

Biodiversity profile

Conservation of Biodiversity in Taiwan

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Introduction

Taiwan is geographically situating in 120°-122° E and 21°-25° N and located 130 km off the southeastern coast of mainland China. The Tropic of Cancer passes through Chia-Yi of central Taiwan. Thus, the island belongs to subtropical and tropical climate regions. The total area of Taiwan is 36,000 km², including Taiwan island proper, the Penghu islets (the Pescadores), Green islet and Orchid islet about one-tenth of Yuan-nan Province of China. About two-third of the Island is occupied by mountains with more than 200 peaks above 3000 m in elevation. There are about 58% area covered by forests, including hardwood forests, coniferous forests, grassland and mangrove forest. Because of great variation of topography from sea level to 3950 m in elevation the climate and habitat changes, leading to luxuriant growth of vegetation and tremendous diversity of species, showing over 4200 species of vascular plants. Of them, 25% of species are endemic, in addition, 5700 fungi species and 19,000 animal species, result in great biodiversity (Table 1).

Nevertheless, because of the rapid growth of population and fast development of industry, the number of species has been seriously reduced and some species become endangered or extinct that also happened to the other parts of the world. Raven (personal communication, 2000) pointed out that over the past 50 years with the addition of about 3.5 billion people, has more than doubled to reach over 6 billion, causing the loss of a quarter of total available top soil, the loss of one-fifth of agricultural land, and the destruction of one-third of forests. Human have driven the rate of biodiversity extinction about 1000 species per year due to the anthropogenic activities of social economic development. To prevent the loss of genetic, species and ecosystem diversity, the movement of natural conservation in Taiwan was initial in 1980 led by the senior author and members of botanical society and environmental specialists. The movement called national attention and government of Taiwan to realize the importance of natural conservancy by establishing the *Environmental Protection Acts* and institution, such as Taiwan Endemic Species Research Institute, COA.

Nature Conservation in Taiwan during Japan Colonization Period (1845-1945)

Taiwan was administrated by Japan government for 50 years (1895-1945). During the period, the policy of natural conservation was paid little attention. Instead, the agricultural and forestry development went fast based on the colonization policy of Japanese administration. For example, tremendous deforestation happened to the Central mountains in particular to the Alishan where a vast area of coniferous forest, such as *Chamaecyparis*, spp and *Cinnamomum camphor*, was cut. Simultaneously, the deforested land was replanted by the species, but the rate of deforestation was faster than that of replanting. On the other hand, several Japanese botanists came to Taiwan and made extensive inventory of plant species by Hayata, Kudo, Sasaki, Masamune, Yamamoto, Sato, etc. (Huang 1993; Huang *et al.* 2002). Basically, the fundamental botanical flora of Taiwan was started by Japanese botanists. A great number of plant vouchers were deposited in herbaria of the Tokyo University, Kyoto University and Taihoku Imperial University (now called National Taiwan University; Chen 1995). In addition, several zoologists particularly entomologists had also paid attention to species collection by inventory, which vouchers were also deposited in the museums of the aforementioned universities. Truly, the aforementioned investigation was the fundamental biodiversity research in Taiwan.

Although biodiversity conservation was not particularly emphasized during the period of Japanese time, some important monuments for plants or vegetations were recognized and established that became the basis of several national parks established later (徐國士 1984).

Conservation of Alpine Vegetations in Taiwan

In general, alpine vegetation growing at above 2000 m in elevation has hardly been disturbed, except natural disaster, such as typhoon or forest fire. The area above timeline or snow line called arctic tundra or alpine tundra has not been disturbed. There are many peaks above 3500 m in elevation. Liu (柳 1956, 1976) reported that alpine coniferous plants, namely, *Juniperus squamata*, *Rhododendron pseudochrysanthum*, *Juniperus*

Table 1. Flora and fauna species in Taiwan.

Wild animals	Species	Endemic %	Vascular plants	Species	Endemic %
Mammal	80	61	Gymnosperm	28	57
Bird	500	17	Angiosperm	3600	28
Reptile	86	31	Fern	610	60
Amphibian	32	11			
Fresh water fish	224	17			
Insect	17,600	63			
Butterfly	400	18			
Total	18,922	60	Total	4238	25

formosana, *Berberis morrisonensis*, *Ribes formosana*, *Rhododendron rubropilosum*, *Gaultheria borneensis*, *Sorbus randaiensis*, and *Lonicera kawakamii* are dominant. In addition, about 70 species of herbaceous plants are growing in the shading area, such as *Artemisia*, *Avena*, *Astragalus*, *Carex*, *Cirsium*, *Deschampsia*, *Festuca*, *Gaultheria*, *Luzula*, *Orobancha*, *Ranunculus*, *Sedum*, *Senecio*, *Thalictrum*, *Phleum*, and *Potentilla* (周昌弘 1990). In addition to aforementioned species, many species growing in the subalpine area are also well conserved. Coniferous plants, namely, *Juniperus squamata*, *Abies kawakamii*, *Chamaecyparis taiwanensis*, *C. formosensis*, *Taiwania cryptomerioides*, *Cunninghamia lanceolata*, *Calocedrus formosana* are under protection. Several dominant hardwood forests, such as *Rhododendron rubropilosum*, *Sorbus randaiensis*, *Dramnacantha angustifolium*, *Vaccinium merrillianum*, *Rubus calycinoides*, *Juniperus formosana* are also under protection. Alpine and subalpine grassland species, such as *Miscanthus transmorrisonensis*, is dominant in the area above 2600 m in elevation. Besides, *Ceratuim subpilosum*, *Galium echinoceroum*, *Fragaria hayatae*, *Anisliaea mornisoniola*, *Agrostis flaccida* var. *morrisonensis*, and *Dryopteris clarki* are growing dominantly in the area. Particularly, *Miscanthus* taxa have been evolved from *Miscanthus chinensis* (low elevation below 1000 m) to *M. transmorrisonensis* (higher elevation above 2600 m) through evolutionary processes (Chou and Ueng 1992).

Dark Period of Natural Conservation (1945-1970)

LAND USE AND DEFORESTATION

After the Second World War in 1945, Taiwan returned to motherhood of China and administrated by the government of the Republic of China (ROC). Soon after 1945 Chinese mainland was under civil war and central government of ROC was settled in Taipei in 1949 after the Communist China took over the mainland China. It was a dark period without any conservation action during 1945-1949. It was a great sacrifice for Taiwanese people during the time period because a lot of agricultural and forest products were contributed to China

for civil war, thus nothing in conservation on biodiversity was made.

After 1949, a tremendous population increase of about two million Chinese immigrants from mainland China resulted in serious environmental and national conservation problems, causing increase land converge use and deforestation.

DEFORESTATION AND FOREST FIRE

Because of rapid increase of population, agricultural land had moved from low elevation to higher elevation of mountainous area. Consequently, many forests were under serious deforestation particular in the Taieishan and Alishan. Coincidentally, the forest fire was frequently happened to the area of deforestation. For example, during the period 1946-1977, the average number of forest fire was 50 per year, reaching the highest peak of 350 to 450 times from 1955 to 1963 (Chou 1981). The loss of forest land was above 1,000 ha, reaching highest peak of 10,146 ha in 1963. Naturally, the loss of plant species and diversity was incredible and hardly estimated. The serious impact of forest fire on ecosystem was described by Chen and Lu (1987) and Chen *et al.* (1986); however, the diversity of species was not estimated.

USE OF AGRICULTURAL CHEMICALS

Agricultural consumption was tremendously increased due to the rapid population growth, thus the agrochemicals used to increase productivity was particularly emphasized during the period 1955-1970. Amount of herbicides, fungicides and pesticides had been increasingly used, leading to jeopardize the soil fertility and water quality. In addition, heavy industry development was also emphasized and ignoring the environmental protection. During the period, economic development was the first priority which was the same as for many developing countries. Thus, Taiwan has suffered from environmental deterioration, such as water, air, and solid pollution. In consequence, the loss of biodiversity was tremendous and nothing was initiated in the improvement of environmental protection during the period. It was a real dark era of biodiversity in Taiwan.

Awareness of Environmental Protection (1971-1980)

The environmental protection and nature conservation is increasingly aware of the importance. In 1971, the Environmental Protection Agent of USA was established, consequently, the natural conservation has been paid a great attention by people of the world. In 1972, The Ministry of Interior Affairs and Ministry of Economy of Taiwan declared the *Hunting Prohibition Act*. Following years, the National Park Act was also established. In 1975, the policy of forestry in Taiwan was changed from deforestation to forest conservation. The management of forests is emphasized on the long-term benefit instead of short-term profit. Deforestation was prohibited; thus, the amount of forest production was remarkably reduced. Based on these environmental protection and forest conservation, the number of wildlife have significantly increased.

INITIATION OF ECOLOGICAL EDUCATION AND NATURAL CONSERVATION

The ecological education in Taiwan had received great attention, since the senior author, C.H. Chou, and colleagues Drs. Y.S. Lin, K.Y. Liu and M.Y. Chen returned from the United States and fully involved in ecological teaching at the National Taiwan University (NTU), National Taiwan Normal University (NTNU), and National Chung Hsing University, respectively. Much earlier, the pioneer ecologist, Prof. C.K. Wang, taught ecology at the Tung Hai University. They began engaging ecological education and research, resulting in significant number of young students and ecologists participated in natural conservation and biodiversity research. The participation of young scholars empowered the natural conservation greatly, reflecting the ecological conservation era in Taiwan was born. Since 1970s, the promotion of biodiversity conservation and natural conservation on vegetation and wildlife habitats have been increasingly recognized and settled.

THE MOVEMENT OF TAMSHUI MANGROVES FOREST PROTECTION

In 1979, the government of Taiwan planned to deforest the swamp land of mangrove forest located in the Tamshui river mouth area for constructing 8000 living quarters for citizens. Our botanists and environmental specialists heard the plan and all stood up for the protection plan. The senior author Chou and colleagues immediately called national attention (Chou and Yao 1980). Thus, the movement of mangrove forest protection soon received enormously support by the public. Through the supports from academic circles (Chou and Huang 1982), news media, and the citizens, we had made tremendous effort to protect this natural forest for almost a year, the Prime Minister Sun finally announced “the mangrove growing areas have to be protected.” This movement was the first case in

Chinese history that our botanists and ecologists were able to call attention to people of Taiwan and citizen abroad to reach success which made a great step towards the national development of natural conservation and environmental protection. In addition, the successful protection of mangrove forest in Taiwan was the key stone for establishing outdoor ecological classroom for environmental education and began in the fundamental research on both ecology and biodiversity in Taiwan (Chou and Huang 1982; Chou and Bi 1990).

Development of Biodiversity Natural Conservation (1981-2000)

During the period 1981-2000, the development of biodiversity and natural conservation was accelerated by governmental and non-governmental organizations (NGOs). In 1982, the Legislative Yuan passed the *Cultural Resource Protection Act*, which includes natural and man-made culture, naturally, the rare and endangered species and wildlife were included. Under the law, the Natural Ecological Conservation Association of Taiwan published a series of study reports, suggesting that the rare and endangered plant and animal species as well as nature reserve sites should be well protected (Chang *et al.* 1985).

PROTECTION OF WILDLIFE (ANIMALS)

Following animals were recommended for protection (Chang *et al.* 1985): (i) the rare and endangered animal species – *Macaca cyclopis* Swinhoe, *Manis pentadactyla pentadactyla* Linnaeus, *Selenarctos thibetanus formosanus* Swinhoe, *Capricornis crispus swinhoei* Gray, *Cervus unicolor swinhoei* Sclater, *Neofelis nebulosa* Griffith and *Lutra lutra chinensis* Gray; (ii) 11 species of birds – *Phasianus colchicus formosanus*, *Otus elegans botelensis*, *Ketupa flavipes*, *Treron formosae*, *Oriolus trailli*, *Lophura swinhoii*, *Ictinaetus malayensis*, *Spizaetus nipalensis*, *Syrmaticus mikado*, *Oriolus chinensis* and *Garrulax canorus*; (iii) ten species of reptiles – *Agkistrodon acutus*, *Takydromus hsuehshanensis*, *Gekko gekko*, *Ophisaurus formosensis*, *Cuora flavomarginata*, *Eretmochelys imbricata*, *Dermochelys coriacea*, *Lepidochelys olivacea* and *Chelonia mydas*; (iv) five species of amphibian – *Hynobius sonani*, *Microhyla butleri*, *Rhacophorus smaragdinus*, *Microhyla inornata* and *Rana taipehensis*; (v) six species of fresh fishes – *Oncorhynchus masou*, *Varicorhinus alticorpus*, *Macropodus opercularis*, *Rhyacichthys aspro*, *Hemimyzon taitungensis* and *Sinogastromyzon puliensis*; and (vi) four species of butterfly – *Troides aeacus Kaguya*, *Troides megellanus*, *Agehana maraho* and *Sasakia charonda formosana*.

PROTECTION OF RARE AND ENDANGERED PLANTS

The rare and endangered plant species are too many to be described here (Chang *et al.* 1985). There are pteridophytes (45 species), gymnosperms (8 species) and angiosperms (more

than 330 species). Referring to family, there are 102 families of angiosperms, 7 families of gymnosperms and 21 families of pteridophytes. Chang *et al.* (1985) also recommended that natural, cultural and landscape areas should be well protected. There were nine rare and endangered plant species recommended for protection: *Cycas taiwaniana*, *Podocarpus costalis*, *Amentotaxus formosana*, *Keteleeria davidiana*, *Fagus hayatae*, *Juniperus chinensis* var. *tsukusiensis*, *Epilobium nankotaizanense*, *Rhododendron kanehirai* and *Rhododendron hyperythrum* (Chang *et al.* 1985).

PROTECTION OF NATURE RESERVE SITES

Eleven nature reserve sites were recommended, these were Tamshui mangrove forest reserve, *Amentotaxus formosana* reserve, Pinglin *Keteleeria davidiana* reserve, Hongyeh *Cycus* reserve, Yuanyang Lake nature reserve, Lishan *Oncorhynchus masou* nature reserve, Swankui Lake nature reserve, Chuyushan nature reserve, Lilongshan nature reserve, Sheashan-Tapajenshan nature reserve, and Suhua costal area reserve (Chang *et al.* 1985).

NATIONAL PARKS

In addition to the aforementioned protection, eight national parks have been established since 1982 according to the *National Park Act*. These parks are Kenting National Park, Yangmingshan National Park, Taroko National Park, Sheiba National Park, Yushan National Park, Kingmen National Park, Taichiang National Park and Dongsha National Park. The total area of the National Park is about 8% of island Taiwan (Figure 1). The national parks provide several important

missions, such as education, research, and tourism; however, the entrance permission has to be approved by the authorities before collecting specimen for research. The parks are limited for number of tourists.

Establishment of Taiwan Endemic Species Research Institute (ESRI, 1992-)

In order to promote research on endemic species in Taiwan, a governmental institution called Endemic Species Research Institute (ESRI) was founded on July, 1, 1992 under the Government of Taiwan Province. The ESRI constitutes five departments, namely, Botany, Zoology, Habitats, and Ecosystems, Management, and Interpretation and Education. In addition, three experimental stations (at low, mid and high altitudes) and three supporting administrative offices are included. The government provides regular funds for research on biodiversity inventory and conservation; even more basic research subjects are open for collaboration from outside of the institution.

Since 1992, tremendous and excellent research findings on scientific papers published both on domestic or/ and international peer review journals and monographs, and proceedings. The ESRI indeed provides most of information concerning biodiversity inventory and natural conservation. Furthermore, the ESRI has reorganized and come under jurisdiction of the Council of Agriculture on July 1, 1999.

Since its establishment in July 1, 1992, ESRI has already completed various infrastructure projects and has actively undertaken biological inventory research and database



Figure 1. Location of main National Parks in Taiwan (resource: <http://www.google.com.tw/imgresimgurl>).

establishment in 21 counties and metropolitan districts of Taiwan. Furthermore, the institute has also conducted rare and endangered species germplasm (genetic resource) collection and restoration research to extend its research achievements in the future goals and directions of ESRI shall be as follows: (i) establish a basic comprehensive database of Taiwan's biodiversity; (ii) create technical systems for endemic, rare and endangered species restoration; (iii) build technical systems and method for locating biodiversity hotspots together with degraded ecosystem conservation, restoration and long-term management; (iv) strengthen research on the mechanisms for and the management of sustainable utilization of native flora and fauna, and benefit sharing of their genetic resources; (v) strengthen research on biodiversity conservation policy and economic incentives; (vi) promote biodiversity education and ecological construction techniques for rural community; and (vii) international collaboration.

To achieve these clearly defined and enormously arduous objectives, ESRI relies not only on the dedication, enthusiasm, hard work and team spirit of all its employees, but also on its researchers, who must continue expending cooperation between academia and industry, and increasing academic exchange and collaboration at both international and local levels. ESRI aims to preserve the integrity of Taiwan's biodiversity and achieve the three conservation goals of maintaining basic ecological processes and life-support systems, preserving the diversity of genetic factors, and guaranteeing the sustainable utilization of species and ecosystems. Taiwan's valuable wild flora and fauna can thus be passed down to and used by future generations (ESRI 2007).

Flora and Fauna of Taiwan

Finally, but not the last, under the auspices of the National Science Council of Taiwan the Council of Agriculture and the Academia Sinica the fundamental studies of biodiversity inventory have been carried out since 1960, resulting in the most important publications, such as *Flora of Taiwan* (Huang *et al.* 2002) and *Catalogue of Life in Taiwan* (Shao *et al.* 2010). In addition, many publications related to biodiversity without mentioning have continuously input into the literature and database of Taiwan Biodiversity.

Conclusions

It is concluded from the aforementioned discussion that the conservation of Taiwan biodiversity has come from difficult years. The nature of Taiwan is full with pretty and luxuriant

vegetation. The biodiversity is rich in such a small island which provides source for huge population. Nevertheless, with the high human population and anthropogenic activities, the island faces with environmental deterioration. Through the efforts of our people, governmental administration, the biodiversity conservation has now been greatly improved. It is our duty to protect the island and maintain the great biodiversity in order to sustain the natural resource for generations to come.

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