## 2.1.2 Laboratory: Plant Breeding

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| Member: | Professor | Tanisaka, Takatoshi, D.Agric.Sci |
| | Associate Professor | Okumoto, Yutaka, D. Agric.Sci |
| | Assistant Professor | Teraishi, Masayoshi, D.Agric.Sci |
| | Assistant Professor | Tsukiyama, Takuji, D.Agric.Sci |
| | KU Visiting Professor | Xu, Zhengjin, D.Agric.Sci |
| | Doctor's program | 5 |
| | Master's Program | 16 |
| | Undergraduate | 4 |

**A. Research Activities (2009.4-2010.3)**

**A-1. Main Subjects**

a) First discovery of an active transposon in rice

A mutant slender glume gene slg was induced with gamma-ray irradiation to seeds of the rice variety Gimbozu. But this slender glume gene occasionally reverts to its wild type allele slg+. We considered that such mutability of slg results from precise excision by a transposon inserted in it. As a result of analyzing the molecular structure of slg, we could demonstrate that a transposon mPing (belonging to one of the non-autonomous transposon family called MITEs) was inserted in the fourth exson of slg, the same gene as Rurm1m (Rice ubiquitin related modifier-1), and that reversion from Rurm1m to its wild type allele resulted from precise excision of the mPing. Thus we successfully identified an active rice transposon by analyzing the mutability of a slender mutation of glume. No active transposons have so far been reported in intact rice plants, and there have been no reports on active MITEs mobile both in intact higher plants and in animals. Mobile transposons used as gene tags in intact plants are powerful tools for function analysis because transposon insertions often inactivate genes. Therefore, this discovery is a milestone for function analysis of rice genes.

b) Genetic analysis of major agronomic characters in rice

A number of japonica- and indica-rice varieties and a large number of mutant lines induced and preserved in our laboratory were analyzed for genetic factors controlling important agronomic characters, such as heading time, plant height and resistance to blast. These genes were subjected to the RFLP or SSR analysis to determine their locations on chromosomes.

Some of these genes were also examined for the effects on phenotypic expression including pleiotropy and gene-gene interaction, and evaluated for their agronomic values.

c) Molecular-genetic analysis of chitinase gene family in rice.

We had identified that there are twelve independent loci of chitinase gene (Cht1 to Cht12) in rice genome. These genes were analyzed for the primary structure and function of enzyme protein in relation to disease - resistance after isolation and purification using E. coli expression system.

d) Analysis of genetic variation in wheat seed storage protein, glutenin

Asian hexaploid wheat (Triticum aeastivum L.) cultivars were investigated for the genotype of high molecular weight gulutenin subunits (HMGS). HMGS is the most important factor determining the bread-baking quality and noodle quality. We are investigating the genetic diversity of HMGS among East Asian wheat cultivar to identify the valuable genotypes for the improvement of wheat quality in Japanese varieties. Then, we found the new HMGS in one variety which showed a specific dough quality comparing to other varieties. It is important to disclose effects of this new HMGS on the characteristics of dought and bread-baking quality.

e) Genetic analysis of major agronomic characters in soybean

A number of varieties and 96 recombinant inbred lines (RILs) derived from the F2 population of 'Peking' and 'Tama-homare' which was developed in our laboratory were analyzed for genetic factors controlling major agronomic characters such as filling duration, stress resistance, seed quality. The genetic map consisting 342 SSR markers loci, three phenotypic gene loci (I ,T andW1 locus) was constructed using above RILs. Based on this map, we found several QTLs (Quantitative Trait Loci) for pre-germination flood tolerance and isoflavone accumulation in seeds (cotyledon).

**A-2.Publications and presentations**

a) Publications

Books

- Yoshikawa, T., and T. Tanisaka: Structure of soybean seed. All of soybean ( edited by K. Kitamura), p96-102, ScienceForum Inc. Tokyo, 2010

Original Papers

- Naito, K., F. Zhang, T. Tsukiyama, H. Saito, C.N. Hancock, A.O. Richardson, Y. Okumoto, T. Tanisaka and S.R. Wessler:
Unexpected consequences of a sudden and massive transposon amplification on rice

gene expression. Nature 461; 1130-1134, 2009
- Monden, Y., K. Naito, Y. Okumoto, H. Saito, N. Oki, T. Tsukiyama, O. Ideta, T. Nakazaki, S.R. Wessler and T. Tanisaka:
High potential of a transposon mPing as a marker system in japonica x japonica cross in rice. DNA Res 16; 131-140, 2009
- Saito, H., Q. Yuan, Y. Okumoto, K. Doi, A. Yoshimura, H. Inoue, M. Teraishi, T. Tsukiyama and T. Tanisaka:
Multiple alleles at Early flowering 1 locus making variation in the basic vegetative growth period in rice (Oryza sativa L.). Theor Appl Genet 119; 315–323, 2009
- Yuan, Q., H. Saito, Y. Okumoto, H. Inoue, H. Nishida, T. Tsukiyama, M. Teraishi and T. Tanisaka:
Identification of a novel gene ef7 conferring an extremely long basic vegetative growth phase in rice. Theor Appl Genet 119; 675–684, 2009
- Karki, S., T. Tsukiyama, Y. Okumoto, G. Rizal, K. Naito, M. Teraishi, T. Nakazaki and T. Tanisaka:
Analysis of distribution and proliferation of mPing family transposons in a wild rice (Oryza rufipogon Griff.). Breed. Sci. 59; 297-307, 2009
- Wang, J., T. Nakazaki, S. Chen, W. Chen, H. Saito, T. Tsukiyama, Y. Okumoto, Z. Xu and T. Tanisaka:
Identification and characterization of the erect-pose panicle gene EP conferring high grain yield in rice (Oryza sativa L.). Theor Appl Genet 119: 85–91, 2009
- Sayama, T., T. Nakazaki, G. Ishikawa, K. Yagasaki, N. Yamada, N. Hirota, K. Hirata, T. Yoshikawa, H. Saito, M. Teraishi, Y. Okumoto, T. Tsukiyama and T. Tanisaka:
QTL analysis of seed-flooding tolerance in soybean (Glycine max [L.] Merr.). Plant Science 176; 514-521,2009
- Tsukiyama, T., J. Lee, Y. Okumoto, M. Teraishi, T. Tanisaka and K. INOUYE: Gene cloning, bacterial expression, and purification of a novel rice (Oryza sativa L.) Ubiquitin-related protein, RURM1. Biosci. Biotechnol. Biochem. 74; 430-432, 2010
- Teraishi, M., Y. Ito, K.Yano, T.Nakazaki, T.Tsukiyama, Y.Okumoto, H.Saito, A. Kitajima and T. Tanisaka: In Silico survey of transposable elements in soybean. J. Crop Res. 54; 71-74, 2009
- Hirata, K., T. Yoshikawa, M. Teraishi, K.Komatsu, M. Takahashi, N. Hirota, T. Nakazaki, T.Sayama, T. Tsukiyama, Y. Okumoto and T. Tanisaka: QTL analysis of seed-flooding tolerance of the yellow soybean variety 'Enrei'. J. Crop Res. 54;75-80, 2009
- Yu,Z., Y.Okumoto, N.Kishimoto, T.Yamamoto and T. Tanisaka: Cool water treatment

ot the underground part of rice at the microspore stage induces severe spikelet sterility. J.Crop Res. 54;81-84, 2009

- Asami, T., Y. Okumoto, H. Saito, Q. Yuan, Y. Monden, M. Teraishi, T. Tsukiyama and T. Tanisaka: Physical mapping of two novel photoperiod sensitivity genes, se14 and se15, using mPing SCAR markers. J. Crop Res. 54; 85-90, 2009
- Karki, S., T. Tsukiyama, Y. Okumoto, M. Teraishi, G. Rizal and T.Tanisaka: Differential distribution of miniature inverted-repeat transposable elements in wild Oryza species. J. Crop Res. 54; 91-98, 2009
- Inagaki, H., T.Tsukiyama, Y. Monden, S. karki, Y. Okumoto, T. Nakazaki, M. Teraishi and T. Tanisaka: Identification of transcripts with mPing sequence in rice. J. Crop Res. 54; 99-102, 2009
- Yoshikawa, T., Y. Okumoto, M. Terai, K.Yamada, M. Teraishi, T. Tsukiyama and T. Tanisaka: High isoflavone content mutants induced from the soybean variety 'Tambaguro' with gamma irradiation . J. Crop Res. 54;111-118
- Monden, Y., K. Naito, T. Tsukiyama, Y. Okumoto and T. Tanisaka: Up-regulation of a rive transposon Ping in the mPing actrive variety 'Gimbozu'. J. Crop Res. 54;119-124, 2009
- Kato, M., M. Nishinaka, Y. Okumoto, K. Kato, T. Ikeda, N. Ishikawa, M. Teraishi, T. Tsukiyama and T. Tanisaka: Modification of gluten property by using the diversity of low molecular weight glutenin subunits among wheat landraces in Asia. J.Crop Res. 54;137-142, 2009

b) Conference and seminar papers presented

- Congress of Japanese Society of Breeding: 13 presentations
- Congress of the Society of Crop Science and Breeding in Kinki: 3 presentations
- Congress of Japanese Society of Genetics: 1 presentation

**A-3.Off-campus activities**

Membership in academic societies

- Tanisaka, Takatoshi, D.Agric.Sci : Association of Japanese Agricultural Scientific Societies (Council member), The Society for the Advancement of Breeding Researches in Asia Oceania (Board member), The Society of Crop Science and Breeding in Kinki (Council member)
- Okumoto, Yutaka, D.Agric.Sci : Japanese Society of Breeding (Accounting auditor), The Society of Crop Science and Breeding in Kinki (Council member)
- Tsukiyama, Takuji, D.Agric.Sci : Japanese Society of Breeding (Council member), The

Society of Crop Science and Breeding in Kinki (Council member)

- Teraishi, Masayoshi, D.Agric.Sci : Japanese Society of Breeding (Council member)

Research grants

1. Grants-in-aid for Scientific Research(KAKENHI)

- Scientific Research (B) : Tanisaka, Takatoshi : Transposition mechanism of mPing and development of high-efficiency transposon-tagging system

2.Other Research Grants

- Independent Administrative Institute (National Institute of Agrobiological Sciences) : Tanisaka, Takatoshi : Genetic and molecular dissection of quantitative traits in rice
- Independent Administrative Institute (National Agriculture and Food Research Organization) : Tanisaka, Takatoshi : Construction of linkage-map, phisical-map and genome sequence dataset of soybean genome "Identification of soybean seed-flooding tolerance gene"
- Research and development projects for application in promoting new policy of Agriculture Forestry and Fisheries : Tanisaka, Takatoshi : Advancement of productivity and functionality of large-seed black soybean for novel demand expansion
- Fujikko Co. Ltd. : Tanisaka, Takatoshi : Collaboration "Breeding of soybean varieties with high quality"
- Fuji Foundation for protein research : Tanisaka, Takatoshi : Identification of genes controlling the contents of seed storage proteins in soybean
- The Nisshin Seifun Foundation : Okumoto, Yutaka : Modification of gluten property by using novel glutenin subunits among wheat landraces in Asia

**A-4.International cooperation and overseas activities**

International joint research, overseas research surveys

- Functional analysis for a erect panicle gene in rice (China, Shenyang Agriculture University)
- Exploitation of the resistance genes for leaf-blast diseases in rce (China, South China Agricultural University)
- Exploitation of genetic factors contributing to the mobilization of mPing in rice (U.S.A., The University of Georgia)
- Studies on improvement of fatty acid composition in oil crops (Germany, Justus-Leibig University)

Visiting Research Scholars

- KU Visiting Professor 1（China）

**B.Educational Activities(2009.4-2010.3)**

**B-1.On-campus teaching**

a) Courses given

- Undergraduate level: Plant Breeding I, II (Tanisaka), Basic Bioresource Science II (Tanisaka), Outline of Bioresource Science I (Tanisaka), Biometrics (Okumoto), Seminar in Crop Science (Tanisaka), Laboratory in Bioresouce Science I (Tanisaka, Okumoto, Teraishi, Tsukiyama), Introduction to Research (Tanisaka, Okumoto, Teraishi, Tsukiyama), Food Safety II (Tanisaka)
- Graduate level: Progress in Mutation Breeding (Tanisaka), Plant Breeding Seminar (Tanisaka), Special Laboratory Work in Plant Breeding (Tanisaka, Okumoto, Teraishi, Tsukiyama)

**B-2.Off-campus teaching etc.**

Part-time lecturer

- Tanisaka, Takatoshi: Takii College of Horticulture (Plant Breeding), Graduate School of Bioagricultural Sciences, Nagoya University (Plant Breeding)

- Okumoto, Yutaka: School of Environmental Science, The University of Shiga Prefecture (Biometrics)

**B-3.Overseas teaching**

International students

- International students : Master 1 (China) Doctral 3 (Egypt 1, Buhtan 1, Bangladesh 1)

**C.Other Remarks**

- Tanisaka, Takatoshi: "Ministry of Education, Culture, Sports, Science and Technology", Member of textbook authorization committee, Member of fact-finding committee for crop breeding., Committee member of National bio-resources project (Chairman of rice subdivision committee), Member of the Gamma-field symposium committee, Member of authorization committee for NARO (National agriculture and food research organization), Member of Rice Genetic Resource Committee