

Review

Endangered vascular plants in Japan

—Present status and a proposal for conservation—

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Abstract: The history of the Red List of Japanese vascular plants is briefly reviewed for editing and research. Especially on the results of recent monitoring, the present status of information and conservation activities on the endangered plants in Japan is discussed and the dynamics of the Japanese flora are taken up, in relation to basic research on plant biodiversity on the Japanese Archipelago. The figures of endangered plants are not very variable during the past quarter of a century, but we can surmise that the conservation of threatened species in Japan has been promoted to some extent. Based on the results of such a study, proposals are made to contribute to the sustainable use of plant biodiversity on the Japanese Archipelago under a global conspectus.

Keywords: Japanese Society for Plant Systematics, Ministry of the Environment, NGOs, non-professional naturalists, Red List, sustainable use of biodiversity

Introduction

The Japanese Archipelago as a whole was covered by dense forests under favorable natural conditions as its complicated topography and warm and wet climate allowed. It is well known that the flora and fauna there are highly diversified. Even after heavy development during the 20th Century, most of the Archipelago was covered in green. The developed area is only a little more than 20% of the space of the whole the Archipelago, and it is easily observed from the air that deep and beautiful green covers the Archipelago. However, we had the impression that the organisms in Japan were more or less influenced by developed land use, especially during the 1980s, under a symbolic term, ‘Remodeling of the Archipelago’, originally meant to make better use of the Archipelago but actually bringing to the Archipelago terrible changes in ecology.

The first trial to review the dynamics of the flora of Japan was made during the International

Biological Program (IBP), when Professors Tatemi Shimizu and Nobuo Satomi listed the threatened species for the first Red List of Japanese vascular plants in 1976 and 77.¹⁾ This list was compiled mostly based only on the information at hand, and it was rather incomplete, although it suggested that the Japanese flora was heavily influenced by human activities during the 20th Century, irrespective of the country’s green appearance in general.

A national survey of the dynamics of the Japanese flora was first organized during 3 years beginning in the 1983 fiscal year, and the first comprehensive Red List was compiled in 1986 and published in 1989.²⁾ This survey was carried out by a special working group organized by the Japan Society of Plant Taxonomists (JSPT at that time, now reorganized as the Japanese Society for Plant Systematics, or JSPS) and supported by two leading environmental NGOs in Japan, the World Wildlife Fund, Japanese Committee (WWF-Japan, now World Wide Fund for Nature, Japan) and the Nature Conservation Society of Japan (NACS-J). Thereafter, the survey was succeeded by the Environment Agency and then by the Ministry of the Environment. The historical development of this survey of the dynamics of Japanese vascular plants is surveyed in Table 1.

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Table 1. History of survey of dynamics of Japanese vascular plants

List	Compiler(s)	Species listed	Year
IBP list	Satomi & Shimizu	576 species	1976, 77
NGO list	JSPT survey group under WWF-J & NACS-J	895 species under IUCN qualitative categories	1986
First governmental red-list	JSPT survey group under Environment Agency	1665 species under IUCN qualitative categories with modification	2000
First monitoring	JSPS survey group under Ministry of the Environment	1666 species under IUCN quantitative categories with modification	2007

Along with the compilation of the Red List of Japanese vascular plants, a variety of conservation activities have been undertaken. Many different important activities have taken place in the last quarter of century, including: 1) research and outreach of the present status of the Japanese flora, especially in relation to endangered plant species; 2) conservation activities executed by various stakeholders, including both governmental and non-governmental organizations; 3) promotion of botanical research on threatened species; and 4) trial of restoration of some critically endangered plant species.

In compiling the 1986 NGO Red List of vascular plants, it was suggested that a variety of influences on the flora were brought to bear on a number of threatened plant species. The most influential three among them were: 1) development of the land or destruction of the natural environment, including cutting down of forest trees, road construction, paving of river banks, land reclamation; 2) over-collection of wild plants, especially for the purpose of trade; and 3) the natural environment itself becoming worse, especially under the influence of human activities including global warming, air pollution, alien species, introduction of artificial chemical substance. It is necessary to control such destructive influences on nature in order to sustain biodiversity on the earth, and recently in Japan various actions by the government, local governments, non-governmental organizations, business and scientific societies, mass media have contributed to this control. Based on such a variety of conservation activities in recent years, we have observed a small amount of improvement in Japan's natural environment, but still the

present status of wildlife in Japan is, regrettably, fairly critical.

In this paper, we will survey: 1) the way in which the Red Lists of Japanese vascular plants have been compiled and monitored; 2) what is the present status of the Japanese flora with respect to sustainability of biodiversity; 3) how much we have succeeded and are succeeding in protecting the threatened plant species in Japan; and 4) how we can expect to establish the sustainable use of biodiversity in Japan in the coming days.

Compared with the risk of climate change or global warming, the risk faced by biodiversity is less understood by the general population. The recent success of the Intergovernmental Panel on Climate Change (IPCC) is much appreciated in elucidating the actual extent of global warming based on scientific research. Along the same lines, it is better to have much more understanding of the risk of biodiversity by decision makers, business people, school teachers, and for this sake more sufficient data should be offered by biodiversity researchers. Whole the biodiversity database is now under networking, for instance, by the activities of Global Biodiversity Information Facility (GBIF), but accumulation of comprehensive database may take sometime to have correct estimation of dynamics of biodiversity. Various contributions are performed now under international collaboration, and the Group on Earth Observations Biodiversity Observation Network, or GEO BON, is working under CBD. To promote the information release from the specialists, however, it is urgently expected to have a model in showing the crisis faced to biodiversity.

As an example of model among such general biodiversity data, we are able to discuss more

Table 2. Members of Specialist and Working Groups to survey the vascular plants

A: Members of Specialist Group	Shinji Fujii, Mitsuru Hotta, Motomi Ito, Kunio Iwatsuki (chair), Yasuro Kadono, Teruo Katsuyama, Hiroyoshi Ohashi, Hideaki Ohba, Tetsukazu Yahara, Masashi Yokota
B: Members of Working Group	Shinji Fujii, Yasuro Kadono, Tatsumi Kato, Teruo Katsuyama, Nobumitsu Kawakubo, Makoto Ogawa, Shunsuke Serizawa, Hideki Takahashi, Masayuki Takamiya, Tetsukazu Yahara (chair), Masashi Yokota, Koji Yonekura

scientifically on a numerical basis the list exemplified by the threatened species. The Red List is edited to show the present risk faced to biodiversity on a numerical basis. At first, the Red List was edited based on qualitative evaluation of the species concerned, as the basic data were insufficient to evaluate them quantitatively. Expecting to have a more scientific basis, the method succeeding quantitative evaluation was established and much more fundamental data are now prepared for the Red List, especially by active surveys in the International Union of Conservation of Nature and Natural Resources (IUCN). The IUCN Red List categories and criteria were revised in 2001³⁾ and this revised document is available on the web: <http://www.iucnredlist.org/info/categories>.

Biodiversity should be understood precisely and in more detail by the general public, and for this reason we should offer much more scientific information on biodiversity, especially through Red List scientific data as a model. For a sustainable earth for coming generations, it is necessary to seek sustainable use of biodiversity, or to maintain the safe life of the spherophylon forever, which was discussed carefully by myself in 2006.⁴⁾ For this sake, we should expect to have more scientific Red Lists for all the earth's organisms. Environmental issues should generally be worked on by everyone on the earth, and we should all consider globally and act locally for this purpose. This paper will discuss the present status of Red List plants in Japan as one of the basic sources of data for sustainability of our only earth.

Materials and methods

Collection of information. The dynamics of the Japanese flora have continuously been observed locally by non-professional naturalists as a hobby based on scientific curiosity as well as a love and worship of wild plants in nature. In monitoring the 2000 Red List of vascular plants in Japan,⁵⁾ the information available is collected as far as is

possible by a working group in the Japanese Society for Plant Systematics under the support of the Ministry of the Environment. The members of this working group are listed in Table 2. Based on the research of this working group, the Ministry of the Environment organized a specialist group to finalize the list. The members of the specialist group on vascular plants are listed in Table 2.

The first monitoring of the governmental Red List that was performed led to the compilation of the 2007 governmental Red List.⁶⁾ All the species on this list were examined and additional species to be observed were listed by members of the working group. A form of data access was designed and circulated to the contributors who were selected in every prefecture. Local contributors collected information in their area either by themselves or with the collaboration of additional non-professional naturalists in their area. Based on the great number of checklists returned from the local contributors, the qualification of category of each threatened species on the 2000 List were carefully reviewed, and evaluation was given to all species examined.

The data access form was sent to all prefectures throughout Japan. Contributors or data-examiners were selected, including a head researcher in each prefecture. The data were carefully enumerated in each prefecture concerned and collected by the working group. For some particular areas, like smaller islands, the members of the working group themselves and/or their collaborators made actual field observations. In case where there was some doubt about the data, communication was carefully exchanged between the local contributors and working group members. After brushing up the collected data, they were placed in the database of the revised Red List.

Evaluation. The data collected were surveyed under the index and each threatened species was placed under the category qualified. The category of each endangered species in 1997 Red

Table 3. Figure on each rank of threatened species in the recent two red-lists

Lists \ Ranks	Ranks								total
	EX	EW	CR	EN	VU	subtotal TH	NT	DD	
2000 list	20	5	564	480	621	1665	145	52	1887
2007 list	33	8	523	491	676	1690	255	32	2018

List and the 2000 Red Data Book of Japanese vascular plants are based principally on criterion E of IUCN (1994)⁷⁾ (Yahara *et al.* 1998).⁸⁾ In addition to criterion E, the criterion ACD is applied as noted in the above literature, but this criterion is not strictly equivalent to criteria A, C and D of IUCN (1994)⁷⁾ and is a surrogate of criterion E.

The 2007 Red List of Japanese vascular plants was compiled primarily based on the version 3.1 criteria of IUCN,³⁾ and will be discussed in details in Fujita *et al.* (in prep.).⁹⁾

Results

Results of monitoring of the 2000 List. The governmental issue of the Red List of Japanese vascular plants was published in 2000 in the first time, and the revised List is now available with the result of monitoring to be made available every five years, or actually seven years after issuing the former Red Data Book. A complete list of the revised editions of the Red List is available on the home page of the Ministry of the Environment, (http://www.biodic.go.jp/rdb/rdb_f3.html), and the number of species in each category is given in Table 3, in comparison with the respective figures on the 2000 List.

After the present monitoring, the total number of species on the revised Red List is not very different from that on the 2000 List. There are 211 new members that are newly added to the revised List. In addition, there are a fair number of species whose categories are more critical than before. It is explained for the reasons of these differences that more detailed observation was made for more species, and those formerly not on the list or doubtful for its qualification are now correctly referred to a particular category with more information.

There are 174 species that were on the 2000 List but have been deleted from the revised List. Some of them are species popular with the public. The modification of the category of these species is mostly as the result of (1) actions by the

Endangered Species Act promoted appropriately for these popular species, (2) activities of NGOs and/or NPOs who better conserved these popular species, (3) more careful observation by the general public, on the basis of the dynamics of these species which are known in more detail. The difference found in the lists between pre- and post-monitoring is summarized in the figures on Table 3.

Some noteworthy examples whose categories are modified in the new List are summarized on Table 4. Among the species listed in Table 4, additional notes may be added to the following species.

1) There are species whose category is suspected to be lowered by conservation activities in recent years. Some volunteer NGO and/or NPO groups worked on the conservation of particular species, and natural populations of these target species recovered in the wild to some extent. The category of *Primula sieboldii*, *Nymphoides peltata*, *Triglochin asiaticum*, *Habenaria radiata* was VU, and conservation activities on these species were fruitful enough to bring their individuals much more into the natural habitats of the species concerned. They are placed under NT in the new List, still expecting to be watched carefully.

2) There are species that are on the List by more careful research of their dynamics. Among them, 3 'extinct' species were rediscovered in the wild. Two of them, *Polygala longifolia* and *Lycoris sanguinea* var. *koreana*, are placed in CR, but *Eutrema tenuis* var. *okinoshimensis* has been observed in its sole locality by more than 250 individuals and is placed under VU.

3) There are species that are excluded from the new List. Many of them were symbols of threatened species and were the targets of conservation. *Adonis ramosa* and *Viola orientalis* were VU on the 2000 List, but are deleted in the new List. In the case of *Gastrodia pubilabiata*, it was EN in the 2000 List but recovered in the field quite well and is deleted from the new List.

Table 4. Some examples of species whose ranks are modified in 2007 list

	Number of species	Examples
Newly added	217	
Placed in higher ranks		
CR to EX	11	<i>Dryopteris shibipedis</i> , <i>Thelypteris erubescens</i> , <i>Ranunculus gmelinii</i> , <i>Rubus hatusimae</i> , <i>Aletris makiyatoroi</i> , <i>Carex disperma</i> , <i>Evrardianthe poilanei</i>
EN to CR	65	<i>Polystichum lachenense</i> , <i>Hypodematum fordii</i> , <i>Salix nummularia</i> , <i>Silene uralensis</i> , <i>Aconitum kitadakense</i> , <i>Ranunculus kitadakeanus</i> , <i>Asarum satsumense</i> , <i>Ribes horridum</i> , <i>Euphorbia octoradiata</i> , <i>Viola okinawensis</i> , <i>Myrsine okabeana</i> , <i>Tricyrtis perfoliata</i> , <i>Cymbidium ensifolium</i>
VU to CR	47	<i>Lycopodium somae</i> , <i>Illigera luzonensis</i> , <i>Vaccinium sieboldii</i> , <i>Titanotrichum oldhamii</i> , <i>Anticlea sibirica</i> , <i>Nypa fruticans</i>
VU to EN	72	<i>Adiantum edgeworthii</i> , <i>Picea koyamae</i> , <i>Sedum sikokianum</i> , <i>Sophora tomentosa</i> , <i>Melastoma pentapetatum</i> , <i>Tricyrtis macrantopsis</i> , <i>Platanthera amabilis</i>
Placed in lower ranks		
CR to EN	148	<i>Acrostichum aureum</i> , <i>Morus boninensis</i> , <i>Oxytropis megalantha</i> , <i>Crepidiastrum linguifolium</i> , <i>Calanthe hattorii</i>
EN to VU	175	<i>Asplenium antiquum</i> , <i>Picea maximowizii</i> , <i>Drosera indica</i> , <i>Arabis tanakana</i> , <i>Menziesia purpurea</i> , <i>Galium tokyoense</i> , <i>Triosteum sinuatum</i> , <i>Sciaphila nana</i> , <i>Lilium speciosum</i> , <i>Cypripedium macranthum</i> var. <i>speciosum</i>
VU to NT	103	<i>Psilotum nudum</i> , <i>Isoetes japonica</i> , <i>Asplenium nidus</i> , <i>Salvinia natans</i> , <i>Betula davurica</i> , <i>Magnolia stellata</i> , <i>Clematis patens</i> , <i>Shibaterantes pinnatifida</i> , <i>Ranzania japonica</i> , <i>Paeonia japonica</i> , <i>Drosera peltata</i> var. <i>nipponica</i> , <i>Corylopsis spicata</i> , <i>Pentorum chinense</i> , <i>Primula sieboldii</i> , <i>Swertia pseudochinensis</i> , <i>Nymphoides indica</i> , <i>N. peltata</i> , <i>Lagotis glauca</i> , <i>Utricularia vulgaris</i> var. <i>japonica</i> , <i>Eupatorium japonicum</i> , <i>Fritillaria amabilis</i> , <i>Iris laevigata</i> , <i>Bulbophyllum japonicum</i> , <i>Calanthe discolor</i> , <i>Pecteilis radiata</i>
Deleted from the list	176	<i>Adonis ramosa</i> , <i>Viola orientalis</i> , <i>Zostera nana</i> , <i>Aspidiastrum elatior</i> , <i>Pandanus boninensis</i> , <i>Alpinia bilamellata</i>

From Red List to conservation activities. Based on the compilation of the Red List, there are a variety of actions made by governmental and non-governmental organizations, groups and individuals.

Publicity of information. It is a basic principle to know the facts in the first place, and the information available should be possessed by all people concerned. In the case of environmental issues, it is inevitable that contributions by every citizen result in the best conservation. And the fact performed on our environment at present should be learned and understood by all people on the earth. The publicity of information on the Red List is one of the most important actions

of both scientists and the government. Research on this will be promoted by the scientists under appropriate aids of the government and analyses should be disseminated both by the scientists themselves and/or through government to all citizens.

The application of the quantitative extinction analysis employed in the 1997 Red List and 2000 Red Data Book of Japanese vascular plants was successfully applied when conservation plan in the Kaisho forest was developed during 2005 World EXPO organization. Scientific contribution by Matsuda *et al.* (2003)¹⁰⁾ explained the facts comprehensively to bring conservation of the area more ideally.

The Japan Association of Botanical Gardens is now in a position to release information on endangered plants to the general public. It is easy for botanical gardens to display the endangered plants which are grown there. Basic research on threatened plants is one of the main targets to be promoted in the botanical gardens, and this is actually performed in many such gardens in Japan. Recently, the Association has a joint programme among several botanical gardens to have a special exhibition of endangered plants, and this particular topic is actually interesting to many visitors.

It is one of the principal duties for the government to disseminate the facts available about our environment to all people concerned, and with respect to this issue we expect to have contributions from the mass media. Modern people get the necessary information mostly through television, the internet and newspapers, and the collective media's contributions to releasing the information on our environment is highly appreciated. Actually, in Japan, information on the Red List has been introduced by various mass media, in addition to formal releases by the government and papers by scientists. And, during a past quarter century, the general population's knowledge of the Red List has to some extent been promoted by publicity of such information, and this understanding has been reflected in the recovery of some popular species.

***Ex situ* conservation.** All native species should be conserved in the habitats in which they have evolved. However, human activities often exert great influence on ecosystems at a particular site and drive the native species there out of their own habitat. And, in some cases, it is hardly possible to conserve particular species in their native habitat. Usually, development has already been taken place to some extent, and conservation efforts are too late when the extent of habitat destruction is noticed. And, there are a variety of species which are hardly able to sustain themselves in their own habitats, at least for the time being.

There are trials to bring such species to proper facilities, such as botanical gardens, and cultivate them artificially there. It is not quite natural but this is recognized as an emergency evacuation from the danger of extinction. The species protected in particular facilities will be sent back to their natural sites when they are expected to be able to survive there after recovery of the environment. Or, at least

the genetic resources of particular species may be maintained artificially in the facilities concerned. It is rather sad to note here that preservation of the seeds and/or DNA of endangered plants is not promoted in the central government of Japan, but both research and actual preservation should be urgently promoted.

Ex situ conservation of endangered plant species has been carried out in botanical gardens and similar facilities in Japan, and the Japan Association of Botanical Gardens (JABG) has a project to perform such trials with close collaboration of the botanical gardens concerned. The species grown in the botanical gardens are often displayed and such a trial also contributes to information release on the Red List of Japanese plants. Recently, JABG has collaborated with Botanical Gardens Conservation International (BGCI) and is succeeding in publicizing information on the endangered plant species.

Early in the 1980s, the University of Tokyo Botanical Gardens had a project to have *ex situ* conservation of Ogasawara (Bonin) endemic and endangered plant species to be grown in the botanical gardens, with particular species being sent back to their native habitats for recovery of natural populations there. The initial success of this trial was reported early in 1986¹¹⁾ and the reports following it were published in various venues, including a book in Japanese.¹²⁾ Now, after continuous experiments and observation over more than 20 years, the re-introduced plants have succeeded in reproducing by themselves in their natural sites, and their life cycles are completed there. We can say this is a successful project by which we may be more self-confident to expect the recovery of the environment, and this project on *Melastoma tetramerum* should be a symbol of this type of research and activity.

We are still faced with the crisis of endangered plants in Japan, and critically endangered species may be expected to be the subjects of much more conservation activity. In addition, the Ministry of the Environment is organizing a survey group to promote the *ex situ* conservation with the professionals from zoos, aquaria, botanical gardens and similar organizations.

Protection of habitat. *In situ* conservation should be successful in conserving habitats in their native condition. However, the increase in human population and diversification of life-style has

necessitated the consumption of much more natural resources, and the influence of human activity on nature is more serious now. No primitive nature is expected to be perfectly conserved, and we must realize the very real threat to biodiversity. Under such a difficult situation, we should concern ourselves with the conservation of nature, even for the sustainability of mankind itself.

In the case in Japan, we dealt with heavy development of the Archipelago, especially in the latter half of the 20th century, and as a result many plant species are threatened. In addition to development, we met with the ruin of Satoyama secondary forests in the backyard of village areas under a change of the local people's life-style. By abandonment of the artificial secondary forest zone, where a higher diversity of organisms is maintained for many years, many species are seriously threatened. Thus, the Japanese flora is faced with the dangerous threat by development of nature as well as abandonment of artificially maintained areas. It is necessary, therefore, to conserve more primitive nature from further development, and at the same time to protect the biodiversity in abandoned secondary forests.

Re-plantation. After success with *ex situ* conservation, re-plantation of cultivated wild plants is expected when the habitat has recovered. The case of *Melastoma tetramerum*^{11),12)} forms a symbolic success, and we can draw a model of the process of recovery by its example. This particularly endangered species was reproduced in botanical gardens, after careful observation of its habitat in natural sites, and a number of young plants were successfully grown. The juveniles in botanical gardens were brought to the native site and planted there with the aid of village people, including primary school pupils. Local people are interested by their own activity in the valuable treasure of their native habitat, and in parallel research has been promoted on this particular species in the native site as well as in botanical gardens. There were a variety of difficult problems to be overcome as noted in the referred papers, but after a careful and continuous trial, this species is now naturally growing in their native sites. It is necessary to keep its habitat forever, and the life of this species is now under observation by the local people with an interest in the sustainability of biodiversity.

Re-plantation is often a subject to be tried by the environmental NGOs and/or NPOs. One should be careful, however, not to introduce materials from other localities even if the materials are identified as the species in question. Very often, species are only temporarily recognized, or at most the local variation is comprehensive. In the case of *Melastoma tetramerum*, there is another species, *M. pentapetalum*, on Hahajima Island in the Ogasawara (Bonin) Islands. When the re-plantation project was under survey, the Hahajima form was not precisely recognized and in the herbarium was placed under a unique cover. Careful comparison revealed that the two are different, but there was a possibility to introduce Hahajima plants to Chichijima. If this was done, then the genes of these two might be confused and we might alter the evolution of *Melastoma* on the Ogasawara Islands. Before introducing materials from another locality, it should be carefully checked if the materials to be re-planted are those of the same species of the extinct or endangered species in the site in question. Artificial altering of natural evolution should be avoided, and conservation activity should be maintained to keep the nature under its natural evolution.

Discussion

1) NGO Red List in Japan. The first trial to enumerate the endangered plants of Japan was made by Satomi & Shimizu¹⁾ when the International Biological Programme was organized. They worked on this List carefully, but at that time they could not organize a national collaboration and enumerated the endangered plants based only on their own information. The list was, therefore, not very complete, but it strongly suggested a survey with a national conspectus.

When the University of Tokyo Botanical Gardens was reorganized at the beginning of the 1980s, I was asked to serve as the director there. Botanical gardens was considered by the Japanese people at that time only as a playground, or at most the places in which the visitors enjoyed amusement or were relieved of their stresses by the beautiful flowers cultivated there. In order to make more visible the activities of the university botanical garden, we expected to promote general scientific activities there and to act in public society as a think tank organization for social benefit.

Two leading environmental NGOs in Japan, the Nature Conservation Society, Japan (NACS-J) and Japanese National Committee of the World Wildlife Fund (WWF-Japan, now World Wide Fund for Nature, Japan) agreed to establish a survey of endangered species in Japan, and we suggested that the Japan Society of Plant Taxonomists (or JSPT at that time, now reorganized and is Japanese Society of Plant Systematics or JSPS) organize a working group to survey the Red List of Japanese plants. With financial as well as manpower aid from these NGOs, the working group of the JSPT made a 3-year survey of endangered plants in Japan from 1983 to 1985. I served as the chairperson of that working group, and the secretariat was in the University of Tokyo Botanical Gardens.

At the same time, the Environment Agency (now the Ministry of the Environment) organized a working group to compile Red Lists for all the Japanese organisms, and I was asked to chair the subgroup for vascular plants. It was just after we started our survey in the joint NGOs & JSPT working group, and I suggested the Environment Agency just to watch our activities there; we thought that the scientific societies should not have duplicate activities, and should have the same conclusion by such a survey under a working group of either governmental or non-governmental organizations.

After a careful survey of the dynamics of vascular plants throughout the Japanese Archipelago, we succeeded in editing the first comprehensive Red List of Japanese vascular plants at the end of the 1985 fiscal year, although this List was not actually published by the two NGOs until 1989.²⁾

2) Red List and non-professional naturalists in Japan. Professional plant taxonomists are limited in number in Japan, and most of them have heavy responsibilities in education and other areas in the universities and museums in addition to research in botany. Nevertheless, we were able to compile the Red List of Japanese vascular plants in only 3 years, and still we can be proud of the quality of this survey with its high standards. This is because we have a number of excellent non-professional naturalists distributed throughout Japan, and we could collect quality data at their hands on the dynamics of local ecosystems from every part of the Japanese Archipelago. They observe the species

and ecosystem around them accurately as their hobby, and they usually have close collaboration with professional botanists in sharing information on flora. Therefore, the basic data at their hands are usually highly reliable, and we could collect the basic data on the dynamics of vascular plants throughout the Japanese Archipelago by their collaboration.

Research on the Japanese flora itself experienced fairly good progress in these years. Systematic study on Japanese vascular plants developed along with the progress in various technologies in analyzing diversities of organisms. Fundamental information on chromosomes, secondary metabolic substances, and nucleic acid data have been accumulated for the Japanese vascular plants in parallel with the development of cytotaxonomy, chemotaxonomy and molecular systematics, respectively.

In addition to these advanced analyses of systematic relationships among the plant species, basic floristic research has been carried out within Japan and globally, especially in East, Southeast and South Asia. Since 1960s, Japanese taxonomists made a variety of so-called overseas research in floras, and a number of specimens were successfully collected in various sites throughout the world and brought to the herbaria in Japan. Promoting international collaboration, Japanese plant taxonomists contributed to the elucidation of the flora of various insufficiently known areas. Initiating such a global survey of floras, the Japanese flora itself has been revised and much more information is available now for further analysis of Japanese native plants. The flora is repeatedly revised, and the most comprehensive recent issues are in Japanese with color illustrations¹³⁾ and in English.¹⁴⁾

I should make a note here about the traditional Japanese concept of loving the nature that surrounds them. Traditional worship of nature by the Japanese people has produced the broad spirit of the naturalist, and there have been so many good non-professional naturalists throughout Japan. Professional botanists have close ties with non-professional naturalists, and comparatively fewer botanists in Japan carried on scientific studies with better collaboration with these non-professional naturalists. This fact was supported very well when we compiled the Red List of Japanese vascular plants, though the number of professional botanists was terribly small in comparison with the very high

diversity of Japan's flora. Non-professional naturalists usually collected basic data as their hobby, and detailed information was available through their efforts on the dynamics of the Japanese flora. The working group to survey the threatened plant species in Japan freely collected such information, as most of these naturalists were quite happy to contribute to nature conservation. They loved the native organisms as if they were part of their families. It was natural that professional botanists sometimes had to check carefully the data offered, including the field surveys of the species in question. The mutual collaboration between non-professional naturalists and botanists was carried out in a very good atmosphere, and the Red List was edited to its higher standard in a very short time.

3) Dynamics of endangered plants in Japan during the past quarter century. Among three main factors leading to plants being endangered, the first one, or the destruction of nature, including the cutting of forests, construction of roads, reinforcement of river-banks and the sea-shore, is checked by access for additional construction, and there are various actions by the government. Just after a successful compilation of Red List of vascular plants in 1986, I had talks with some higher officers in the Environment Agency and suggested that they draw up an Endangered Species Act in Japan. In the latter half of the 1980s, however, it was quite difficult to have such an Act in Japan, as the government was so positive at that time in developing the Archipelago under the so-called bubbling business condition.

At the end of 1980s, circumstances changed rapidly in Japan, when the outline of the Biodiversity Convention then under consideration was visible. The Japanese government was interested in adopting such a Convention, and they considered the circumstances very carefully. It was good timing that the Red List of vascular plants was ready then, and based on such a basic botanical survey, an Endangered Species Act came to be under discussion. I was involved in the activities of the Wildlife Steering Council affiliated with the Environment Agency, and the Endangered Species Act was actually approved in 1992 just before the so-called Environmental Summit was organized in Rio de Janeiro. Japan signed the Biodiversity Convention there, and ratified it in 1994 as one of the top runners of the developed countries to promote its effects.

When the Endangered Species Act of Japan was under discussion, many biologists prominent in nature conservation were doubtful about the proposed Act, as it was rather weak in its conservation concept, still considering the possibility of development more than the protection of nature. My point at that time was to stress the importance of the fact that the government had declared the right of native species to be carefully protected.

After the establishment of the Endangered Species Act, the interest and understanding of the Japanese people on environmental issues developed fairly well, although rather slowly, and the conservationists and their sympathizers have made great contributions. The Japanese spirit of loving wild organisms is partly revitalized, and endangered species are now under careful watch by the general public. As the development of the Japanese Archipelago still progresses, the lives of some wild species are kept in a critical state. After the Biodiversity Convention became effective, the Japanese government first compiled the National Strategy for Biodiversity in 1995. The primary issue of strategy was compiled rather hurriedly, and documents from the various ministries and agencies were just bound in a strategy. This strategy was noted to be revised every 5 years, and the New National Strategy was issued in 2002, with careful editing of the documents proposed from the ministries and agencies concerned. In the New Strategy, monitoring is proposed every year, and actually the result of monitoring was issued every year in detail. The third version was issued in 2007, and sustainability of biodiversity is expected here in global conspectus and under long-term vision.

In addition to these contribution and success, scientists published a number of books with beautiful illustrations to have publicity how the endangered plants issue is serious.^{15)–20)} And, I issued books on this topics, in 1990²¹⁾ to review the contribution in early history of conservation activities and in 2007²²⁾ to summarize recent success to overcome the crisis we are faced to.

By such promotion of general understanding of people, the endangered species issue was also taken up in the media with higher visibility, and it became difficult to harvest endangered species for trade. When a large-scale development is proposed, it is necessary to have access to the wild species there and endangered species should carefully be

observed. The Endangered Species Act has had some effect in conserving endangered species in this way.

4) Monitoring of biodiversity by the Red List as a useful indicator. It is rather difficult to explain to the general public why it is necessary to sustain biodiversity. They do not understand how desperately biodiversity has been affected by human activity. In the case of climate change, especially global warming, the general public recognizes our difficult situation, and many people sincerely consider how we can contribute to keeping climate change a natural process. We succeed in explaining this to the general public mostly by applying statistics and numerical information. In addition, it is possible in the case of climate change to estimate the future based on mathematical indicators. However, we have to point out that most of the general public does not realize why we have to halt global warming. And, we have to warn that it is biodiversity that will be seriously damaged by rapid global warming, and human beings cannot survive if the biodiversity on earth is destroyed. Biodiversity is a concept that cannot easily be understood by statistical treatment, because diversity is an opposite concept to common principle.

Among various phenomena surrounding biodiversity, the endangered species issue can be discussed using statistics. Also, we can use the dynamics of threatened species as an indicator to evaluate the dynamics of biodiversity itself. Various ranks of threatened species were carefully distinguished based on a scientific basis as far as possible, and the ranking of various species according to their risks is more or less scientific now. And, we can evaluate the present situation of biodiversity as indicated by the dynamics of threatened species. We can judge the soundness of biodiversity by the dynamics of endangered species, and such a statistical figure is useful to the general public to understand the ways in which biodiversity is abused, or through it how much of the earth becomes dangerous.

In the 2000 edition of the National Strategy for Biodiversity, the Japanese government recognized the crisis of Biodiversity under 3 items: 1) development and other human activities are causing species loss and extinction, as well as the destruction and fragmentation of ecosystems; 2) in some places

biodiversity has changed, because necessary human activities have been neglected; and 3) alien species and chemical materials are adversely affecting biodiversity. Among them the first item notes the crisis indicated by endangered species.

It is difficult to show the dynamics of biodiversity in figures, as biodiversity consists of diverse facts and is difficult to be statistically treated. We can easily enumerate the various facts around biodiversity and discuss the crisis faced, but they are always particular examples as diversity itself is not universal. We can examine the statistics of the figures around threatened species, although it is still more or less vague by objective standards. The reasons why species are threatened vary according to the species concerned, and we are counting various species under general criteria. Still, we may say that the statistical figures on endangered species are a very good indicator of how much biodiversity is threatened and in crisis. It is useful in explaining the crisis of biodiversity to have more understanding of this subject by the general public. At times the topics on endangered species are taken up for some popular species, and even call attention to them by way of sentimental sympathy. We should have sound scientific bases to show the crisis of biodiversity objectively, and to this purpose the evaluation of endangered species is under investigation.

In monitoring endangered species it is important to realize the present status of biodiversity's dynamics, or to test the health of nature. It is often said that basic research on endangered species is not necessary, as biodiversity should only be conserved in sustaining the ecosystem concerned. It is true that no species can be perfectly conserved only with regard to the species in question, as the species is alive as an element of biodiversity, or living as an element of the spherophylon.³⁾ In addition, it is necessary to have statistics on endangered species to realize how much biodiversity is in crisis, or to what extent the spherophylon is suffering from its disease, and to applaud the general public in collaborating with all people on the earth for the sustainability of biodiversity, or long-life of the spherophylon.

Conclusion

We have surveyed the recent history of the dynamics of Japanese vascular flora, and we

observed that artificial pressure to the plants was decreasing. Among the three major influences—destruction of ecosystem, over-collection for trade, and global change of the environment—the former two are now more or less better controlled, especially by better understanding of more people on the endangered species issue. Control over destruction of the ecosystem as a result of development and over-collection for the sake of trade are less now, because many horticultural shops are collaborative with the concept of conservation. The general public understands nature conservation much better, and they treat rather severely the over-collection of wild plants and the unlimited destruction of nature. Promotion of this topic has been made by governmental and non-governmental organizations and yielded better conditions.

Now, we see that the biodiversity of vascular plants on the Japanese Archipelago was seriously endangered, and we recognize that some improvement may be suggested in recent monitoring procedures. We may say that over-destruction has not proceeded at such a rapid pace in a few past years, as the worldwide recession has recently disturbed the pattern of economic expansion. Even if we consider such a situation, we may say that some particular endangered plants in Japan are now recovering from their critical status, and this success is again attributable to our own efforts. Recovery is still seen only for a few representative species, but we can see from these examples that it is possible to have healthy recovery from terribly endangered status to a less threatened status by our contributions. And, I would note here that most of the contribution for better, or more accurately less worse, condition were made voluntarily by people who love the plants under a concept of harmonious co-existence between man and nature.

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References

- 1) a) Shimizu, T. and Satomi, N. (1976) A Preliminary List of the Rare and Critical Vascular Plants of Japan (1). Kanazawa; b) Shimizu, T. and Satomi, N. (1977) A Preliminary List of the Rare and Critical Vascular Plants of Japan (2). Kanazawa.
- 2) Threatened Species Research Group (ed.) (1989) Red-list of Vascular Plants of Japan. World Wildlife Fund, Japan & Nature Conservation Society, Japan, Tokyo (in Japanese).
- 3) IUCN (2001) IUCN Red List Categories and Criteria version 3.1. IUCN, Switzerland.
- 4) Iwatsuki, K. (2006) Spherophylon, the concept of life at a level higher than that of the individual. *Proc. Jpn. Acad., Ser. B* **82**, 270–277.
- 5) Environment Agency of Japan. (2000) Threatened Wildlife of Japan — Red Data Book 8: Vascular Plants. 2nd ed., Japan Wildlife Research Center, Tokyo (in Japanese).
- 6) Ministry of the Environment, Japan. (2007) Threatened Wildlife of Japan — Red Data Book 8: Vascular Plants: corrections and additions. Japan Wildlife Research Center, Tokyo (in Japanese).
- 7) IUCN (1994) IUCN Red List Categories. IUCN, Switzerland.
- 8) Yahara, T., Kato, T., Inoue, K., Yokota, T., Kadono, T., Serizawa, S., Takahashi, H., Kawakubo, N., Nagamasu, H., Suzuki, K. *et al.* (1998) Red list of Japanese vascular plants: summary of methods and results. *Proc. Japan. Soc. Pl. Taxon.* **13**, 89–96.
- 9) Fujita, T., Ogawa, M., Katsuyama, T., Kadono, Y., Kawakubo, N., Serizawa, S., Takahashi, H., Takamiya, M., Fujii, S., Matsuda, H. *et al.* (2008)

- Crisis of Japanese vascular flora demonstrated by quantifying extinction risks for 1697 plant taxa (in prep.).
- 10) Matsuda, H., Serizawa, S., Ueda, K., Kato, T. and Yahara, T. (2003) Assessing the impact of the Japanese 2005 World Exposition project on vascular plants' risk of extinction. *Chemosphere* **53**, 325–336.
 - 11) Iwatsuki, K. and Shimozono, F. (1986) Botanical Gardens and the conservation of an endangered species in the Bonin Islands. *Ambio* **15**, 19–21.
 - 12) Iwatsuki, K. and Shimozono, F. (1989) Science to Save the Endangered Plants. Kenseisha Co. Ltd., Tokyo (in Japanese).
 - 13) a) Satake, Y., Ohwi, J., Kitamura, S., Watari, S. and Tominari, T. (eds.) (1981–82) Wild Flowers of Japan: Herbaceous Plants I–III. Heibonsha Co. Ltd., Tokyo (in Japanese); b) Satake, Y., Hara, H., Watari, S. and Tomimori, T. (eds.) (1989) Wild Flowers of Japan: Woody Plants I–II. Heibonsha Co. Ltd., Tokyo; c) Iwatsuki, K. (ed.) (1992) Ferns and their allies. Heibonsha Co. Ltd., Tokyo.
 - 14) a) Iwatsuki, K., Yamazaki, T., Ohba, H. and Boufford, D.E. (eds.) (1995) Flora of Japan I: Pteridophytes and Gymnosperms. Kodansha Co. Ltd., Tokyo; b) Iwatsuki, K., Ohba, H. and Boufford, D.E. (eds.) (1999–2006) Flora of Japan IIa–c: Dicotyledons (Gamopetales). Kodansha Co. Ltd., Tokyo; c) Iwatsuki, K., Yamazaki, T., Ohba, H. and Boufford, D.E. (eds.) (1993–1995) Flora of Japan IIIa–b: Dicotyledons (Archichlamydae). Kodansha Co. Ltd., Tokyo; d) Iwatsuki, K., Ohba, H. and Boufford, D.E. (eds.) (2008–2009) Flora of Japan IVa–b: Monocotyledons. Kodansha Co. Ltd., Tokyo (to be published).
 - 15) Iwatsuki, K. (ed.) (1992) 50 Species of Threatened Japanese Plants. Tsukiji-Shokan Co. Ltd., Tokyo (in Japanese).
 - 16) Kato, T. and Ohta, H. (eds.) (1993) Endangered Species in Japan. Hoikusha Co. Ltd., Osaka (in Japanese).
 - 17) Japan Society of Plant Taxonomists (ed.) (1993) Red Data Book Threatened Plants in Japan. Noson-Bunka-sha Co. Ltd., Tokyo (in Japanese).
 - 18) Iwatsuki, K. (ed.) (1994) Red Data Plants — A Pictorial of Japanese Flora Facing Extinction. Takarajimasha, Inc., Tokyo (in Japanese).
 - 19) Yahara, T. (ed.) and Nagata, Y. (photo.) (2003) Red Data Plants. Yama-Kei Publ. Co. Ltd., Tokyo (in Japanese).
 - 20) Ohba, H. (ed.) (2004) Endangered Plants of Japan: A Florilegium. Aboc Co. Ltd., Kamakura (in Japanese).
 - 21) Iwatsuki, K. (1990) Endangered Plants of Japan. Kaimeisha Co. Ltd., Tokyo (in Japanese).
 - 22) Iwatsuki, K. and Fukuda, Y. (2007) Endangered Japanese Plants. Kenseisha Co. Ltd., Tokyo (in Japanese).

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Profile

Kunio Iwatsuki was born in 1934 in Hyogo Prefecture. After graduating from Kyoto University in 1957, he started his research career as a botanist, and studied plant taxonomy, especially on the pteridophytes. After a career in Kyoto University for 30 years from an undergraduate student to a full professor, he moved to the University of Tokyo in 1983 and served as the Director, Botanical Gardens. Retiring from the University of Tokyo, he served in Rikkyo University during 1995 and 2000 and the University of the Air during 2000 and 2005. He is at present the Director, Museum of Nature and Human Activities, Hyogo. He was awarded the Duke of Edinburgh Prize in 1994, and was nominated as a Person of Cultural Merit in 2007.

He succeeded in systematic works in some particular groups of pteridophytes and gymnosperms, and in floristic studies in East and Southeast Asia. In addition to his own research success, he could form a wonderful research groups resulting in contributing research in plant systematics. Contribution to molecular systematics was one of the successes of his research group in early days in this field. He also made a contribution to science administration, and actually was the president of Botanical Society of Japan, Japanese Society for Plant Taxonomists, International Association of Botanic Gardens and others.

In addition to his success in basic botany, his research area extended to conservation biology, and served in editing Red-data Lists, Red-data Books and so on, with ideal collaboration with non-professional naturalists worked throughout Japan. He made contributions in various governmental and non-governmental organizations, either national or international.

