

## **Biodiversity research and training program in Thailand**

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*Abstract:* Biological diversity is the variety of life forms—microorganisms, plants, and animals including humans—at all levels of organization from genes to populations, species, ecological communities and ecosystems. Such diversity of life is a legacy of evolutionary processes. Tropical forests, including those occurring in Thailand, are rich in biological diversity. They are essential bioresources for human survival and wellbeing in terms of food, medicines, clothing and housing. These bioresources also provide us with novel genetic materials for development of modern biotechnology. Thai people have made use of these bioresources for their traditional ways of living for millennia. However, Thailand has lost innumerable life forms as a large percentage of tropical forest has been destroyed by human activities during the past four decades. Such loss of biodiversity is likely to have tremendous effects—often unpredictable—on the productive lives of all living things including ourselves. A basic knowledge of these living things is needed in order to facilitate conservation and management and to better understand how to use biological resources in a sustainable manner. Therefore, the Special Program for Biodiversity Research and Training (BRT) was established in November, 1995, under the joint sponsorship of TRF and BIOTEC, to support basic research in tropical biology as well as studies on policy development and management of biodiversity in Thailand.

Evolutionary processes of life on earth fundamentally involve genetic differentiation and genomic adaptation to microenvironmental variation of habitats. As a result, a tremendous diversity of species of microbes, fungi, plants and animals occurs in a variety of ecological settings throughout the world, particularly in the tropical regions. Such a variety of life forms is collectively known as biological diversity, or biodiversity for short. Hence biodiversity encompasses all levels of organization of life from genes to populations, species, ecological communities and ecosystems. These varieties of living things have long been and continue to be essential resources for human survival. Around the world, people directly use the microbes, fungi, plants and animals in their surroundings as sources of agricultural products, traditional medicines and tools, and many other species are used indirectly as sources of pets, recreation and essential ecological services. “Ecological services” include the benefits often taken for granted: water in the atmosphere, rivers and ground, soils, recycling of our wastes, and protection from the extremes of climate.

The natural world of biological diversity is concentrated in tropical forests and coral reefs, including those that exist in Thailand. Thailand is a relatively small country with a total area of about 513,000 km<sup>2</sup>, of which 20–25 percent is covered with forest. Thailand also has long coastlines of some 2,600 km facing the South China Sea to the east and the Andaman Sea on the west side. In the past, 70 percent of the total land area was covered with various kinds of tropical forest including broad-leaved evergreen, dry dipterocarp and pine forest, mixed deciduous forest, peat swamp forest and mangrove forest along coastlines (ref. 1). About 1/3 of the coastal areas are bordered by mangrove forests. These variations of forest type provide terrestrial and aquatic habitats for numerous life forms in complex ecosystems. The tropical forests support some 12,000 species of vascular plants, roughly 15,000 known species of animals and about 10,000 known species of microorganisms (ref. 2). It is believed that more than 100,000 species

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of living organisms in tropical forests of Thailand await to be discovered. Thus Thailand is situated in one of the richest areas of the world with regard to biological resources, and spans a range of latitude from about 5° to 21° N. A good example of this wealth is Huay Kha Khaeng/Thung Yai Naresuan Wildlife Sanctuaries which have been designated as a "World Heritage Site" by UNESCO. Over 100 national parks designated by the government are also rich in flora and fauna and are becoming attractive places for ecotourism.

Thailand has a long and rich history of over 700 years of sovereignty and glory. The artistic but crumbling ancient monuments and temples bear witness to the influence of biological nature which surrounded the local community in pre-Thai civilizations. That influenced the development of cultural diversity and folklore (ref. 3). The prehistoric site at Ban Chiang located in Khon Kaen Province, northeastern Thailand, dating back over 5,000 years, appears to presage many features of development of traditional lifestyles in Thailand. In addition, the Thai classical performing arts and the fine arts reflect a society influenced by the natural beauty of the surrounding landscape and its biological diversity (ref. 4).

Thai society depends on an enormous variety of vegetables, spices, fruits and flowers occurring naturally or in cultivated fields. Most cultivated fruits and vegetables have close wild relatives which persist in fields and forests. Thai food includes a wide variety of dishes which are particularly healthy because of the variety of herbs and spices they contain (ref. 5). Thai cuisine, in fact, ranks among the world's greatest culinary achievements. This cuisine proclaims artistic creativity, variety and bold tastes besides its benefits to health. It is based on the ingenious use of native biodiversity.

Wild plants of agriculturally important species contain the genetic resources needed to breed crops for resistance to pests and pathogens. Varieties of rice, for example, have been developed to be grown in floating farming, in paddy farming and in dry conditions in the highlands. A number of local species of vegetables and tropical fruits, for example, lemon grass, chilli, mangoes and sugar cane, have been used by local people throughout Thai history and have become associated with the traditional lifestyle. In addition, natural products from many species of plants have been used as pesticides. Crude extract from the kernel of *Azadirachta indica* A. Juss. var. *siamensis* Valetton (Thai: neem) contains azadirachtin (triterpenoids group) which has been used as an effective pesticide against many species of agricultural pests including cockroaches, locusts, fleas, ticks and plant hoppers.

People of Thailand have used herbs and medicinal plants as sources of drugs for traditional remedies of ailments throughout the long history. Hence, ethnomedicine has been developed and has evolved, tested through time, into the intricate art of folk medicine (ref. 6). Such indigenous knowledge has been perpetuated by being passed down from generation to generation within ethnic tribes. For instance, *Curcuma longa* Linn., has been used for treatment of peptic ulcer and dyspepsia, *Diospyros mollis* Griff., has been used to get rid of hookworm and *Clinacanthus nutans* Lindau, is used for treatment of burns, eczema and herpes simplex. The best known example is *Croton sublyratus* Kurz (Family Euphorbiaceae) which has been used by local people for a long time as an effective treatment for peptic ulcer. Nowadays it is known to contain plaunotol, an acyclic diterpene group of natural products, and it has been commercialized under the trade name "Kelnac" by the Sankyo Co. It is estimated that more than 800 species of plants contain bioactive organic compounds which might be useful for pharmaceutical products (ref. 7).

Descriptions on palm leaves concerning herb usage in folk medicine (Samud Khoi, in Thai), by various ethnic groups, is evidence that the ancestral inhabitants of this region had developed their own systems of tradition medicine long ago. These ancient descriptions of folk medicine are most valuable documents in the development of traditional Thai medicine and Thai medicinal plants.

Thai people have made use of these local bioresources as food, medicine, clothing and housing to support their living (ref. 8). The development of civilizations and cultural evolution has had a synergistic relation with the natural biological world that has long been taken for granted (Fig. 1).

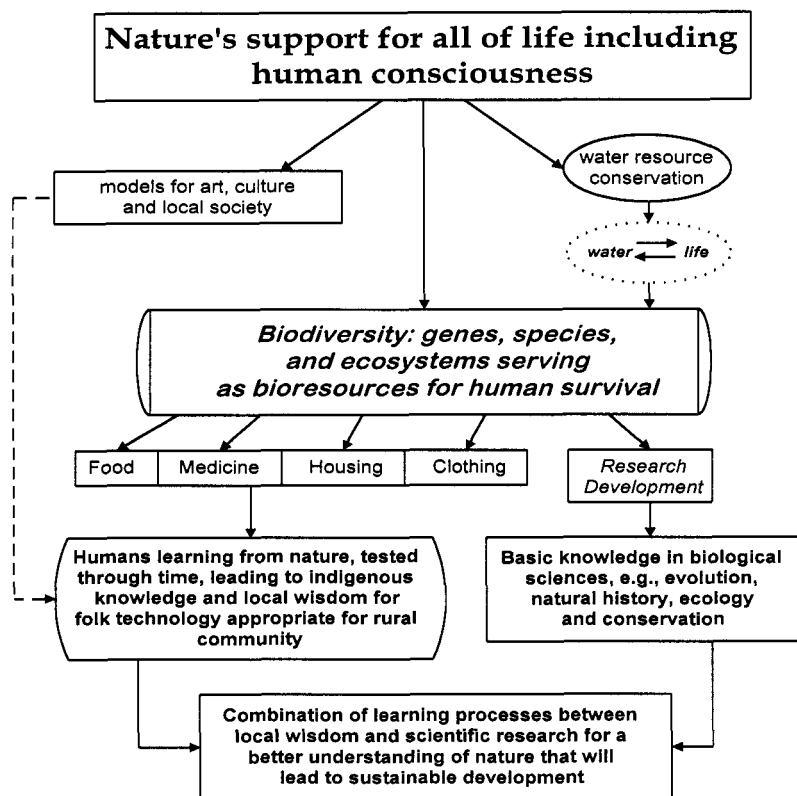


Fig. 1 The value of biodiversity to the evolution of cultural diversity and human survival.

The Thai people lived peacefully and sustainably surrounded by the balanced and green environment, for over 200 years, until the 1960s when the Thai government launched its first National Economic and Social Development Plan. As a consequence of the series of national development plans during the past 35 years, Thailand has lost biodiversity and bioresources at an alarming rate. Tropical forests have decreased sharply from 70 percent to only about 25 percent now. The mangrove forests have diminished more dramatically. The rivers and estuaries of the country are suffering even more damage, as a result of upland deforestation, industrial pollution, damming, dredging, canalization and shoreline obliteration. Rivers are extremely rich in fishes and invertebrates, but they are common multiple use environments and no one takes responsibility for managing or conserving their biota.

The widespread reduction of terrestrial and aquatic habitats for all life forms is inevitably leading to tremendous loss of biodiversity, and many species have suffered due to stochastic as well as human-caused changes in the natural environment. Many species have become endangered and some are "critical", that is, in imminent danger of extinction if action is not taken to save them (ref. 9). Many examples are known among the birds of Thailand, which are perhaps the best known components of our biodiversity. Recent records show that among the 946 known species of birds found in Thailand, 7 species have become extinct, 37 species are critical, 69 species are endangered and 248 species are vulnerable (ref. 10, 11). Other species of animals are also facing a similar fate due to loss of habitats by deforestation and other human activities such as clear-cutting and unregulated logging as well as hunting for food and for trade.

Thailand is also rich in flora. About 12,000 species have been taxonomically studied, but only approximately 20 percent of the total has so far been included in the *Flora of Thailand* monographs. We do not know how many species have been lost, or will be lost, as a result of extensive deforestation during the past 4 decades. However, it is believed that at least 1,000 species of plants are regarded as critical; for

instance, *Kerriodoxa elegans* (white palm), *Vatica diospiroides* (rubber tree) and *Maxburretia furtadoana* (palm tree) occurring only in southern Thailand; *Afgekia mahidole* (a kind of swine tree) rarely found in Kanchanaburi, western Thailand; *Bretschneidera sinensis* and *Trigonobalanus doichangensis* in northern Thailand, etc.

An abundant diversity of microbes, fungi and slime molds, and lichens has recently been discovered from forests in different parts of Thailand, but by far the greatest number remain to be discovered. Systematic studies and bioprospecting assays of these bioresources are currently underway in the laboratories of the National Center for Genetic Engineering and Biotechnology (BIOTEC).

Access to these bioresources basically depends upon scientific knowledge in tropical biology, which in turn can be used as guidelines for selecting the most promising species and sites for bioprospecting. However, the most fundamental and pressing questions about our biodiversity deal with systematics and taxonomy. How many species of plants, animals and microorganisms exist in different ecological settings in Thailand? How are they related? When do they occur? What microbes and fungi are essential for ecological services such as maintaining soil fertility? These questions must be addressed for a better understanding of our biological diversity and how to protect and manage it.

Until recently, there has been very little support for these kinds of basic research from the government of Thailand. Systematics and taxonomy, population biology, genetics and ecology, as well as biological surveys and species inventories, have long been neglected. Thus, researchers in these fields had to find their own financial support from funding agencies outside the country. This was not always an easy task for junior or even some senior biologists. Now the situation is changing, partly due to the environmental awareness of the Thai people, and the impact of the Earth Summit, particularly the Convention on Biological Diversity (CBD), in Rio de Janeiro, Brazil, in June 1992. Thai people have also become increasingly aware of the significance of ecological services. That awareness usually arose following disasters such as landslides, drought, severe flooding, salinization, loss of riverine fishes, etc., resulting from unwise development. Academic and industrial researchers also have become more aware of the economic importance of biological diversity which serves as genetic resources for agricultural crops, pharmaceutical products, and for new approaches in biotechnology as well as valuable sources of traditional medicine.

The Thai government has set up two independent funding agencies as part of the long term development on science and technology: the National Science and Technology Development Agency (NSTDA) established in 1991, and the Thailand Research Fund (TRF) founded in 1992. The TRF provides support for basic and applied research activities in various disciplines including science and technology, arts, humanities, sociology and education. NSTDA is organized into divisions which support research and training in a few broad priority areas: material science (MTEC), information technology (NECTEC), and genetic engineering and biotechnology (BIOTEC). BIOTEC has given broad support to projects in DNA technology, crop development and improvement, fermentation technology, and bioprospecting of natural products from wild species.

It has become clear in these endeavors that lack of knowledge of taxonomy, distribution and ecology of native species will continue to be a major impediment to the discovery and development of useful animals, plants, and microorganisms, particularly those living in tropical forests. Realizing these problems, BIOTEC, in collaboration with TRF, has established a Special Program for Biodiversity Research and Training (BRT), which is expected to become a major part of a new National Center for Biodiversity to be established soon. The major objective of the BRT program is to promote research on and conservation and sustainable use of biological resources. This program has made available substantially increased funding for basic and applied research in disciplines relating to biodiversity, encompassing its various subsystems: genes and genetic systems, species and ecological diversity, and ecosystems. As the name implies, the aims of this BRT program are: (1) to train a new generation of scientists and leaders in population biology, genetics, ecology and evolutionary biology, incorporating the modern tools of molecular biology, and (2) to improve research capacity in basic and applied disciplines in order to

improve our knowledge of biodiversity and its conservation and management. The BRT program has been approved to run for 5 years (1995–2000) with a total budget of about 500 million baht.

The BRT is supporting research and training activities under the following headings:

#### **Program 1. Systematics, genetics and ecology**

This program emphasizes studies which increase knowledge about biodiversity, with emphasis on genetics, species, communities and ecosystems. The projects which constitute this program include taxonomic work, surveys and inventories of particular environments or ecosystems, and studies of the ecology, population genetics and distribution of important species.

#### **Program 2. Monitoring of populations and ecosystems**

The monitoring activities funded under this program seek to describe and understand the dynamics of ecological systems and examine the effects of human disturbance over time. The projects funded are to monitor populations, especially the abundance and distribution of species; mangrove communities; growth, mortality and reproduction of forest trees; and the physical and biological functioning of ecosystems. At least one project involves establishment of a long-term ecological research site.

#### **Program 3. Economics, society and indigenous knowledge related to biodiversity**

This program focuses on the knowledge and uses of biodiversity by local residents and communities through systematic collection of folk knowledge, study of indigenous plants and animals, the effects of human activity on the biosphere, and local wisdom of ecologically sustainable agricultural methods.

#### **Program 4. Information coordination**

This program recognizes the opportunities created by the rapid advance in information technology and seeks ways in which that can be used to enhance the capability of biodiversity researchers to organize and store data efficiently and make it available to others. The monograph series *Thai Studies in Biodiversity*, or *TSB*, is being launched.

#### **Program 5. Human resource development and training in tropical biology**

This program supports high quality training and educational activities such as improvement in graduate programs, research grants and scholarships for Masters' and Doctoral studies at Thai universities, workshops, seminars and conferences. This is a major objective of the BRT program.

#### **Program 6. Development of technological proficiency for sustainable social and commercial uses of biological resources**

Projects under this program aim to identify organisms with pharmacological, agricultural, social and industrial uses, and to develop human, scientific and technological resources for research and development of natural products. The scope of the program includes increase of technological capacity to study and develop natural products in Thailand; research on sustainable uses of biological resources; collection and storage of organisms with potential for scientific and commercial applications.

#### **Program 7. Policy development and management of biodiversity**

Projects under this program promote development of policies and management capacities by which biological resources can be sustainably utilized. Projects focus on analysis of social and economic incentives for managing biodiversity resources; examination of roles and values of biodiversity in society, the economy and the environment.

During the past two years of operation, the BRT program has supported some 70 research projects and 120 scholarships leading to M.Sc. and Ph. D. degrees in various fields of tropical biology. The success of the BRT's efforts in the conservation of biodiversity and bioresources and revival of indigenous knowledge as well as folk technologies will depend on the attitudes and perceptions of people, especially policy makers. The government of Thailand has committed itself to the notion that conservation of biodiversity will be a prerequisite for the attainment of a modern and sustainable economy and increases in the quality of life. Environmental awareness has been increasing among the Thai people, which is particularly evident in the country's relatively free press. But since Thailand has a relatively free market economy, the commitment and cooperation of all parties concerned, including local people, scientists, NGOs, the private sector and government, will be essential for intelligent management and conservation of biological diversity.

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