
Increase in lifestyle related disease and food waste

According to the survey by Ministry of Health, Labour and Welfare, the death rate due to a malignant neoplasm and vascular disorder accounts for approximately two-thirds of the whole deaths. The death rates of cancer and cardiac disease are increasing year by year. The self-medication for the making of health is recommended by the Ministry and the application of food product having bioregulatory function became important. On the other hand, food industries evacuate approximately 2 million tons of food wastes. About 80% of the food waste was occupied by food manufacturing industry and the discharge of the food waste is not readily suppressed. We perform a study to prepare some functional components from food waste and make use of them for maintenance and improvement of health.

Hypotensive peptides obtained from tamari soy sauce residue

The residue evacuated from soy sauce production reaches 100,000 tons a year and becomes social concern. The tamari soy sauce (tamari) used for sushi and sashimi is almost made from a soybean while general soy sauces (koikuchi) are made with about 50% soy-beans and 50% wheat. The content of peptide in tamari is 2 times higher than that in koi-kuchi and tamari is abundant in relatively larger peptide. We have purified angiotensin converting enzyme inhibitory peptides, which showed significant reduction in systolic blood pressure when they were orally administered to spontaneously hypertensive rats.

Tamari soy source residue



Measurements of blood pressure of rat

Utilization of food waste to functional foods

In addition, we have purified the compound which inhibited cancer cell proliferation from tamari residue and also prepared functional components from waste *Porphyra* (nori) or used green tea leaves. If we able to purify some components which showed bioregulatory function from food waste, we may reuse them as functional foods. We will continue to work such kind of study.

Department of Life Sciences

Analyze food function by using animals and cells

Keywords

Nutritional chemistry; Food resource; Health benefit

Associate Professor
Masahiro Nishio, Ph.D.

What are carotenoids from functional point of view?

When you buy foods, are you looking only quantity of calories and salt? If there are such people, we suggest looking foods from a different viewpoint. The food constituent include salt and other material such as carotenoids. What are the functions of carotenoids? To analyze the function is our mission.

Foods is converted to pharmaceutical products

The Nori (*Pyropia yezoensis*) is regarded as good amount of carotenoids especially, we pay attention to lutein. The lutein is purified from Tagetes. The lutein constitutes the color of the petal of Marigold. The lutein cannot biosynthesize in vivo. There are a lot of lutein in the retina. What is the meaning of all this? Actually, lutein maintain eyes health by protective effect of the retina from the blue light.

We have been trying that applying a lutein to eyes by eye drops. The lutein belongs to carotenoid and is unsuitable for eye drops. The carotenoids have known that those cannot use eye drops by hydrophobicity. We have studied it for the purpose of attenuating the hydrophobicity. Lutein was hydrophilic by nanomicelle. It becomes hydrophilic when we handle lutein in PVP. The hydrophilic lutein (a nanomicelle lutein) could make eye drops, and the retina was protected when we used these eye drops, lutein is presented which inhibiting photodamage.

We found that hydrophilic lutein (a nanomicelle lutein) acted on light disorder retina effectively.

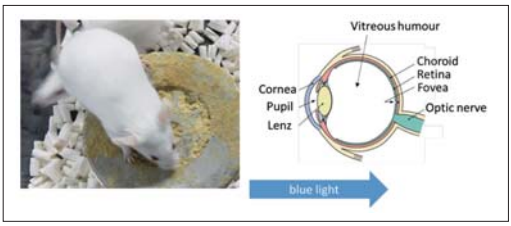


Fig. Schematic view of the blue light disorder

Lutein would have different effectivity by its nanoparticles

The retina protection of the lutein nanoparticles varies in a nanomicelle by a kind of becoming it. Lutein nanoparticle can be retinal protective effect, we would analyzed which is better PVP nanoparticle or other nanoparticles.

Department of Life Sciences

Let`s examine muscle cells composing of blood vessels

Keywords

Chemistry (sugars, aminoic acids, buffers); Organism (cells, gene, protein, nucleic acid); English

Professor
Tsuyoshi Okagaki, Ph.D.

Blood vessels are made up of muscles

Blood vessels regulate blood pressure by controlling the flow of blood. To tell the truth, the vessel wall is consisted of muscle cells. Vessels stretch or contract as muscle rather than being kept constant structure as a hose. Let's study how muscle cells of the blood vessels work.

The Structure of blood vessel and types of cells that constitute it

Cells that constitute a blood vessel are endothelial cells and smooth muscle cells. Differed from cells of other organs, properties of vessel cells are affected easily by the conditions of health in adulthood. Please try to imagine that you were bleeding by injured finger. It is necessary to reproduce the cells to recover tissues of the finger. To grow the cells in an injury, new capillary vessels must be created to carry nutrients there for the reproduction of tissue. Endothelial cells make the guidelines of capillary vessels by branching off from thick blood vessels. After the guidelines are completed, the smooth muscle cells move along the guideline to form the vessel walls. Smooth muscle cells adjust the blood pressure by contracting and relaxing with expanding and shortening the cross section of blood vessels.

We want to examine the relation of illness and disorder of vessels

Blood vessels are closely related to various illnesses. Arteriosclerosis is causes of various lifestyle-related illnesses: such as heart disease, cerebral infarction, and hypertension. Angiogenesis (new birth of capillary vessels) is causes an increase or growth of tumor tissue, and if we have diabetes, the wall of blood vessel becomes brittle. We have examined what genes or proteins participate in smooth muscle cells on these lesions. It is the purpose that we examine by aseptic culture of the blood vessel cells taken from experimental animal such as a mouse. Let's know more about the role of the blood vessel.

Legend of Figure 1
Students are working at a clean bench to inoculate vessel cells cultured in plastic dishes.

Legend of Figure 2
A student is changing medium of plastic dishes in a clean bench. Vessel cells are attached on the surface of the bottom of plastic dishes.

Department of Life Sciences

Pursuit of the molecular mechanisms of moving proteins

Keywords

Muscle; Molecular machine; Biology; Physics; Chemistry

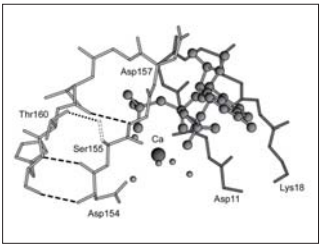
Associate Professor
Atsushi Ooi, Ph.D.

Mechanism of molecule machines

We can think the proteins which carry out cell movement in vivo as very small delicate machines. The proteins which compose muscle have been studied for a long time. However, there are also unexplained parts about the molecular mechanism of the conversion of chemical energy of ATP molecules into mechanical energy for movement. Differing from macro machines, molecular machines are small enough to be directly affected by Brownian motion. To understand the mechanism of molecular machines, we are using various approaches in the study.

Fish muscle as a target

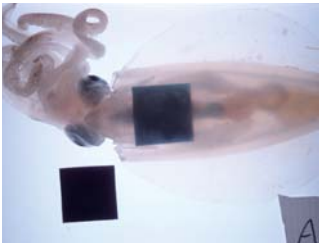
Among the homeotherms living on land, interspecies differences in protein comprising muscle are not profound. On the other hand, muscles of fish are adapted to various environments on the earth and have many variations in the way protein are expressed and itself. For example, in freshwater fish which have a wide range of living temperatures; one of the protein of muscle, "actin" acquires the tolerance to changing temperature by substituting a few amino acid residues.



An amino acid substitution (Ser155 to Ala) in carp muscle actin

Perspective and future development

Mainly we aim to elucidate the molecular mechanism of muscle from the point of view of comparative physiology and comparative biochemistry. Moreover, we also research the preservation and processing technology of muscle based on such studies. In recent years, we have succeeded in the development of a method to maintain the transparency after mortality of the mantle muscle of oval squid. It has already been put to practical use in Mie Prefecture.



The mantle of oval squid at 6 hours after the catch

Department of Life Sciences

We search “beauty” and “health” in marine animals

Keywords

Seaweeds; Supplement; Active oxygen, Ultraviolet rays, Skin care;
Seaweed

Professor
Wataru Miki, Ph.D.

Seaweed and Phytoplankton are the treasure of the mountain

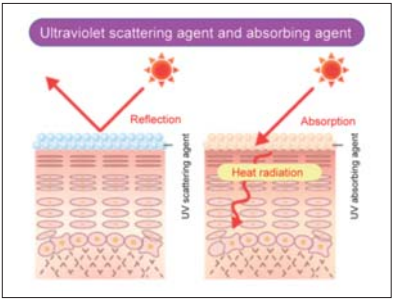
Various kinds of organisms inhabit in the sea. In particular, the seas of Mie Prefecture are major production areas of seaweed. Mie University is situated in the best environment to perform the industry-university co-operation among the national university since there are many laboratories on marine resources and creative awareness of the fishermen on seafood is also high. In our laboratory, we have been searching useful materials for human among many constituents of phytoplankton and seaweed.

Healthy people change to ultra-healthy people

Our research target is “healthy people”. It is not a medicine; materials such as food that serves to prevent the disease, more supplement materials to enjoy the sports. We are exploring and screening the cosmetics material which would become effective for health. Specifically, anti-aging, metabolic syndrome prevention, fatigue accumulation prevention, improve endurance and agility, whitening, anti-ultraviolet rays, wrinkles prevention and repair, hair damage prevention, repair and theme.

Comfortable UV protection

In recent years, global warming has become a problem. UV radiation reaching the earth also increases. As a result, it can cause the spots and skin irritation and can damage the hair to generate the excess active oxygen or a different cause of illness in UVA and UVB amount have also increased. However, ultraviolet light is not just the poor. Vitamin D is active and also plays an important role in promoting the absorption of calcium. Therefore, we need to socialize very well with ultraviolet rays. As UV protection, I can be considered a method to absorb as a way to scatter ultraviolet rays. Examples of the ultraviolet scattering agent, since it contains a metal such as zinc or aluminum which is absolutely tend much of a burden on the skin.



Department of Life Sciences

In order to create stress-resistant and delicious "*nori*"

Keywords

Seaweed; Environmental stress; Stress response; Disorder

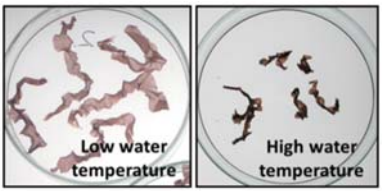
Associate Professor
Makoto Kakinuma, Ph.D.

"*Nori*" is one of the important seaweeds used as food

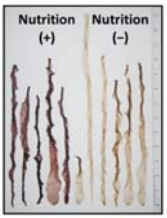
You often eat "*onigiri*" and "*sushi*" wrapped in the dried sheet "*nori*". The dried sheets are made from *Pyropia* thalli cultivated in the sea. In Japan, the growth period of cultivated *Pyropia* thalli is from autumn to spring, in which seawater temperature is low. *Pyropia* production holds a high position in the marine aquaculture and food industry in Japan. Recently, the sea condition turns worse, which causes serious problems such as the frequent outbreaks of disease and discoloration in *Pyropia* cultivation farms.

We are trying to understand the stress responses in *Pyropia* thalli

When the sea condition exceeds a certain range, *Pyropia* thalli feel stress. We focus on seawater temperature and nutrient changes in several factors causing the stress. With slight rising seawater temperature and decreasing nutrition (nitrogen, phosphorus, and so on) in seawater, growth and metabolism of the *Pyropia* thalli do not make progress well. As these results, the *Pyropia* thalli become strange in the form, color, flavor, and taste. Then, we have investigated what happens in the thallus cells at molecular level.



High water temperature causes abnormal growth of the laver.



The laver fades by nutritional deficiency.

We have investigated the life phenomena in marine organisms

We may be able to find out the hint to produce the "*nori*" having stress tolerance and high quality by understanding the molecular mechanisms for stress responses in the *Pyropia* thalli. The marine organisms, which inhabit the special environment such as the sea, show various interesting phenomena. Would you like to challenge to elucidate the molecular mechanisms?

Department of Life Sciences

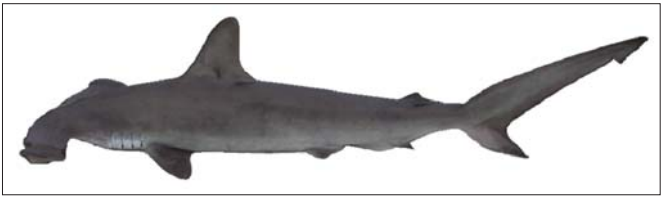
Why does the shark have tolerance against urea denaturation?

Keywords
Chemistry; Biology; Protein

Professor
Satoshi Kanoh, Ph.D.

Proteins of shark have tolerance against urea denaturation

Shark contains urea in the range of 0.3 to 0.5 M to exert resistance against high osmolarity of seawater. It is well known that urea interferes with hydrogen bonds of biological macromolecules as an effective protein denaturant, affects hydrophobic interaction in proteins, and destabilizes the structure of water bound to proteins. However, proteins in shark can maintain their physiological functions even in the presence of urea as proteins of teleost such as carp and tuna in the absence of urea. We study why shark survive even in the presence of urea which is one of the most typical protein denaturants.



Hammerhead shark used in our study

Strategy for development of protein structures resistant to urea

We study resistant mechanism to urea denaturation of muscle contraction protein of shark. Especially, we investigate how myosin molecule which has a central role of muscle contraction changes the molecule structure to tolerate urea denaturation. Already, we found that some amino acid of certain site of myosin molecule is substituted and the myosin is adapted to tolerable structure to urea denaturation.

We want to elucidate molecular mechanism of urea-resistibility of shark muscle myosin

Myosin is macromolecule and complicated structure. We are studying relatively simple structure part in myosin molecule now, but we want to study more complicated structure part and which mechanism the shark acquire ability of toleration of urea denaturation.

Department of Life Sciences

How do clams keep their shells closed?

Keywords
Clam; Muscle; Protein; Chemistry; Biology

Associate Professor
Daisuke Funabara, Ph.D.

The strongest muscle: adductor muscle

Can you open shells closed tightly of clams by hand? It is difficult. Clams close their shells using adductor muscles that can generate very strong power. The force strength reaches over 10 kg per cm^2 of muscle cross-sectional area. Surprisingly, the adductor muscle does not get tired because it is an energy-saving muscle. It can keep shells closed for long periods with little energy consumption. Very interesting. I would like to disclose the mechanism at the molecular level.

What is difference between adductor muscle and normal ones?

Although muscle is composed of various proteins, each muscle has common functional proteins. The muscle proteins in each muscle just slightly differ from each other in sequences of amino acids. The slight differences cause big differences in functions of muscle proteins in various species. I believe that studies focused on the differences in muscle proteins would answer questions why adductor muscle can maintain its tension for long periods with little energy consumption.

Let's study life phenomena around you

There are many life phenomena around you, but you cannot explain most of their molecular mechanism. Life phenomena can be explained by knowing functions of biomolecules like genes (DNA, RNA) and proteins in living things. You would be fascinated with mysterious life phenomena produced by thousands of biomolecules that give environment adaptability to living things.

Department of Life Sciences

Science of cleaning in food industry

Keywords

Key word is “interface”. Learn firmly the biological, chemical and physical fundamentals.

Professor
Satoshi Fukuzaki, Ph.D.

Cleaning is our daily work

The cleaning is indispensable work in making a healthy life. Let`s look back on our day. Such as face washing, hand washing, brushing teeth, bathing, food-dish-washing, clothes washing, room cleaning, and bathroom cleaning, we have spent a lot of time of the day on cleaning. In food-manufacturing factory, similarly to our daily life, much time is spent on cleaning of facilities and processing equipment. Increasing in the efficiency of the cleaning operation is urgent issue in all food-manufacturing factory.

Cleaning operation in food-manufacturing factory

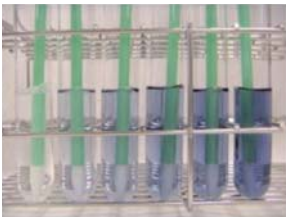
Controlling an interface

Cleaning is the interface technology. Scrubbing equipment surface with a brush (physical force) requires a large amount of energy and time. The first step in planning cleaning procedure is to understand the characteristics of soils and equipment surface. It is essential to clarify the interaction forces governing the adsorption strength of the soil. Based on these investigations, detergent ingredients (chemical force), such as alkaline agent, surfactant, and oxidizing agents are selected. The practical role of detergent is to reduce the energy for a physical cleaning process. If suitable detergents are selected, the energy requirement will be reduced to only several percent of that needed for physical cleaning alone.

Effective chlorinated-alkaline foam cleaning

Are “visible clean conditions” OK?

In the food hygiene, the most important issue is preventing microbiological contamination. In the hygiene management, therefore, it is necessary to remove invisible soils and microorganisms. In other words, “visible clean conditions” are not the end of the cleaning operation. Research and development of a method of assessment of the cleanliness is also one of the important issues related to cleaning technology.



Assessment of the cleanliness by swabbing

Department of Life Sciences

Microbes hunting from marine environments

Associate Professor
Reiji Tanaka, Ph.D.

Keywords

Bacteria; The hunter of bacteria; Function; Applied microbiology

Subjects required for research

Microbiology required for chemistry. In particular it is necessary to understand the chemical reaction formula and also to understand the metabolism.

Unknown microorganism in the ocean

Organism that we cannot see is called microorganism. This world is under 0.1 mm. The millions of bacteria live in 1 ml of seawater. Many bacteria live in beautiful sea water. But the ecological aspects of many kinds of bacteria are still unknown and it is difficult to cultivate.

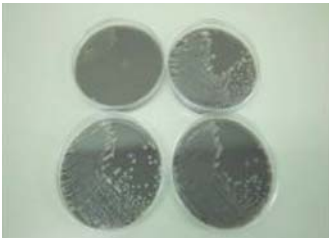
You can become hunter of microorganism

Our purpose is to understand unknown function of microorganism and apply for industry use. The main research is to search new microorganism which have an ability to degrade some high molecular compound. This is the "hunter of microorganism".

Sampling of the sediment in Ise Bay using our research ship "Seisui-Maru"

Application of property of microorganism

We try to search bacteria that can degrade seaweed. These bacteria have many kinds of enzyme to degrade polysaccharide. We want to apply this enzyme to make chemical and energy. Moreover, we want to search these bacteria from the gut of marine invertebrates. We want to try to focus on unknown subject with everyone.



A new species of bacterium that have an ability to degrade brown algae

Department of Life Sciences

Why fish meat becomes spoiled?

Keywords
Muscle; Enzyme; Biology; Physics and Chemistry

Associate Professor
Takahoki Aoki, Ph.D.

Mystery of protease "cathepsin"

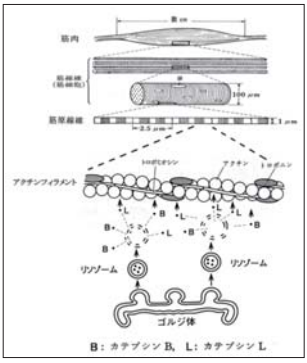
We regard the proteases which take charge of metabolism *in vivo* as delicate molecular machines. Especially, the proteases contained in lysosomes, named cathepsins, have been studied since the 1950's. But there is still a mystery about them because these molecular machines destroy themselves by their activity to hydrolyze proteins. Unlike industrial micro machines, to understand the system of metabolism *in vivo* where micro machines destroy big machines (= large proteins), various research methods are needed, such as the microscopic observations of decaying muscle cells and biofunctional experiments.

"Cathepsin" shows high activity in fishes muscle

There is no difference in the cathepsin type between land homeotherms and fishes. However, cathepsins in fishes have a higher activity than land homeotherms. Marine fishes with a high content of red muscle like mackerel or skipjack have a higher activity than carp or sea bream. Because of this reason, mackerel muscle is not suitable for preparation of "surimi".

"Cathepsin" research challenges in food processing development

By using comparative physiological and biochemical data on cathepsin expression in fish muscle, we are trying to develop methods for food preservation and processing. Recently, we succeeded to make "surimi" from slimy mackerel (Scomber australasicus) by the condition of decreased pH.



The role of cathepsins in fish muscle postmortem

Department of Life Sciences

“Biological Manufacturing” by blue ocean strategy

Keywords

Biotechnology; Blue ocean strategy; Synthetic biology; English

Professor
Yutaka Tamaru, Ph.D.

The synthetic biology that fully use te biotechnology

The earth was born approximately 46 billion years ago, while first life was born in the sea approximately 38 billion years ago. Besides, the creature has taken long time and evolved. Therefore, there are various kinds of creatures on the earth. On the other hand, the creatures have evolved for an interesting point by getting the genetic information from the different kinds and have been thought that they adapted to their environment by changing their cells functionally. This means that the creatures make their functional cells for an interesting point by introducing the genes which are not present in a cell artificially means to produce functionally expedient cells.

Eye-opening “transparent goldfish”

It is the example of what something is a chance and a field of vision opens out suddenly and the actual situation of things comes to be able to understand to be an eye-opener. We thought that we may be able to understand the actual situation of the life phenomenon by developing transparent goldfish and succeeded in developing the transparent goldfish called Mie-Mie (It means Mie Univ. and attraction and show) in 2010 (Fig.1)

Fig.1 Transparent goldfish

“Biological Manufacturing” by using the goldfish

The goldfish is one of the pets which was imported from China in Muromachi era (approximately 500 years ago) and 25 kinds of goldfish have been maintaining up to now. We can observe inside of goldfish`s body easily by introducing fluorescence protein gene in its body and can get a specific antibody by injecting the antigens into bubble eyes. This means that it brings about innovation to let the goldfish which has been cultivated as a pet from ancient times to produce recombination proteins and antibodies. Now, I can realize new creation by using these fish biotechnologies.

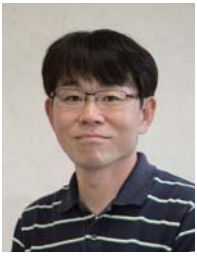
Fig.2 Goldfish (Bubble eye)

Department of Life Sciences

Invitation to marine biotechnology research (Searching, analysis and utilization of marine resources)

Keywords

Marine Biotechnology; Marine Polyphenols; Antioxidants; Functional biomolecule; Biorefinery



Associate Professor
Toshiyuki Shibata, Ph.D.

Research on utilization of seaweed

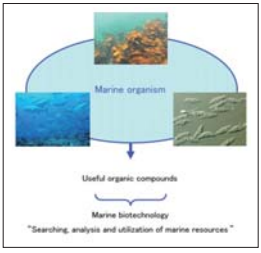
Brown algae are the largest biomass in the seaweed. For example, in the case of *Saccharina japonica* (Japanese name: konbu), the length of the plant body is approximately 10 meters. The brown alga *Macrocystis pyrifera* (English name: Giant kelp), which are distributed in Northeast Pacific Ocean, grow to more than 50 metres. It is well-known that these brown algae form a kelp bed called a "marine forest". Therefore, it can be thought that the seaweed is one of the abundant marine resources. The research subjects of my laboratory are as follows: (1) searching novel organic compounds from seaweed, (2) analysis of structure and physiology function of the isolated compounds, (3) development of use of the compounds (e.g. antioxidants, antibacterial agents, and anti-allergic agents).

Marine polyphenols: phlorotannins

Recently, many researchers are paying attention to physiology of polyphenols. The catechins (from tea leaves) and the anthocyanins (from berries) are well known polyphenols. Marine algal polyphenols, phlorotannins, which have only been found to exist within brown algae, are formed by the polymerization of phloroglucinol. As the result of research in my laboratory antioxidative activities of phlorotannins were found be around 2-10 times higher than those of catechins (tea polyphenols).

Aspire to the frontier of marine biotechnology

As with mineral resources, marine organism is one of the valuable natural resources. The area of the Japanese territorial waters (4.4 million Km^2) is the 6th place in the world. So, it is thought that the marine resources are abundant countries in Japan. Let's aim at the frontier of the marine biotechnology research with us.



Department of Life Sciences

Trying to explore the mysterious world of shellfish

Keywords

Breeding; Akoya Pearl Oyster; Biology; Genetics; Aquaculture

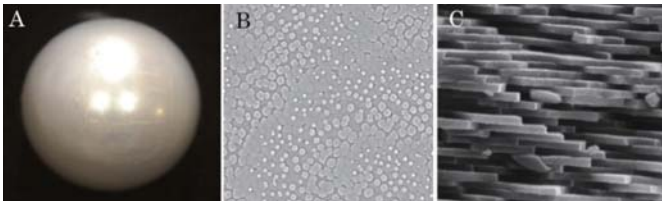
Professor
Akira Komaru, Ph.D.

We are seeking for high quality pearl

Bivalves are important as species in marine products. Mie Prefecture is a producing center of corbicula, short-necked clam, pacific oyster and Akoya pearl oyster. These fisheries have been performed actively since long ago in Mie Prefecture. Now we would like to introduce study on quality improvement of the Akoya pearl oyster. Japanese pearl culturing industry is continuing to hang low because of disease and environmental degradation of fishing ground. We aim to discover how we can produce high quality pearls effectively.

Relationship between beauty of pearls and gene expression of pearl protein

Pearls are made from calcium carbonate and protein. Pearls come from gene expression. We have evaluated the difference between high-quality beautiful pearl and commercially non-valuable pearls in crystal structure, and also clarified the relationship between pearl quality and gene expression level of pearl protein. Even if the beautiful pearl judged from the naked eyes is magnified tens of thousands times with an electron microscope, it has so beautiful structure in the surface and cross section (see photographs). Once Akoya pearl oyster get a big stress, its gene expression change and then crystal structure of pearl are distributed. This is connected directly with the quality drop of the pearl.



A:Whole image of pearl B:Surface structure of pearl C:Cross sectional structure of pearl

Let`s contribute to the innovation of cultured technology

To improve competitiveness of pearl culturing, we must continue to improve quality of Akoya pearl oyster by breeding, technique of nucleus inserting operation, method of farming and fishing ground industriously. As a number of this university, we think it is our mission to understand forming mechanism of high quality pearls and cause of quality drop of the pearl and to lead it to innovation of technology. Study of the pearl is a wonderful research field because you can note the micro-level beauty and natural beauty of pearl.

Department of Life Sciences

Unknown history revealed by DNA analysis

Keywords
DNA; Evolution; Endangered species; Alien species

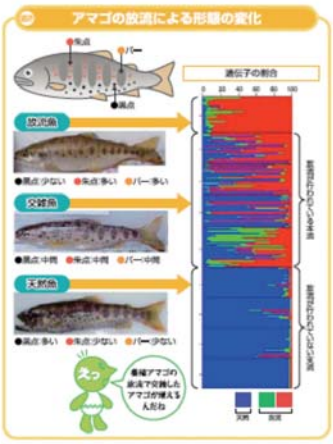
Professor
Kouichi Kawamura, Ph.D.

What does DNA inform us?

In the 21th century, we often face the stories in TVs or newspapers, such as identification of suspects of a murder case by DNA analysis, and reunion of separated parents and children based on DNA information. As you know, DNA is a genetic code, which consists of only 4 kinds of nucleotides. Recent studies have revealed this genetic code is not only a program to make the body of the creatures, but also contains information related to many life phenomena, such as ecology, physiology and behavior. What kind of information can we obtain from the analysis of DNA?

Stocking of cultured fish changes wild fish

At present, stocking of cultured fish is practiced in many parts of Japan, to compensate for the decrease of fisheries resources caused by environmental deterioration and overfishing. The Amago salmon is a beautiful freshwater fish, which is called Queen of stream, and inhabits Honshu and Shikoku. However, its populations and habitats are continuously decreasing, as is often the case of other freshwater fish. Therefore, stocking of cultured Amago salmon is commonly practiced. We investigated body coloration and DNA of Amago to evaluate the influence of this stocking against wild Amago populations. In consequence, we elucidated that stocking of cultured fish changes characteristics of both body coloration and DNA in wild populations.



Stocking of cultured fish changes not only DNA but also phenotype of Amago salmon.

We investigate the mysteries embedded in biodiversity and the history of species from genes

DNA includes information such as the history of species evolution, the process of population expansion, population demography, hybridization and the degree of inbreeding. This information is invisible only from human eye. By revealing this hidden information with DNA analysis, we not only reveal the process of species evolution, but also cope with environmental problems such as the protection of endangered species and eradication of exotic species.

Department of Life Sciences

Studies on sensory physiology and feeding behavior of fish

Keywords
Biology; Chemistry; I love fish!

Professor
Jun Kohbara, Ph.D.

Having a meal is important

Having a meal is the most important for living things to maintain life but don`t you think that the dish which is not delicious or the meal when do not want to eat is nonsense!In fact, the fish is also exactly same to us. We are studying about “what kind of meal (food) do they think delicious?” or “when do they want to have a meal (eat food)?” Especially the person who likes fishing may be always thinking such a thing, don't you think so?

Taste system and the feeding behavior of fish

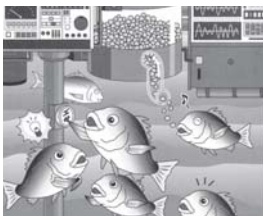
We have found that the fish well respond to amino acid when we recorded the taste response to various substances by using a method called electrophysiology. Besides, we gradually came to understand that a combination of different amino acids and co-existence of amino acids with ATP related substances are important to initiate feeding behavior. Recently we have started fish feeding behavior experiment utilizing the learning ability of fishes. Namely, we use self-feeding machine for the fish through which they can get food when they pull the switch with mouth in a water tank. This is based on “Operant conditioning”. We can know easily when they use food dispenser and the total amount of feed they have consumed if we connect self-feeding machine with the computer. We are taking part in developing new fish feeding technology without feed waste.

Fig.1 Photo of electrophysiological experiment on taste response of tuna fish.

Fig.2 Schematic diagram of self-feeding system.

For a future aquaculture technology

We again recognized the importance of farm-raised fish as protein source which support food of the human in future. One the other hand, aquaculture gives loads in environment. We are working on the development of aquaculture technology for future with exploiting ecological and feeding characteristic of each farm-raised fish.



Department of Life Sciences

Colorful visual world of fishes

Keywords

Visual sense organ; Retina; Visual pigment; Opsin Gene; Adaptation to the environment; Evolution; Fish diversity

Associate Professor
Taeko Miyazaki , Ph.D.

Fish can see the ultraviolet spectra

The ancestral vertebrates were tetrachromat could see red, green, blue and ultraviolet wavelength but mammals lost sense of UV-vision during the evolution. However, some fish species have retained UV-vision. Fish evolves their color vision variously to adapt for aquatic light environment which is much more complex than the terrestrial animals.

Visual pigments and photoreceptors in the retina

Visual pigment, protein substance that function in light reception, is included in the photoreceptor cell of the retina. Alaska Pollack, which lives in water depth of 200 m, has double cone cells which includes two green-sensitive visual pigments having different peak absorbance. Striped beakperch, living in 20 m depth of the shore reef, possesses a central single cone cell which includes blue-sensitive pigment and four surrounding double cone cells which contains red- and green-sensitive visual pigments in a square unit. In the retina of Nibble, in addition, ultraviolet-sensitive accessory single cones occupy the corners of the square unit. Thus, both the visual pigments and photoreceptor arrangements in the retina differ among fish species by their habitat depths (Fig. 1).

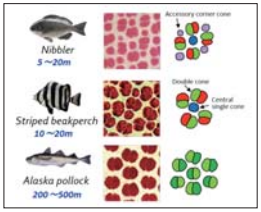


Fig.1 Cone photoreceptor mosaics and visual pigment classes in fishes inhabiting different depths.

Relations between fish color vision and habitat depths -An example from the suborder Scombroidei-

In general, absorption of water in wavelengths is greater for longer wavelengths and UV radiation, and shorter wavelengths are scattered greater, thus blue-green light penetrates deepest in clear water. Analyzing visual pigment genes of the scombrid fishes, which have done adaptive radiation in depths widely from the deep water to the sea surface, absorbance classes of the pigments' gene much correspond with wavelength at their habitat depth. For example, snake mackerel and/or cutlassfish which lives in deep water expresses only one cone opsin gene of green class, while bluefin tuna and chub mackerel that lives in middle layers expresses one type of blue opsin gene and two types of green opsin genes. Moreover, shallower water species of red Japanese barracuda duplicate both of blue and green opsin genes (Fig.2).

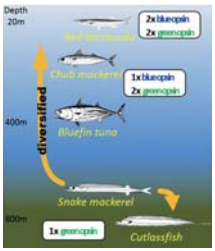


Fig.2 Relationships between opsin class and habitat depth in scombrid species.

Mie Prefecture faces toward the inner bay Ise-Bay and also the open sea Kumano-nada, and we can touch various fish species. I expect that information obtained from the investigation about fish color vision will contribute not only understanding fish behavior and ecology in the natural sea but also developing techniques of fish breeding and exhibition in aquariums.

Department of Life Sciences

Production technologies of living food organisms for marine fish larvae

Keywords

Aquaculture; Fry production technology; Larvi culture; Live foods; Zooplankton, Phytoplankton; Biomass

Professor
Takao Yoshimatsu, Ph.D.

Historic significance of the pioneer studies of Mie University on live food which enabled the artificial production of marine finfish

By the understanding of the worldwide spread of fish loving consumers and contribution to human health, now aquaculture production of the world has grown to occupy more than 40% of the total fishery production. Start of aquaculture activities is a way to supply of healthy and viable seedlings of target aquatic species. In this field, Faculty of Bioresources of Mie University had a great contribution of Nobel Prize class. If there is no enough quantity of live foods (small zooplankton) as prey, we cannot produce the seeds of marine finfish in hatcheries for farming (Fig.1). About six decades ago, when a challenging trial to produce marine finfish larvae in hatchery was initiated in Japan and also in the world, nobody had a good solution on this point. Many researchers had struggled to find good and viable candidate prey for marine fish larvae in the world without any success for a long period. At that time, Professor Takashi ITO from the Faculty of Fisheries of Mie Prefectural College (one of the predecessor institutions of the today's Faculty of Bioresources) firstly succeeded the isolation of a brackish zooplankton (Brachionus plicatilis sp. complex) from wild and he suggested its use as an potential initial food organism for marine species to his colleagues. A door of the artificial production of marine finfish was established and opened for the first time by this brilliant success.

Fig.1 We need enough number of live food for rearing marine finfish larvae.

For improvement of the productivity of live foods for larvi culture

In our laboratory, we have carried out many studies on various kinds of initial live foods including the rotifer so far. By those results of research outputs, great improvement of the productivity and stability of the live foods, both of zoo- and phytoplankton, was achieved. By the way, our research group has the world record of the rotifer culture density.

The application to the field of trip science such as the biomass production

Various results of research provided in a culture study of the most important rotifer as an initial live foods make it possible and applicable for the cultures of other live foods, i.e., phytoplankton and water fleas etc. (Fig.2). We would like to utilize our knowledge also on biomass production using various phytoplankton to solve energy and environmental problems on the earth in future.

Fig.2 various aquatic animals that we use as test animals in our laboratory.

Department of Life Sciences

Fish disease control

Keywords

Aquaculture; Fish diseases; Microorganisms; Immunity; Vaccine; Biology (clinical gene; homeostasis); Chemistry; English

Associate Professor
Tadashi Isshiki, Ph.D.

Development of preventive measures against fish diseases

As the intensive aquaculture has been developing, disease problems have increased and caused serious economic losses in the fish production (Fig. 1). Our group has attempted to establish preventive and control measures against fish diseases. Especially, vaccination is an effective strategy for fish disease control in aquaculture.

Fig.1 A diseased Japanese flounder shows hemorrhage markedly in the lateral musculature, leading to an economic loss in the fish production.

A vaccine development

Most bony fish are poikilotherms and their entire physiology, including immune function, is strongly influenced by the water temperature. To develop an effective vaccine, we focus on temperature dependence of the immune function of fish. Our vaccination trials with an inactivated virus at the optimal temperature for fish species gave some of the promising results that a highly protective and lasting immunity against the virus was established in the vaccinated fish (Fig. 2).

Fig.2 A healthy Japanese flounder is vaccinated by intraperitoneal injection.

Studies on fish immune system

Molecular biology may help to clarify the fish immune system in detail. But almost of this mechanism is still unknown. In our ongoing investigations, we focus on the expression of immune-related genes in response to the effective vaccine, which will be useful for dissecting the immune response mechanisms induced by the fish vaccine at the molecular level.

Department of Life Sciences

To know whales and dolphins is to know humans

Keywords

Sea; Whale; Dolphin; Porpoise; Environment; Conservation; Resources

Professor
Motoi Yoshioka, Ph.D.

Background of research and motivation

There are porpoises in the sea near Mie University. Campus of Mie University is located in the location facing the large bay, Ise Bay. In Ise Bay, the finless porpoise which is less than the length 2m has all year round living. Whales and dolphins, including the finless porpoise are animals which stand at the top of marine ecosystems. We have been studying lives and interactions with humans of the finless porpoise in an environment of Ise Bay.

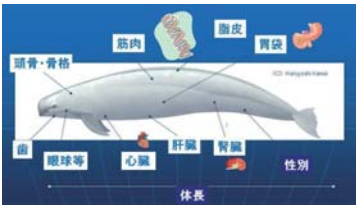
Life of becoming clear some finless porpoises

Finless porpoises of Ise Bay are genetically different from those in other areas (such as Seto Inland Sea and Arike Sea) and consist of a separate population. In a survey by airplane, about 3000 individuals are living within Ise Bay. Their diets are with wide range from organisms in the bottom of the sea to fishes on the surface. Depending on the season, some of the finless porpoises are out to the outside of the bay (but not go to deep water depth in Kumano Sea).

Consider a human life to continue monitoring

At the coasts of Mie Prefecture, deaths of finless porpoises have been found in the year at least 30-50 animals. By examining and collecting specimens of stranded porpoises, we have found their lives a little. By the concentration of pollutants and cause of deaths becoming apparent, we can assess the impact of human activities to the porpoises and the sea. Sea and finless porpoises are thought of as a "mirror" of a human to live on land. Continuous investigations of the finless porpoise lead to know what is happening in the environment and teach us what to do.

A finless porpoise stranded on the beach near the campus of Mie University



Various samples collected from a stranded finless porpoise

Department of Life Sciences

Increasing the fish stock without seed stocking

Keywords

Biodiversity and ecosystem; Ecology and environment; Evolution and phylogeny; Fisheries

Associate Professor
Yodo Taiga, Ph.D.

Dealing with the natural resources fishing is hunting – They decrease with catch

We get rice, vegetables and meat from farms. However, more than half of fish as food are derived from natural resources which have been caught in such sea and rivers. Even if aquacultured fish, they are fed with natural fish. About fish, we are still in the hunting era. In other words, fish stocks are decreased by over-catch or environmental deterioration, such as eel and tuna well-known as recent topics. Actually, a huge quantity of fishes are decreasing. In order to increase these reduced fishes, until now, it has been released artificial breeding fish larvae (seed) into the sea and river. However, recently it has come to be known as seed stocking is not necessarily a good approach.

It is not mean that fish increases if release, and it is not necessarily that the increase is good.

If the fish has decreased by environmental deterioration, they will not increase by seed stocking because the seeds will not survive. In the same way, the seeds will not survive in waters where alien species such as largemouth bass reduce the fishes. When the decrease caused by over-catch, it is seems that seed stocking is effective. However, if seed stocking increase fish successfully, it will damage biodiversity and environment. For example, seed stocking brings the pathogens or alien species, and seed stocking also decrease or disturb genetic diversity of the native populations.

Why fishes decrease? How can we increase?

How do we increase the fish without seed stocking? I think that clarify a cause of decrease and remove this to maintain the environment where the fishes inhabit and estimate the sustainable amounts of catch are necessary for increasing fish. We must know what kinds of and how much fish live in each environment and their various ecological habits and life history. Because, much various fishes are live in nature as member of ecosystem, unlike grains or livestock animals in farms. We should rather examine it before it is too late.

Department of Life Sciences

Physical fitness measurement of fish

Keywords

Fish; Swimming ability; Critical swimming speed (Ucrit)

Subjects required for researches

Biology; Physics; Mathematics

Associate Professor
Yoshitaka Morikawa, Ph.D.

Swimming ability of fish species show large differences

Swimming ability test for rainbow trout *Oncorhynchus mykiss* in an open-top swimming tunnel

The ability of fish to swim is one of the most important and basic abilities in terms of species survival. However, just as there are some people who are naturally good at running long distances while others are not, in fish different swimming abilities occur in relation to feeding and the environment. In this research we mainly focus on fish present in rivers to examine whether it is possible to measure the swimming ability to evaluate the adaptability to the flow conditions of various environments.

Fish inhabiting in rivers have various swimming abilities

In most fish two types of muscle, red muscle and white muscle are used in swimming. Red muscle is resistant to fatigue, and is mainly used in long distance migrations and continuous swimming in rivers. Whereas white muscle although it can exert a large instantaneous force, it shows rapid fatigue. White muscle is used in specific swimming, for example to capture prey or escape predators. We are using a water channel with a re-circulating current flow to generate various flow rates to examine swimming ability for exotic species such as black bass (*Micropterus*) as well as Japanese indigenous fish. We have measured swimming ability based on both swimming sustainability as well as instantaneous power. As a result, it was clarified that char *Salvelinus leucomaenis* doesn't have a very high sustained swimming ability although they inhabit the headwaters of rivers such as mountain streams. And the swimming ability of smallmouth bass *Micropterus dolomieu* is almost the same as that of pale chub *Opsariichthys platypus*, which widely occur in pelagic habitats in Japanese rivers indicating that the swimming ability of bass is not a constraint for the further expansion of distribution of this exotic species.

Preservation of species and environment based on swimming ability

If the swimming ability of the fish species is known, then the impact of river improvements such as bank protection works and river mouth construction projects can be evaluated for potential effects on the ecosystem caused by anthropogenic changes in the flow pattern. For example, the fish way when estuary weir built in a river must be designed with the swimming ability of the fish in order for the fish to be able to go back and forth upstream and downstream from it. Also, by knowing the swimming ability of piscivorous exotic fish such as black bass, the river habitats utilized will be valuable information for helping to elucidate the adaptation mechanism of invasive fish.

Department of Life Sciences

Harmful and toxic phytoplankton; to confront the threats of the micro-organisms

Keywords

Harmful/toxic phytoplankton, red tide, marine toxin, cyst, marine environment

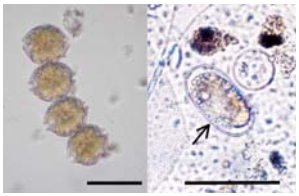
Professor
Akira Ishikawa, Ph.D.

Study on harmful/toxic phytoplankton

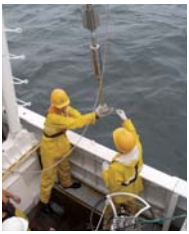
SEAWATER, that is a planktonic world! Plankton is an important organism supporting aquatic ecosystem from its bottom of the trophic levels as a primary producer. On the other hand, some phytoplankton are known as causative species of red tides killing fishes, and/or as toxic species causing toxification of bivalves, such as scallops and clams. Thus, fisheries industries have been exposed to those threats of the harmful /toxic phytoplankton. To confront such threats, we need to know the relationships between their outbreaks and environmental conditions in the coastal waters.

Population dynamics of the harmful/toxic phytoplankton

Some species of the harmful/toxic phytoplankton produce resting stage cells (i.e. cysts) in their life cycles; the cysts are distributed in the bottom sediments. The cysts play crucial roles in survival under the adverse conditions for vegetative (planktonic stage) cells and in seeding blooms. Therefore, elucidating the ecological behavior, as well as physiology, of the cysts is important to predict their outbreaks in natural waters and to avoid eventual fisheries damages. From this point of view, we have been investigating the relationships between cyst germination and environmental conditions in the field. On the basis of those works, we have revealed population dynamics of several harmful /toxic phytoplankton species.



[Left] toxic dinoflagellate *Alexandrium catenella* (4 cells connected) and [Right] cyst of the species (arrow). Scale bars indicate 50μm.



Collection of sediment core from the sea bottom using a gravity corer. The photograph was taken on board of T/S SEISUI-MARU, Mie University.

The relationship between expanding distribution of harmful /toxic phytoplankton and the global warming

Sea surface temperature is recently on the upward trend under the influence of the global warming. In conjunction with this event, warm water species of the harmful/toxic phytoplankton is now expanding their distribution to the northward in Japan. This is a problem occurring not only in Japan but also all around the world. We are then making efforts to confront those novel threats of the harmful/toxic phytoplankton in cooperation with scientists in the world.

Department of Life Sciences

Sea production and nutrient cycle

Keywords
Chemistry; Biology; Geology; Mathematics

Assistant Professor
Kazunori Taguchi, Ph.D.

Why is there the distribution of the chemical constituents of the seawater?

Marine foodchain is sustained by the organic production of small phytoplanktons that are visible only under a microscope but they also can not be active if there is no inorganic and trace components necessary in seawater. The fact is there is the elements utilized by plants on deep water than surface water abundantly for a chemical characteristic observed most commonly on the ocean. Phytoplanktons carry carbon of the atmosphere to deep water masses and store busily, consequently this biological pump is also associated with global warming. The distribution of chemical tracers is very useful to understand the ocean internal cycling.

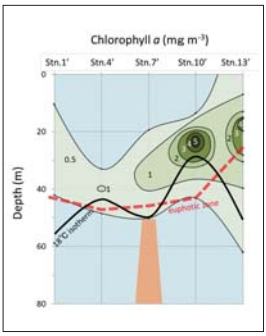
We study science which is occuring in nature

Gone aboad a ship, by examining the actual sea in the field, so we can better understand the various phenomena that occur in a system called the ocean which is one of big nature. Come on, let`s go out to the voyage.

Measurements of primary production in seawater by FRRF

The biological production in upwelling waters

When the richer deep water which includes the nutrients is transported to the surface ocean drenched in sunlight, production of the phytoplankton by photosynthesis becomes very active. The sea area where such an upwelling phenomenon occurs is the place that is important and interesting in biological oceanography. There is a mountain which is called a seamount in the sea, and the upwelling occasionally occurs in a place of such terrain. Phytoplankton biomass increased more than three times at the place called the Kanesunose Bank of the Omaezaki offing during a day, and this increased organic matter goes around and maintains the ecosystem of a rich sea area.



Vertical profiles of chlorophyll *a* along a SW-NE transect in the area of Kanesunose Bank

Department of Life Sciences

Tree planting plan in the desert under water

Keywords

Biology (ecology, plants); the students who want to do under water research are advisable that you good at swimming

Associate Professor
Akira Kurashima, Ph.D.

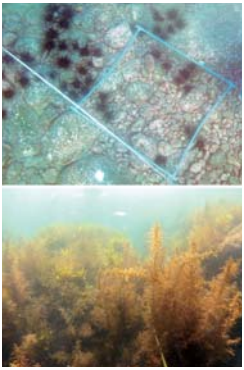
What is a desert in the sea?

Seaweeds are organisms like land plants. There are some places called "Isoyake" in the sea where few seaweeds grow, Isoyake looks like a desert. It is so, but Isoyake is expanding to Japanese seas to all over the world. Since few fishes, shrimps and shellfishes live in the place, Isoyake is lonely. People research in physiology and ecology of seaweeds to recover areas of sea encroached by Isoyake.

Seaweeds appear in a "desert in the sea"!

Diving researches reveal that high density of Diadema spp. find in the Isoyake area in southern part of Mie Prefecture. Because of the light quantity and the temperature of seawater were suitable for seaweeds growing, researchers assumed that grazing by Diadema spp. caused Isoyake around this area. Thus, they remove Diadema spp. from Isoyake area. As a result of this, they succeeded in increasing seaweeds. In addition to that, they calculated the time to remove them and to repair this area. Students who can dive helped these researches to succeed.

Students helped to remove Diadema from Isoyake area.



Effect of removing Diadema on Isoyake area. The upper picture shows the Isoyake area before Diadema removal, and lower picture shows after removal.

Adaptation to various factors in desertification

Isoyake is caused not only by Diadema but also grazing by fishes, global warming, water pollution, low nutrients and the other factors. With these researches we are able to adapt to only limited Isoyake. We need to do indoor culture experiments and diving researches to clear physiology of seaweeds and mechanism of Isoyake. Let us start greening of deserts of the sea bottom to call back various lives.

Department of Life Sciences

Studies on management of organisms as marine resources and on maintenance of their ecology

Keywords

Marine resources; Ecology; Mathematics, Information science, Organism

Professor
Yasushi Harada, Ph.D.

Research background

Varieties of fish and shellfish population are decreased by an excessive intake and inefficient utilization because we catch them in smaller size. Even more, organisms that are decreased in population size by environmental destructions except the fishing industry, It is important topic for us to protect, increase and effectively utilize these organisms.

For example

Trawling can catch various sizes of fishes but some of the fish that can sell in very high price if we wait for them to be growing up in bigger. We cannot effectively utilize these resources if we catch a lot of these smaller size fishes. This problem is solved by a net of coarse meshes but it occurs other problems which do not allow us to catch the fish which we want to take and so on. Besides, if we limit the size too big, the fish that we catch may decrease and amount of price may also decrease.

To be solved

We need to know the number of organisms, the amount of organisms and their response to these fluctuations for controlling the problems of aquatic resources. Furthermore, we need to evaluate growth and breeding for controlling the fluctuation, death due to fishery or cause of nature. Therefore, not only performing regular investigation and experiment about the field group but also analyzing fishery data is an important method. Furthermore, when population dynamics and environmental conservation measures are expressed on computer by mathematical principle model for simulation, the sort of valid plan or important method can be figured out. As a result, we think of enforcement if we think the plan is valid. In this way, understanding the written law, the number of organisms, the amount of organisms and these fluctuations indicating organisms by number and thinking method can protect these organisms which are necessary. Ecological research is practiced hardly using a mathematical principle model. A person who likes mathematics and computer and want to apply it for minimizing biological problems or it might turn a person who likes not only biology but also mathematics.

Fishes collected by trawling of Training Ship "Seisuimaru"

Department of Life Sciences

Study of biodiversity in ocean

Keywords

Marine ecology; Endangered species; Introduced species; Shellfish; Crabs; Benthos

Associate Professor
Taeko Kimura, Ph.D.

Unknown species

Do you know the number of species in the sea that do not have backbones such as shellfishes, crabs, and starfishes are more than the number of species in the sea that you know such as fishes, whales, and dolphins? A lot of these species have not named yet. Most of the ecology of these species is mystery. Do you know many exotic species live in the sea around Japan? On the other hand, we find out that many species are on verge of extinction. The purpose of studies is to clear the ecology of these species to preserve resources of marine life and biodiversity in the sea.

Where did introduced species come?

Introduced brown mussel (*Xenostrobus securis*)

Unexpectedly, you can see marine introduced species around you. For example, when you go for fishing in the harbor, you can see a lot of black bivalves in the wall of rock. These are blue mussels, introduced species from the Mediterranean Sea. You can sometimes see small brown mussels that resemble blue mussels in that wall. These are introduced species too. This species found for the first time in Hyogo in 1970's. This had been thought a subspecies of resemble freshwater Golden mussels in Asia. In fact small brown mussels are very different from Golden mussels. The origin of small brown mussel is Australia and New Zealand. That found out clearly when shapes of internal organs, proteins and DNA of Japanese mussel compare with those of mussel from the original home. We say not appearances but contents. However, specialists even were deceived.

How to contact between human and marine animals

Japan is a country girled by the sea, so Japan exchanges with a lot of countries through the sea. Then, many marine species in a foreign country moves to Japan. Some of them stay in nature. As a result, they have sometimes serious effects on an ecosystem and an industry in Japan. It is necessary to know that what live in Japan from the outset, then we can investigate into whether new introduced species come or not. We are investigating into biota and biology of each species by field research. Do you investigate into marine species together?

Kii-Kuroshio Bio-Regional Field Science Center (Affiliated Facilities Administration Division)

Affiliated Facility-Farm Station

The study of germs on the spots

Professor
Hitoshi Okuda, Ph.D

Keywords

It is important for describing phenomenon correctly to attentively observe, arrange and analyze. In order to fulfill the purpose, we need to study mathematics, physics, chemistry along with biology

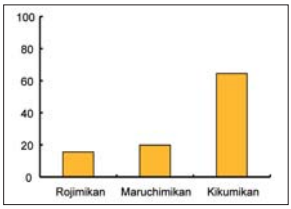
Too good

Supermarkets do not sell and especially do not advertise even though it is very delicious. It is difficult to be circulated because it is a small grain, its surface is roughness, its taste is a little sour and its shelf life is short even though tastes good. The mandarin that their producers are compelled to captive use is "kikumikan". Kikumikan means one of physiological disorder of fruits caused by extreme drying in summer but not a variety.

Kikumikan

A questionnaire survey

We want consumers to eat and evaluate. So get them to compare the tastes of "Rojimikan", "Maruchimikan" and "Kikumikan". As a result, most common people affirm Kikumikan.



Approval rating for each type of fruit

Rational water management

If producers can produce Kikumikan that consumers are gold, their business is improved and a successor ought to peer, but a lot of term is needed to alter Unshumikan to Kikumikan. Especially cautionary note is extreme drying. In summer, high temperature drying is essential for Kikumikan while it causes weakening of the tree. Then we begin to study of rational water management to stable produce Kikumkan with the intention, and suggest three bases (1) fruiting stress (2) sheet mulch (3) aridity index to generate Kikumikan without weakening of the tree.

Kikumikan will be delivered to your hand

We strive publicity activities of Kikumikan through various opportunities. As a result, the stores which sell "Kikumikan" increase steadily. "Kikumikan" will be sold in neighboring supermarket.

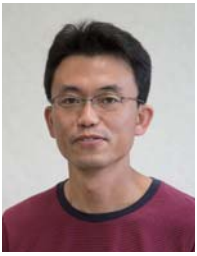
Affiliated Facility-Farm Station

Stable production of soybean

Keywords

Soybean; Foliage; Photosynthesis; Water

We investigate the mechanisms of yielding and vegetative growth of crop plants, mainly in the field condition. Farm station is located about 10km in the north-west direction of Mie University and Japanese natural scenery surround us (Fig.1).



Associate Professor
Kiyoshi Nagasuga, Ph.D.

The cause of low soybean self-sufficiency in Japan is instability of the production

Soybean are the main ingredient of bean curd, miso and soy sauce which are indispensable to dietary life in Japan. However, Japan`s self-sufficicency in soybeans is too low (2-3%). The cause is that the price of foreign produced soybeans is lower than that of home produce soybeans and that production don`t steady every year caused by the difficulty of soybeans cultivation in Japan.

We want to control the growth of soybean stems and leaves

In Japan, we sow soybean seeds in the field around the rainy season. Soybeans in early growth stage grow well because soil is wet in this season. However, excessive vegetative growth make mutual shading, and these caused the decline in sunlight exposure to whole leaves whch needs photosynthesis, as a result, the production stability.

We have studied the relation between vegetative growth and soil water condition.

Soybean vegetative growth is controlled by any proteins?

Soybeans stems and leaves grow well in the wet soil condition. It revealed that growing soybean is prompted by increasing temperature (Fig. 2). The main substances which change activity by temperature in vivo are proteins. So, we plan to analyze “where is the control protein, leaves, stems or roots ?” and “what role does the protein have in the organ ?” in the future.

Fig.1 Farm station in the Mie University.

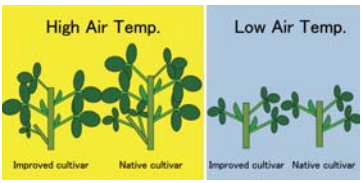


Fig.2 Relationship between soybean vegetative growth and air temperature (Air Temp.).

Affiliated Facility-Farm Station

Looking into the food

Keywords
Food; Analysis, Function

Associate Professor
Takashi Mishima, Ph.D.

Measure the components of food

What is in the food we eat? We often eat something unconsciously. In addition, when someone say “the food is good for health”, it becomes boom immediately. However, we also need to consider the balance of food. Thus, we measure the components of food in our laboratory.

Make clear the components of various crops

Food are usually made from plants, animals and microorganism. Not only the nutrition of food but also the function is clear in study of components of material and processed food. In our laboratory, we not only study about carbohydrate, protein, lipid, mineral, vitamin but also various functions.

Healthy life starts from eating

Even we measure the components of various food blindly, it is not easy for us to find the special one. However, if we accumulate knowledge and change the way of thinking, we will find something new unexpectedly. We attempt to find something in our daily eating habits and up to now, we are searching for the truth of food that consider good for health.

Cultivate Tomato sample

Wash

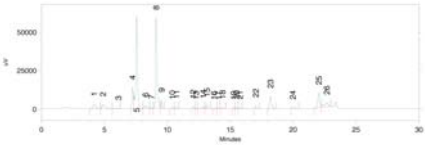
Cut

Homogenize

Filtrate

Prepared sample

Analyze by HPLC



Amino Acid elution pattern

Analyze by Plate Reader

Total Tomato Analysis

Department of Life Sciences

Forest tells us

Associate Professor
Shinya Numamoto, Ph.D.

Keywords

Forest environment; Hydrology; Erosion control; Prevention of natural disaster

Requirement subject of study

The subject about natural environment (Earth Science; Geology, Physics, Biology)

Forest environment and living infrastructure

Japanese have lived based on the blessing of forest which we regard as the place of living or the subject of respect since a very long time ago in Japan which is covered with the forest about 70%. However, people worry about the degradation of unmanaged forest because the number of forests are increasing as a result of the change the use of wood materials and the energy resources or the economy and the social condition. In contrast, some huge landslide disaster occur in the mountain slope covered with forest which looks rich. Therefore, we have to watch closely about the forest, mountain region and river basin, not uncommon extreme climates.

Multifunctionality of the forest; Forest, Soil & Rock, Water

From understanding normal condition of forests

It is important to monitor at ordinary times to understand process that a natural disaster occurs. But the forest have various expression and sustain in the four seasons change growth and decline. Moreover, we can notice the sign by knowing ordinary forest not only forest stands but also rainfall, spring water, stream discharge and litter coverage, soil condition, we always observe various elements which form forest environment. We can evaluate possibility or stability of slope disaster by observing slow or slight change of land surface or ground move. Observing of the forest hydrology and the soil runoff and slope monitoring in forest used for research are another examples.

Forest hydrological observation; Hirakura University Forest, since 1987.

Natural disasters are always close to our daily life on Japan's unstable ground in long term perspective. When people look at a disaster event, they may expect some river improvement in their living area to prevent sediment-related troubles but many sediment disasters occur in forest covered slope of mountains regions or in the mountain torrents. So it is important for the people can notice a sign of change from forest area and it is necessary to elucidate "why" that when, where, how the phenomena happen.

Erosion control; Research of a deep landslide occurred in forest slope, 2011.

Affiliated Facility-Farm Station

One step closer to God — Fish and the history of the Earth

Keywords

Biology (taxonomy, ecology, genetics, etc.); English; Chemistry; Statistics

Professor
Seishi Kimura, Ph.D.

In fact, we don`t know much about fish

About 500 million years ago, the ancestors of modern fishes appeared on Earth, and they have subsequently undergone an extensive speciation into the amazing diversity of fishes seen today. Mankind continues to use fish as important food resources, and fishes play very important roles as a predators and as prey in aquatic ecosystem. Despite this importance, we still do not know fishes well — much remains to be learned about their ecology and even their taxonomy, the basis of modern biology.

New-species hunter?

We try to clarify and reveal the real classification of fishes, through studies of their systematics, speciation, taxonomy, etc. During these studies, we sometimes find a fish that has no scientific name; this is a new species. We have discovered and given scientific names to about 30 new species of fish. However, the discovery of new species is a kind of "by-product" of our work. Our main purpose is to reveal the real classification of nature; viz. what species of fishes make up a genus or family? Where do these fish live? How did they diverge and speciate into their current phylogenetic relationships?

Figure 1. A carangid fish, Decpaterus smithvanizi Kimura, Katahira and Kuriiwa 2013, described by us. This species is distributed from the Andaman Sea to Indonesia.

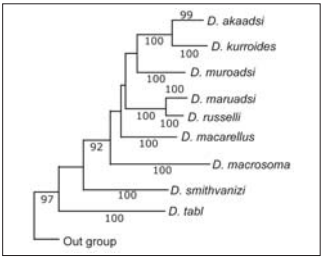


Figure 2. A molecular-phylogenetic tree of the Indo-Pacific carangid fish genus Decapterus.

One step closer to God

If God created all life in this planet, researchers who clarify the classification system of nature come one step closer to God by revealing His handiwork. Also, doing so provides a sense of satisfaction and accomplishment. Research on fishes contributes greatly to basic biology and it is essential for the development of fisheries biology, ecology, genetics, etc.

Moving laboratory Training ship - Seisuimaru

Keywords

Ship, oceanographic observation, atmospheric observations, field surveys. Ocean surface observation survey is not only the activities leading to the general sciences, but also the collaborative works as a group and development of human resources who have sense of cooperation, compassion towards the others from the life in the ship as a secondary product.

Captain
Yoichi Maekawa

Chief Officer
Toru Nakamura

Second Officer
Karin Okada

It is a training ship that does the oceanographic observations and collection of organisms

Seisuimaru is the training ship that develops the field scientists conducting survey researches on marine organisms, ocean environment, and meteorological conditions of the ocean surface.

What kind of works is it doing?

As in the way of measuring temperature, humidity, direction, and strength of the wind on land, ocean water temperature, salinity concentration, direction and strength of the ocean currents are measured. Moreover, when sampling the organisms, after the determination of the tools which are better to use for sampling such as nets, baskets, and fish hooks etc. according to life style of the organism sampling is done. Sometimes it might capture the mud in bottom of the sea and even together with bedrock be collected.

A scene of marine observation

A scene of collection of organisms

It is not just only the sea

The ocean and the atmosphere have a close relationship. By giving off the balloons into the sky after attaching various sensors to them and filling them with helium gas at the sea level, observations are carried out in the sky until up to the 10,000m or more away from the sea. We are able to investigate from far up in the sky to the bottom of the sea.

Training Ship- Seisuimaru

Keywords

Ship, oceanographic observation, collection of organisms, atmospheric observations, field surveys, ocean surface observation and by staying in the limited space of the ship the observations are conducted cooperatively. From there, it is possible to develop the sense of responsibility and coordination that accomplish the duties and feel compassion against the friends.

【Deck division - 9 people, including the academic staff】
Captain of the ship
Yoichi Maekawa
Chief officer
Toru Nakamura
Second officer
Karin Okada
Third officer
Junya Okumura
Boatswain
Mitsumasa Adachi
Storekeeper
Masao Nishioka
Quartermaster
Hideki Hiraga
Quartermaster
Kenichi Mori
Quartermaster
Noboru Ohta

【Engineering division - 4 people】
Chief engineer
Hiroki Imanishi
First engineer
Kazuya Mae
Second engineer
Motoki Yamamoto
Number one oiler
Toyo Oka

【Radio division - one person】
Chief passer
Taira Harasawa

【Food service division - two people】
Chief Steward
Masamichi Ueda
Steward
Tsukasa Wake

The latest energy-saving ship

Seisuimaru has a variety of observation equipment and it conducts the marine observations, collection of organisms, and atmospheric observations etc. in oceans all over the Japan. Since it is running on electrical propulsions (by turning the propeller in the same way as electric motors and electric vehicles), it is possible to do eco-driving, with small vibrations and noise of the ship hull, and therefore it is adaptable to do observations.

Training Ship "Seisuimaru"

Work of the crew

The roles of crew are divided into divisions such as deck, engine, radio, and food service and has different roles in each division. Deck division is responsible to guard the ship during the voyage and maintain the ship hull. Engine division is responsible to operation of generators and maintenance and adjustments of the various machineries. Radio division is responsible for communication affairs and office works in the ship. Food service division prepares meal for passengers in the ship. In addition to the duties specialized for them, works related to going in and out of the port and observations are carried out by all members in the crew.

Get closer to the ocean

Around 70% of earth's surface is covered with the ocean and an unknown world has spread out there. Even though the marine researches are not often conducted as the set schedule, due to the influences of meteorological conditions and oceanographic phenomena, it is possible to see the wonderful views of sunrise from the horizon and schools of dolphins. Why don't you try to familiarize with the sea and deepen the understanding of the ocean by using the Seisuimaru?

View of schools of dolphins from the bow

Support to the experiments and training

The Affiliated Facilities Administration Division can be cited as one of the special characteristics achieved substantially by the Faculty of Bioresources of Mie University. Experimental forest located in the woodland area of the east Kishu region, farms located in countryside of the Ise plains, the woodland area, the fisheries experimental station located in the Rias coastal area of the Shima region and then until up to the training ship (Seisuimaru) sail to the Kumanonada, which is also a valuable fishing ground in curoshio ocean currents…. various experiments,and training have been carried out using the fields as the letters "top of mountains to bottom of the sea. This training is supported by the technical staff of the Affiliated Facilities Administration Division.

Affiliated Facility - Farm Station

Our specialized tasks are the cultivation of rice, vegetables, fruit trees, and processing of agricultural products. Even though the vegetables seedlings are prepared for this training period, preperation of them is good hard work as the growths of the plants are influenced by weather. Manufacturing of processed products such as jam & miso (fermented soybean paste) etc. and operation of agricultural machines such as tractors are supervised. Matsusaka beef cattle are also being brought up.

Affiliated Facility -Forest Station

Thinning methods for sustainable use of forests and shipping methods of the wood from the forest are supervised. Maintenance and repairing of the roads in the forest to walk during the training period are carried out as daily operations, and we endeavor to ensure the safety of this training. Fauna in the forest is also being investigated. WOOD JOB!

Affiliated Facility - Fisheries Research Laboratory

During the training of collecting samples from the beach, after entering to the sea, observe the organisms while swimming and collect them. At that time, we monitor students and ensure their safety. In addition, we assist the works of marine surveys and collection of fishes that are carried out in the coast travelling by ship. Since the Fisheries Research Labolatory is located in a remote island, support to the life in this training period for accommodation and preparation of disaster prevention is also an important duty.

Affiliated Facility -Training ship "Seisuimaru"

Under the command of the captain, we concerned 24-hours overall navigation of the ship. When conducting the training related to ocean & meteorological observations, and investigation of organisms etc., we are responsible for the manipulation of observation & operation equipment, and ensuring the safety of the work is also our important duty. Sea becomes a good senior of the life during the long-term voyage.

For more information, please refer to the page of seisuimaru.

Team of Graduate School of Bioresource

What kind of place is an office? We will let you know our job!

In charge of general affairs,first floor office

What are general affairs?

Usually you rarely associate with persons who work in the office. Isn't that so? We would like to introduce some of our office works which is hard to understand somehow. Our office is located in the first floor of the building of Faculty of Bioresources and there are 22 people in total. Office works are divided into general affairs office, planning & coordination office, and academic affairs. Our works in general affairs division have various official procedures and have diverse activities. The scholarships having close relation to you and the courses open to public are introduced here.

What is meant by 'Scholarship'?

Two independent donation type scholarship systems have been established in the Faculty of Bioresources. The purpose of both systems is to economically support to the excellent students who have intention to engage in researches or projects related to agriculture, fisheries, and civil engineering etc. in the future.

Awarding ceremony of the Bunji Watanabe Scholarship

·The Bunji Watanabe Scholarship was established by Mr. Bunji Watanabe, the founder of Sansho Bussan Co. Ltd. voluntarily. This focuses on undergraduate 3rd year students and first year graduate students.

·Asahidoboku Co. Ltd. Scholarship was established by Asahidoboku Co. Ltd. voluntarily. This focuses on first year graduate foreign students.

What is meant by 'courses open to public'?

Faculty of Bioresources offers courses two times per year in summer & in autumn. Courses open to public introduce clues of academic knowledge through lectures & experiments by using the different section in every time creating opportunities for general public to learn on the environment and science. In summer, by performing the experiments that can be absorbed both by elementary school or elder children and their parents and in autumn by conducting lectures targeting the high school or elder people, explain emphasizing on the environment and the health and then gradually delve into more specialized subject matters intriguingly.

What is the planning and coordination office?

Planning & coordination office carries out the services relevant to the wide range of supports for students and the faculty staff. For example, it proposes plans to help the students for job hunting, send information towards out of the University through holding symposiums which research achievements of the academic staff can be publicized. Moreover, we consider about the future of the faculty with the dean, and help to promote the reformation of the organizational structure and the lecture curriculum.

What kind of place is an office? We will let you know our job!

In charge of the academic affairs, first floor office

What is meant by 'academic affairs'?

We involve in various services related to the students from academic studies to the student life. We think that there are much confusion in students due to drastic different academic system than the high school and about the University life etc. In such situations, we try to create an environment that students get come and feel free to ask questions or for discussions. As the in charge of academic affairs our great pleasure is to send the students who have grown as a full man to the society behalf of the University.

Faculty of Bioresources ～from entrance to graduation～

In Mie University, one year is divided into two semesters. First semester falls on from April 1st to September 30th and second semester fall on from October 1st to March 31st. Time period for one lecture is 90 minutes. End semester examination is carried out at the end of each semester and credits are given when pass the subject. Lecture courses are divided as educational subjects and majoring subjects. The education subjects (integrated subjects and foreign languages, etc.) that become basics of the majoring subjects are emphatically studied with in the first year. From the second year, students will start learning of majoring subjects in order to enhance the expertise knowledge. In second & third year, majoring subjects are learned and during fourth year after writing the graduation thesis in the laboratory, when the credits requirement for graduation becomes complete, it is possible to graduate in spring and can get a bachelor degree, master or a doctoral degree.

Moreover, there is a system in which academic staff or lecturers in the University are supported to the students similar to the role of the teacher in-charge of the class in the high school, in academic side and in the side of spending life at the University, from entrance to graduation. In addition, distribution of the list of students' records after the each semester also performed by that particular lecturer.

Graduate school of Bioresources ~as one of the route after the graduation of Bachelor's degree~

If you want to get more specialized knowledge after graduating from the undergraduate course, you can precede further researches by entering into the graduate school. You can get a master's degree after completing two years of Master course. Enrollment rate from undergraduate to graduate school is in the range of 30-40% of these past several years.

We are always with students

Please come to the academic affairs division, if you have been troubled with the University life, any time about anything we discuss with students. We are looking forward to help you.

We support you sincerely

Office affiliated to the laboratories
Sustainable Resource Sciences majoring module
Environmental Science and Technology majoring module
Life Sciences majoring module

Feel free to contact us

Counters of offices affiliated to laboratories have been provided in three locations according to each department, which is fourth floor (Environmental Science and Technology majoring module), fifth floor (Life Sciences majoring module) and seventh floor (Sustainable Resource Sciences majoring module). At each counter, various mediation services are carried out as a partner of lecturers, students, agencies, and suppliers. The content of the service is various according to the career of the particular clerk. "I don't know where to consult." In such a case, please feel free to come to our counter. We also accept inquiries by telephone, FAX and E-mails.

Environmental Science and Technology majoring module

Life Sciences majoring module

Sustainable Resource Sciences majoring module

We support to the education and the research

Research activities of the professors and students are supported such as conducting of budget management of the necessary parts of the laboratories and their settings, assisting the management and operation of analytical instruments, lending out the OS (windows) having contract with departments & majoring modules, issuing the product key etc. Moreover, when there is a sudden holding of the conferences, changing of lecture rooms and supplementary lessons etc. at the university, at such times, lending out the keys and reserving the lecture rooms, setting of machines required for presentations are carried out. Even when problems occur in copy machines, printing machines, and lighting equipment, minor procedures related to contacting suppliers and machine repairing are undertaken. In addition to that, in some major events such as entrance examination, graduation ceremony, and open campus etc. hold inside the University, we are responsible for side services in behind the scene related to that type of occasions.

We are committed to do prompt contacts and information dissemination

One of the special characters of Faculty of Bioresources is that there are many number of the lecturers and students in the Faculty. Therefore, mails to be handed over and parcels to be delivered, materials to be distributed inside the University, documents to be circulated and number of items to be handled are considerably high. We make sure that each material reaches to the relevant place or person securely by adapting various ways. For mails, we contact by telephone or by E-mail or deliver to the mail box of the lecturer. In addition, with respect to information required for employment information and students' life by using the Moodle (group fair to contact the lecturers and students), we deliver the information to the students' smart phone. To be able to accomplish comfortable education and research always, we support you sincerely.

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Published in April 2015