Biodiversity of Rice Paddies

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In ecosystems of rice paddy, moderate disturbance by human activity have maintained the secondary nature and nurtured diverse living organisms. Pursuit of economy and efficiency at the time of high economic growth, however, had caused the rapid increase of dry rice paddies and thus rapid decrease in diversity and abundance of living organisms. Starting with rice-fish being listed in the red data book of Ministry of the Environment as an endangered species, once common species such as amphibians including Japanese brown frog, fishes including *Acheilognathus typus* and *Lefua echigonia*, insects including fireflies and whirligig beetle, plants algae including *Ricciocarpos natans* and *Chara braunii* are now facing extinction. They are species that found near the human environment (satoyama and satoumi) and that have lived in a flood plane, where they are regularly disturbed. Destruction of ecosystem caused by promotion of productivity and efficiency of agriculture has lead to this crisis. The main concept in discussion on the future agriculture is a sustainable relationship between human activity (agriculture) and rich biodiversity.

Biodiversity of Rice Paddies Nurtured by Farm-scape

The sustainable system of rice paddies nurturing biodiversity in Japan has been maintained not only by the function of rice paddies themselves. The farm-scape contains ridges of rice paddies, farm road, water channels, ponds, wetlands, and homestead forests, and they are compactly cohered in a small area. There are about 200 species of dragonflies living in Japan, and this number is comparable to that of the entire Europe. In addition, there are 21 species that belong to genus *Sumpetrum*, and the species such as *S. kunckeli* and *S. eroticum eroticum* requires not only rice paddies but also forests and ponds for reproduction (i.e. diverse farm-scape)

Sustainable Fertilizer Components of Rice Paddies

It has been considered that a fertilizer has to be applied by human. In soil examination, only chemical and physical properties are normally discussed and only chemistry is emphasized in plant nutrition. In other words, nutrition science, including that for human, almost lacks biological view. Effect of biodiversity on soil has hardly been considered.

As a fact, however, there are farmers that yield 600 kg/10a from rice paddies without fertilizer. Water is taken from groundwater, containing little nutrients. However, more than 600 loaches per 1000 m^2 clime up to a paddy field in a breeding season. The nutrients such as phosphate, calcium, iron, and potassium contained in loaches are in fact ten times higher for the same weight than eels, which are considered to be nutrient rich, bearing the idea that ““dojou” (eels in

Japanese) is “dojou” (also soil in Japanese) of rice paddies.” Such a material cycle of ecosystem is required for development of a sustainable agriculture.

The whole is greater than the sum of its parts

In the last 200 years, holism has been considered to be too idealistic and regarded as armchair theory. The mainstream was that a life form was considered as a complex machinery mechanism and its pars can be analyzed to reveal how they are made and function. Molecular biology and genetics are the products of this trend.

Yet some innovative biologists at the end of 20th century and after have started to notice an organic approach, a new ecological concept that we human beings are also a part of the biosphere and resonate with the life network covering the earth. This is the idea that “the whole is greater than the sum of its parts.” If considering a life form by dividing it into individual parts, the characteristics that make it alive would be lost. When plants or animals are exposed to a harmful substance, they would evolve to become resistant against it. Evolutionary change is a result of flexible response to changes in environments and other factors that the species has experienced.

Citizen-Participatory Biological Survey of Rice Paddy

The citizen-participatory biological survey has been developing in such a trend. It has been 20 years passed since the surveys have started all around Japan in 1992. The purposes are to feel the connection with life of rice paddy, to consider sustainable development, spiritual richness, tradition, and culture, and to promote a sustainable society.

It is not a discussion of “human or nature” or “economy or environment, but a discussion of how to build a sustainable agricultural system centering on revival of local community and safety with small energy investment and consideration to economy. We cannot discuss local ecosystem without consideration with human activities. It is now required to develop an integrated concept toward “a sustainable agricultural, cultural, and economic sphere” in harmony with nature. Frogs, spiders, and dragonflies are not only beneficial species that feed on insect pest but also the organisms that make us feel familiarity and reassurance with rice paddy. When farmers and consumers together understand organisms in rice paddies, they would see what is “farmer’s consideration with environment” and “food safety” and importance of community revival. These experiences have led to such an activity as “proclamation for rice paddy in harmony with living organisms”. It is claimed that an indicator for biodiversity in rice paddy require a system that comprehensively evaluate various indicators including biodiversity, environment, and culture.

Restoration of the rice paddies damaged by the tsunami of the Great East Japan Earthquake

It is an urgent issue to restore the rice paddies damaged by the tsunami of the Great East Japan

Earthquake. For desalination with small energy investment, it is highly effective to use resilience of ecosystem.

Winter-flooded rice farming is considered to be a sustainable agriculture that has the history of over 4000 years, with its origin in the world's largest terraced rice paddies in Yunnan province, China. In Japan, there is a record in the "Senkamachi" in Mikkabi, Shizuoka in the Muromachi era. Yosa-Buson's poet "Geese returning home, the moon reflected on every rice paddy, that is misted over at night" and the words "rice paddy winter water" in the "Aizu nosho" by Yojiemon Sase indicate the evidence of winter-flooded rice paddy in the Edo Era.

In Europe, meanwhile, winter-flooding has been introduced as a measure against salt damage in such delta areas as Ebro Delta in Spain, Camargue Delta in France, and Po Delta in Spain since 1990s. The winter-flooded rice farming has continued as an effective measure for coexistence of local agriculture and biodiversity.

We have successfully desalinated and restored the rice paddies by "winter-flooding" that best use resilience of ecosystem and water, without relying on chemicals, specific fungi, or a great amount of soil dressing. It is obvious that the capability of continuing agriculture whether or not a field was damaged by the tsunami is the evidence of a sustainable agriculture. Thus, high biodiversity in agricultural community would grow a sustainable agriculture.

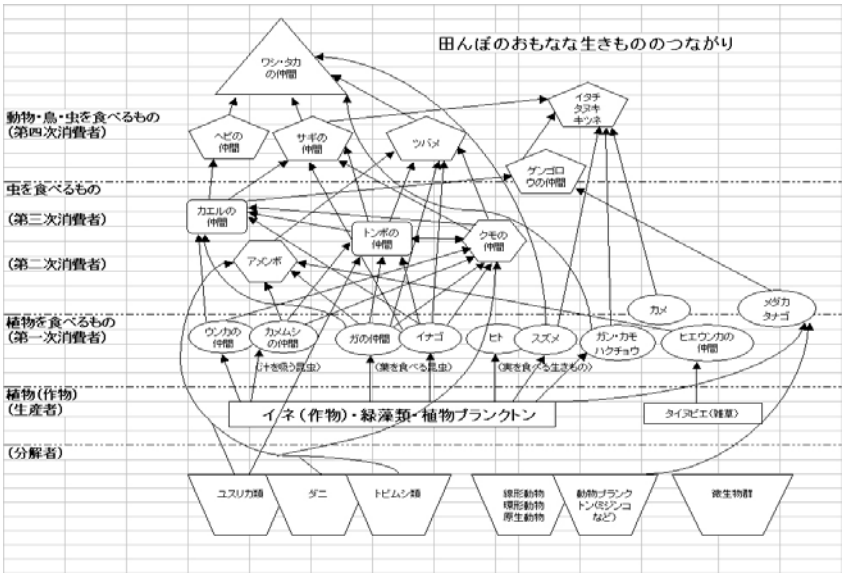

Fig. 1. Links between organisms in rice paddy. ("Biological Survey of Rice Paddy" NPO Rice Paddies Network Japan