

## Environmental Education and Biodiversity: Creating a Society in Symbiosis with Nature

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**T**HANK you for inviting me to lecture today for this public lecture series “Contemporary Civilization and Environmental Crisis” hosted by the Institute of Oriental Philosophy.

Today, I would like to present my ideas in three separate stages. I want to start with the question of exactly what environmental education is, and then I’ll explain what biodiversity is. Finally, through introducing my personal history I’d like to talk about how I became interested in environmental education and biodiversity.

### **Education for the Creation of a Sustainable Society**

To begin with, environmental education in Japan, as you are aware, began with education about pollution. After a while, the concerns and issues surrounding pollution subsided and then a movement toward nature conservation grew. At the time, nature conservation education was almost the same as environmental education. We then entered the current stage.

We should not forget that the Minamata incident, which occurred when pollution-related issues had reached a peak, was central to environmental education. If any of you are teachers, I would like to ask you to teach your students about “the four major pollution-related diseases” (Minamata Disease, Niigata Agano River Organic Mercury Poisoning, Itai-itai Disease, Yokkaichi Asthma), and explain to them that these incidents occurred in Japan.

The Japan Environmental Education Forum, which I am currently involved in, is a non-governmental organization (NGO). It was formerly known as the Kiyosato Environmental Education Forum, which began in 1987. The Japanese Society of Environmental Education was established in 1990, and it stressed the importance of environmental educa-

tion. Before then, environmental education was “nature related,” in other words it involved groups that were observing nature through camping and other outdoor activities. After the nature conservation movement began, these groups moved into environmental education.

On the other hand, there were some who thought that this movement was useless, and so-called “earth-related” groups started to tackle environmental problems. Furthermore, other activists became involved in what became known as “life-related” groups. These three groups had acted independently until recently when those involved in environmental education in Japan began to integrate. Integration in this context means activities that improve various connections and relationships, such as people to people, people to society, and people to nature, from the community to the global level.

In 1997, an international conference on environment and society held in Thessaloniki in Greece promulgated the Thessaloniki Declaration, which was an agreement that stated, “environmental education... it may be referred to as education for environment and sustainability.”

As you know, the term “sustainable development” came from the Global Summit held in 1992 and this was one theme within the movement. However, these days the term “sustainable society” is gaining favor over “sustainable development.” This change in terminology is a major problem in itself. During the Global Summit, many developing nations insisted strongly that there could be no environmental education without development. This was actually one aspect of the North-South divide. But later on, the term “sustainable society” came about through agreement between North and South. Although there are various arguments on this issue concerning details, I would like to introduce four common understandings of “sustainable society.”

Firstly, it means to hold a long-term perspective concerning future generations, which is to maintain the gifts we have inherited from the environment. Secondly, it aims at a society and culture that deepens bonds and connections to the earth. This relates to sustaining the environment while considering symbiosis and the mutual prosperity of nature and people. Thirdly, it is to explore new paths that will enhance sustainability by eliminating waste and fulfilling humans’ basic needs. Finally, it is to promote a coalition among people in various positions in society through participation, cooperation, or role-sharing. These are the four common understandings held by the Ministry of the Environment and the Ministry of Education, Culture, Sports, Science and Technology.

The Thessaloniki Declaration states that we can understand environmental education as a way of creating a sustainable society. We are try-

ing to achieve this goal in various areas. There are a number of issues involved, but my specialty is conveying to children and the general public the importance of ensuring biodiversity. I also want to consider the multiple connections between living beings, as this is related to our understanding of the food chain. It is from these two standpoints that I am motivated personally to contribute toward creating a sustainable society.

I imagine everyone here today has their own fields of specialization or areas of interest. After working in this field up until now, I feel that thinking about things in a general sense is important, although trying to convince others or raise awareness from a generalist perspective is ultimately fruitless. I was a professor at Soka University until 2006, and I taught my students that one needs to have a specialty and then do something useful based on that. In other words, one should use the four years of university education to develop a specialty and then make a contribution toward a sustainable society after graduating and joining the workforce. Therefore, I would like the students to develop their specialties. I feel that general subjects cannot be addressed without looking at areas of specialization. In school education these days, the time spent on general subjects is being reduced. However, in order to utilize the class for general subjects and convey to children its importance, educators themselves need to have a specialty. If not, they will be carried away by current trends. In this sense, I taught students in the hope that they become teachers who would be able to face their own students as educators, and who will be able to see and understand complex, diverse aspects based on a solid foundation of their specialized fields. My aim was to try to discuss issues with them that would become the axis and foundation for environmental education.

### **Biodiversity: A Bustle of Living Creatures**

British biologist Norman Myers was the first person to research the diverse range of creatures that exist on earth (biodiversity). In 1979, he published *The Sinking Ark*, which includes the idea that if the extinction of creatures continues at the current rate, cultures will also die out. This became the starting point for considering biodiversity as an important issue. In 1980, Thomas E. Lovejoy, a tropical biologist, used the term “biological diversity” for the first time. This established a foundation for the field of “conservation biology,” which is currently in use. In the beginning, however, the term “biological diversity” was used.

In 1986, however, the National Forum on Biological Diversity was

launched as a national strategy in the United States. This conference was hosted by the National Academy of Sciences of the United States of America and the Smithsonian Institute, which is famous for research in biological diversity. Participating in the conference was Walter G. Rosen, who was a senior program officer from the National Research Council Commission on Life Sciences serving on its Board of Basic Biology. He would comment on other people's research, for example, by saying that it was not useful for humans. As he was in that position, it could be that he invented the term "Biodiversity" as a promotional term for National Forum on Biological Diversity.

The difference between biological diversity and biodiversity is that the term "logical" is skipped. Rather than being based on some rational explanation, the new term was intended to target the sensibilities of the general public. After the more understandable term "biodiversity" came into use, it was translated into Japanese. Therefore, it can be said that this term was invented after 1986.

What, then, is biodiversity exactly? Actually, various specialists have their own ideas about it and there is no coherent definition. Specialists, government administrators, or people in corporations have different understandings of the term. I would like to explain biodiversity here according to the definition of Hiroya Kawanabe (Director General of Lake Biwa Museum).

He argues that biodiversity is "a term that describes living creatures themselves and the entirety of their relationships to one another. It also encompasses that notion that 'forms,' 'activities,' and 'lives' of living creatures have been interconnected since the earth began." I believe this explanation is easy to understand, which is why I wanted to introduce it to you.

To put it another way, biodiversity can be expressed as a "bustle of lives" or a "bustle of living creatures." Specialists are considering three methodologies for protecting this "bustle of lives." When the Biodiversity Treaty was signed in 1992, it was suggested that the issues surrounding biodiversity should be researched from three different perspectives, which I will briefly explain.

The first is "intraspecific diversity," which means the diversity of genes. It is a concept that expresses intraspecific variability. The greater the variation of a species, the stronger is its potential for biodiversification. There are different species around us that are raised with no variation, such as most agricultural crops. If they are attacked by disease, they simply die out. However, species cultivated through nature alone includes genetic diversity. From an evolutionary perspective, this is sup-

porting evidence for microevolution (minor genetic changes within a species or a small change in organisms). For instance, some creatures have blue eyes. This is due to genetic variation in a species that can be traced down to molecules of DNA. A particular base sequence of DNA varies and manifests in a particular form and character.

The second is “interspecific diversity,” which is about diversity of a species and difference between species. This is at the level of “macroevolution.” Blue eyes, for example, are related to microevolution. Macroevolution, however, is about the origin of color vision. How did color vision come about? What colors do frogs see? What about birds? Therefore, macroevolution deals with issues on a larger level, such as amphibian species, fish species, or avian species, such as how the Class fish evolved into the Class Amphibia and then to the Class Reptilia.

Thirdly, the concept of “ecosystem diversity” was proposed by a British plantecologist A.G. Tansley in 1935. For example, we can recognize “a pond,” but it is hard to understand a “pond ecosystem.” Crucian carps inhabit ponds in an abiotic environment with factors such as the pond water temperature and water quality. They eat small plankton, and are, in turn, eaten by birds, for example, kingfishers or herons, and so the food chain is connected in this way. Let us consider this cycle as one set. In order for crucian carps to survive, how much solar energy goes into the pond, and how much of that energy does one vegetable plankton absorb? How many vegetable planktons do animal planktons eat, and what kind of channels in food chain does the solar energy that falls into one square meter of the pond go through and reach the body of a large sized fish in the end?

Naturally, the existence of this flow of energy means that a flow of substances also exists, and this can be described as a food chain or a food web. In 1935, a proposal that we should research this as one “system” was put forward. This is called ecosystem research, and the largest ecosystem we are dealing with is the earth ecosystem.

### **Extinction Rate One Million Times Faster than in Jurassic Period**

I have presented a broad outline of three major areas in the research of biodiversity, but biological diversity itself has expanded over a long period of time. At times, however, things regressed due to mass extinctions, a phenomenon that occurred five times in the past. Actually, from around one billion one hundred million to nine hundred million years ago, the earth experienced four glacial periods. Around six hundred mil-

lion years ago the equator was covered with ice due to global cooling.

Looking at aquatic invertebrates for example, studies on the number of fossils of arthropods show that there were five mass extinctions in the past. Arthropods are invertebrate animals that have segmented bodies. Consider the limbs of insects—they have nails, something like a palm for their arm, a tibia, a femur, and strong legs. Their limbs are similar in structure to human legs. The bodies of most arthropods are covered by solid chitin. Crustacea, which includes creatures like shrimp and crabs, are considered to have the most obvious form of shells.

Do you know about sea slaters, which are crustaceans that run around the rocks on the beach? When I take my students to a rocky shore and show them these creatures, they scream and run away. If I catch one and show the students its abdominal limbs, they make even more of a fuss. But my point is that their limbs have excellent structure. The pill bug is a similar type of insect that started to live on land. For some reason, everyone thinks pill bugs are cute. Even kindergarten children love pill bugs. This would be an intriguing research theme. In any case, it is very interesting that the body structure of crustacean creatures, which moved from the ocean to the land, shows traces of the evolutionary process.

I mentioned that studies on the number of arthropod fossils in the “number of families” show that there were five mass extinctions in the past. Various events that occurred on the earth caused the extinction of a number of species. This means that a few times throughout history, biological diversity had been lost. Biological diversity was at its greatest level until the dinosaurs became extinct sixty-five million years ago.

On average, the number of vertebrates that became extinct in the last two hundred million years is approximately nine hundred thousand species over a period of a million years, although this figure varies depending on the research. At present, however, humans are causing the extinction of creatures at a rate over one million times faster than that of the Jurassic period. Until now, climatic changes on the earth caused the loss in biodiversity. However, I would like you to recognize that it is the human species that is now causing these losses.

I am going to address three issues related to biological diversity here. The first, needless to say, is the reduction and extinction of species caused by human activity. Human activity includes problems such as global warming, climatic change, destruction of the ozone layer, increase of ultraviolet radiation, and the disappearance of marine species due to marine pollution.

The second issue is the change in environmental quality in various *satoiyama* (natural rural areas that have been developed for agricultural

use). Currently, there is an active *satoyama* protection movement. What really impressed me after starting work at Soka University was the rich biological diversity on campus. Furthermore, the university is located next to a *satoyama*. I try as much as possible to take students outside and talk to them about various things. I was, however, troubled to learn that some fourth-year students did not even know that these areas existed around the campus. In any case, the founder of Soka University, Mr. Daisaku Ikeda, chose a wonderful location for the campus.

I am surprised that students today are so indifferent to small creatures or the plants in their immediate environment. They do not even know their names. I experienced this at a couple of universities. When students do not know creatures' names, sometimes they cannot comprehend discussions about nature. In a similar way, if teachers do not know the names of students in their classes, they could not communicate with them.

If we do not know the peaceful environment in which the “seven vernal plants” grow or how tasty they are, for example, we cannot even begin to understand biodiversity. I think that this type of knowledge is the basis for understanding.

In any case, Soka University campus is surrounded by a rich *satoyama*. What impressed me during observing various *satoyama* is that there is always a mountain deity and a fox deity neatly enshrined. Each village has its own *satoyama*. Every February, on the day of *hatsuumata*, the village people gather around for a sake drinking ritual and invite the mountain deity to make an appearance in the fields. They move to the fields and drink another round of sake, welcoming the mountain deity. Once they have welcomed the deity, it turns into the rice field deity. When the time comes, the deity returns to the mountain again. This form of agricultural worship is very important.

The third issue is the potential for ecological disruption due to factors such as introduced species and the influence on ecology caused by chemical substances. These three issues are the major problems related to biodiversity in Japan.

## **The Ecological System is the Foundation for Human Survival and the Source of Culture**

Let us now consider why it is important to sustain biodiversity. I suggest that this can be roughly summarized into four categories. Firstly, biodiversity is the foundation of human survival. Humans themselves are part of nature and the earth itself is one symbiosis in which humans are just

one species. Biodiversity supports the foundation of human survival and controls the ecosystem.

Secondly, the foundations of safety and efficiency beyond generations are established because of biodiversity. Safety beyond generations means that we obtain various benefits from biodiversity—these are called ecosystem goods and services. We receive a number of free services from the ecosystem without realizing it, such as air temperature adjustment and those creatures that are nurtured by the sun. The richer the biodiversity, the safer the earth becomes because of such benefits.

Efficiency in this context means an efficient, recycle-based society. We cannot go back to the time of Edo period, which was a great recycle-based society. When I talk to the students about forested areas, I explain why people in the past treasured them. In my understanding, a forested area behind a farmer's house is a place that produces precious organic fertilizer from litter. By mixing it with the faeces from domestic animals like pigs, horses and cows, farmers were able to make excellent organic manure. *Quercus acutissima* and *Quercus serrata* trees are very important species and they are excellent for producing organic manure. When the diameter of these trees has reached about 25 centimeters at breast height, the local people would cut them. In this method, new shoots grow from the cut and people select a strong shoot and develop it. This regeneration of new branches established a cycle. The cut branches were made into charcoal in a furnace, and charcoal was placed on a cattle-driven cart and taken to Edo to be sold.

Farmers purchased human excretory substances from Edo with the money they made from selling charcoal. At times people may have bought rice or sake, but human excretory substances were very precious. While I was still a child, one would see horse or cattle faeces being transported on the Koshu Kaido (one of the five routes that has been used since the Edo period). This shows that there was frequent traffic between the city center of Tokyo and the surrounding *satoyama*. This is what a recycle-based society means. While we cannot go back to that way of life now, Edo had a wonderful culture. The Edo period is now being reevaluated from this perspective.

Thirdly, there are sources of effectiveness and usefulness. For example, there may be some creatures in danger of extinction whose existence is a powerful panacea for us. This could include some wild species that might be used to improve breeding. As biodiversity is so great, there must be all kinds of secrets in nature that we are unaware of.

Fourthly, biological diversity supports the richness of culture. Small things, such as knowing what the “seven vernal plants” or the “seven



autumnal plants” are, or encountering various wild plants on the way to school or work and knowing the names of these plants—these are the things that make one’s life richer.

Next, I would like to discuss the goals toward establishing a natural symbiotic society. What do humans need to do in order to not only conserving biological diversity but to keep creating biological diversity for the future?

One thing we can do is to maintain ecosystems that are specific to local areas. In other words, humans can maintain an ecosystem in which creatures can continue to evolve or change. In the 1980s, the academic subfield of conservation biology developed within the field of biodiversity. The ultimate goal of this field is to maintain evolutionary change. Conservation biologists have a great interest in the process of evolution and hope to maintain an ecosystem in which evolution can occur. Through conserving biodiversity and variations at all levels including genes, species, association, and the ecosystem, we can ensure diversity. This is the driving power behind evolution so we are in a position to protect the ecosystem in which the process of evolution can be maintained.

By the way, from about ten years ago it was decided that teaching evolution in science classes at junior high school level in Japan was no longer necessary. This section was cut and moved to the senior high school education curriculum. Thus, evolution is only taught to students who are going to go on to study natural sciences. It is, consequently, important for us to recognize that some Japanese people have not studied evolution at all in the last ten years.

The second goal is preventing the extinction of species and avoiding the risk of extinction. The third goal is the sustainable use of biological resources.

## **Interaction with Living Creatures**

I would like to talk about my formative childhood experiences and attending agricultural school.

I was born in 1932 at Nakano ward, Tokyo. During the Great Tokyo Air Raids on 10 March 1945, our entire house was burnt down. Fortunately, though, my family members survived. Someone in front of me who was trying to escape was hit by a firebomb. I was shocked to see an arm flying in the air. I am still amazed that I survived. Later, I moved to my father’s brother’s house in the countryside. I attended what is now Saitama Prefectural Toyooka High School, which was formerly known

as Toyooka Agriculture School. Although there were some junior high schools in Saitama Prefecture, including Kawagoe and Urawa, you would have to ride on a train for a long time to get there. In those days, you were a certain target for an air strike if you travelled long distances. Grumman planes flew down and shot at anything that moved. Therefore, it was too dangerous to commute to those junior high schools for me. While I was at the agricultural school also, planes came down toward us when we were working in the field and the crew could see our faces. We lived under these horrendous conditions. Yet, while this problem of commuting was the reason why I went to that agricultural school, I would not be here today if it had not been for that school.

I studied pig farming at the school. There was one piglet per five students and our teachers measured how much weight it gained in a month, which was how we were graded. My group worked very hard to ensure that our piglet, who was named Buko, gained weight. We showered Buko with affection, but at the end of our final year, we had to kill it by our own hands, cook it up into pork soup, and eat it. I remember crying uncontrollably as I ate that soup. That was the first time I really felt that humans needed to kill living creatures for food in order to live. My mother taught me to say *itadakimasu* (a phrase that means I humbly receive, which is said before eating a meal in Japan) but I gained a true understanding of its meaning through this practical study of pig farming.

There was also practical training in rice farming, which involved knowing where the rice plants were. So many weeds grew around my plants that they toppled over, causing me quite some trouble. But now I look back at those times with fondness. There is a plant called barnyard grass, *Echinochloa crus-galli* var. *oryzicola*, which mimics rice plants and quietly takes over the rice field. We can learn a lot from barnyard grass.

Among the creatures that I encountered during my agriculture training at this school are the larva of *Athalia rosae*, which eats raddish leaves, and *Cotesia glomerata*, which is a parasite of cabbage butterfly larva. After going through various twists and turns in life, I became an assistant in biology at Tokyo Gakugei University in 1962 and made these insects my subject of research.

I will briefly explain about how I become interested in environmental education through the study of insects.

I was deeply affected by the book *Silent Spring* by Rachel L. Carson, which was translated into Japanese for the first time in 1964. My generation grew up with DDT, which was what the information in *Silent Spring* was based on. We lined up in the school yard and were sprayed

with DDT from the tops of our heads. I did not know what it was, so I breathed in the fumes and it had a pleasant fragrance. Strange things occurred two or three years after DDT was sprayed in the fields. Until then, we would sit around the fields eating rice balls and lots of flies would come around and form a black mass. We used to chase them away and keep eating. At night, lots of mosquitoes would be buzzing around as well. However, after the fields were sprayed they no longer came. Ironically, DDT had this wonderful effect on our lives. However, as Carson said, DDT signaled a death warning.

After I became an assistant at the university, I grew vegetables in the university field, such as white turnips and cabbage, without using pesticides in order to raise cabbage worms. A female student in our research lab was growing about 300 cabbageworms for her graduation research project. One day she called me at night and asked me, "Professor, I have no food to feed these cabbageworms. Can I buy cabbage or daikon radish at the supermarket to feed them?" I agreed and she bought daikon radish shoots and fed them. The next morning when I went to the university, I was stunned to find that most of the cabbageworms had died, their bodies had shrunk, and saliva dripping from their mouths. Daikon radish shoots that were sold in supermarkets in the 1970s killed these cabbageworms, and we were eating this food.

I was so shocked by this that I visited the manager of the supermarket. I told him, "we fed cabbageworms these daikon radish shoots and they died." The manager has a rather strange expression on his face. "They died," I repeated. He replied, "Of course they died. Pesticides are used on these vegetables to kill these insects." To my regret, I could not point out that cabbageworms and humans have same cells. From around 1965 to the 1980s, we were eating agricultural products that were dipped in pesticides. Maybe this is why various problems are occurring. This was the first incident in which I started to realize the importance of environmental education.

My talk has touched on a number of issues, but I would like to end this lecture by discussing my "protoexperience" when I was in third and fourth grade at primary school. Around that time, there was a thicket of Japanese cypress trees, *Chamaecyparis obtusa*, of around 100 meters in length that stretched from my home to school. When I went to school, I climbed up a tree in the front yard of my house with a backpack on my shoulders. I then pulled a branch of a tree in front of me and jumped to the next tree. I swung from tree to tree quickly, and jumped off when I got to the school yard. It was great fun. It built up my physical strength, and at the same time I learned what branches would be dangerous to

grab onto, what kind of alluring aroma Japanese cypress trees give off, and so on. Sometimes I saw a bird's nest. It was a space where I could fool around like an orangutan, or play around with a bunch of my naughty friends. It became my protoexperience with nature, and through this I was able to interact with other living creatures.

It was more like time spent playing rather than learning. Children could play to their hearts' content. At that time, parents were busy and there was nobody to tell you that you could not play there. I have a couple of scars from stitches after injuring myself falling from a tree. I remember licking the wound and discovering that blood tasted salty. I learned later in class that human blood contains similar components as seawater and then realized why blood tasted salty.

When I was a child, I also killed many creatures, especially insects. I caught dragonflies, pressed their chests, and pulled their tails. I inserted a toothpick in the body when the chest and abdomen separated. At times I would set a pair off in a grisly competition with each other. One day, however, after I pressed a dragonfly's chest and tried to pull its tail, I felt a slight "pit-a-pat." Actually this was not the heart but rather a muscle reaction. Nevertheless, I suddenly thought to myself, "This is a heartbeat." After that I began to feel guilty about killing insects. The point is that I really would not have understood this guilt if I did not kill dragonflies in the first place. I guess today's children probably cannot understand this feeling because they do not have these kinds of experiences. I would like to ask those people who are involved in education to also consider these things.