

Panel Discussion: Present and Future on Biology of *Porphyra*

Panel discussion was carried out to epitomize the 8th Natural History Symposium, which is entitled “Present and Future on Biology of *Porphyra*” at Natural History Museum and Institute, Chiba, Japan on November 30, 1996. This panel discussion was organized by Masahiro Notoya and Masahiko Miyata.

Notoya, M. (Tokyo University of Fisheries, Chairman)

Fortunately, we have a large number of participants. I would like to thank you for taking part in this symposium as the representative of the organizing committee. I think that participants have opinions about the lectures in this symposium. Now we would like to open the discussions.

Today we started this symposium from taxonomical section, but in the discussions we would like to reverse in order of the lectures and would like to start with the actual situation of Nori (*Porphyra*) cultivation. I would like to ask the speakers to talk about the point of the lecture.

Kakino, J. (Chiba Prefectural Fisheries Experiment Station, Futtsu Branch)

It is said that there is a demand for ten billion of sheets of Nori in Japan and recently it is slight oversupply. As a result, the low quality products of Nori does not sell. We should produce the high quality products of Nori. In the regions produced only low quality products and conducted uneconomical cultivation, for example, a small quantity, the processes of Nori production should be rationalized by joint production, for example. In case of Chiba Prefecture, recently we perhaps regard too much important to produce high quality Nori, so there are some problems, for example, the mistake of select the strain. Now we should review the problems of Nori cultivation.

Notoya, M. (Chairman)

I would like to ask the influence of water pollution in culture field on diseases of Nori.

Tsuchiya, H. (Chiba Prefectural Fisheries Experiment Station)

Even if we understand causes of diseases of Nori, it is difficult to solve problems of diseases. I think we are familiar with Akagusa-re-disease more than any other diseases. This disease happens in October to November every year at the same area in Chiba Prefecture. In Chiba Prefecture, in autumn we have the most rain in a year. If Akagusa-re-disease comes in contact with fresh water, it releases a great number of zoospores, therefore the disease spreads and do not end till late December in which the water temperature is lower. This pattern is repeated every year. *Porphyra* cultivation is a large business, therefore the experimental measures for diseases are not effective. It is more realistic for us to coexist with diseases.

Notoya, M. (Chairman)

Please talk about the idea of the Fisheries Agency to Nori cultivation.

Nakaoku, T. (High Technology Office, the Fisheries Agency)

At High Technology Office, the Fisheries Agency, we research and develop technology of Nori cultivation. First of all we provide research assistance in subsidy to fisheries research station in prefectures, for selection of useful strains, production of new strain by cell fusion, development of technology to distinguish strains of Nori by DNA polymorphism, development of technology to prevent diseases by monoclonal antibodies and PCR method, etc. We also conduct the Gene Bank Project to preserve and distribute diverse genetic resources. The project is the basis of improvement of strain. Now about 200 strains are cultured in Nori. We also preside the meeting for the study of cultivation technology of Nori with fisheries research stations in prefectures and exchange information each other. We would like to continue to assist to apply results of the basic study, which lectured in this symposium, to actual

cultivation.

We also think that the most important problem in *Porphyra* cultivation is a overproduction. And in the future domestic consumption is not expected to increase and price level is not expected to rise. We must improve the technology to produce the high quality and proper quantity products without spending too much cost taking account of the present consumption level and price level.

The Fisheries Agency has never taken notice of the possibility of cultivation on land, which Dr. Chen mentioned. Since there was a case the technology could change the production methodology in the past, we would like to look at the progress of such technology.

Notoya, M. (Chairman)

I ask the course of the study about gene bank.

Fujiyoshi, E. (Seikai National Fisheries Research Institute)

The survival rate of *Porphyra* in cryopreservation is still low. Furthermore we cannot introduce this technology into actual production because of the use of special apparatus, for example, program freezer. I have examined the cryopreservation in which the program freezer is not used, but the survival rate vary widely depend on materials or stage in life cycle. In the future I would like to examine the survival tests under various conditions and the methods of cryopreservation of spores or protoplasts. And I also would like to develop the simple method of cryopreservation of *Porphyra*, which everybody is able to use as materials when want to use.

Notoya, M. (Chairman)

Dr. Chen introduced the new method of Nori production using the cell suspension culture. Do you have any other new idea in Nori cultivation?

Chen, L. (National Research Council of Canada)

My talk is not today's technology but tomorrow's technology. Japan is the leader of *Porphyra* cultivation, therefore we have to

think about next step. We need to have a technology to solve problems of disease, environmental pollution, etc.

I talk about the cell suspension culture in my lecture. I thought when I started this study; *P. linearis* is unsuitable for cultivation because neutral spore is not released, therefore I have to find a substitute for neutral spore. I contrived the technology to seed Nori net using cultured cells. I think that part of the technology is able to be applied to the present cultivation to solve the problems of disease and environmental pollution in the early stage. The hole of the technology is not able to be applied. I propose the technology as tomorrow's one.

Notoya, M. (Chairman)

Cryopreservation and cell suspension culture are industrial production different from the present cultivation in sea.

Miura, A. (Aomori University)

At Keahole Point of Hawaii Island, Hawaiian Islands (U.S.A.), Toyama Bay and Kochi (Japan), the Nori cultivation using deep water is examined. Deep water is useful for cultivation in that it is eutrophic, clean and temperature is even.

Oohusa, T. (Yamamoto Nori Research Laboratory)

In cultivation on land, the problem is electric cost. If this problem is solved, it is possible to culture *Porphyra* on land. And more problem is the reuse of culture medium. This problem is solved by the improved filter. I think the *Porphyra* cultivation with deep water, at Keahole Point of Hawaii Island, Hawaiian Islands (U.S.A.), is useful in Japan, too. However, if we cultivate on land or with deep water, the system of *Porphyra* production must be changed to the new system to produce all year round. I think the present system must be changed to the more large-scale production system on one hundred persons level. The problem must be solved previous to the introduction of the new technology.

Miura, A.

Recently, it is said that there is the discus-

sion about cultivations of algae on the moon under the project of development of the cosmos. If we culture Nori in the closed system as land cultivation, this idea is very interesting.

Notoya, M. (Chairman)

Next, we would like to discuss strain and breeding.

Miura, A.

We got the breakthrough on the crossing between *P. yezoensis* and *P. tenera*. It has large quantities of amino acids, especially arabin and glutamic acid. It is said that researchers in Canada is examining the gene to control the production of specific amino acid. Do you know the result of this research?

Fujita, Y. (Nagasaki University)

I don't know about its research. I cannot explain the gene products special amino acid from metabolic pathway. I would like to know the information about such gene. I think that we should have a fight to seek the strain have large quantities of special amino acid. Did you confirm whether the breakthrough is such strain?

Shin, J.-A. (Tokai University)

We crossed between *P. yezoensis* and *P. tenera* because the strain 'AKATSUKI', we produced formally, the cross breeding between two strains of *P. yezoensis* have faults of which the cultivar become hard gradually with harvest and color is reddish because of the much phycobilin. From the result of cultivation of the breakthrough, the cultivar is blacker and softer than 'AKATSUKI' and have large quantities of arabin and glutamic acid in amino acids. However, when the breakthrough was cultured in sea, primary buds died after releasing large quantities of monospores. We have to breed the strain of which primary buds are not die.

Yamashita, T. (Fukuoka Prefecture)

We have cultured the breakthrough in sea for three years. As Dr. Shin said, primary buds of the breakthrough died almost all and secondary buds appeared before primary

buds died. We are examining cultivation of F_1 from secondary buds of the breakthrough.

Shin, J.-A.

We cultivated the F_1 from secondary buds, but the primary buds of F_1 also died. I don't know why died. I think that the method producing amphidiploid is useful to solve this problem.

Notoya, M. (Chairman)

As concerns these problems, I think we must study the heredity in detail.

Next, as concerns the distinction of strains by DNA, generally layman think all information, for example, phylogeny, species, etc., is involved in DNA. But actually, only part of DNA is examined.

Mizukami, Y. (National Fisheries University)

I lectured the method compare the variation part of DNA. There is a method compare the distinction of the whole sequence of DNA, too. I cannot decide which method is better, but I think we also have to use the latter method in the future.

I introduced the RAPD method and RFLP method by which everybody examine DNA, even if not have expensive apparatus.

Notoya, M. (Chairman)

There are different results on the study of systematics based on DNA with the using method, often. More recently, it is said that *P. yezoensis* and *P. tenera* are same species based on DNA. Why do such different results show?

Mizukami, Y.

It is very important problem. I think we propose the concept of species (or strain) based on DNA sequence and DNA patterns. As concerns systematics, there is the method distinguish by dendrogram based on DNA sequences. However, this method have a fault of which the result is different with the using mathematical analysis. I introduced some genetic markers to distinguish my using strains. Therefore, I think we should propose the concept of strain is constructed based on the difference of my using genetic markers, as a example.

Notoya, M. (Chairman)

I ask the meanings of term 'strain, breed, form' which use both in actual cultivation and taxonomy.

Yoshida, T. (Hokkaido University)

There are many forma and breeds in land cultivated plants. There is International Code of Nomenclature of Cultivated Plants with International Code of Botanical Nomenclature in land cultivated plants. If the parents of the strain are evident and the strain is distinguished to the parents evidently, this strain must be named anyway, and this name is not written in Latin. I think natural form and cultivated breed should be distinguished. As concerns taxonomy, recently molecular taxonomical knowledges have been increasing. In the early stage of study of molecular taxonomy, researchers compared the traditional taxonomical system and phylogenetic tree based on molecular analysis. Subsequently, they emphasized that molecular taxonomy is right and traditional taxonomy is not. More recently, it is main that researchers compare the two and reexamine the taxonomical characteristics. I think this is right treatment.

As concerns taxonomy of *Porphyra* in Japan, anyone does not study except a few specialists because of its difficulty. But, I think somebody can get some results if study hard. From my experiences, simple species in morphology as *Porphyra* should be examined in fresh materials. And we must leave materials as specimens when study some materials. The specimens must be deposited in public herbariums. If we don't conduct them, our study does not develop in the future.

Kawashima, Y. (Japan NUS. Co., Ltd.)

As concerns cultivated breeds, there is the registration system of breed established by the Ministry of Agriculture, Forestry and Fisheries. We can register only posterity of *P. yezoensis* or *P. tenera* in seaweeds. The breeds must have characteristics different from its parent. If we register a breed, we must describe the characteristics of the breed in detail according to the research report of classification of the characteristics of breeds (Japan Fisheries Resource Conservation Asso-

ciation, 1980). It is said that internationally the species is able to be registered is tendency to be spreaded to all plants. There are 467 registered species in Japan, but only two species in seaweeds.

We tried to breed the high temperature resistant breed by cell fusion. However, we did not have a clear aim to breed. This work is not only part of biology, but part of economy. I think we can use the technology in today's lectures if we decide the aim to breed.

Notoya, M. (Chairman)

Recently, the species diversity and the species preservation is much talked. I ask the present situation of them, especially about natural species.

Yoshida, T.

The Fisheries Agency designated *P. tenera* the threatend species in 1994. I have asked many reseachers the presence of *P. tenera* for a few years. I have a sence of impending crisis on the presence of *P. tenera*. I think that cultivated breeds have been very different from natural species since the field seedling was finished. At the present time, *P. tenera* inhabits in limited place and *P. angusta* and *P. kuniedae* are almost not found, too. It is impossible to confirm the extinction of marine organisms. Therefore, we must examine the presence of these species and have more information on it. In *Porphyra*, I think the inland sea species decreases relative to the open sea species. I hope that you examine the presence of *Porphyra* in the future.

Miyata, M. (Natural History Museum and Institute, Chiba)

Recently, the preservation of the diversity of species, gene and ecosystem is much talked. However, the concept of species, the basis of them, is unclear. From the data of UNESCO, the number of species described till now is about 14% of all species on the earth. We must clarify whether the species described till now is present now. We reported the presence of *P. tenera* at Futtsu Ponit and Professor Yoshizaki (Toho University) found *P. tenuipedalis* living at Chiba Port, respectively in Tokyo Bay. To clarify what species present is basis of taxonomy. This basic work

must be conducted.

Under these circumstances, we propose 'Nori 2000 project'. We wish to gather specimens of *Porphyra* species from today, November 30, 1996 to November 30, 2000, and deposit specimens to Algological Herbarium, Natural History Museum and Institute, Chiba (CBM-BA).

According to the list of Japanese seaweeds (Yoshida *et al.* 1995), 28 species of *Porphyra* are described. The type specimens of these species, especially on type locality in Japan and its vicinity, must be opened to the scientific activities under International Code of Nomenclature of Cultivated Plants with International Code of Botanical Nomenclature.

By the way, over time, the greatest value of the variety of life may be found in the opportunities it provides humanity for adapting to local and global change. The unknown potential of genes, species and ecosystems represent a never-ending biological frontier of inestimable but certainly high value. Genetic diversity will enable breeders to tailor crops to new climatic conditions.

A diverse array of genes, species and ecosystems is a resource that can be tapped as human needs and demands change.

Biodiversity conservation entails a shift from a defensive posture—protecting nature from the impact so development—to an offensive effort seeking to meet peoples' needs from biological resources while ensuring the long-term sustainability of Earth's biotic wealth. It thus involves not only the protection of wild species but also the safeguarding of the genetic diversity of cultivated species and their wild relatives. This goal speaks to modified and intensively managed ecosystems as well as natural ones, and it is pursued in the human interest and for human benefit. As a result, biodiversity conservation seeks to maintain the human life support system provided by nature, and the living resources essential for development.

Notoya, M. (Chairman)

Do you have any questions and opinions?

Chihara, M. (The Japanese Red Cross College of Nursing)

In this symposium, there were many suggestions how we study seaweeds include *Porphyra* in Chiba Prefecture. I hope that researchers try to study on the molecular taxonomy of not only the cultivated breeds but the natural species. I think *Porphyra* is studied from various aspects more than any other taxon. Furthermore I think that if researchers study *Porphyra* with various methods of molecular taxonomy, the study of *Porphyra* should progress.

Aruga, Y. (Tokyo University of Fisheries)

I would like to talk about cryopreservation. Conchocelis is used for various aims, for example, cultivation. However, if we preserve *Porphyra* species, we have to preserve n phase (=foliose thallus), namely pure line. We must consider how to use the cryopreserved foliose thallus, too. There was the report that the conchocelis developed from cultured cells in the lecture of Dr. Chen. Cultured cells is n phase and from which conchocelis (2n phase) develops. We must examine this strange phenomenon.

Miura, A.

The cultured breed is not different from the taxonomical form. There are five criteria about cultured breed, which are decided by law. One of the criteria is whether the breed has the distinctness in significant characteristics. This criterion is the most important.

Notoya, M. (Chairman)

I lectured the life histories of *Porphyra*. *Porphyra* has various life histories. I have studied the life histories only in culture, but we have to study ones in nature. I ask the perspective on them.

Yasui, H. (Hokkaido University)

There are 30 species in Bangiaceae in Japan and ca. 20 species in Hokkaido. In Hokkaido, *Porphyra* is not cultivated, so all species in nature. *Porphyra* appears in autumn and have a unique substratum and reproductive mode to individual species. We lectured the ecology of species in the south Hokkaido. We have to study the details

about it and study the ecology in other parts of Hokkaido.

As concerns the preservation of biological diversity, there are some methods of the preservation, such as gene bank, cryopreservation, etc. However, originally *Porphyra* inhabits in nature, therefore it is ideal that *Porphyra* is preserved in nature. In the

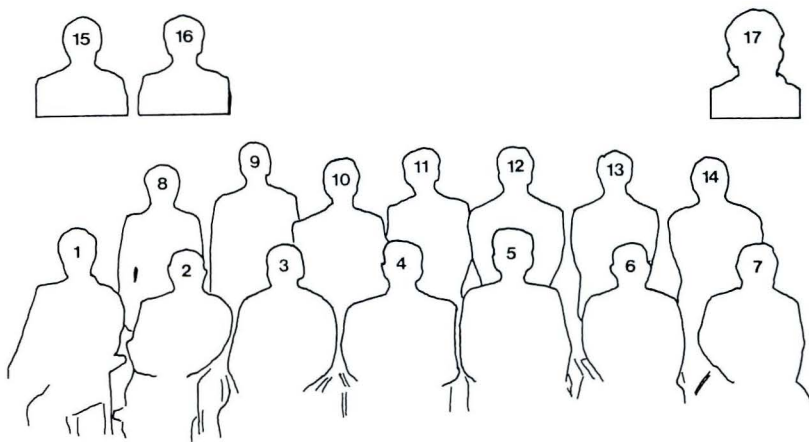
future, we must increase basic information in nature on *Porphyra*.

Notoya, M. (Chairman)

Thank you for your attention for a long time to this panel discussion, Present and Future on Biology of *Porphyra*.



Fig. 1. A scene of panel discussion on the Symposium at auditorium, Natural History Museum and Institute, Chiba, on November 30, 1996.



Photograph of the Participants

The 8th Natural History Symposium, "Present and Future on Biology of *Porphyra*"
(Chiba, Japan on November 30, 1996)

The front row: 1 — Y. Fujita (Nagasaki Univ.), 2 — L. C.-M. Chen (National Research Council of Canada), 3 — M. Numata (Chair, President of Natural History Museum and Institute, Chiba), 4 — M. Notoya (Program Committee Chair, Tokyo Univ. of Fisheries), 5 — T. Yoshida (Hokkaido Univ.), 6 — A. Miura (Aomori Univ.), 7 — Y. Mizukami (National Fisheries Univ.)

The back row: 8 — M. Hara (Hokkaido Univ.), 9 — U. S. Rao (Nagasaki Univ.), 10 — J.-A. Shin (Tokai Univ.), 11 — H. Tsuchiya (Chiba Prefectural Fisheries Experiment Station), 12 — H. Yasui (Hokkaido Univ.), 13 — N. Kikuchi (Natural History Museum and Institute, Chiba), 14 — M. Miyata (Secretary General, Natural History Museum and Institute, Chiba), 15 — J. Kakino (Chiba Prefectural Fisheries Experiment Station, Futtsu), 16 — T. Tanaka (Chiba Prefectural Fisheries Experiment Station, Futtsu), 17 — E. Fujiyoshi (Seikai National Fisheries Research Institute)