

**The 1st Review Committee of Plant-Microbe Symbiosis
Evaluation and Suggestions**

(March 5, 2019)

Division/Team Name: Plant-Microbe Symbiosis Research and Development Team
(Yasunori ICHIHASHI, Team Leader)

1. Achievements and plans for the Team

(1) Have the current achievements reached the standards of those made by the major international bioresource centers?

- Achievements made by the PI at his former post are highly appreciated to contribute to the development of the BRC's projects.
- This Team was inaugurated in the current fiscal year. In addition to the PI's achievements at his former post, this year's achievements are the results from preliminary experiments for several objectives that the Team plans to advance in the future. Presently, all are reaching satisfactory levels, and the Team can be expected to accomplish its plan in the future.
- Research facility and instruments are being installed with which the projects can be conducted in comparable environment with the world's bioresource centers. Their projects are taking the form of 1) the development of resources for arbuscular mycorrhizal fungi (AMF) and rhizosphere microbes, 2) the establishment of a model system for plant-microbe symbiosis study by utilizing *Brachypodium distachyon*, and 3) the development of "Agroecological engineering system" to achieve a sustainable recycling-based society. In particular, the PI brings highly advantageous omics technology to the Team.
- Based on the novel transcriptome techniques which developed by the PI, the Team is proceeding with multi-omics analysis which are adapted to the agricultural field. The research approach can be evaluated as satisfactory to develop a new theory on the relationships among the plant-microbe-soil environments.

(2) Have sufficient achievements been made for contributing to society and to the research community within Japan and overseas?

- The Team's projects have just been established; however, a co-authored review on plant-microbe symbiosis was published in the journal *Nature Plants*. It is evident that the Team is making social contributions.

- It is highly appreciated that the Team organized the inaugural meeting of the *Brachypodium distachyon* and AMF consortium in order to understand the needs of the research community.
- Transcriptome and microbiome analyses of over 2,300 samples have been performed from 47 collaborative research projects. These contributions to the research community is large.
- The contributions to the research community are evident as the PI gave guest lectures at domestic conferences and graduate lectures, etc.
- It seems waste of time and effort for this Team with young researchers to spend their time on outreach activities as a means of social contribution. However, considering their high ability to permeate into similar age brackets, these initiatives should be kept in the future, while maintaining a balance with research needs to be concerned.
- In the future, we expect that their contributions to the research communities within Japan and overseas will be more than satisfactory.

(3) Are current activities and plans based on the results of the 3rd Mid- to Long-Term Plan or the achievements in the previous position? Are they in line with the BRC's 4th Mid- to Long-Term Plan (7 years from 2018 to 2024)? Are they appropriate and do they contribute to the development of the center?

- The “development of rhizosphere microorganism resources” fits to the BRC's 4th Mid- to Long-Term Plan, and can be expected to contribute to the center's development. It seems reasonable that the development of resource will be materialized by establishing a model system for plant-microbe symbiosis study as well as by the consolidation of information which contributes to its applications in the agricultural field. At the same time, promotion of a wide range of research projects from the establishment of model experiment systems to field omics may face the need for effective collaboration with other research institutions and the flexible management of the Team.
- Although the development of AMF resources is their most important mission, the Team needs carefully to collaborate with The National Agriculture and Food Research Organization.
- They are promoting the construction of multiple omics and informatics as bio-digitalization technology to develop a new system “Agroecological engineering system” to evaluate the interactions of crops, microbes, and soils in agricultural field. This project contributes to the center’s mission of health, food, and environmental solutions.
- When the technological developments progress well, it will greatly contribute to the center’s development.

(4) What are resources to be developed and research/ technological development to be undertaken in addition to those currently planned in the initial 4th Mid- to Long-Term Plan?

- At this time, smooth progression of the initial plan is the top priority.
- The research group organized by Dr. Maria Harrison leads AMF symbiosis research. They have generated many symbiotic mutants of *Brachypodium distachyon*. It is desirable for this Team to collaborate with her group to contribute to the research field.
- It is necessary to isolate the AMF strains which can be cultured *in vitro*, easy to analyze at the molecular level, and highly effective for crop inoculation. Moreover, it is desirable that the Team should supply the community with symbiotic microbes isolated and screened by the microdroplet technology that the Team will develop.
- Since the research projects utilize various comprehensive omics analyses integrated by informatics, reinforcement of infrastructure of informatics is vital for this Team.
- The development of AMF and uncultured rhizosphere microbes must be prioritized at the perspectives of food, health, and the environment. To accomplish this goal, it is necessary to develop the single cell characterization technology without culturing, a single cell's genome analysis as well as single-cell imaging analysis.
- The research and development focusing on resources unique to Japan like medicinal plants that the Team proposed, is anticipated from a practical aspect.

2. SWOT analysis

(1) Are the results of the presented SWOT analysis valid?

- They are generally adequate.
- “Members with various research backgrounds” is not entirely a strength. Depending on the method of management, disjointedness can become a weakness as “diversification of the research project” is listed under “weaknesses”. This concern is expected to be overcome by the effective team management.
- Some of the SWOT analysis results might be inadequately as research and development projects. “Decrease in students entering doctoral programs” is an analysis of societal factors and does not reflect the research Team's current state. In addition, the development of novel resources should be included in the SWOT analysis since this will contribute significantly to the development of the BRC.

(2) Are the countermeasures for the results of the SWOT analysis appropriate?

- It is generally appropriate.
- One positive external factor, a “shift in scientific trends toward symbiotic biology,” indicates an opportunity but also the difficulty of entry into fields where competition is increasing. Therefore, it is desirable that the PI deals effectively with the project management based on the opinions by the review committee.
- “Diversification of the research project,” cited as a weakness within the organization, is a major source of concern. However, this seems unavoidable for a team in its first year. As plans progress, it will become necessary to clarify how they will converge into the specific research project along with the BRC's missions.
- There may be some difficult aspects to intellectual property (IP)-related collaboration. If the Team has a researcher from private company, however, it may make R&D more closely in tune with society's needs.

3. International collaboration

(1) Is the international collaboration being actively addressed, and is the Team functioning as a hub of international scientific technology?

- The state of international collaboration is good enough as its initial stages.
- Active efforts, such as a visit to the international AMF resource center, are evident.
- The Team is taking part in an international symposium on plant-microbe symbiosis. Similar types of participation are expected going forward.
- Worldwide collaboration with symbiosis researchers who study on *Brachypodium distachyon* should be started in the near future.
- This is a stage where the Team should focus on getting the project on track. Its function as a hub for international scientific technology is a topic for future discussion.

4. PI assessment

(1) Is the PI fulfilling the role in line with the BRC mission?

- The PI is playing a role in accordance with the BRC's mission.
- The PI is developing novel technology to develop AMF resources, as well as establishing a model system for plant-microbe symbiosis study. Such efforts are viewed as fulfilling their role well.

- The Team is already advancing the *in vitro* propagation of AMF. In the future, it can be anticipated the development, storage, provision, and characterization of novel resources.
- (2) Do the PI's achievements in research and development (R&D) satisfy international standards in light of the following three aspects? (i) Results output and impact, (ii) Contribution to specific missions of each laboratory regarding research support and collaborative exchange programs within RIKEN, (iii) Pioneering new fields of research, acquisition, and commercialization of intellectual property rights, social education for science, the fusion of different fields, and social contribution
- Considering this is the beginning phase, results according to the three international standards are satisfactory.
 - Regarding (i):
 - Adoption as the project's representative of a primary national research project "Cross-ministerial Strategic Innovation Promotion Program (SIP)" supported by the Japanese Cabinet Office is commendable.
 - A co-authored review of plant-microbe symbiosis has been published in *Nature Plants*, with high international impact.
 - Regarding (ii):
 - The PI is participating in RIKEN's internal cross-sectional program (iSYM). Further increase of research results is expected in the future.
 - It can be judged to reach international standards.
 - Regarding (iii):
 - The PI is actively addressing integration in different research fields, such as plant science, agricultural science, microbiology and informatics.
 - The PI established a foundation for conducting strategic researches, e.g., field omics analysis and the screening of uncultured microbes using a microdroplet technology. The PI is now progressing with the acquisition of an external budget to form the foundation for implementation of their plan.
 - The PI is planning applications of IP for contributing to the novel use of breath capture technology that the PI developed. This is being adopted by the RIKEN grant for patent strengthening.
 - Additionally, the PI's role is being fulfilled by contributing to the outreach activities, e.g., Tsukuba City Future Creation Conference.

(3) Is the PI appropriately tackling the management and operation of the Team? In addition, does the PI make efforts for training and development of young talent?

- The PI is working appropriately on team management and operation. He is also making efforts to develop young talents.
- Despite of a broad range of research projects the Team planed, the PI is utilizing the latest information systems to create a smooth communication within the lab and have consistently conducted excellent management and operations.
- The PI is also in receipt of large external funds, such as the SIP (FY2018-FY2023).
- Although the Team is still in its inaugural year, the Team members including young researchers and research assistants seem to be working well. Young members should be watched intently whether they produce his/her own results relevant to the research Team.
- In addition to the laboratory comprising mainly young members, the PI is also making efforts to train a visiting researcher from private company and a visiting student from university.

End