



INTRODUCTION

**INTRODUCTION TO  
TAIWAN BIODIVERSITY RESEARCH INSTITUTE**

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## Foreword

Biological diversity is the keystone of the survival of humanity and the necessary condition for the sustainable development of human society. Since the signing of the Convention on Biological Diversity (CBD) in June 1992 by world leaders at the United Nations "World Summit" in Rio de Janeiro, Brazil, the conservation of biological diversity has become a key global issue. However, despite being so, the speed of biological diversity loss globally has yet to slow down. The Convention on Biological Diversity held the 10th Conference of the Parties (COP) in Nagoya, Japan, in 2010, where the Aichi targets were established as the overall strategy and targets for developing biological diversity protection worldwide after 2010. However, ten years have passed with biodiversity loss persisting worldwide. The 15th COP to the Convention on Biological Diversity at the end of 2022 was held in Montreal, Canada, and the adoption of the Kunming-Montreal Global Biodiversity Framework was the most significant achievement of the conference. 4 main long-term goals and 23 action targets that must be achieved by 2030 were established in this Framework, establishing the most important basis for global biodiversity conservation in the next decade.

This is one global trend that Taiwan must participate in. Despite the unique and enriched environment paving the way for Taiwan to feature an abundance of flora and fauna resources, with the rapid expansion of population in the past few decades and the development and exploitation of natural resources as the result of economic growth, the natural environment in Taiwan has faced tremendous damage with some species such as the Formosan clouded leopard (*Neofelis nebulosa brachyura*) extinct in the wild with other endangered species also on the line. With the intent to conserve Taiwan's existing endemic species and genetic diversity and sustain the long-term balance of its ecosystems, in January 1990, former Taiwan provincial

governor Mr. Chiu Chuang-Huan called for the establishment of the Taiwan Endemic Species Research Institute (TESRI) under the Department of Agriculture and Forestry. After 18 months of intense preparation, TESRI was formally established on July 1, 1992. With the streamlining of the Taiwan Provincial Government, TESRI came under the authority of the Council of Agriculture, Executive Yuan, on July 1, 1999. In the domains of species survey, endemic/rare species biology and ecology research, the taxonomy and identification of wild species, and the promotion of ecological education, TESRI has accumulated abundant results and experiences highly acclaimed in all domains. On August 1, 2023, with the restructuring of the Council of Agriculture into the Ministry of Agriculture, TESRI became the Taiwan Biodiversity Research Institute (TBRI) under the Ministry of Agriculture as a government agency to advance biodiversity survey, research, conservation, and promotion in Taiwan. Facing the challenging mission, TBRI will start anew and take our steps firmly despite the difficulties.

The natural environment in Taiwan with its richly diversified lives is intertwined with the humanity inhabiting the island, forming a dense web of life, creating an interconnected community of shared destiny that requires comprehensive and cautious protection. Given the mutual impact between the environment, biology, and humanity, biodiversity conservation has evolved beyond a mere scientific concern but one which requires holistic thinking and integrated action. As a government agency, TBRI embraces its mission without hesitation, demonstrating the utmost passion while taking innovative approaches with unwavering determination to effect critical changes in this critical era.

Director, *Jia-Dong Yang*

Taiwan Biodiversity Research Institute, Ministry of Agriculture



## 1. History

Formerly known as the Taiwan Endemic Species Research Institute, TBRI was established on July 1, 1992, under the Department of Agriculture and Forestry of the Taiwan Provincial Government. After the downsizing of the Taiwan Provincial Government, the Institute came under the administration of the Council of Agriculture (COA) of the Executive Yuan on July 1, 1999, and renamed the Endemic Species Research Institute, Council of Agriculture, Executive Yuan. In 2023, in line with the restructuring of the central government, the Council of Agriculture became the Ministry of Agriculture, and the Institute was renamed the Taiwan Biodiversity Research Institute (TBRI) of the Ministry of Agriculture on August 1. TBRI is the government agency responsible for biological diversity research, survey, and ecological conservation promotion in Taiwan.

Research Building at TBRI. (by Tung-Chi Ho)



## 2. Organization Structure and Duties

### 2-1. Organization Structure

Taiwan Biodiversity Research Institute, Ministry of Agriculture

Director

Deputy Director

Chief Secretary

- Secretariat Office
- Personnel Office
- Accounting Office
- Wild Animals Division
- Wild Plants Division
- Ecosystem Management Division
- Resource Management Division
- Conservation Promotion Division
- Wushikeng Research Center
- Tengzhi Research Center
- Hehuan Mountain Research Center
- Qigu Research Center



農業部生物多樣性研究所  
Taiwan Biodiversity Research Institute

#### Introduction to the logo

Biological diversity signifies everlasting species and ecosystems, therefore, with connectivity at heart, "TBRI", the first letters of the Taiwan Biodiversity Research Institute are inter-connected as a symbol of the everlasting ecology, forming the image of a sustainable ecosystem.

## 2-2. Duties

At TBRI, there are five divisions of Wild Animals, Wild Plants, Ecosystem Management, Resource Management, and Conservation Promotion, and the four research centers of the Wushikeng, Tengzhi, Hehuan Mountain, and Qigu, as well as the three offices of the Secretariat, Personnel, and Accounting. The duties of each division/office are as follows:

### (1) Wild Animals Division

The survey, taxonomy, and identification of wild animal diversity; the biological and ecological research of wild animals; the research of causes for endangerment and conservation actions; long-term monitoring; research of wild animals in the agricultural ecosystem; impact assessment and prevention of alien species; collection, preservation, and application of specimens and genetic resources; research on wildlife rescue, veterinary medicine, and conservation medicine; and other researches related to the conservation of wild animal diversity.

### (2) Wild Plants Division

The survey, taxonomy, and identification of wild plants; the causes of endangerment and conservation actions; long-term monitoring; research of wild plants in the agricultural ecosystem; impact assessment and prevention of introduced plants; collection, preservation, and application of specimens and genetic resources; and other research related to the conservation of wild plant diversity.

### (3) Ecosystem Management Division

Set up indicators for national biological diversity; information gathering and analyzing; monitoring of the distribution of important and vulnerable ecosystems; assessment of ecosystem functions, structures, operational mechanisms, and service functions; system planning of ecosystem hotspots and protected areas, and adaptation strategies for climate change; the survey, improvement, and restoration of agricultural, special, and aged ecosystems; the survey, monitoring, and analysis of special cases with major impacts; and other research related to ecosystem management.

### (4) Resource Management Division

Conservation and utilization of biodiversity and wild crop relative resources; establishment, analysis, and application of wild genetic resources, important genes, and genomes; sustainable utilization and industrial development of biodiversity resources; protection, management, and academia-industry collaboration of R&D results in biodiversity; establishment, management, maintenance, and application of biodiversity databases; research of social and economic-related policies and measures on biodiversity; and other studies related to the resource management of biodiversity.

### (5) Conservation Promotion Division

Conservation and education promotion of biodiversity resources; conservation education promotion of biodiversity in rural areas; international cooperation of biodiversity conservation campaign; compilation, planning, and evaluation of research programs on biodiversity; research on diversification of display and interpretation on biodiversity conservation; management of course design and

campaign material production on biodiversity conservation; recruitment, training, and management of biodiversity conservation volunteers; and other studies related to the popular science and promotion on biodiversity conservation.

### (6) Wushikeng Research Center

The survey, research, conservation, restoration, monitoring, and promotion of biodiversity in the Wushikeng area; management-related businesses of national forest compartments under the administration of the Wushikeng Research Center; low altitude environment and ecology, wild biological diversity, genetic resources conservation, research of genetics, restoration, and breeding; and other matters related to the Wushikeng Research Center.

### (7) Tengzhi Research Center

The survey, research, conservation, restoration, monitoring, and promotion of biodiversity in the Tengzhi area; management-related businesses of national forest compartments under the administration of the Tengzhi Research Center; medium altitude environment and ecology, wild biological diversity, genetic resources conservation, research of genetics, restoration, and breeding; and other matters related to the Tengzhi Research Center.

### (8) Hehuan Mountain Research Center

The survey, research, conservation, restoration, monitoring, and promotion of biodiversity in the Hehuan Mountain area; management-related businesses of national forest compartments under the administration of the Hehuan Mountain Research Center; high altitude environment and ecology, wild biological diversity, genetic resources conservation, research of genetics, restoration, and breeding; and other matters related to the Hehuan Mountain Research Center.

### (9) Qigu Research Center

The survey, research, conservation, restoration, monitoring, and promotion of biodiversity in the Qigu coastal area; research of the establishment, operation, and management of the Qigu coastal wetland biology database; promote the popular science of wetland conservation of the Qigu coastal area; and other matters related to the Qigu Research Center.

### (10) Secretariat Office

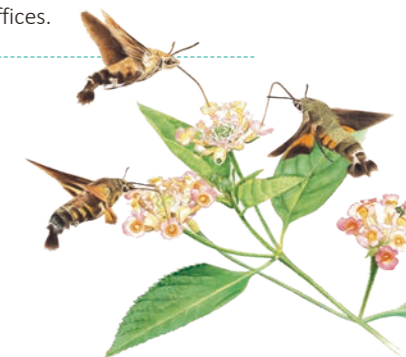
Performance, secretarial administration, correspondence keeping, petty cash, procurement, general management, asset, offices, janitor management, parliament liaison and media PR, and other miscellaneous matters not under the administration of other divisions and offices.

### (11) Accounting Office

Annual accounting, general accounting, and statistical affairs.

### (12) Personnel Office

All personnel affairs of TBRI.



### 3. Personnel Funding and Resources

TBRI has funding for 80 employees.

The personnel funding quota for the year 2024 was for a total of 129 employees, including 72 full-time staff, three long-term contract employees, four short-term contract employees, 46 technicians, three janitors, and one chauffeur.

### 4. Key Research Directions

- 4-1. The survey of biodiversity baseline data in Taiwan, and the establishment of the database.
- 4-2. Collection and establishment of biological and ecological baseline data for endangered and rare wild animals.
- 4-3. Strengthen the survey and evaluation of native animal and plant conservation, sustainable utilization, and biodiversity hotspots.
- 4-4. Establishment, monitoring, reporting, and announcement of the indicators of indicator species and representative ecosystems.
- 4-5. Analysis and research of adaptation strategies for the main pressure source of special, important, and vulnerable ecosystems.
- 4-6. Research of the system planning assessment and operation management of ecosystem hotspots and protected areas.
- 4-7. Collection and preservation of wildlife genetic resources.
- 4-8. Establish the rescue, treatment, and conservation medicine of sick and injured wild animals.
- 4-9. Establish monitoring models and management strategies for Taiwan's low, medium, and high-altitude ecosystems.
- 4-10. Investigate and monitor exotic invasive species and research related prevention techniques.
- 4-11. Promote personnel fostering and training for biodiversity conservation mainstreaming and community-based ecology development.
- 4-12. Promote international academic cooperation and exchange of biodiversity conservation.



Pacific Golden Plover (*Pluvialis fulva*) (by Jih-Wei Tsai).

## 5. Status of Research Projects

- 5-1. Wild Animals Division
- 5-2. Wild Plants Division
- 5-3. Ecosystem Management Division
- 5-4. Resource Management Division
- 5-5. Conservation Promotion Division
- 5-6. Wushikeng Research Center
- 5-7. Tengzhi Research Center
- 5-8. Hehuan Mountain Research Center
- 5-9. Qigu Research Center



### 5-1. Wild Animals Division

Taiwan's terrestrial wild animals are remarkably diverse, including approximately 86 species of vertebrate mammals, 600 species of birds, 90 species of reptiles, 37 species of amphibians, and up to 23,918 species of insects registered in the Catalogue of Life in Taiwan (TaiCOL). The wild animals currently researched by TBRI include the groups mentioned above of terrestrial vertebrates; the insects include butterflies and moths of the order Lepidoptera, as well as species of the order Diptera and family Tipulidae; the invertebrates include taxa of earthworms, land snails, slugs, freshwater shrimps and crabs, and spiders. Since our establishment, TBRI performed a systematic inventory of Taiwan's wildlife based on county and metropolitan areas. By establishing the ecological data of these wild animals, we further conducted the taxonomy, identification, and genetic diversity research of the various species, the risk assessment and control research of exotic species, further selected some of the endemic or endangered species in Taiwan for relevant research and conservation, hoping to achieve the goal of protecting the diversity of wild animals in Taiwan.



A. Mikado Pheasant (*Syrnaticus mikado*) (by Zhao-Hui Lin).  
B. Taiwan Barbet (*Psilopogon nuchalis*) (by Zhao-Hui Lin).  
C. Steere's Liocichla (*Liocichla steerii*) (by Zhao-Hui Lin).

## Research Achievements

### (1) Establishment of the ecological data of wild animals in Taiwan

Since 1992, TBRI has conducted resource surveys for wild animals in Taiwan, including mammals, birds, reptiles, amphibians, freshwater fishes, butterflies, dragonflies, spiders, snails, and earthworms, accumulating 250,000 entries of ecological survey data. Furthermore, we preserved 40,000 pieces of wet and dry wild animal specimens, which we make available for academic research, taxonomic comparison, and ecological education.



Moths specimens (by Li-Cheng Shih).

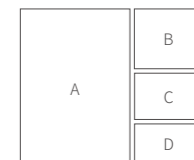


Animal specimen repository (by Liang-Chou Hsu).



### (2) Promote the general survey of wild animals with Citizen Science

TBRI proactively encourages participation from volunteers, who conduct a wide array of long-term species data collection as citizen scientists. Ongoing programs include the Taiwan Breeding Bird Survey (BBS Taiwan, covering the Formosan Rock-Monkey, *Macaca cyclopis*), Taiwan Roadkill Observation Network, Taiwan Spider Club, and Taiwan Land Snail Garden. These monitoring results enhance the baseline data of biodiversity in Taiwan, providing essential data that can offer preliminary ecological information from the small scale of engineering constructions to the large scale of the overall environmental changes in Taiwan. Also, with volunteer participation, we can improve the ecological knowledge and literacy of the citizens, which can further help promote biodiversity conservation in Taiwan.



- A. Search and investigation of mammal traces (by Hsi-Chi Cheng).
- B. Infrared camera trap set up to investigate wild animals (by Hsi-Chi Cheng).
- C. Salamander investigation in Hehuan Mountain (by Chun-Fu Lin).
- D. Sampling and survey of aquatic insects (by Chun-Fu Lin).

**(3) Publish the Red List of Taiwan Terrestrial Vertebrates**

In 2017, TBRI collaborated with the Forestry and Nature Conservation Agency on the first Red List of Taiwan Terrestrial Vertebrates with Taiwan, Penghu, Kinmen, and Matsu areas as scale. To reflect the rapid changes of the natural habitats, TBRI plans to complete the updated version of the Red List of Taiwan Terrestrial Vertebrates in 2024, which will cover terrestrial mammals, amphibians, terrestrial reptiles, freshwater fishes, and birds.

**(4) Implement conservation actions for endangered species**

For the conservation of endangered wild animals in Taiwan, TBRI collaborated with the Forestry and Nature Conservation Agency in 2017 on the inventory of endangered wild animals, drafted conservation strategies, and gradually implemented conservation actions. So far we have completed conservation action plans for 21 endangered wild animals, building a critical foundation for the promotion of conservation actions for endangered wild animals in Taiwan, including Ryukyu Flying Fox (*Pteropus dasymallus formosus*), European Otter (*Lutra lutra*), Leopard Cat (*Prionailurus bengalensis*), Formosan Pangolin (*Manis pentadactyla pentadactyla*), Mountain Hawk-Eagle (*Nisaetus nipalensis*), Eastern Grass Owl (*Tyto longimembris pithecops*), Russet Sparrow (*Passer cinnamomeus*), Okinawa Frog (*Nidirana okinavana*), Taiwan Salamander (*Hynobius formosanus*), *Hynobius fucus*, *Hynobius glacialis*, Sonan's Salamander (*Hynobius sonani*), Arisan Salamander (*Hynobius arisanensis*), Miyajima Keelback (*Hebius miyajimae*), Yellow-margined Box Turtle (*Cuora flavomarginata*), Chinese Pond Turtle (*Mauremys mutica mutica*), *Squalidus banarescui*, *Squalidus iijimae*, *Sasakia charonda formosana*, Mountain Swallowtail (*Papilio maraho*), and *Troides magellanus sonani*.



A		
B	C	E
	D	F

- A. Leopard Cat (*Prionailurus bengalensis*) (by Yu-Hsiu Lin).
- B. Formosan Flying Fox (*Pteropus dasymallus formosus*) (by Hsi-Chi Cheng).
- C. Chinese Box Turtle (*Cuora flavomarginata*) (by Jhih-Wei Tsai).
- D. Broad-tailed Swallowtail Butterfly (*Papilio maraho*) (by Chung-Wei You).
- E. Harpist Frog (*Nidirana okinavana*) (by Chun-Fu Lin).
- F. Mother and child Formosan Pangolins (*Manis pentadactyla pentadactyla*) (by Shu-Ling Chen).

(5) Wildlife rescue and treatment research and promotion of life education

a. The TBRI Wildlife Rescue and Research Center was established on December 22, 1993, as the first dedicated wildlife rescue organization in Taiwan when the concept of wildlife rescue was still in its early development days. On July 2, 2018, the Center moved into the newly built wildlife rescue building, complete with an ICU, hyperbaric oxygen therapy chamber, animal endoscope system, laser therapy machine, and various wards designed specifically for different animals. To prepare for reintroduction, we also set up outdoor shelters and restoration training areas, increasing the opportunities for wild animals to be cured and reintroduced to the mountains.

b. The Wildlife Rescue and Research Center accepts on a daily basis injured native wildlife from citizens, civil society organizations, and government organizations, rescuing over 700 animals on average per year and providing extended sheltering to over 1,000 protected wild animals. All medically treated wild animals have detailed registration of information including species, sex, age, type of injury or sickness, where they were found, the date, and the kind of medical treatment received. The data provides for not only medical research but also recommendations for ecology and environment conservation.

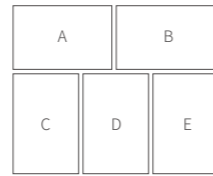
c. The Wildlife Rescue and Research Center provides emergency treatment, care, and reintroduction training for wild animals, as well as adequate activity rooms and venues for display. We promote life education with animal ambassadors trained by specialists, while proactively working with religious groups and enterprises to jointly campaign wildlife reintroduction and conservation programs. The Center is currently the most important base for wildlife conservation in Taiwan.

- A. Wildlife Rescue and Research Center (by Kuan-Fu Lin).
- B. Conduct life education with an animal ambassador (by Chieh Chang).
- C. Working with Bliss and Wisdom Buddhism Foundation to reintroduce Crested Goshawk (*Accipiter trivirgatus formosae*) (by Pei-Shan Liu).
- D. Treating the Formosan Pangolin (*Manis pentadactyla pentadactyla*) attacked by dogs (by Pei-Shan Liu).
- E. Flight conditioning for a Black Kite (*Milvus migrans formosanus*) before reintroduction (by Wei-Xiang Wang).
- F. Amputation surgery for Formosan Black Bear (*Ursus thibetanus formosanus*) (by Pei-Shan Liu).



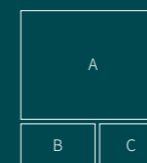
(6) Taxonomy and Research of Invertebrates

In the study of annelid earthworms, TBRI has so far published 59 new species, 3 new sub-species, and 15 newly recorded species. The checklist of earthworms from Taiwan and its adjacent Lanyu, Penghu, Kinmen, and Matsu islands includes a total of 120 species of which 75 species and subspecies are endemic, demonstrating the rich biodiversity of the earthworm fauna in Taiwan. Furthermore, four new species and 11 newly recorded species were published in the spider diversity research, establishing 610 species in the List of Spiders in Taiwan with 141 endemic species. Much ongoing research will uncover the diversity of spiders in Taiwan.



Taiwan endemic species published by our colleagues:

- A. *Amyntas catenus* (by Huei-Ping Shen).
- B. *Metaphire taiwanensis taiwanensis*, the largest earthworm in Taiwan (by Huei-Ping Shen).
- C. Taiwanese Tree-dwelling Wolf Spider (*Hogna arborea*) (by Ying-Yuan Lo).
- D. *Oxyopes taiwanensis* (by Ying-Yuan Lo).
- E. *Oxyopes hasta* (by Ying-Yuan Lo).



- A. *Satsuma albida* (by Chi-Li Tsai).
- B. *Graphium agamemnon* (by Yu-Chuan Chiu).
- C. *Byasa impediens febanus* (by Yu-Chuan Chiu).

### (7) Prevention and control of alien species

Since the first appearance of the Cane Toad (*Rhinella marina*; one of the top 100 alien species) in the Caotun Township in November 2021, TBRI has proactively participated in the removal of such species, providing a concentrated shelter for cane toads caught by researchers and volunteers. These captured individuals were, in turn, provided to schools of various education levels for research or animal dissection courses, fulfilling the life value of alien species. Meanwhile, we take part in meetings of the Forestry and Nature Conservation Agency on amendments to relevant regulations, hoping to remove the species altogether and relieve the threat of cane toads to the natural ecology in Taiwan.

### (8) Assist in Suhua Highway improvement construction and plan measures that are friendly to wild animals

In the Provincial Highway 9 Suhua Highway Mountain Section Improvement Project and Indicator Biological Research Plan during the Construction and Operation Phase, TBRI assisted the Suhua Improvement Engineering Office in the survey of ecological resources, building an environment friendly to ecology, and providing concrete improvement measures to set an ecological conservation example for the environmental impact assessment of major transportation constructions.



A. Cane Toad (*Rhinella marina*) (by Chun-Fu Lin).

B. Executing the Suhua Highway Improvement Project, the TBRI monitors the movement of Formosan Serow (*Capricornis swinhoei*) along mountainsides (by Jhih-Wei Tsai).

## Future Development

- (1) We will use citizen science to implement the survey of various wild animals in Taiwan, collect the temporal and spatial distribution data of species, their relative abundance, and other ecological data, and conduct long-term monitoring of the population trend of wild animals.
- (2) Research the taxonomic placement and endemism of wild animals in Taiwan.
- (3) Analyze the factors threatening endangered species in Taiwan and provide action plans for conservation.
- (4) Reinforce the collection and preservation of wildlife specimens and genetic materials in Taiwan and apply them to conservation genetics research and species identification.
- (5) Build up research for wildlife rescue, reintroduction training, and conservation medicine, and use wildlife ambassadors to develop activities for environmental education.
- (6) Assist in promoting wildlife-friendly measures for the agricultural ecosystem and facilitate the harmonious existence between humanity and wildlife.





## 5-2. Wild Plants Division

There are around 380,000 known species of plants in the world today. They can be classified as algae, bryophytes, lycophytes, monilophytes, gymnosperms, and angiosperms. Because they lack vascular bundles, algae and bryophytes are known as "non-vascular plants"; by contrast lycophytes, monilophytes, gymnosperms, and angiosperms have vascular bundles and are thus called "vascular plants". Among the vascular plants presently known in Taiwan, the lycophytes have 48 species in 3 families, followed by monilophytes with 759 species in 35 families, gymnosperms with 30 species in 8 families, and angiosperms with around 4,490 species in 199 families, among which, a quarter of them are Taiwan endemic species. There are about 1,500 species in the bryophytes of non-vascular plants.

Even though fungi are not categorized as plants, TBRI still includes fungi in the Wild Plants Division research scope to complete the diversity research. According to the estimation of biologists, the number of fungi in any area is roughly 6 times the number of vascular plants, hence it is estimated that there are approximately 20,000 species of fungi with only 6,000 species currently recorded in Taiwan, which shows that Taiwan needs to step up on the research and survey of fungi resources.

Since its establishment, TBRI has proactively undertaken inventory surveys and systematics research on vascular plants, bryophytes, and fungi by counties and metropolitan areas. Through such research, TBRI established species lists, images, and basic distribution information that are useful in the conservation and sustainable utilization of Taiwan's biological diversity, and restoration of endangered plants. In addition, to mitigate the continued spreading of alien invasive plants and their impact on Taiwan's economy and ecology, TBRI also explored and researched the ecologies and spreading trends of specific invasive species, and further designed appropriate strategies for their prevention and control.



A. *Aster ovalifolius* (by Chiuan-Yu Li).  
 B. *Wahlenbergia marginata* (by Chiuan-Yu Li).  
 C. *Scutellaria indica* (by Chiuan-Yu Li).  
 D. *Echinops grijsii* (by Chiuan-Yu Li).

## Research Achievements

### (1) Survey of plants, algae, and fungi resources

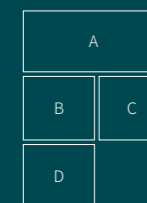
We have completed the general survey of vascular plants, bryophytes, and fungi by counties and metropolitan areas, and the symbiotic mycorrhizal fungi survey of special habitats including saline-sodic soil, coastal forest, abandoned limestone mining areas, and landslide areas, as well as the establishment of the list of coastal benthic diatom in Taiwan.

### (2) Research of plant taxonomy

Since publishing the second edition of Flora of Taiwan, TBRI has continued its survey and research of wild plants. In addition to the newly recorded and naturalized species published in academic journals, 3 volumes of Flora of Taiwan: Bryophytes, 1 volume of Flora of Taiwan: Selaginellaceae, and 3 volumes of Flora of Taiwan: Poaceae have been published. Further work has been expanded on establishing the DNA molecular sequence database for Poaceae species, and research on the molecular phylogenetics of the vascular plant taxa.



Dr. Raven (center) visiting, photograph taken with researchers and Dr. Peng Ching-I (second left) on Hehuan Mountain (provided by Tsai-Wen Hsu).



A. *Helminthostachys zeylanica* (by Chau-Ching Huang).

B. *Hypopterygium formosanum* (by Kuei-Yu Yao).

C. *Pogonatum urnigerum* (by Kuei-Yu Yao).

D. Taiwan pleione (*Pleione bulbocodioides*)

(by Chih-Hui Chen).

### (3) Research of plant ecology

Respective permanent sample plots have been established at the three research centers of Wushikeng, Tengzhi, and Hehuan Mountain for long-term monitoring, and have proven to be more significant in light of the increasingly severe climate changes globally. Observation and documentation are conducted for the phenology of special species and testing of their photosynthesis property, for example, the capacity of carbon dioxide absorption and storage for different species, which could benefit the research and ecology management of ecophysiology.

### (4) Restoration of rare and endemic plants

Working with the Taiwan Society of Plant Systematics, TBRI completed respectively the evaluation of the species in the Red List of Vascular Plants of Taiwan in 2008-2010 and 2016-2017 and published the 2017 Red List of Vascular Plants of Taiwan with a total of 1,016 species, among which 5 species are extinct in the wild, 22 are facing regional extinction, 195 are critically endangered, 283 are endangered, and 511 are vulnerable. Annual registration and conservation evaluations are conducted regarding endangered plants on the Red List to provide basic information for the subsequent genetic resources preservation and restoration programs. Basic information for endangered plants in Taiwan have been established including *Rhododendron kanehirai*, *Hygrophila pogonocalyx*, *Nymphoides lungtanensis*, *Cephalotaxus wilsoniana*, *Podocarpus nakaii*, *Helminthostachys zeylanica*, *Phellodendron amurense* var. *wilsonii*, and *Bupleurum kaoi*, and restoration projects have been drafted for *Rhododendron kanehirai* and *Hygrophila pogonocalyx* with taskforces set up respectively to implement the restoration of these species.

### (5) Drafting and implementing conservation action plans for endangered species

Since 2015, TBRI has implemented the conservation action plan for Philippine ground orchid (*Spathoglottis plicata*), starting from the species biology research, population dynamics, and breeding research to reintroduction to the native habitat, followed by conservation education and campaign held locally to introduce conservation to the community and become a complete example of plant conservation. Also, we began the conservation action plan for bamboo orchid (*Arundina graminifolia*) in 2019. Following these experiences in conservation promotion, we are taking steps in conservation actions targeting the species and populations which are continued decline, fulfilling the conservation responsibility as a public agency.

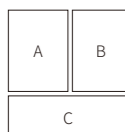
### (6) Website and database creation

The Taiwan Botanic Database (<http://tbd.tbn.org.tw>) is created with the accumulated basic information for 8,925 vascular plants, 12,314 entries of plant resource survey, 50,700 plant specimens, and a total of 17,043 pieces of ecological images for 3,189 species of wild plants in Taiwan.



- A. Alpine vegetation survey (by En-Liang Chu).
- B. Establish permanent sample plots for plant survey (by Hsiu-Chuan Chen).
- C. Measure the grade with a gradiometer (by En-Liang Chu).
- D. Soil sampling (by En-Liang Chu).
- E. Measure the diameter of the woody plant at breast height (by En-Liang Chu).





A. *Barnardia japonica* of liliaceae (by Chiuan-Yu Li).  
 B. *Ophioglossum austroasiaticum* (by Ming-Ya Shen).  
 C. *Cephalotaxus wilsoniana* (by Kuo-Fan Liao).

## Future Development

- (1) Continue resource surveys of plants, algae, bryophyte, and fungi by counties and metropolitan areas, and enhance the surveys of endemic, endangered, threatened, rare plants, and those with insufficient information, and the continued monitoring of permanent sample plots.
- (2) Enhance the contents of the Botanic Database, continue to create the database of survey results, and digitize the images of plant specimens for online search services. In response to changes in the plant taxonomy system, TBRI will work with the Taiwan Biodiversity Network in redesigning the Taiwan Botanic Database. In addition to providing the latest list of vascular plants, we will continue to create a management system of botanical scientific names.
- (3) Taxonomy research can mainly be categorized into traditional taxonomy research and systematics research. TBRI will continue to carry out traditional taxonomy research, which requires more work, and gradually develop the systematics research by building on it. Promote discussion of plant systematics and phylogeography, apply the method of systematics and markers of molecular biology to understand the diversity of plants in Taiwan, and explore species phylogeography.
- (4) Enhance the restoration of rare and endangered species, and continue to conduct the survey and registration, and the research of ecophysiology and the mechanism of breeding and restoration based on the endemic, threatened, or endangered wild plants in the Red List of Vascular Plants of Taiwan, 2017. Select and preserve mycorrhizae strains with the potential to be applied as plant or habitat restoration. Also, create a system for the preservation of genetic resources, and promote endangered species for greening and beautifying the environment to serve both the purposes of genetic resource preservation and sustainable use.
- (5) TBRI commissioned the Taiwan Society of Plant Systematics in 2020 to bring together experts and scholars of all taxa to evaluate the priority of conservation based on the 989 threatened plants in the Red List of Vascular Plants of Taiwan 2017, from which 264 were chosen as plants requiring priority conservation. In the future, we will continue to revise based on the distribution and status of the 264 plants to gain more comprehensive population information, and when it is appropriate, re-evaluate their latest threats, priorities, and measures to be taken.
- (6) For threatened plants with unspecific population status, TBRI will partner with citizen scientists in surveys and use the long-term monitoring data of the population to analyze and estimate the national distribution hotspots of the threatened plants, and produce public maps for follow-up conservation planning or decision-making.





### 5-3. Ecosystem Management Division

Taiwan is an island of high mountains with places that are extremely high and places extremely cold; Taiwan and its surrounding islets are situated on the border of temperate and tropical zones, some are close to the mainland while others are close to the ocean, despite the limited land area, these are the reasons Taiwan has such diversified ecosystems with abundant endemic species. However, over the past decades, many important and unique ecosystems have faced severe threats, including habitat loss and fragmentation, degradation, overhunting, and the invasion of alien species. These pressures have caused the populations of various wildlife species to decline rapidly, and the ecosystem services and functions they provide are also rapidly and continuously lost.

Since its establishment, TBRI has proactively promoted fundamental research on various ecosystems. This long-term monitoring of ecosystem status and trends, identifying the threats to their integrity, exploring the nature-based solutions for restoring degraded ecosystems, and developing principles to ensure the sustainable functioning of critical ecosystems in Taiwan. To enhance the conservation of vital and unique ecosystems and habitats, TBRI focuses especially on analyzing population trends of wild animals and biodiversity indicators. These efforts aim to better understand ecosystem conditions and changes, evaluate the main threats, and develop targeted conservation strategies and action plans.



A. The river ecosystem of Mugumugi in Hualien (by Wan-Jyun Chen).  
B. *Nanhaipotamon formosanum* (by Jhih-Wei Tsai).  
C. *Macrobrachium asperulum* (by Jhih-Wei Tsai).  
D. *Mictyris brevidactylus* (by Pei-Cheng Wu).

## Research Achievements

### (1) Indicators and monitoring of biodiversity

Combine the forces of government agencies, academic institutions, and civil society organizations, use systematic and opportunistic citizen science to draft the creation of national biodiversity indicators and long-term monitoring programs, such as Taiwan Breeding Bird Survey, Taiwan New Year Bird Count, eBird Taiwan, and iNaturalist Taiwan. With the active participation of citizen scientists, we annually compile over a million data entries, enabling us to update population trends for individual species and composite species indicators. This approach ensures a robust and dynamic framework for monitoring Taiwan's biodiversity.

### (2) Planning of conservation areas

Explore the temporal and spatial distribution of wildlife with open biodiversity data, deploying methods including species distribution model, seek expert opinions, and identify critical habitats to produce various publicly accessible biodiversity maps. To date, we have published distribution maps for 379 terrestrial vertebrate species, important habitat maps of red-listed threatened plants, and waterbird hotspot maps. These resources help to identify biodiversity hotspots and prioritize areas for conservation and management efforts. In addition to supporting spatial planning for conservation policies, we are also developing research on risk analysis and ecosystem service assessment to evaluate the threat from natural and human activities and quantify the value of ecosystem service to humanity. These findings serve as the scientific basis for conservation decision-making.



TBRI researchers promote flooding the shallot field to provide an alternative foraging habitat for the Black-tailed Godwit (*Limosa limosa melanuroides*) during the transit of shorebird migration in the autumn (by Jhih-Wei Tsai).



The Red List of Threatened Species drafted by TBRI lists Red-necked Stint (*Calidris ruficollis*) as vulnerable (VU) (by Jhih-Wei Tsai).

### (3) Research of freshwater ecosystem

#### a. Creation of river ecology data

Over the years we have completed additional surveys of the fish, shrimp, crab, and bird resources at 158 major rivers and branches, establishing a total of over 340,000 records covering 153 fish species, 33 shrimp species, 45 crab species, 224 bird species, 25 amphibian species, and 52 reptile species, as well as information for water quality and hydrology. We have also completed surveys for fish, shrimp, and crab species for 9 rivers within the impact range of the Provincial Highway 9 Su-Hua Highway Improvement Project, establishing over 20,000 records related to water quality, hydrology, and species distribution.

#### b. Research of river indicator species and their microhabitats

We have completed the surveys of habitat suitability curve for indicator fish species in many rivers, including water depth and flow speed, and the research of life histories such as feeding habits and breeding mechanisms; we have also completed the general survey, population distribution and biology, molecular phylogenetics research of *Geothelphusa nanao* in the 9 rivers within the impact range of the Provincial Highway 9 Su-Hua Highway Improvement Project, and uses *Geothelphusa* freshwater crab as indicator species to reflect the status of the river habitat.

#### c. Research relevant to river engineering and connectivity

We have completed the research of migration habits for 8 native fish species in submerged orifice fishways during different seasons, including the optimum and maximum water head difference. With academic and industry collaboration, we have completed the development of the combined fishway, which was improved upon the traditional fishway, adjusting according to the river flow to facilitate fish migration and sand discharge in the river, while also capturing the parameters of burst and cruise speed of 6 native fish species and the impact of different water temperature to the fish swimming capability to assist the design of fishways. We have also completed drafting the proposal for the Hushan Reservoir-associated river ecosystem management to inform the competent authority of operation and management strategies, and lower the negative impact of reservoir engineering on the associated river ecosystems.

#### d. Research of freshwater species and establishing the Red List

Over the years, we have completed the species biology and habitat research for various freshwater species including Formosan Landlocked Salmon (*Parasbora moltrechti*), Puli Torrent Loach (*Sinogastromyzon puliensis*), freshwater crab species, Formosan Landlocked Cherry Salmon (*Oncorhynchus masou formosanus*), Lanyu Rhinogobius (*Rhinogobius lanyuensis*), and Kikuchi's Aphycypris (*Aphycypris kikuchii*), and compiled with the information in the river ecology database mentioned above to evaluate the level of threat to freshwater species and establish the Red List of Freshwater Fishes of Taiwan.

#### e. Draft conservation strategies and actions for threatened and endemic freshwater species

Over the years we have completed or continued to draft conservation strategies for various threatened species, such as the conservation action strategy initiative for Formosan Landlocked Cherry Salmon, the conservation action plan for Banarescu's Minnow (*Squalidus banarescui*) and the conservation action plan for Iijima's Minnow (*Squalidus iijimae*), and promoted the various conservation actions to lower the risk of species extinction including evaluation of extraterritorial release habitat for Formosan Landlocked Salmon, engaged in conservation platforms of various species, and payment for ecosystem services provided by the important habitat of Formosan Landlocked Salmon.

#### f. Research of freshwater crab species and extrinsic factors

Conduct relevant research on any extrinsic factors which could potentially impact the distribution and population change of freshwater crab species, such as natural disasters (typhoons) or environment (habitat, water quality, and hydrology).

### (4) Research of coastal endemic species and special ecosystems

Monitoring coastal crab species population distribution and habitats, only the population in Tainan is currently stable while the population in Hsinchu is gradually recovering. Detailed change analysis is conducted for the central Taiwan estuary and Tainan City coastal area with the area of shoreline shrinking and reasons for it explored to inform coastal conservation and management. Agal reef shoreline survey and conservation are conducted with a focus on large benthic vertebrates for cluster survey, and the X-ray fluorescence spectrometer is used to detect the level of heavy metal, which makes important baseline data for agal reef conservation and management.



- A. Surveyor conducts aquatic species surveys with an underwater camera (by Cheng-Hsiung Yang).
- B. Electrofishing (by Cheng-Hsiung Yang).
- C. Species measurement and identification (by I-Han Chen).
- D. River habitat measurement (by I-Han Chen).

**(5) Ecosystem restoration**

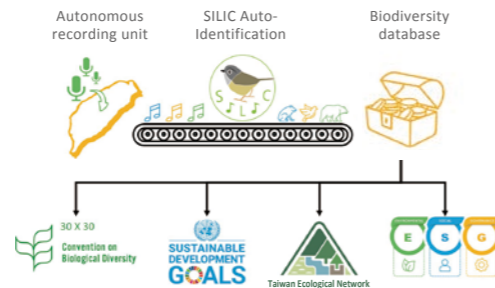
- a. Photovoltaics: Taiwan is proactively developing renewable energies, and fishery-electricity symbiosis is an important item in promoting ground-mounted PV Systems, with the decrease of natural wetlands, artificial wetlands have become important alternative habitats for waterbirds, among which, the fishery is an essential grounds for waterbirds to feed and rest. We systematically conducted various surveys on wetlands, including salt ponds and fisheries, to address the environmental impact of PV development. Based on these findings, strategies such as avoidance, downsizing, mitigation, and compensation were implemented to lower the negative impact on the environment during the development, and by working with relevant groups, we move in the direction of improving habitat quality and gradually test potential ways to restore habitats in the abandoned salt pans along the southern east coast in Taiwan.
- b. From 1997 to 2014, we helped the Water Resources Agency in implementing the program of "ecological conservation measure for the Hushan Reservoir engineering - survey and research planning for forest and river ecosystems", with the policy to construct a reservoir as a pretext and mitigating the negative impact of the construction works on the forest and river ecosystems as the goal, we conducted necessary life history research on various important indicator species, researched ways to improve habitats and resulting benefits, and relevant results and recommendations have been provided to the Water Resources Agency to implement on-site the ecological conservation measures.

**(6) Biodiversity-friendly practices in agriculture**

Agriculture is the system for human food production, while also being one of the causes of biodiversity loss in the past. In recent years, to achieve sustainable development in our farming system in Taiwan, we have put into place long-term monitoring of agricultural ecosystems, conservation actions in agricultural ecosystems, and promoted participatory guarantee systems in agriculture. The goal is to make our agriculture a system that features both production and ecology, embodying the diverse functions and values of the agricultural ecosystem.

**(7) Development and application of automatic biomonitoring**

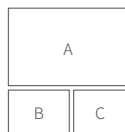
With the rapid development of AI and relevant information technology, applying automatic monitoring to various ecosystems and biodiversity monitoring is no longer far-fetched. For sound monitoring, TBRI has already completed the Sound Identification and Labeling Intelligence for Creatures (SILIC), a system that is already applied to different ecosystems like national parks and farmlands for acoustic animal monitoring. We have also made over 14 million records of data open for scientific research and public use, greatly filling the gap of insufficient biological survey information.



Schematic of SILIC (provided by Shih-Hung Wu).

A	
B	D
C	

- A. Drained fish farm becomes an important feeding ground for waterbirds (by Pei-Cheng Wu).
- B. Agricultural ecosystem provides food supply (by Wan-Jyun Chen).
- C. Promote environmental-friendly farming is key in recent conservation works (by Wan-Jyun Chen).
- D. A raptor perch is set up in an environmental-friendly farming area, and a camera trap is used to collect ecological information (by Wan-Jyun Chen).



A. White-eared Sibia (*Heterophasia auricularis*) (by Pei-Cheng Wu).  
 B. The Monitoring Avian Productivity and Survivorship Program of Taiwan (MAPS) setting up a net to capture birds (by Jia-Lang Lai).  
 C. Bird survey measuring and documenting in MAPS (by Jia-Lang Lai).

## Future Development

- (1) With citizen science as the important enforcing mechanism, we will establish robust biodiversity indicators and monitoring systems, and reinforce the statistical methodology research for large-scale and high-volume monitoring data. Maintain the stable operation of citizen science and update the population trend and biodiversity indicators annually.
- (2) Promote ecosystem status evaluation and spatial planning research, apply long-term land use type changes and environment monitoring information in Taiwan to establish the evaluation and risk prediction model for ecosystem status, and provide a basis for conservation decision-making and national spatial planning.
- (3) Enhance the biological research and habitat monitoring of freshwater ecosystems and conduct distribution surveys and research for areas with insufficient information or threatened freshwater species, while expanding species conservation, restoration, and application of alien species prevention and control measures through horizontal collaboration.
- (4) Promote steadily coastal and wetland ecosystem monitoring and restoration evaluation, continue the monitoring research of the western coast and wetland ecosystem status, compare the threats faced by different populations, proactively seek various collaborations to provide different restoration recommendations, and participate in habitat restoration actions.
- (5) With the principle of being biodiversity-friendly in exploring agricultural operations that can benefit both production and ecology, promote long-term monitoring systems for agricultural ecosystems in Taiwan to achieve the goal of sustainable development.
- (6) Automatic biomonitoring can fill the insufficiency of professional investigators and citizen scientists, in the future, we will continue to introduce the latest technology related to AI and AIoT and develop automated tools such as Bat Echolocation and camera trap image identification, and expand application to agriculture, fishery, and biodiversity monitoring of various other ecosystems.





## 5-4. Resource Management Division

In addition to promoting and implementing the conservation of biological diversity, the key objectives of the Convention on Biological Diversity include the sustainable use of the components of biological diversity and the fair and equitable sharing of the benefits arising from the utilization of genetic resources. To achieve these objectives, the Convention not only states in the preamble that countries have sovereign rights over their biological resources and are responsible for conserving and sustainably using them, but also emphasizes the development of biotechnology. It further highlights the importance of linking efforts to protect biodiversity within traditional lifestyles to the economic goals of sustainable use, aiming to ensure that conservation outcomes promote local economic development. Therefore, in terms of biodiversity conservation, the Resource Management Division follows the objectives and spirit of the Convention on Biological Diversity, proactively engaging in research on the nurturing and restoration of wildlife, preservation of genetic resources, and sustainable use of resources. This mainly includes building an ecology education park on the concept of ex-situ conservation by systematically collecting and preserving genetic resources of native plants, and safely introducing modern knowledge and technology to biological diversity research, in addition to using tissue culture and biotechnology to restore endangered species and develop natural compounds, information and communication technology is also used to establish a biodiversity database of Taiwan. Furthermore, to achieve public participation and benefit sharing, we align with local biological resource characteristics to guide communities in promoting ecotourism and revitalizing local economies. We anticipate enhancing the comprehensiveness of conservation efforts through these management strategies and effectively improving conservation outcomes.



- A. A pavilion in the ecology education park (by Shu-Ling Chen).
- B. Maple trail in the ecology education park (by Shu-Ling Chen).
- C. Ecological education park in 1997 (by Shu-Ling Chen).
- D. View of the ecology education park in 2023 (by Shu-Ling Chen).

## Research Achievements

### (1) Establish preservation technologies for threatened plant genetic resources

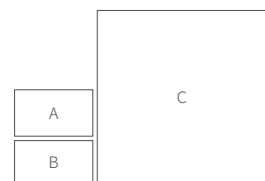
Establish the propagation system for threatened plants in Taiwan and draft the optimal propagation strategy for their ex-situ conservation. Propagate individuals of different populations or different individuals within the population of important threatened plants, and maintain the species' genetic diversity as a reference for the propagation of other threatened plants in other areas.

### (2) The establishment and management of the ecological education park

Using the 3.5 hectares outdoor space where TBRI is located, recreate a featured ecological environment similar to natural ecology, plant various native plants according to the features, and attract diverse animals to dwell here. Currently, there are close to 700 species of native plants in the Park. A self-guided interpretation system has been established to provide information on species and the Park, which achieves the functions of ex-situ preservation of genetic resources, conservation research, and environmental education.

### (3) Research on the collection and sustainable use of plant genetic resources

Collect plant genetic resources, survey the distribution, population, and phenology information of each species, establish a genetic resource database, and evaluate its preservation benefits, utilization value, and conservation priority. Increase the plant genetic resources of the ecology education park at TBRI for academic research or practical use, ensuring that the genetic resources will not become extinct.



- A. Cattle Egret (*Bubulcus ibis*), commonly seen at the ecology education park (by Shu-Ling Chen).  
B. *Heliophorus ila matsumurae*, commonly seen at the ecology education park (by Shu-Ling Chen).  
C. Japanese Rhinoceros Beetle (*Allomyrina dichotoma*), commonly seen at the ecology education park (by Shu-Ling Chen).

#### (4) Technology R&D patent acquisition and authorization

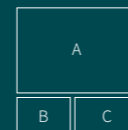
Innovative R&D of single-spore culture for Niu-chang-chih (*Antrodia cinnamomea*) and method for incubating fruiting bodies of Niu-chang-chih on *Cunninghamia* lanceolate logs adopted by the Agricultural IP Review Committee under the Ministry of Agriculture for 5-year non-exclusive authorization, with the technology transferred to two domestic manufacturers in Taiwan. Both the innovative R&D of the preparation method for truffle strain liquid and cultivation method of truffle mycorrhizal, and the use of marjoram essential oil for brown root rot prevention and treatment obtained patents from the Republic of China.

#### (5) Establish a biodiversity information distribution and application platform for Taiwan

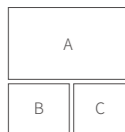
TBRI has established a comprehensive platform for distributing and promoting the use of biodiversity information through the Taiwan Biodiversity Network (TBN) and the Herbarium of Taiwan Biodiversity Research Institute (TAIE) database. This platform adheres to open data principles and the FAIR data principle (Findable, Accessible, Interoperable, Reusable). TBN offers open access to extensive wildlife ecology information collected by TBRI experts, scholars, and citizen scientists, while providing an online search service for wildlife distribution in Taiwan. The TAIE database complements this by digitizing wildlife specimen collections, offering online search of the fully digitized TAIE collection. The information service provided by TBRI through this platform has become a crucial national infrastructure, widely applied in scientific research and environmental evaluations. It serves as a foundation for informed decision-making in biodiversity-related matters. This integrated approach ensures that Taiwan's rich biodiversity data is not only preserved and accessible but also actively contributes to scientific advancement and environmental stewardship.



Promoting the Taiwan Biodiversity Network through market stalls (Upper by Liang-Chou Hsu; lower left by Chie-Jen Ko; lower right by Tun-Yu Chen).



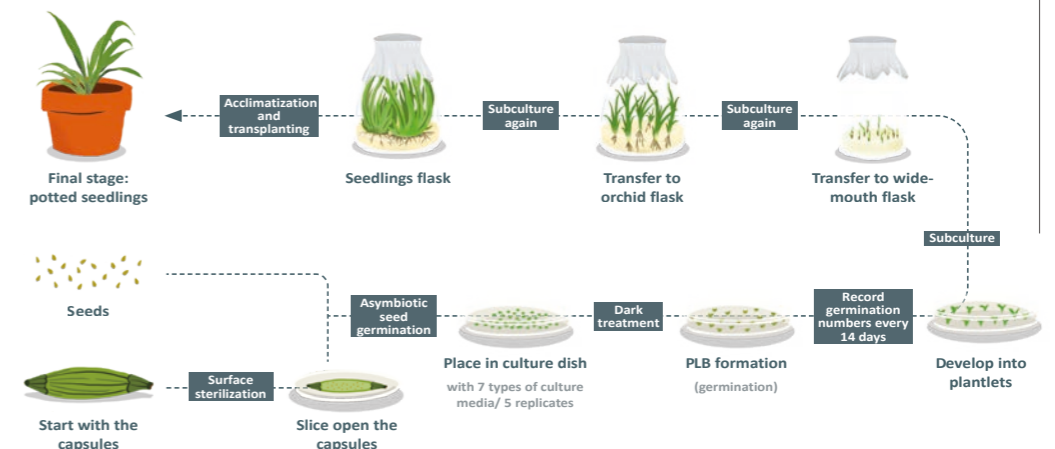
A. Small Yellow Pond-lily (*Nuphar pumila*) in the pond of the ecology education park (by Shu-Ling Chen).  
B. *Chlorophyllum molybdites* in the ecology education park (by Hsiu-Wen Huang).  
C. *Dictyophora indusiata* in the ecology education park (by Hsiu-Wen Huang).



Threatened plants restored:  
 A. *Arundina graminifolia* (by Chiuan-Yu Li).  
 B. *Dendrobium linawianum* (by Chiuan-Yu Li).  
 C. *Spathoglottis plicata* (by Chiuan-Yu Li).

## Future Development

- (1) Strengthen the establishment and maintenance of information platforms for the storing, managing, and circulating Taiwan's biodiversity data and specimen information. Develop advanced data integration models to support research and decision-making in ecology conservation, climate change mitigation, and sustainable development. Implement regular system and data backups, while maintaining and updating software and hardware architecture to ensure the database system's reliability. Improve data quality and integrity, continuously accumulating wildlife distribution information to enrich Taiwan's wildlife database. Enhance data linkage and update mechanisms, optimize search interfaces, and expand API functionality to promote broader data utilization.
- (2) Enhance the value-added applications of biodiversity information system through talent cultivation and the integration of Geographic Information System (GIS) and spatial distribution patterns. Transform collected or digitized wildlife basic maps and data into actionable information. Utilize this information to support evaluations and decision-making in ecology conservation, sustainable development, environmental education, and conservation policy. These efforts aim to increase the practical value and application of ecology data across various sectors, ultimately contributing to more effective biodiversity management and conservation strategies.
- (3) Enhance the development and use of natural compounds from Taiwan native plants or large fungi with edible and medicinal value. Conduct systematic research to effectively develop natural compounds and proceed with R&D of relevant products to increase human health and wellbeing while maintaining the sustainable use of biological resources.
- (4) Establish a preservation system for the genetic resources and genetic diversity of threatened plants. Combined with field survey research and plant phenology studies of threatened plants at TBRI, use tissue culture propagation technology to further research strategies for ex-situ conservation and propagation for threatened plants. This serves as basic research for the propagation, genetic resources preservation, and future restoration of other threatened plants in Taiwan.



Flow chart of asymbiotic seed germination test in threatened plants



## 5-5. Conservation Promotion Division

At the 10th COP to the Convention on Biological Diversity held at Nagoya in Aichi Prefecture Japan in 2010, it was understood that the objectives were still unachievable after almost two decades of promotion, and the main reason lies in the lack of effective education and promotion. The governments and the general public are insufficiently aware of biological diversity, therefore, by promoting biodiversity mainstreaming, it is hoped that through popular science and promotion, everyone can understand the value of biodiversity and take corresponding conservation actions by 2020 at the latest. As for

the 15th COP to the Convention on Biological Diversity held in Montreal Canada in 2022, the Kunming-Montreal Global Biodiversity Framework was adopted, in which 23 action targets were outlined to be achieved by 2030 with one being to improve awareness, education, monitoring, research, and knowledge management of biodiversity. Therefore, an important task and target at the TBRI Conservation Promotion Division is to promote biodiversity conservation mainstreaming through education campaigns, development of teaching materials, community building, publication campaigns, and volunteer services, and enhancing the awareness of biodiversity for all while attracting people to engage in conservation actions.

## Research Achievements

### (1) Establishment of the Conservation Education Center for proactive promotion of ecology education

Since formally opening to the public on March 23, 1999, the TBRI Conservation Education Center provides interpretation services, updates annual special exhibitions, and holds ecology film festivals and relevant events such as Leopard Cat Day and Leopard Cat Week from time to time. We continue to attract returning visitors, which is greatly beneficial to conservation campaigns and ecology education campaigns.

### (2) All-age ecology conservation camp provided, removing all temporal-spatial restrictions for full empowerment

In addition to providing services to schools visiting the Center, TBRI also sends nature interpreters to schools to provide services, so far, we have hosted over 1,000 visits and served over 90,000 visitors. In recent years, TBRI also proactively organized all-age ecology conservation seminars to empower education and training, events including parent-children day camp, the Cub Summer Camp, middle and high school ecology camps, and college and university ecology training camps are also held. Training can also be tailored for specific subjects such as farmland observers and citizen science training camps. Some extension education courses even produce cheerful clips that are uploaded to the internet, providing complete learning with restrictions of time and space removed.



Dr. Jane Goodall signing when she visited the Conservation Education Center in 1999 (provided by TBRI).



A	
B	C
D	E

- A. Group photo with participating guests during the opening of the special exhibition (by Liang-Chou Hsu).
- B. Group photo of students at the Cub Summer Camp (by Liang-Chou Hsu).
- C. Night observation by students at the Cub Summer Camp (by Liang-Chou Hsu).
- D. Parent-child one-day ecology camp campaign event (by Liang-Chou Hsu).
- E. Campaign event making bat houses (by Liang-Chou Hsu).

**(3) Implement the Satoyama Initiative and promote ecological communities**

Since 2009, TBRI has been lending the services of our professional researchers in assisting communities promote ecological education events, initiating the mechanism of ecology community building, and achieving the goal of "ecology for community and community for ecology". Recently we have incorporated the spirit of Satoyama Initiative to empower community partners in improving the ecological awareness and survey capability of community members, promote the alliance and partnering of Satoyama-style community partners, and reinforce the virtuous circle of mutual benefits in ecology.

**(4) Diversified publications and videos featuring both popular and academic science**

TBRI proactively turns research results into publications with various promotion brochures and pamphlets, annual research reports, Nature Conservation Quarterly, Taiwan Biodiversity Research journals, and varied ecology videos. In recent years, we further diversified in publishing comic books including "Save the Leopard Cat" and "Café Moss" to provide education amidst fun and featuring both popular and academic science in our extension education. Our publications have repeatedly won awards with many reposts online increasing our exposure, greatly adding to the breadth, depth, and strength of our promotion and campaigns.

The Nature Conservation Quarterly won the Outstanding Publication Recommendation by the 46th Golden Tripod Awards in 2022



Taiwan New Year Bird Count Annual Report



The Nature Notebooks



Biological Resources Interpretation Volumes

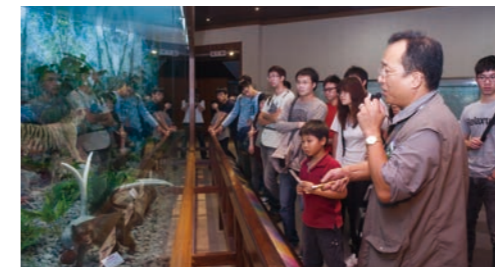


The Bryophyte Notebooks



**(5) Volunteer training to expand public volunteering service**

To expand the coverage of public volunteering services, TBRI set up the "Volunteer Service Program" to organize volunteer recruitment and training. There are currently 250 volunteers in service with a total of 20,000 volunteer hours per year, assisting with TBRI businesses such as nature interpretation, specimen production, field survey, and plant maintenance, greatly benefitting the need for human resources at TBRI. We also host regular seminars empowering volunteers and set up reward systems to reinforce our relationship of mutual aid.



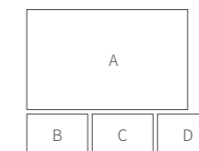
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- A. "Good Morni MIT" at the Starlight Theater during sunset (by Liang-Chou Hsu).
- B. Guests performing with the Leopard Cat ambassador on stage (by Liang-Chou Hsu).
- C. Parent and child making the Formosan Black Bear (by Liang-Chou Hsu).
- D. Volunteer providing interpretation inside the Conservation Education Center (by Liang-Chou Hsu).
- E. Group photo of volunteers returning to visit (by Liang-Chou Hsu).



## Future Development

- (1) Improve the quality of interpretation and enhance the operation management of the Conservation Education Center to increase operation performance and achieve sustainable operation.
- (2) Promote the Satoyama-style ecological community partnership, deepen community biodiversity conservation, assist residents in organizing resource conservation, ecology community building, survey and interpretation talent training, and promote ecotourism.
- (3) Increase the various ecological training, seminars, and camps held and services provided at schools, organize campaign events on specific dates, and collaborate with other agencies and organizations to expand the promotion of biodiversity conservation.
- (4) Continue to increase the various printed and multimedia publications, and promotions released through publishing and authorization, and further popularize the concept of conservation via authorization, reposting, gifting schools and agencies, exhibition, and sales.
- (5) Working in line with the promotion of agri-food policy by the Ministry of Agriculture. In addition to proactively training seed lecturers, TBRI also enhances the promotion of agri-food education through course developments, organizing seminars, and incorporating courses into camps.



- A. Life tree theatre (by Liang-Chou Hsu).
- B. The whale skeleton displayed at the Conservation Education Center (by Liang-Chou Hsu).
- C. Campaign event at school (by Liang-Chou Hsu).
- D. Campaign event at school (by Liang-Chou Hsu).

## 5-6. Wushikeng Research Center

Located at Zihyu Village in Heping District, Taichung City, the Wushikeng Research Center was established in 1993, covering around 353 hectares of national forest within the 122nd compartment of the Daan Creek working circle, at 670 to 1,834 meters in elevation. It provides for the rearing and propagation, genetic resources preservation, and restoration of endemic and rare species in Taiwan, as well as long-term monitoring and test research site for the broadleaf forest ecosystems at low altitudes, doubling not only as the research base for researchers but also playing an important role in the species preservation and maintenance of ecosystems. In response to the long-term requirements of wildlife research, conservation, and operation management, the Center conducts long-term monitoring of ecosystems, maintains forest roads for transportation, and sets up research and conservation facilities, maintaining a good habitat while ensuring reasonable protection and usage of natural ecological resources through effective operation and management. The management of experimental forest within the area follows the regulations of the Wildlife Conservation Act and Forestry Act.

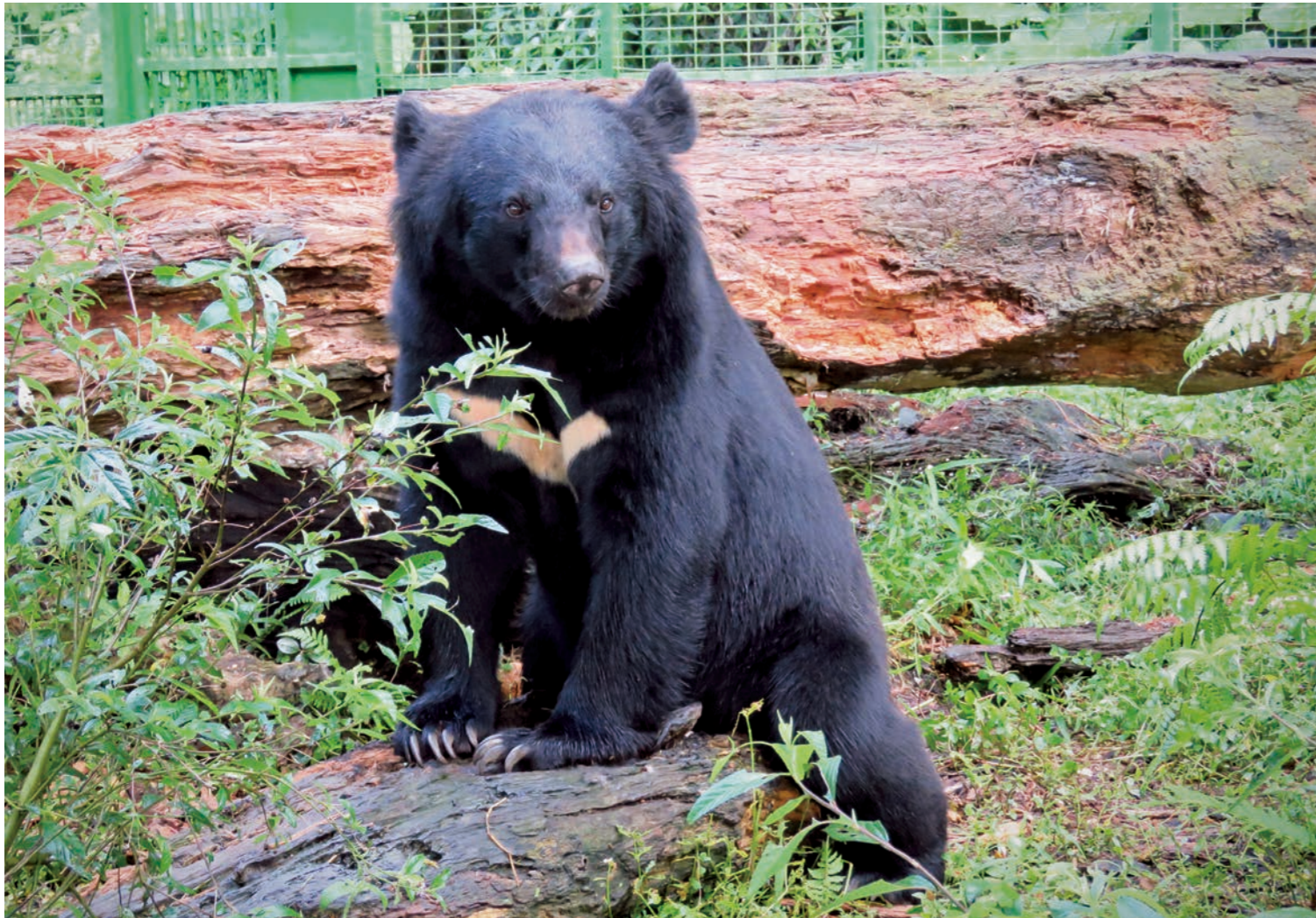


## Research Achievements

- (1) Establish and collect the long-term monitoring data of the ecosystems in the Wushikeng area, increasing the people's understanding of the ecosystems in the low altitude area in Taiwan, while providing references to the research of environmental resources in the low altitudes. Compiling the survey data over the years, records have been taken for 618 species of vascular plants in 140 families, 29 bryophyte species, 46 mammal species in 20 families, 119 bird species in 41 families, 19 amphibian species in 5 families, 33 reptile species in 7 families, 9 freshwater species in 5 families, 23 firefly species in 2 families, 204 butterfly species in 5 families, 618 moth species in 33 families, and 37 aquatic insect species in 24 families.
- (2) The sheltering, rearing, training, and reintroduction of protected wild animals. The key sheltering species is the endangered Formosan black bear. In addition to everyday rearing and care, we conduct breeding, restoration, and conservation research in artificial captive environments, so far, we have successfully bred 5 Asian Formosan black bears. In recent years, the focus has been on orphaned cubs or the medical care, training, and reintroduction of wounded bears.
- (3) Many native or endemic rare plants are propagated or restored within the area, including *Rhododendron kanehirai*, *Podocarpus fasciculus*, *Mahonia oiwakensis*, *Pyracantha koidzumii*, *Cephalotaxus wilsoniana*, *Cycas revoluta*, and *Citrus tachibana*. It is greatly beneficial to the preservation, restoration, and educational display of the genetic resources of native plants.

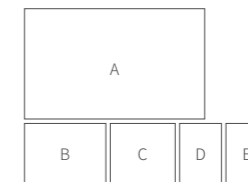
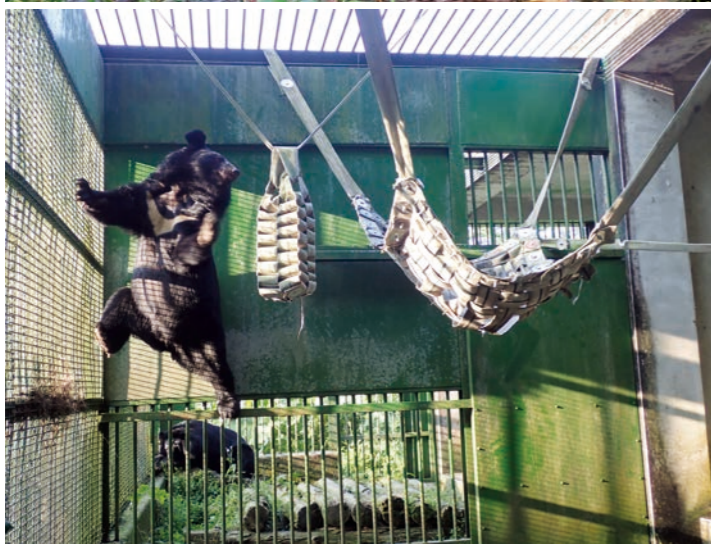


- A. Wushikeng Research Center (by Jui-Yau Cheng).  
B. Wushikeng River (by Tung-Chi Ho).  
C. Fireflies at the Wushikeng Research Center (by Li-Cheng Shih).



## Future Development

- (1) Continue in the Wushikeng area the animal and plant resource surveys according to ecological changes, population monitoring of main species, collect and record climate factor data in the area, and establish the basic information and dynamic changes of the low altitude ecosystems, to inform the operation and management, and conservation of natural resources.
- (2) Conduct research relevant to the wild animals sheltered and discuss feasible reintroductions or other handling methods.
- (3) Continue collecting, preserving, and growing native plants, and work with the Wild Plants Division to shelter low-altitude rare and endangered plants with habitats destroyed, and exercise its function of genetic resources preservation and restoration of low-altitude species.
- (4) Collaborate with domestic and international universities and academic research agencies to research biological resources, biology, and diversity in low altitudes, and organize field practice for relevant courses.



- A. "Happy", the Formosan black bear sheltered extendedly at the Wushikeng Research Center (provided by Wushikeng Research Center).
- B. Use hammock and forage bag for environment enrichment (provided by Wushikeng Research Center).
- C. Behavioral training for health care for the bears (by Jui-Yau Cheng).
- D. Dark Woolly Bat (*Kerivoula furva*) (by Hsi-Chi Cheng).
- E. Genetic resources preservation for *Dendrobium linawianum*, a critically endangered plant in Taiwan (by Yen-Long Chen).



## 5-7. Tengzhi Research Center

Located at Baoshan Village in Taoyuan District, Kaohsiung City, the Tengzhi Research Center was established in 1995, covering around 219 hectares of what used to be the national forest within the 57th compartment of the Laonong Creek working circle. At 1,160 to 2,635 meters in elevation, the average annual temperature is approximately 15°C with 2,200 millimeters of average annual precipitation. With 20 hectares of tree plantation in the area, the rest is natural forest. Vegetation includes the Tsuga-Picea zone, Quercus zone, and Machilus-Castanopsis zone, among which, the Tsuga-Picea zone features Formosan Hemlock (*Tsuga chinensis* var. *formosana*), Taiwan Spruce (*Picea morrisonicola*), and Master's Pine (*Pinus armandii* var. *mastersiana*) as dominant species, while the Machilus-Castanopsis zone sees more of Japanese Chinquapin (*Castanopsis cuspidata*), *Engelhardia roxburghiana*, Sharp-leaf Litsea (*Litsea acuminata*), Alishan cinnamon (*Machilus philippinensis*), and *Phoebe formosana*. The forest type is intact with rather abundant wild animal and plant resources. Aligned with the conservation research, operation, and management of wildlife, the Center set up one after the other research offices, test equipment, and remote monitoring systems, and conducted long-term ecological surveys, research, and monitoring of species, forest road patrol, and habitat environment maintenance, providing an excellent base for the biodiversity research of medium-altitude forest ecosystems, cultivation and preservation of endemic or rare species, long-term ecosystem monitoring, and environmental education.



Tengzhi Research Center surrounded by the forest, and a wildlife survey conducted in the Tengzhi area (by Chuan-Yu Li).



A		
B	C	E
	D	F

A. Formosan Serow (*Capricornis swinhoei*) (by Chiuan-Yu Li).  
 B. Owlet of Brown Wood-Owl (*Strix leptogrammica*) (by Tun-Yu Chen).  
 C. *Odontolabis siva parryi* (by Ming-Chang Lin).  
 D. *Lithocarpus lepidocarpus* (by Chiuan-Yu Li).  
 E. *Schisandra arisanensis* (by Chiuan-Yu Li).  
 F. *Cyclosa ginnaga* (by Ying-Yuan Lo).

## Research Achievements

- (1) Three permanent sample plots are established for long-term monitoring by the Tengzhi Research Center for regular survey of wildlife resources, so far records have been taken for 346 vascular plant species in 103 families, 86 fungi species in 34 families, 43 mammal species in 17 families, 116 bird species in 41 families, 21 reptile species in 5 families, 6 amphibian species in 3 families, 109 butterfly species in 10 families, 722 moth species in 24 families, 477 insect species of the Coleoptera order in 29 families, 1 insect species of the Odonata order in 1 family, 5 species of the Diptera order in the Tipulidae family, and 13 terrestrial mollusk species.
- (2) Various test equipment including fixed transects, infrared camera traps, nest boxes, light traps, and audio-visual automatic monitoring systems are set up for the phenological, taxonomic, and reproductive biology research of specific wildlife species, and assist in the works of the preservation and cultivation of genetic resources.
- (3) The coniferous-broadleaf mixed forest type here is intact with enriched biological resources, providing a base for various academic research organizations and universities for biodiversity research.

## Future Development

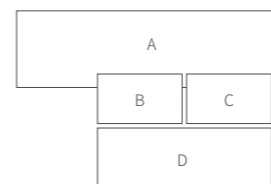
- (1) Continue in the Tengzhi area the wildlife resource survey and monitoring according to ecological changes, collect and record climate factor data in the area, and establish the basic information and dynamic changes of the medium altitude ecosystems, to inform the operation and management, and conservation of natural resources.
- (2) Conduct systematic medium-altitude biology research and establish a database for medium altitudes to complement the long-term monitoring system of biological resources.
- (3) Work with domestic and international universities and academic research organizations to research biological resources, biology, and biodiversity in the medium altitudes.
- (4) Develop the research of protection and sustainable use of the medium altitudes and enhance conservation education and campaign.



## 5-8. Hehuan Mountain Research Center

Located at the meeting point of Hualien County's Siulin Township and Nantou County's Renai Township, the Hehuan Mountain Research Center was established in 1994 upon approval from the Executive Yuan. Originally managed by the Dongshi Forest District Office, the 80th compartment of the Dajia River working circle and the 68th compartment of the Liwu River working circle in Hualien covering a total of 250 hectares of national forest were entrusted with the Center as land for the High-altitude Experimental Station.

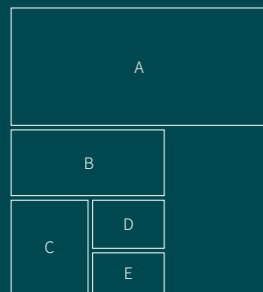
The Center sits in the Hehuan Mountain area, the middle section of the Central Mountain Range, to the north are Pulu Mountain and Chu Mountain with Pingfeng Mountain and Cilai Mountain to the east. The highest point is the Northern Hehuan Mountain sitting at 3,422 meters above sea level, which is the source of the Liwu River in the east and the Dajia River in the east. The climate is cold and usually humid, freezing in the winter with occasional snow and covered in frost for 6 months a year, it sees 3,500 millimeters of average annual precipitation. Made up of 239 hectares of natural forest and 11 hectares of tree plantation, the woodland has 6 plant communities according to its different vegetations including grassland, *Abies kawakamii* forest, *Abies-Tsuga* mixed forest, *Tsuga formosana* forest, *Pinus taiwanensis* forest, and Rhododendron thicket. Responding to the long-term requirement of conservation research and operation and management, the Center has established an office quarter, purchased necessary equipments for survey and research, set up the regional network and internet equipment, providing for survey, research, conservation, and monitoring of biodiversity in the high altitudes in Taiwan, and forest ecosystem management and environmental education.



- A. View of the Hehuan Mountain (by Li-Cheng Shih).
- B. Hehuan Mountain Research Center (provided by TBRI).
- C. Hehuan Mountain Research Center (by Li-Cheng Shih).
- D. *Abies kawakamii* (by Li-Cheng Shih).

## Research Achievements

- (1) According to surveys, there are 425 vascular plant species from 76 families, and animals including 16 mammal species from 8 families, and 4 amphibian species from 3 families; insect species from 12 orders, including 92 Lepidoptera species from 8 families and approximately 900 moth species; records have been taken for 66 bird species from 28 families, including 44 resident birds, 19 winter migrants, and 3 summer migrants, with 25 migrant bird species leaving records of breeding on Hehuan Mountain.
- (2) Completed the preliminary biological resource survey of the Hehuan Mountain area and established three long-term permanent forest sampling plots in 1998 with forest microclimate stations providing local climate data.
- (3) Other than maintaining the natural succession of the habitats, biodiversity, and ecosystems, we also invite other TBRI divisions and stations, or other research units and universities to collaborate on many biodiversity surveys, monitoring, and research.
- (4) Published books include *The Colorful Spirits of the Hehuan Mountain*, the field guide of *Seasons in the Mountain: Alpines of Mt. Hehuan*, and *Moths of the Hehuan Mountain*.



- A. Winter in Hehuan Mountain  
(by Chun-Yuan Huang).
- B. *Rhododendron pseudochrysanthum*  
(by Li-Cheng Shih).
- C. *Apamea aquila substriata*  
(by Li-Cheng Shih).
- D. Formosan Salamander (*Hynobius formosanus*) (by Chun-Fu Lin).
- E. Taiwan Rosefinch (*Carpodacus formosanus*) (by Pei-Cheng Wu).



## Future Development

- (1) Continue in the Hehuan Mountain area the animal and plant resource surveys according to ecological changes, population monitoring of main species, collect and record climate factor data in the area, and establish the basic information and dynamic changes of the high-altitude ecosystems, to inform the operation and management, and conservation of natural resources.
- (2) Conduct systematic high-altitude biology research and establish a database for high altitudes to complement the long-term monitoring system of biological resources.
- (3) Work with domestic and international universities and academic research organizations to research biological resources, biology, and biodiversity in the high altitudes.
- (4) Develop the research of protection and sustainable use of the high altitudes and enhance conservation education and campaign.

## 5-9. Qigu Research Center

One kilometer north of the Zengwen River, the Center sits in the administrative district of Qigu in Tainan City, managing 1.76 hectares of land. Originally a building constructed by the Tainan County Government for the Black-faced Spoonbill Conservation Management and Research Center, the County Government handed over the building to TBRI in April 2009 for comprehensive development, and the preparation office for the Qigu Research Center was set up. With the restructuring of TBRI on August 1, 2023, Qigu Research Center was officially established. The center is committed to the ecological survey, monitoring, and research of coastal wetlands, and the Black-faced Spoonbill Ecology Exhibition Hall was established to promote education of coastal wetland ecology and improve public awareness of wetland ecology.

The Center sits adjacent to the only two national-level wetlands in Taiwan. The Zengwen Estuary Wetland and Sicao Wetland are important habitats for migratory waterfowl in winter, including the most renowned, Black-faced Spoonbill (*Platalea minor*), a treasured rare migrant listed as an endangered bird species in the IUCN Red List. Half of the black-faced spoonbill worldwide spend their winter in the southwestern coastal wetlands in Taiwan from September to the following April each year. Also, as one of the few natural lagoons remaining in Taiwan, the Qigu Lagoon is surrounded by mangroves, aquaculture fish farms, and salt ponds. The lagoon is an iconic natural landscape along the southwestern coast and an excellent site to research the ecology of coastal wetlands. As Taiwan is an important hub of the East Asian Flyway for migratory birds and a key site for cross-border research for scholars worldwide, the Center anticipates becoming the research base for international long-term wetland surveys for wetland experts and scholars from Taiwan and the world in the future. The Black-faced Spoonbill Ecology Exhibition Hall functions as a venue for exhibition, collection, and interpretation, develops ecological lesson plans, and promotes coastal wetland ecology education with practical actions.



## Research Achievements

### (1) Wetland biodiversity monitoring

The biodiversity and water quality are regularly monitored for the fish species, shrimp species, and crab species at the fixed sample stations in the Qigu Lagoon every season, while the biodiversity of bird species is regularly monitored at fixed line transects in the northern fish farm, eastern fish farm, and Qigu River, providing baseline data for long-term biodiversity monitoring. So far, records have been taken for 202 fish species in 60 families, 122 bird species in 36 families, and 371 vascular plant diseases in 72 families.

### (2) Set up SOP for wetland survey and surveillance system

Seeing that there should be a standardized method of monitoring and data recording, with data feeding to the database for extended accumulation which could be compared and interoperable, and achieving the goal of long-term monitoring, the Standard Operating Procedure for the Monitoring System of Wetland Ecosystem Biodiversity was established and promoted in Taiwan through education and training.

### (3) Regional-scale monitoring of fish farm biodiversity

Starting in 2021, the Center has been collaborating with the Ecosystem Management Division in setting up the regional-scale monitoring of fish farm biodiversity in the Qigu aquaculture area. Data for two complete winters have been accumulated, recording over 320,000 birds of 138 species in 40 families. All recorded lists have been uploaded to the open database. They provide baseline data for ecological capacity assessments when policies are developed in response to net zero by 2050, including for fishery and electricity symbiosis.

### (4) Operation and management of the Black-faced Spoonbill Ecology Exhibition Hall

In addition to the multiple ecology exhibitions and workshops held each year, parent-child camps are also organized for parents to learn with their children and achieve the purpose of promoting ecology, thus improving the educational function of the Black-faced Spoonbill Ecology Exhibition Hall, The Exhibition Hall was certified as an environment education facility in 2016 with the certification extended in 2021, and environmental education facilities evaluations passed in 2019 and 2023 respectively.

### (5) Promote the popular science of wetland biodiversity

Translate wetland ecological research into teaching materials appropriate for elementary and middle schools. So far, we have produced the following teaching materials: Banding Black-faced Spoonbill, Recognizing Coastal Plants, Searching for Wetland Treasures, Wetland Frogs, First Step to Be A Naturalist, The Oyster Stories, and Alien Species. Every year, we provide on-campus lecture services, and organize wetland outdoor events and biodiversity observation workshops, introducing wetland ecology education to schools.



- A. Experience riding the fishing raft (by Meng-Chi Hung).
- B. Black-faced Spoonbill Ecology Exhibition Hall (provided by Qigu Research Center).
- C. Wetland biodiversity survey (provided by Qigu Research Center).
- D. Nature interpreter leading an outdoor tour (by Meng-Chi Hung).



Banded Gray-tailed Tattler (*Tringa brevipes*) resting in a Changhua coastal fish farm (by Pei-Cheng Wu).

## Future Development

- (1) Continue the long-term biodiversity survey in Qigu wetland and establish coastal wetland basic research and long-term monitoring baseline data to inform the assessment and research of environmental and social changes.
- (2) Collaborate with universities or research institutes to establish long-term social-ecological research (LTSER) so that various wetland surveys and research materials can be integrated more effectively to inform the planning of environmental policies.
- (3) Research the various ecosystem services of wetlands including biodiversity, habitat, and carbon sequestrations to inform the conservation and management of wetlands.
- (4) Enhance wetland conservation promotion, translate ecological research into popular science, advance the ecological education function of the Black-faced Spoonbill Ecology Exhibition Hall, and recruit volunteers to improve the quality of nature interpretation.



Pied Avocet (*Recurvirostra avosetta*) foraging in the Beimen shallot field (by Pei-Cheng Wu).



## 6. Conclusion and Outlook

Since the establishment of TBRI in July 1992, we have been committed to the survey and research of biological resources in Taiwan, establishing a database of baseline data, genetic resources conservation and restoration of rare and endangered species, and conservation promotion and campaign, laying an important foundation for conservation works in Taiwan. In response to the international trend of biodiversity conservation and taking the opportunity of government reorganization, following our restructuring as the Taiwan Biodiversity Research Institute, we will take on even bigger challenges and missions, building on existing results to achieve further goals. Future goals include:

- (1) Complete the survey and research of wildlife, the collections of specimens and genetic resources, and the establishment of the biodiversity database.
- (2) Enhance the research on biology, conservation strategy evaluation, and restoration technology of endemic, rare, and endangered species.
- (3) Establish biodiversity indicators and long-term monitoring systems, publish regular monitoring reports, and compile them into national reports.

- (4) Research the conservation, restoration, operation, and management of important ecologies and wildlife habitats.
- (5) Research the surveillance, prevention, control, and removal technologies for invasive alien species.
- (6) Enhance the sustainable use, benefit-sharing, and management mechanisms for local wildlife genetic resources.
- (7) Education and campaign on biodiversity, promote communities and public engagement in biodiversity conservation.
- (8) International academic exchange and cooperation.

As a member of the international society, Taiwan should actively implement the works of biological diversity. To achieve this goal, TBRI not only demands that all staff exercise the spirits of "quality, precision, and teamwork," and be amply ambitious with a strong sense of mission, we look to build on our past research achievements and experiences, respond to the international trend of conservation strategies, and work concertedly to safeguard the biodiversity of Taiwan. We sincerely invite the people of Taiwan to participate in biodiversity conservation, give our all to the natural environment, and gift our future generations with a sustainable future where "mankind exists in harmony with nature".

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