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Agro-pastoral system in Brazil
(Photo by K. Fujisaki and M. Kokubun)

CONTENTS

JIRCAS
JAPAN INTERNATIONAL RESEARCH CENTER FOR AGRICULTURAL SCIENCES

Toward Global Partnership in Agricultural Research

Nobuyoshi Maeno
Director General

On August 1, 1996, I became the second Director General of Japan International Research Center for Agricultural Sciences (JIRCAS) after succeeding Dr. Keiji Kainuma who retired from the Ministry .

Under the dynamic leadership of Dr. Kainuma, the former Tropical Agriculture Research Center was reorganized into JIRCAS and the difficult task of setting up a new structure was eventually accomplished.

During the three-year tenure of Dr. Kainuma, the new orientation of the JIRCAS activities was defined, for example new research facilities were constructed, comprehensive research projects were implemented, research activities in various countries that hitherto had not been targeted for research collaboration, such as Kazakhstan in Central Asia were initiated, the JIRCAS Visiting Research Fellowship Program at Tsukuba was inaugurated, research activities in Japan were further promoted while the relations between JIRCAS and the Japan International Cooperation Agency (JICA) became much closer.

Therefore, presently, the research activities of JIRCAS are being expanded and promoted along the basic strategy built-up during the past three years as follows:

1. Expansion of the areas targeted for research collaboration

When TARC was reorganized into JIRCAS, the areas targeted for research collaboration expanded to cover all the developing regions, in addition to the tropical and subtropical regions. However, due to the constraints on the budget earmarked and on the research capability, it became necessary to set up priorities. Presently, research collaboration with the countries located in the Asian region accounts for 80% of the total, mainly due to geographical considerations and a certain similarity in culture. Although in the case of Africa and Latin America, research is implemented mainly in collaboration with the CGIAR centers, etc., in future, the relations with the countries located in these regions may gradually expand. In addition, since the research themes taken up vary mainly with the countries and regions, the strategy adopted must be adjusted accordingly.

2. Importance of research dealing with information systems and socio-economic aspects

For the selection of research themes relevant to the needs of the countries and for the effective implementation of the projects, it is necessary to collect, process and analyse in a comprehensive manner, information pertaining to agriculture, forestry and fisheries fields in various regions. In addition, it is essential to develop appropriate technology compatible with the socio-economic conditions of the respective regions. To achieve these objectives, it is important to promote information activities aimed at integrating social and natural sciences.

3. Multidisciplinary versus unidisciplinary approach

Due to the complexity of the agricultural ecosystems and of the social systems, in order to develop techniques for the promotion of sustainable development of agriculture, forestry and fisheries activities in harmony with the environment, it is more than ever necessary to adopt a systematic and integrated strategy instead of an isolated and fragmentary approach. Therefore efforts should be made to promote the implementation of comprehensive projects on a multidisciplinary basis in addition to specific studies. Research covering information sciences and socio-economic aspects, as mentioned previously (2), should place emphasis on the drafting and implementation of integrated projects.

4. Development of collaboration on a multinational basis

Hitherto, research collaboration with the NARS had been implemented on a bilateral basis with the respective countries and organizations. However, for large scale problems common to several countries or regions, the implementation of research collaboration on a multilateral basis would be more effective and efficient. Therefore, in future, in order to promote collaboration on a multinational basis, it will be necessary to gain the understanding and cooperation of the related NARS.

5. Link between research carried out overseas and in Japan

The research strategy adopted since the establishment of TARC consisted of dispatching researchers to various countries to carry out collaborative research in the respective regions. In future, this system will be essentially maintained. However, in the case of basic advanced research fields requiring the use of sophisticated equipment and instruments, it is preferable to use the facilities available in Japan. Therefore, JIRCAS has set up its own research facilities in addition to utilizing the equipment and facilities available in other research institutes located in the Tsukuba Research Complex. As a result, in future, since the links between research carried out overseas and in Japan may become closer, a system whereby research carried out in Japan could alleviate the difficulties in the execution of research projects overseas could eventually evolve.

6. Development of human resources (training programs and fellowships)

To contribute to the development of sustainable agriculture, forestry and fisheries activities, it is essential to promote research as a resource base, hence the need to train researchers who can fulfill such requirements. To achieve this objective, JIRCAS currently sponsors two types of fellowships in making the best use of advanced facilities and of an environment conducive to research. These activities aim at enhancing the capability of the invited researchers while promoting research collaboration with the JIRCAS

researchers. In addition, it is anticipated that when the recipients of the fellowship return to their respective countries, they will become the core partners for research collaboration with JIRCAS.

For the past three years, the activities of JIRCAS have become widely recognized within the agricultural research community worldwide and JIRCAS has received requests from a large number of countries for the initiation of research collaboration.

Therefore, the collaboration on a partnership basis between JIRCAS, NARS, CGIAR centers, etc. should pave the way for a global partnership for the development of techniques aimed at the preservation of the global environment and the promotion of sustainable agriculture, forestry and fisheries activities.

However, due to the limitation in the number of researchers and research funds, it will be essential for JIRCAS to fully utilize its comparative advantage and to identify research priorities best suited to its capability and to the needs of the respective countries and regions.

JIRCAS RESEARCH HIGHLIGHTS

Use of Stored Pearl Millet Pollen in Wheat Haploid Production

Masanori Inagaki

The use of wheat haploids in breeding programs is of great interest to breeders, since the production of haploid plants followed by chromosome doubling enables the breeders to obtain genetically homozygous lines. The successful production of doubled haploids provides the most rapid means for developing recombinant inbred lines with favorable uniformity in selection procedures.

The method for producing wheat haploids from cultured pollen which has been referred to as anther culture technique, is still limited by the differences in the responses of wheat genotypes. On the other hand, the method using wide crosses followed by embryo rescue has recently been developed. Significant technical advances have been attributed to pollen selection from subfamily species and application of plant growth regulators. However, since this type of methodology always requires the presence of viable pollen at the time of pollination and restricts haploid production duration, the development of an adequate pollen storage technique could enable to alleviate this shortcoming.

The effects of drying and freezing on the viability of maize and pearl millet pollen and the crossabilities of wheat with stored pollen were examined in this study. Pearl millet pollen is relatively more tolerant to drying and freezing than maize pollen. As a result, pollen storage at ultra-low temperatures for one year did not affect the haploid production frequency in wheat × pearl millet crosses, but markedly reduced the frequency in wheat × maize crosses. Stored pearl millet pollen can be used as an alternative donor for producing wheat haploids when fresh pollen is not available (Photos 1 and 2).

Efficient production of wheat haploids complements conventional breeding programs, and accelerates the release of new varieties in developing countries where rapid varietal development is critical for sustainable wheat production systems.

Photo 1: Embryo formation in wheat, self-pollinated (left), and crossed with stored pollen of pearl millet (right)

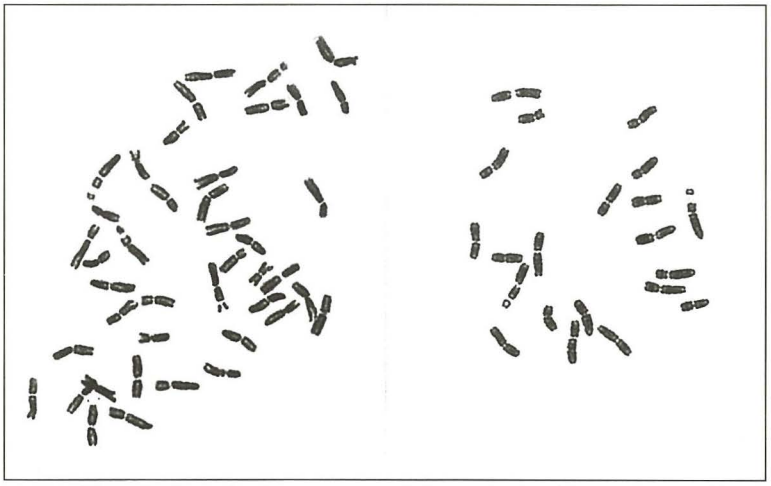

Photo 2: Somatic chromosomes of plants obtained from wheat, self-pollinated (left, 2n=6x=42), and crossed with stored pollen of pearl millet (right, 2n=3x=21)

Options for Mitigating Methane Emissions from Tropical Rice Fields

Kazuyuki Yagi

Atmospheric concentration of methane (CH_4) has been increasing rapidly in recent years. Because CH_4 is a radiative trace gas (greenhouse gas) and takes part in atmospheric chemistry, the rapid increase could be of significant environmental consequence. The scientific report of the Intergovernmental Panel on Climate Change (IPCC) concluded that a 10 to 15% reduction in the CH_4 emissions from individual sources would stabilize the concentration in the atmosphere. Of the wide variety of sources, wetland rice fields are considered to be an important source of atmospheric CH_4, because the harvested area of rice increased by about 70% during the last 50 years, and it is likely that CH_4 emissions increased proportionally. Recent estimates suggest that global emission rates of CH_4 from rice fields account for about 4-19% of the emission from all sources.

Due to the large amount of global emission, the reduction in CH_4 emission from rice cultivation is very important to stabilize the atmospheric concentration. In addition, since it is possible to control the emissions by agronomic practices, rice cultivation must be one of the most hopeful sources for mitigating CH_4 emission. In particular, tropical rice fields are important because more than 70% of the world rice acreage is located in this region. The current studies which aimed at measuring the CH_4 flux from rice fields and at developing options for mitigating CH_4 emissions from tropical rice fields were carried out within the framework of a collaborative project among the National Institute of Agro-Environmental Sciences (NIAES), Japan International Research Center for Agricultural Sciences (JIRCAS) (formerly Tropical Agriculture Research Center), Department of Agriculture, Thailand (DOA), and Malaysian Agricultural Research and Development Institute (MARDI) from 1991 to 1996.

Field measurements of CH_4 flux were conducted at 9 sites in Thailand (5 sites in the central plain and 2 sites each in North and Northeast Thailand). The CH_4 flux from rice paddy fields to the atmosphere was measured by using the closed chamber method (Photo 1). The measurements were performed during the rice cultivation period. The results showed a large variation in CH_4 emission rates among the sites. The average emission rates during the rice cultivation period ranged from 1.1 to 23.0 mg m^{-2} hr^{-1}. A relatively large flux was observed in the northern and northeastern sites, whereas a small flux was observed in rice fields with acid sulfate soils and soils with a low content of labile organic matter and high content of free oxides. The results indicated that the soil properties and agronomic practices including water and organic matter management affected the CH_4 emission rates from rice fields.

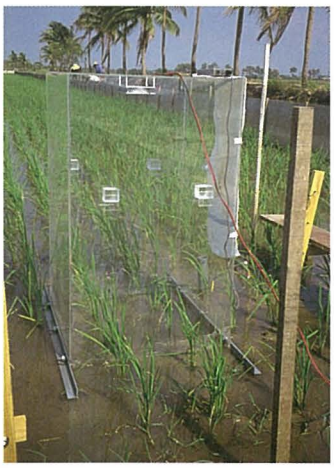

Photo 1: Closed chamber method for CH_4 flux measurements

Effect of organic matter application on the CH_4 flux was also investigated. Application of rice straw to paddy soils prior to flooding increased the total CH_4 emission 3.8- to 10.4-fold. The largest CH_4 flux was observed in the early stage of cultivation in the plot with rice straw application, whereas in the latter stage in the plot without rice straw application (Fig. 1). Green manure application also increased CH_4 emission significantly. On the other hand, some organic amendments such as palm oil wrung residues and complehumus did not affect the CH_4 emission rates significantly. These results indicate that fresh organic matter containing a large amount of labile fractions significantly enhances CH_4 emission from rice fields. For mitigating CH_4 emission from tropical rice fields, aerobic degradation of organic matter by composting or incorporation into soil during the off-season drainage period could also be proposed.

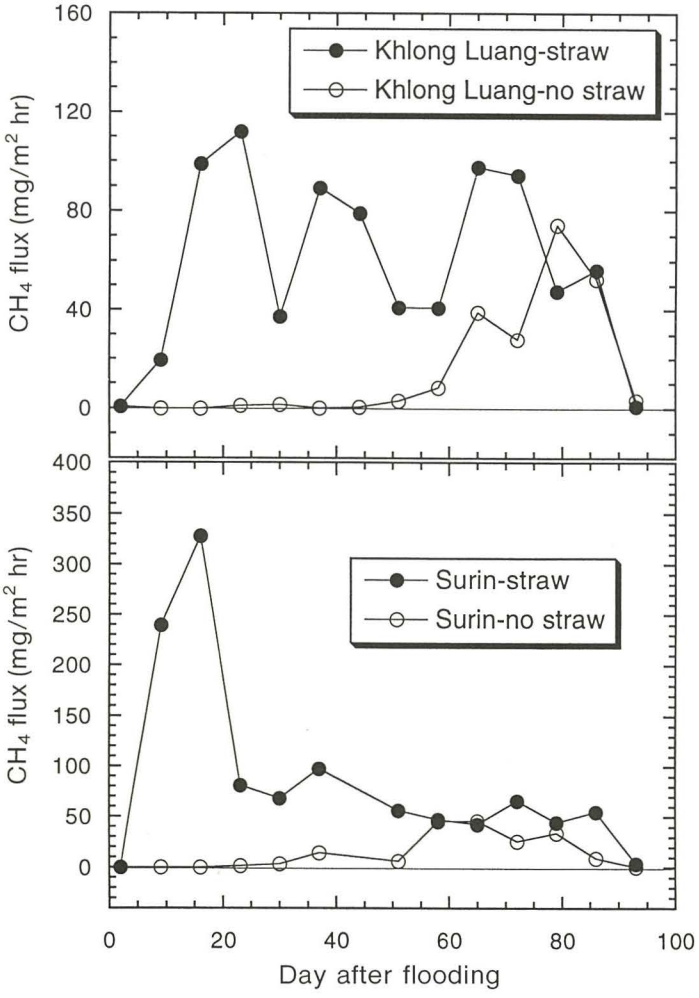

Fig. 1. Effect of rice straw application on CH_4 emission from rice fields

Biotype of *Fimbristylis miliacea* (L.) Vahl. Resistant to 2,4-D in the Muda Area

Hiroaki Watanabe, Md. Zuki Ismail and Nai-Kin Ho**

In the Muda area, chemical weed control began with the use of 2,4-D dimethylamine in the early 1960s and wettable powder formulation of 2,4-D iso-butylester became popular among farmers from the early 1970s because of its superior effectiveness for the control of broadleaved weeds and sedges. *Fimbristylis miliacea* (L.) Vahl. is the most common annual sedge in direct-seeded rice fields in Malaysia. The weed could be controlled easily by the application of 2,4-D at the rate of 0.8 to 1.0 kg a.i./ha. However, a 2,4-D-resistant biotype of *F. miliacea* was observed in the off-season of 1989 in a farmer's field in Kampung (Kpg.=village) Gulau, locality D-III in the Muda Irrigation Area, where 2,4-D had been seasonally applied since 1975.

Photo 1: Rice field infested with Fimbristylis miliacea *(L.) Vahl.*

Differences in the susceptibility to 2,4-D dimethylamine between biotypes were investigated in a pot experiment. R-type recovered after the application of 2,4-D dimethylamine at doses up to 1.39 g a.i./m^2 (equivalent to 16 times the recommended dose), whereas the susceptible biotype (S-type) from Kpg. Titi Batu, locality G-IV, MADA, was strongly affected at all rates higher than 0.022 g a.i./m^2 (equivalent to one-quarter of the recommended dose). The R-type was not distinguishable from the S-type based on taxonomic characters such as panicle form, shape of spikelets, glume and nut (seed). There were no statistical differences in the size of panicles and spikelets between the biotypes.

R-type showed a cross-resistance to other phenoxy compounds such as 2,4-D iso-butylester, 2,4-D ethylester, 2,4-D sodium salt and MCPA. However, no distinct differences were observed between the biotypes in the reaction toward propanil, paraquat and glufosinate ammonium.

Distribution of the R-type was investigated using soil samples from 100 rice fields in the Muda area in 1993. R-type plants were detected in five rice fields at different locations, including Kpg. Gulau, while only S-type plants were found in the other 95 rice fields, indicating that most of the rice fields in the Muda area were infested with the S-type. Infestation with *F. miliacea* and percentage of R-type plants were investigated in Kpg. Gulau. No relationship was observed between the degree of *F. miliacea* infestation and R-type percentages. R-type percentage decreased from 1993 to 1995 in the rice fields where 2,4-D compound herbicides had not been applied since 1992.

In Malaysia, the use of sulfonylurea compounds such as bensulfuron-methyl and metsulfuron-methyl is increasing steadily and tends to replace 2,4-D herbicides. Herbicide-resistant biotype often evolved by repeated use of the same herbicide. Continuous monitoring of the herbicide-resistant weeds is imperative in the Muda area.

* Muda Agricultural Development Authority (MADA)

Photo 2: R-type treated with 2,4-D dimethylamine

Photo 3: S-type treated with 2,4-D dimethylamine

PEOPLE

Katsuyuki Minami, Director of the Environmental Resources Division, JIRCAS, was selected by the International Union of Air Pollution Prevention and Environmental Protection Associations (IUAPPA) in cooperation with the International Academy of Sciences (IAS) as the first recipient of the award "Hopes for the Future for a Sustainable World" for his work on "The Effect of Agricultural Practices on Methane Emissions from Rice Fields".

Kiyoshi Tanaka, a forest pathologist, became Director of JIRCAS's Forestry Division on October 1, succeeding Dr. Yasuo Osumi. Dr. Tanaka was until recently Research Coordinator at the Forestry Agency, Ministry of Agriculture, Forestry and Fisheries (MAFF). He carried out most of his research work at Hokkaido Research Center and Kansai Research Center, Forestry and Forest Products Research Institute, MAFF. He also spent one year as Visiting Scientist at the Pacific Southwest Forest Experiment Station (USDA) in California, USA from 1978 to 1979.

≪Project Report≫

Comprehensive Studies on the Development of Sustainable Agro-pastoral Systems in the Subtropical Area of Brazil

Kozo Fujisaki

JIRCAS is committed to contributing to a more effective implementation of collaborative research programs to promote sustainable development of agriculture, forestry and fisheries in harmony with the local conditions and environment in the developing regions through the establishment of closer relations with both overseas and Japanese research organizations. Based on the strategy of JIRCAS, the research project entitled "Comprehensive Studies on the Development of Sustainable Agro-pastoral Systems in the Subtropical Area of Brazil" will be implemented during the period 1996-2002.

The subtropical area of Brazil

The subtropical area of Brazil has been considered to be one of the areas where modern agriculture originated in South America. This area, where continuous cultivation of field crops has been carried out on a large scale as the major agriculture system with extensive cattle grazing, is extremely important to the food supply and economy of Brazil at present. This area which covers about 400 thousand km^2 (approximately equal to the Japan land area) has a triangular shape, straddling the cities of Londrina, Botucatu, Ribeirao Preto and Campo Grande. Also, the area is characterized by the settlement of hundreds of thousands of Japanese-Brazilian farmers who are mainly providing essential food commodities for the Sao Paulo and Rio de Janeiro megalopolises.

In the subtropical area of Brazil, the increase of agricultural production has been achieved by continuous expansion of arable land and high dependence on the net primary productivity of fertile land with minimum input. As a result, in most of this area the land has become environmentally vulnerable and the efficiency of production has remained low without improvement of agricultural technologies. Plant growth retardation associated with continuous cropping, the occurrence of diseases, outbreaks of pests, and soil erosion threaten agriculture in this area and are the main constraints on sustainability and productivity.

New project on agro-pastoral systems in the subtropical area of Brazil

This research project is focused on the development of sustainable farming systems with high productivity in environmentally degraded areas in the subtropical zone of Brazil, with emphasis placed on land utilization through the adoption of crop-pasture rotation systems. For this purpose, the following research themes will be taken up:

1) Analysis and evaluation of indigenous and traditional land utilization systems for agriculture
2) Multidisciplinary studies for the adoption as sustainable crop-pasture rotation systems
   ① Mixed and multiple cropping agricultural systems employing soybean as a main crop for field crop diversification
   ② Introduction and management of forage crops in mixed, multiple-cropping systems for soil improvement and erosion control
   ③ Dynamics of soil fertility and plant nutrition in crop-pasture rotation
   ④ Control of biotic agents, e.g., pathogens, pests and weeds
   ⑤ Management of grazing cattle in crop-pasture rotation
3) Socio-economic evaluation of crop-pasture rotation from the standpoint of farming systems
4) On-farm participatory research on newly developed "agro-pastoral systems"

Project sites

The studies will be mainly carried out in collaboration with research centers affiliated to EMBRAPA, namely National Research Center for Beef Cattle (CNPGC) and National Research Center for Soybean (CNPSo). The expertise of CIAT in crop-pasture system development in South American countries will be sought. Also, collaboration with the JATAK International Center of Agriculture Technology, which is one of the Japanese non-governmental organizations for Japanese-Brazilian farmers, will be promoted.

Photo 1: Two traditional herdsmen, "Gaucho", at Campo Grande

Photo 2: Soybean farm contiguous to a pasture at Campo Grande, as a prototype of agro-pastoral systems to be implemented in this study

≪Topics≫

Mr. Matsumoto, Chairman of AFFRC, and Dr. Maeno, DG of JIRCAS, Visited Indonesia

Masahito Sato

Mr. Sakuei Matsumoto, Chairman of the Agriculture, Forestry and Fisheries Research Council (AFFRC), Ministry of Agriculture, Forestry and Fisheries (MAFF), and Dr. Nobuyoshi Maeno, Director General of JIRCAS visited Indonesia in August 1996. They had the opportunity of meeting with his Excellency Sjarifudin Baharsjah, Minister of Agriculture of Indonesia, Dr. Faisal Kasryno, Director General of the Agency for Agricultural Research and Development (AARD), Ministry of Agriculture (MOA) and the Directors of the Institutes affiliated to AARD.

They exchanged views about the future orientation of research collaboration between the Institutes affiliated to Indonesian organizations, namely AARD and the Institutes affiliated to MAFF, namely JIRCAS.

It was eventually agreed: 1) that research collaboration implemented by JIRCAS for the development of technology in the field of agricultural production should also include socio-economic aspects to promote rural development in taking account of the conditions prevailing in the respective regions of Indonesia, 2) that it is essential that research collaboration deal with the expansion of agricultural production compatible with the preservation of the natural environment on a global scale in order to achieve sustainable development of agriculture and 3) that for the effective implementation of the research projects it is desirable that JIRCAS promotes research collaboration with the Indonesian organizations in paying a close attention to the technical cooperation activities sponsored by JICA.

Mr. Matsumoto and Dr. Maeno visited several research institutes affiliated to AARD, such as the Central Research Institute for Food Crops and Research Institute for Food Crop Biotechnology in Bogor, as well as The Research Institute for Coastal Fisheries in Ujung Pandang. They also met with JICA administrators and experts in Jakarta and visited the ESCAP · CGPRT Center in Bogor and JICA Mangrove Forest Conservation Project in Bali.

Photo 1: Meeting with the Minister of Agriculture of Indonesia (from left to right): Dr. Effendi, Dr. Maeno, Honorable Sjarifudin Baharsjah, Mr. Matsumoto, Mr. Kadowaki, Mr. Kawamoto, Mr. Sato

Recent Advances in Nutrition and Feeding Standard of Farm Animals in Asian-Australasian Countries:

Satellite Symposium of the 8th Animal Science Congress of Asian-Australasian Association of Animal Production Societies (AAAP)

Hirofumi Hayakawa

International symposium on the above theme was held in Tsukuba Science City during the period October 20-21, 1996 under the joint auspices of the National Institute of Animal Industry (NIAI), Japan International Research Center for Agricultural Sciences (JIRCAS) and Japan Livestock Technology Association (JLTA). From 12 countries, 105 scientists, including 34 from abroad, in the fields of animal nutrition and animal production participated in the symposium.

Photo 1: Participants in, and presentation, at the symposium

Livestock play a vital role in the rural economies of the Asian-Australasian region. Recent advances in animal nutrition are making great strides in many countries. However, there are still many problems to address technically to achieve an optimum level of animal production under practical conditions. Development of feeding standard for farm animals together with feed information on nutritive values, both being the outcome of research activities in the field of animal nutrition, is originally expected to require the collaboration of both researchers and animal farmers.

Keynote addresses were as follows: "Nutrient requirements for ruminants in the tropics" by Dr. B.A. Young from the University of Queensland, Australia, "Development of feeding technologies and contribution of nutrition research to dairy farming in Japan" by Dr. S. Oshio from National Grassland Research Institute (NGRI), and "Concept of the Asia-Pacific regional feed composition information network" by Mr. K. Kosaka from JIRCAS. In the country reports, scientists from Malaysia, Thailand, Indonesia, Vietnam, Nepal, Korea, China and Japan made presentations on related topics.

The symposium provided a new opportunity to discuss these important issues and search for the solutions through the promotion of collaborative networks in this region.

≪Visiting Scientists≫

Artificial Propagation of Giant Freshwater Prawn

Muharijadi Atmomarsono
Research Institute for Coastal Fisheries, South Sulawesi, Indonesia 90511

The giant freshwater prawn, *Macrobrachium rosenbergii*, is one of the important crustaceans mainly cultured in the countries of the Asia-Pacific region, and North and South America. However, the production of prawn larvae in the hatchery is still insufficient due to the dependence on the use of natural spawners, and therefore, the prawn larvae must be partly supplied by using wild forms. Many methods have been applied to increase the production rates, but information about reproductive mechanisms and means of controlling larval diseases in the early stages is still lacking.

It is well known that eyestalk ablation in prawns can stimulate the molting cycle and vitellogenesis based on species, age, and stage of the ovary. Part of my current work involves the examination of the structure and processing of vitellogenin (yolk protein) in female *Macrobrachium rosenbergii* by sampling the hemolymph of eyestalk-ablated prawns and analysing samples using sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) followed by western blotting. In subsequent experiments the role of the ovary will be examined to determine whether the ovary itself functions as an endocrine organ to promote yolk protein production and/or serves as a source of endogenous vitellogenin.

Macrobrachium rosenbergii prawns migrate naturally to brackish water areas during the time of spawning, when the female broods an egg mass attached to the abdominally located setae. Prawns may be prone to diseases at any stage of their life cycle. Since diseased breeders which are infected with pathogenic fungi can contaminate their larvae, it is necessary to separate the eggs from the breeders for disease prevention. If eggs are put into freshwater, the larvae die soon after hatching. In order to determine the optimal conditions of salinity or osmolarity of the water media for hatching and survival of giant freshwater prawn embryos, I am analysing osmoregulatory mechanisms and testing the use of sea water at various percentages. Results thus far suggest that water media with an osmolarity between 500-600 mOsm (about 50% sea water) are most satisfactory. Identification and evaluation of fungi isolated from giant freshwater prawns will also be carried out in the near future.

Photo 1: M. Atmomarsono (right) and M. N. Wilder are monitoring the conditions of culture of the giant freshwater prawn

Evaporation and Formation of Secondary Salts

– Challenge to Desertification –

Chang Qing
Xinjiang Institute of Biology, Soil and Desert Research, Chinese Academy of Sciences, People's Republic of China

It is estimated that about 10% of the land on our planet is being affected by salinization which is now recognized as an increasing cause of land and stream degradation in arid and semi-arid lands. Arid and semi-arid areas account for almost half of the land area of China. Salinization and resulting desertification are the most serious challenges to agriculture and the environment in these regions.

Relevant studies in the fields of agriculture, geochemistry and environmental sciences have been carried out. During the past 5 years, I studied the occurrence and mineralogy of salt-affected soils in the desert area of northwestern China. The soil salts are derived from weathering products of rocks, while the redistribution of salts mainly depends on the water movement and evaporation rate. We were able to elucidate the mechanism of salt accumulation and identify mineralogical species on a relatively large geographic scale.

Now, my research theme is focused on the mechanism of formation of evaporative secondary salt minerals under simulated arid conditions. Under climatic conditions characterized by high temperature and scarce precipitation, evaporation is the dominant link between rock weathering and salinization from weathering products. Our recent experiments suggest that surface properties and porosity of solid phase (soil matrix) and, density and adhesion of liquid phase (soil solution) are important factors determining the processes of evaporation-precipitation.

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