Biodiversity and Its Conservation and Management in the Hindu Kush-Himalayan Region of China

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Abstract

The Hindu Kush-Himalayan (HKH) region of China is a large area with extremely complex topography and an extremely diverse climate. The biodiversity of the region can be assessed at three levels, i.e., ecosystem diversity, species' diversity, and genetic diversity; and its conservation and management are reviewed in the present paper. The ecosystem, which is most diverse in the northern hemisphere, varies from tropical rain forest to desert to super-alpine glacier, i.e., snow ecosystems. The species' diversity in this region is also outstanding, with 13, 000 species of higher plants. Forty genera of angiosperms alone are endemic to this region. Genetic resources are especially precious, both for the tolerance of their genes to various extreme environments and for the over 230 species of wild relatives of crops and more than 20 species of wild relatives of livestock. In addition, there are over 1,500 species of medicinal plants and more than 90 species of medicinal animals, apart from thousands of species of ornamental and other plants of economic value. However, the loss of biodiversity in this region has reached serious proportions due to the denudation of natural forests and irrational use of bioresources, following the rapid growth in human population and economic activities. Fifty-six nature reserves have been founded for *in situ* conservation, and *ex situ* conservation is also being carried out in the region under discussion. Suggestions are made in the present paper for a better understanding of biodiversity and more effective conservation and management in this region.

Contents

INTRODUCTION

The Hindu Kush-Himalayan (HKH) region of China is a huge area and includes most of the Qinghai-Xizang (Qing-Zang) Plateau and the Hengduan Mountains' region, adjacent to the neighbouring countries of Afghanistan, Pakistan, India, Nepal, Bhutan, and Myanmar in the southwest and linked to the Kunlun Range, Hoh Xil Range, Tangula Range, and Bayan Har Range in the north. The area extends eastwards towards the eastern edge of the Hengduan Mountains, covering Xishuangbanna in Yunnan in the south. The total area is over two million square kilometres. This vast area covers the three principal climatic zones, namely, tropical, temperate, and frigid. The southern and southeastern parts are influenced by the Indian Ocean monsoon, while the Pacific monsoon is predominant in the mountains on the eastern edge. Therefore, the southern and eastern parts of this region have dense precipitation and are humid, whereas the northwestern parts, deep in the plateau and far from the ocean, are extremely dry. Between the two there is a wide, semi-arid intermediate zone. Different combinations of temperature and precipitation and the complex topography make for an extremely varied climate. The general topography of the region is higher in the west, forming 'the two major terraces', the Qing-Zang Plateau and the Hengduan Mountains. The Qing-Zang Plateau is both the largest and highest plateau in the world. Along the main range of the Himalayas, there are 11 peaks over 8, 000masl, among which is included the northern side of Qomolangma (Everest) which at 8, 848.13masl is the highest mountain in the world.

Numerous mountains on this plateau are covered by everlasting snow, and numerous glaciers run down from high mountain peaks. Therefore, the plateau is called the 'third pole'. The highest mountain in the Hengduan range is Gongga Mountain, with an altitude of 7, 556m.

The region under discussion was mostly a part of the Tethys before the late Paleozoic. With the Haixi Orogeny, Indo-China Orogeny, and Yanshan Orogeny after the Triassic period, it began to rise gradually and, due to the Himalayan Orogeny, a land began to form in this region in the Early Tertiary period. During the last 10 million years or so, it continued to rise and formed this youngest and highest plateau which is called 'the roof of the world'. During the lifting caused by endogenic forces, the etching effect of exogenic forces on the plateau, dominated by erosion, also was augmented by an increase in the difference of topography. The HKH region, due to the long-term effects of the above endogenic and exogenic forces, contains a wide plateau, high mountain ranges, criss-cross canyons, rift zones, plateau lakes, and many other topographical features. The lifting of the plateau has also affected the topographical features, climate, and fauna and flora in adjacent regions. This effect was particularly significant in the Quaternary period, when alpine and subalpine sectors were covered by snow and glaciers. The southern and southeastern parts, on the other hand, where latitudes are relatively low, were influenced by the monsoon and protected by the plateau and mountains from the cold waves coming from the north, forming a refuge for many ancient plants and animals. The complex topographical features and climate have provided diverse habitats where a great variety of ecosystems and organisms have originated and developed.The Hindu Kush-Himalayan region of China, the southeastern part in particular is one of the richest regions in the world in terms of biodiversity.

The Yanlai remains found in Nyalam County of southern Tibet (Xizang) and the Karuo remains found in Qamdo County of eastern Xizang suggest a much earlier understanding and use of biodiversity by human beings than known hitherto. Such use is thought to date back to the New Stone Age. In the Karuo remains discovered in 1978, crops and bones of birds and mammals were found, indicating that agriculture was the main activity, with hunting and animal husbandry as secondary pursuit, 4,600 years ago in Tibet (Xizang). The oldest cliff wall paintings in China are found in ten sites, e.g., in Mengsheng, Mangpo, Minliang, Dinglai, Mangkan, Yongde in Cangyuan Wazu Autonomous County, and in Yunnan Province. The paintings depict hunting and collecting activities and also show pictures of animals such as leopards, monkeys, elephants, cattle, pigs, sheep, and birds. These paintings date back to the New Stone Age, 3, 000 years ago. From these paintings it can be surmised that indigenous people raised domestic animals in addition to hunting. Tibetan works, such as the "Yue Wang Yao Zhen" (Tibetan name 'Sao Ma La Ying'), produced in 720A.D., recorded 780 kinds of Tibetan medicines, among which 440 were from plants and 26 from animals. Later, the number of Tibetan medicines increased to 1, 002 as found in the "Si Bu Yi Dian" written by Yu Tuo Yuan Da Gong Bu et al. in about 753A.D.

Despite the biodiversity of the region, it is economically underdeveloped and poor. The irrational exploitation of natural resources, pollution, and denudation of forests in particular have resulted in a serious impact on ecosystems and on the survival of an enormous number of species. The loss of biodiversity in this region, which is of great importance globally, is a serious problem. With continuing growth in population and in economic development, the conflict between the use and conservation of biological resources will become even more intense. This situation is serious as the region's ecosystems play an important role in maintaining the stability of the climate within the region and beyond. In addition, the Chinese part contains a large number of economic species, particularly wild relatives of cultivated plants and domestic animals, medicinal plants and animals, and flowers, which are valuable not only for China but also for the rest of the world. The adaptability of many species to extreme environments make their genes valuable. Although the Hindu Kush-Himalayas (HKH) form a natural region, it cuts across national boundaries and, therefore, the conservation of the region's biodiversity requires regional and international cooperation.

In this paper, the biodiversity of the HKH region of China has been assessed at three levels, i.e., the ecosystem, species, and genetic levels. Conservation and management of biodiversity in this region are described, and, finally, recommendations are made for further research, conservation, and management.

CURRENT STATUS OF BIODIVERSITY IN THE HKH REGION OF CHINA

Description of Biodiversity

Ecosystems' Diversity (Including Farming Ecosystems)

Various combinations of the three climatic elements, latitude, longitude, and altitude, produce great changes in climate within the region, e.g., from humid to arid, from tropical to frigid. With the climate changes, ecosystems vary greatly and change generally from forests in the southeast to plateau desert in the northwest, and then to bushes and alpine meadows. The diversity of ecosystems here in this region has two outstanding features, i.e., it reflects, to a large extent, all ecosystem types in the Northern Hemisphere, but it also demonstrates a strong regional character, and, therefore, it has a unique natural landscape. According to 'The Vegetation of China' (Wu 1980), the ecosystem in this region is mainly composed of the following types.

Rain Forest Ecosystems

Ravine rain forests are found in humid and hot valleys below 1,000m on the southern slopes of the eastern Himalayas and in southwestern Yunnan Province. They are composed of *Diptero-carpus turbinatus, D. gracilis, Artocarpus chaplasha, Dysoxylum binectariferum*, and *Duabanga grandiflora*, replaced by formations of *Shorea assamica* on relatively dry slopes.

Monsoon Rain Forest Ecosystems

Evergreen monsoon rain forests - These rain forests occur in Xishuangbanna, Yunnan Province. Forests composed of Antiaris *toxicaria* and *Pouteria grandifolia* are distributed throughout the

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low mountains, hills, and terraces below 800m, while *Pometia tomentosa* and *Terminalia myriocarpa* occur in humid valleys and extend upwards to 1, 100m on southern slopes. A single dominant formation, *Parashorea chinensis*, with heights of up to 60m, is found in Mengla County, Yunnan Province. On the edge of the basins in the Langcang River Valley, *Semecarpus reticulata*, *Phoebe nanmu*, and *Paramichelia baillonii* occur at altitudes of from 1,300 to 1,500m, due to the effect of temperature inversion.

Semi-evergreen monsoon rain forests - These are found in southwestern Yunnan. *Ficus altissima* and *Chukrasia tabularis* occur in basins of river valleys below 1,000m, while forests of *Mesua forrea* are confined to sunny slopes at altitudes of 550m in Mengliang.

Deciduous monsoon rain forests - These are distributed on sunny slopes at altitudes of from 700-1,200m in the lower reaches of the Langcang and Lujiang rivers, with only one formation, *Bombax malabarica* and *Albizia chinensis*.

Rain forest and monsoon rain forest ecosystems in this region are not very large in area but are complex in structure, with enormous amounts of species of plants, fungi, and insects. A large number of tropical animals, for example, *Hylobates spp, Nycticebus coucang, Pavo muticus*, four species of birds in the family *Bucerotidae*, and reptiles such as *Varanus* salvator are frequently found in this area. Also, a number of species from the sunbird family (*Nectariniidae*) pollinate flowers from *Aeschynanthus* (*Gesneriaceae*) and *Loranthaceae* species. The numbers of *Dicaeum* spp depend on the quantity of fruits of parasitic plants (Zhu et al. 1979). In China, *Elephas maximus*, an endangered species, occurs only in Xishuangbanna, and *Panthera tigris corbetti*, also an endangered species, occurs only in Honghe, Xishuangbanna, and Dehong in Yunnan Province.

<u>Evergreen Broad-leaved Forest Ecosystems</u>

These are found in the southeastern parts, extending westwards to the Boqu Valley of the Himalayas (Li 1985). They occur at altitudes of from 1,500 to 2,800m and are composed of *Cyclobalanopsis*, *Lithocarpus*, and *Castanopsis* from the family *Fagaceae*, but *Cinnamomum*, *Machilus*, and *Phoebe* from the family *Lauraceae* also appear in relatively humid habitats. Dominant species in this type of forest ecosystem vary in different areas and different conditions, although the families and genera to which they belong are rather similar.

There are semi-evergreen, broad-leaved forests on the southern slopes of the East and Central Himalayas (Li 1985). These forests consist of species such as *Cyclobalanopsis xizangensis*, *C.*

lamellosa, and *Quercus incana*, which are green in winter but change colour according to season. The birds and mammals are diverse and abundant in these evergreen, broad-leaved forest ecosystems.

Sclerophyllous Evergreen, Broad-leaved Forest Ecosystems

These are distributed in western Sichuan, northwestern Yunnan, and southeastern Xizang. They differ from this type of forest in other regions of the world. These forests develop in a climate which is humid in summer and dry and cold in winter. Components of these forests are sclerophyllous evergreen species of *Quercus*. The sclerophyllous, evergreen broad-leaved forest ecosystems in this region are somewhat similar to those found along the coastal areas of the Mediterranean region in ecological aspects, indicating a relationship between this type of ecosystem and the coastal tropical vegetation of the Tethys in the Tertiary period (Wu 1980). This type of ecosystem can be divided into two subtypes. The first subtype consists of ravine sclerophyllous *Quercus* forest ecosystems, mainly distributed in ravines in the lower reaches of the Jinsha River and its tributaries at altitudes of (1,200) 1,500-2,600m, where there are formations of *Quercus cocciferoides* and *Quercus senescens*. The second subtype consists of mountain sclerophyllous, *Quercus* forest ecosystems. These are found from the upper areas of medium-high mountains to the subalpine belt at altitudes of from 2,500-3,900m. Formation of *Quercus aquifolioides* is confined to the Hengduan Mountains, while *Quercus gilliana* may extend westwards to Tangmai of Tibet (Xizang), and *Quercus semecarpifolia* are distributed in Gyirong and Nyalam, Tibet. Leaf fossils of *Quercus senescens* and *Q. semecarpifolia* were discovered in a 1.5 million year-old stratum at altitudes of 5, 700-5,900m on the northern slope of Xixabangma Peak in the central Himalayas by an expedition from the Chinese Academy of Science (CAS). The two above-mentioned species of 'living fòssils' are evidence of the evolution of Tethys flora.

Mixed Conifer and Broad-leaved Forest Ecosystems

This kind of ecosystem is dominated by *Tsuga spp*, which are mixed with broad-leaved species and other conifer elements. Found in the mountains at altitudes of from 2,500-3,100m in western Yunnan and southern Tibet are mixed conifer and broad-leaved forests dominated by *Tsuga dumosa*, while those dominated by *Tsuga chinensis* are mainly found on shady or half-shady slopes in the mountains of the middle and upper reaches of the Mingjiang River at 2,500to 3,000m and in the lower reaches of the Qingyi and Datu rivers at 2,200 to 2,500m. The upper limits ot these forest ecosystems could be considered as the boundary between the East Asian Kingdom and the Holarctic.

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Evergreen Conifer Forest Ecosystems

These consist of two types. Type one is the temperate conifer forest ecosystems which are composed of formations of *Pinus armandii*, distributed in the Hengduan Mountains at altitudes of from 2,500 to 3,000m and formations of *Pinus densata*, distributed in ravines of the Hengduan Mountains and extending westwards to the middle reaches of the Yarlung Zangbo River. The second type consists of cool-temperate, evergreen conifer forest ecosystems, including *Picea* and *Abies* forests (dark conifer forests) and *Sabina chinensis* forests. Among a total of 26 formations of *Picea* and *Abies* forests in China, 17 occur in this region, 12 of them being endemic. Their vertical distribution is from 2,400m on the eastern edge to 4,500m in the west. All six formations of *Sabina chinensis* forests in China can be found in this region, and they occur often near the upper limits of *Picea* and *Abies* forests.

Deciduous Conifer Forest Ecosystems

These are cool-temperate and consist of *Larix* spp (*Sect. Multiseriales*). These forests are distributed throughout the subalpine belt in a narrow ribbon or in patches. The tree species in conifer forests are relatively few, but shrubs, herbs, mosses, lichens, and fungi are well-developed and are the main sources of food for animals. *Muntiacus feae* is the most frequently found mammal. Birds mainly demonstrate Holarctic elements, e.g., *Phylloscopus affinis*, *P. pulcheo*, *Parus dichrous*, *P. ater*, which are resident, chiefly feeding on insects, and are of importance in protecting conifer forests. Among the above-mentioned ecosystems, those that develop cryptic, deciduous broad-leaved forests are *Alnus nepalensis* forest ecosystems.

Evergreen Broad-leaved Bush Ecosystems

These are found in the tropical part of western Yunnan and are mainly represented by formations of *Homonoia riparia* in tropical valleys and *Macaranga denticulata* and *Microcos paniculatus*, which form after monsoon rain forest ecosystems are cut down.

Evergreen Coriaceous Bush Ecosystems

These are mainly found in the subalpine and alpine belts of the Hengduan Mountains and the Himalayas at altitudes of (3,800) 4,000-4,800 (5,000)m. They develop in humid and semi-humid habitats and consist of evergreen, microphyllous and cold-tolerant shrubs. Thirteen formations of this type occur in this region, 84 per cent of the total of 16 in China.

Evergreen Conifer Bush Ecosystems

These are often found above the cool-temperate conifer forest belt, forming a subalpine bush-meadow belt, or they occur on sunny and stony slopes at medium-high altitudes. They may also be found on alpine and dry slopes with meadows but without forests. Three formations can be recognised: *Sabina squamata*, *Sabina pingii var. wilsonii*, and *Sabina wallichiana*. Such bushes are dwarved and cushion-like, but *Sabina squamata* and *S. wallichiana* become trees when they occur below the timberline.

Deciduous Broad-leaved Bush Ecosystems

There are three types. The first type consists of warm, deciduous broad-leaved bushes in five formations (e.g., *Coriaria nepalensis*) found on low mountains or hills up to 3,300m in altitude along river valleys. The second type consists of temperate, deciduous, broad-leaved bush ecosystems, found at altitudes of from 3,500-5,000m. There are 13 formations, such as the mesophytic formations of *Rosa sericea* and the xerophytic *Caragana versicolor*. The third type consists of Alpine, deciduous, broad-leaved bush ecosystems, mainly distributed on cold and humid shady or semi-sunny slopes at altitudes of from 3,500- 4,700m. There are four formations among which are *Sàlix cupularis*.

Meadow Ecosystems

There are two types, i.e., the typical and the Alpine. Typical meadow ecosystems are adapted to mesophytic and temperate environments. Two principal formations occur in this region, *Roscoea alpina* and *Gueldenstaedtia yunnanensis* with *Elymus nutans*, and are mainly found on relatively gentle mountain slopes and terraces at altitudes of from 3,200-3,700m. Alpine meadows are dominanted by cold-tolerant and mesophytic perennials. The most widely-distributed meadow ecosystems in this region are six formations consisting of *Kobresia* spp, e.g., *Kobresia pygmaea*. They occur in the alpine bush-meadow belt above forests and on the plateau table at altitudes of from 4, 000-5, 200m, or they occur in glades. *Polygonum* spp, *Saxifraga* spp, and *Gentiana* spp are the dominant species of other mixed alpine meadow ecosystems.

Steppe Ecosystems

The altitudes at which steppe ecosystems occur gradually rise from the northeast to the southwest in the temperate zone of China. Three types of steppe ecosystem develop in this region, i.e., Meadow- steppe ecosystems, represented by *Pennisetum flaccidum* on terraces along the middle reaches of the Yarlung Zangbo River; Typical steppe ecosystems, containing four formations such as *Stipa bungeana*, Desert-steppe ecosystems, which have three formations such as *Stipa breviflora;* and Alpine-steppe ecosystems, composed of *Stipa purpurea* and seven other formations; these are widely-distributed on the continental Qing-Zang Plateau, forming a unique, horizontal alpine-steppe landscape.

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Desert Ecosystems

The desert ecosystems in this region are mainly distributed on the northern slopes of the Kunlun Range in southern Xinjiang and northern Tibet and in the Ngari District of northern Tibet (Xizang). Superxerophytic semi-shrubs and small shrubs are the constructive species. Recognised in this type of ecosystem are formations of *Ceratoides latens* and the other seven formations, among which cushion-like, semi-shrub formations of *Ceratoides compacta* inhabit alpine deserts at altitudes of from 4,600-5,500m. In the hot and dry valleys of the Jinsha River, the Dadu River, and southeastern Tibet, at altitudes of from 400-2,000m, succulent and spiny bush ecosystems of *Opuntia ficus-indica* and *Euphorbia royleana* develop. These ecosystems are composed of naturalised exotic plants, making this system different from all the other ecosystems mentioned above.

Alpine Debris Sparse Ecosystems

These ecosystems develop on debris in the lower parts of the alpine perpetual snow belt and consist of mesophytic and meso-xerophytic perennials and cushion-like plants. The vertical distribution of these ecosystems depends on the altitudes of glaciers and the snowline, and they generally arise from the north to the south, reaching 5,800m in altitude in the Gangdise Range in Tibet. Frequently seen in these ecosystems are the many species of *Saussurea* sub-genera, *Amphilaena*, and the subgenera, *Eriocoryne*, *Rheum*, *Draba*, *Androsace*, *Saxifraga*, *Polygonum*, *Rhodiola*, and so on. A cushion-like herb, *Stellari decumbens*, extends upwards to 6, 140m in the Himalayas. It was reported that G.Singh collected *Christolea himalayensis* in the Himalayas at an altitude of 6,300m. This may be the highest altitude in the world at which a flowering plant has been found.

Different alpine ecosystems in this region are intermixed and vary with altitude and slope direction, so that animals in alpine forests, bushes, meadows, and steppes are often intermingled, forming an alpine forest-steppe (meadow) fauna, represented by ungulates such as *Cervus albirostris* and *Moschus sifanicus*. The Tibetan snow chicken, *Tetraogallus tibetanus*, is found in bushes and on glaciers, feeding on tender leaves and flowers. Frequently seen in alpine desert ecosystems are ungulates such as *Pantholops hodgsoni*, *Bos grunniens*, and *Asinus kiang* and resident birds such as *Pseudopodoces humilis* and *Montifringilla ruficollis*.

Super-alpine Glacier and Snow Ecosystems

This area is usually referred to as the 'life-forbidden area', yet some insects, such as flies, snowfleas, and acarids, occur and are found up to 6, 750m. Swam (1981) believes that they feed on organic scraps blown by the wind and nutrients in the air and thus calls this highest living belt a 'wind-forming belt'. Lower organisms may reach even higher altitudes. A bacterium, *Geodermatophilus obscurus everesti*, for example, was collected among gravel on Qomolangma at an altitude of 8, 306m.

Aquatic Ecosystems

This type of ecosystem does not show obvious zonation.Six water systems originate in this region, and there are about 1, 500 large and small lakes, of which 35 have areas larger than 100sq.km. The biotic component of a lake is roughly the same as that of the water system connected with the lake. Each water system has its own features in the components of aquatic species and food-chain composition. The Qing-Zang Plateau possesses only one endemic fish genus, the *Oxygymnocypris*, which is found in the middle reaches of the Yarlung Zangbo River (Wu and Wu 1992), whereas Yunnan possesses 40 endemic fish genera, of which 28 are concentrated in the Langcang River and its tributaries, the distribution centre for fish in China (Chu 1987) . Water bodies and wetlands in this region are the habitats of many species of birds such as the black-necked crane *(Grus nigricollis)*.

Farming Ecosystems

There is little cultivated land in this region, and it is mainly found in the eastern and, southeastern parts and in the Yarlung Zangbo Valley where agricultural practices have a long history and farming ecosystems are rather complex. The main grain crops in this region are rice, wheat, barley, buckwheat, potatoes, sweet potatoes, and so on. In addition, other crops, such as soyabeans, rapeseed, and vegetables, are also cultivated in this region. Timber forests, fruit trees, crops, intercropping or crop rotations of green manure, and grain crops all form a variety of agriculture and forestry complex ecosystems. Tea gardens, orchards, and rubber tree plantations are also important farming ecosystems.Tea gardens are confined to the tropics and subtropics, while tropical fruits, such as mangoes, bananas, pineapples, and rubber trees, are mainly found in the tropics of Yunnan. Cultivated in subtropical areas of this region are evergreen fruit trees, such as oranges, tangerines, tomatoes, bananas, mangoes, litchies, and longans, while in the temperate mountains deciduous fruit trees, such as apples, pears, chestnuts, walnuts, and peaches, grow.

Bamboo Forest Ecosystems

Bamboo forests are composed of many bamboo species. Tropical bamboo forest ecosystems are dominated by *caespitose* (sympodial) bamboo species, e. g., *Bambusa* spp and *Dendroc-*

alamus spp. Subtropical bamboo forests are the most complex in both type and component, but they are dominated mainly by *Phyllostachys* spp, *Chimonobambusa* spp, and others. Temperate mountain bamboo forests are constructed mainly of *Fargèsia* spp. The largest individual of *Dendrocalamus giganteus*, having a DBH of one metre and a height of 25m, was found in 1983 in Xishuangbanna, whereas the *Gelidocalamus fangianus*, growing at altitudes of from 2,300-3,600m in western Sichuan, are only one metre tall and three millimetres in diameter. The latter, and other bamboo species, such as *Fargesia* spp, *Chimonobambusa* spp, and *Qionzhuea* spp, are the main food for rare and precious animals, such as the giant panda (*Ailuropoda melanoleuca*), *takin* (*Budorcas taxicolour*) (Yi 1985; Qin 1985).

Species' Diversity

The number of species on the earth is estimated to be from five to 30 million (Wilson 1988), but only about 1.4 to 1.7 million have been recorded. China has recorded 128,000 species of organisms, of which 32,000 are higher plants, a little less than those recorded in Brazil and Malaysia (including Indonesia as a floristic region). The number of vertebrates in China is also rather high in terms of the overall total recorded in the world. However, insects recorded so far in China account for only 2.6 per cent of the species in the world (Table 1), and this may indicate that many new species are still to be recorded.

Table 1: Principal Biotic Groups in China and in the World

Groups	Species in China (SC)	Species in the world (SW)	SC/SW (%)
Insects	45, 000	1, 700, 000	2.6
Other	30, 000	250, 000	12
inverterbrates	3, 000	30, 000	10
Fish	279	4, 184	6.7
Amphibians	380	6, 300	6
Reptiles	1, 186	9, 040	13
Birds	572	4, 180	13.7
Mammals			
Algae	8, 000	24, 000	33.3
Bryophytes	2, 500	23, 000	10.9
Ferns	2, 500	12, 000	20.8
Gymnosperms	200	790	25.3
Angiosperms	27, 000	250, 000	10.8
Fungi	10, 000	69, 000	14.5

It has already been stated above that extremely diverse and complex ecosystems have developed in extremely diverse habitats in this region. Correspondingly, a rich diversity of flora and fauna has evolved in this region. The following features of species' diversity in the Hindu Kush-Himalayan region of China are recognised.

Species' Abundance

Taxonomic investigations in this region are still not adequate, and thus no complete list of species is available. However, 13, 000 species of higher plants have been recorded in this region, accounting for over 40 per cent of the total in China. Some major groups in this region are particularly abundant. The angiosperms, with more than 100 species in China, are listed in Table 2 as an example.

Table 2: Angiosperms 100 species in China (genera controversial in taxonomy, e.g., Silene, Prunus, Quercus, Senecio, Fargesia, are not included)

Name of Genus	Species in HKH Region of China (SHC)	Species in China (SC)	Species in the world (SW)	SC/SW (%)	SHC/ SC (%)
Acer	4	>15	>20	7	30.
Acontium	15	c.19	c.35	54.	78.
Alium	3	c.11	>50	2	34.
Arenaria	c.9	c.11	c.30	36.	81.
Artemisia	9	18	c.30	6	52.
Astragalus	12	21	>200	13.	44.
Berberis	12	>20	c.50	4	63.
Camellia	3	c.18	c.22	81.	19.
Carex	>20	>50	c.200	2	4
Clematis	5	.11	c.30	39.	4
Corydalis	c.18	c.30	c.35	85.	6
Delphilium	10	25	>52	49.	40.
Elatostema	7	14	36	38.	54.
Ficus	6	12	c.100	1	61.
Gentiana	20	24	c.40	61.	80.
Ilex	c.6	c.12	c.40	3	5
Impatiens	>7	>20	>90	22.	3
Ligularia	8	11	12	85.	7
Lithocarpus	3	c.11	>30	36.	32.
Lysimachia	5	13	>18	73.	39.
Pedicularia	c.25	>34	>50	6	73.
Polygonum	8	c.14	c.25	5	60.
Primula	24	29	c.50	58.	82.
Ranunculus	5	12	c.60	2	46.
Rhododendron	>30	c.55	c.85	64.	54.
Rubus	8	19	>70	27.	42.
Salix	13	25	>52	49.	50.
Saussurea	>12	>30	>40	7	4
Saxifraga	18	20	>40	50.	91.
Sedum	7	12	c.47	26.	56.
Viola	4	11	>50	22.	40.

<u>Complex Flora and Fauna Elements</u>

The Holarctic and Palaeotropical elements in the flora and the Palaeoarctic and Oriental elements in the fauna have met horizontally and vertically in the east and south of this region. Along the vertical profile of the Namjagbarwa Mountains in southeastern Tibet, one can see the change in vegetation from tropical rain forests in valleys to cushion-like vegetation at high altitudes and the floristic transition from Indo-Malayan elements (e.g., *Dipterocarpus* spp) in the Palaeotropical flora to Himalayan-endemic elements in the Holarctic flora. Wu (1979) enumerated 15 principal distribution area types of seed plants in China. It is interesting to note that all these 15 types have representives in the Hindu Kush-Himalayan region of China.

Ancient Origins of Flora and Fauna

The central and western parts of this region were a part of the Tethys before the Tertiary period. In 1964, the CAS expedition to Xixabangma Peak discovered *Stegosauria*, *Saurischia*, seed ferns, and fossils of Gymnosperms, at an altitude of 4,300m at the Mesozoic stratum of Tingri County in southwestern Tibet. In addition, they found fossils of the world's largest fish dragon and other aquatic organisms. This illustrates that, apart from the oceanic fauna, terrestrial flora and fauna existed on islands and along coastal areas of the Tethys Sea in the Mesozoic period. These have been replaced at present by young alpine biota on the Qing-Zang Plateau, whereas, in the southeastern parts and on the eastern fringe of this region, Tertiary or even more ancient animals, such as the giant panda, and plants, such as *Davidia*, *Eucommia*, *Podocarpus*, *Amentotaxus*, *Alsophila*, and *Angiopteris*, have survived. *Tricarpelema* (*Commelinaceae*), a genus endemic to this region, consists of three species, *T. giganteum* in Bhutan and northeastern India, *T. xizangense* in Medog County, Tibet, and *T. chinense* in Mabien County, western Sichuan (Figure 1). They all grow in evergreen forests below altitudes of 1, 750m. The disjunct pattern of the genus illustrates the ancient nature of the flora.

High Proportion of Endemics

Endemic genera and species are numerous in the Hindu Kush-Himalayan region of China. There are 40 endemic genera of angiosperms, *Sinodoxa*, *Sinocarum*, *Dipoma*, *Lomatogoniopsis*, *Anemoclema*, *Acanthochlamys*, and so on, most of which are temperate in nature. Genera with a large number of species in this region often have a high proportion of endemic species. For example, of *Primula*, 146 species are endemic, making up 60 per cent of the total number of species (242) in this region; of *Gentiana* half (110/220) the species are endemic; a similar situation is also true for *Aconitum*, *Delphinium*, *Ligularia*, *Pedicularis*, *Saxifraga*, *Rhododendron*, and so forth. As has been mentioned under 'Aquatic Ecosystems', 28 fish genera are endemic to Yunnan, i.e., parts of the Langcang (Mekong) River and its tributaries. No data are available concerning the number of genera and species endemic to the whole of the Hindu Kush-Himalayas, but, as an example, we can take three families, *Commelinaceae*, *Companulaceae*, and *Scrophulariaceae* with which we are relatively familiar. The *Commelinaceae* has one genus, *Tricarpelema*,

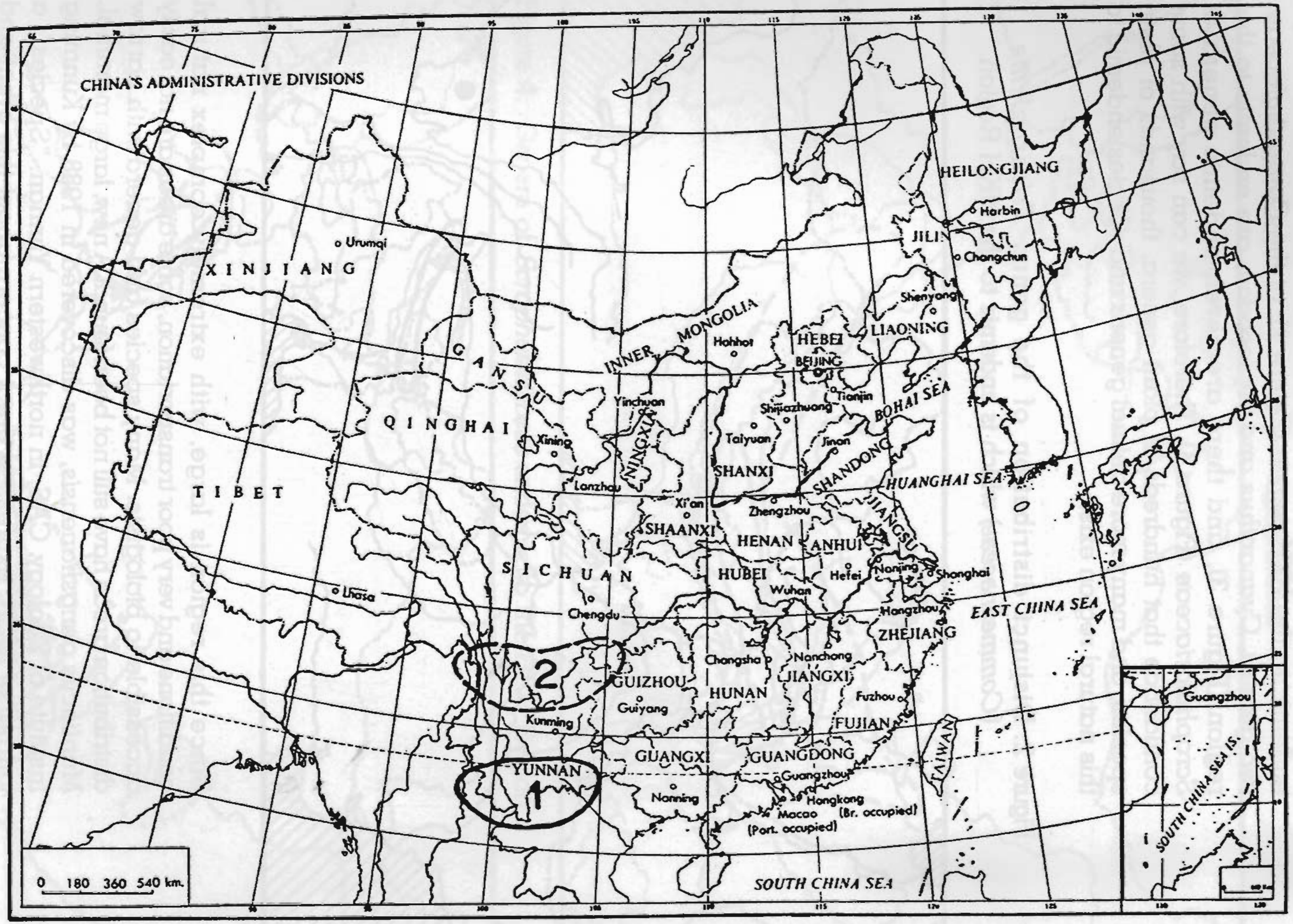
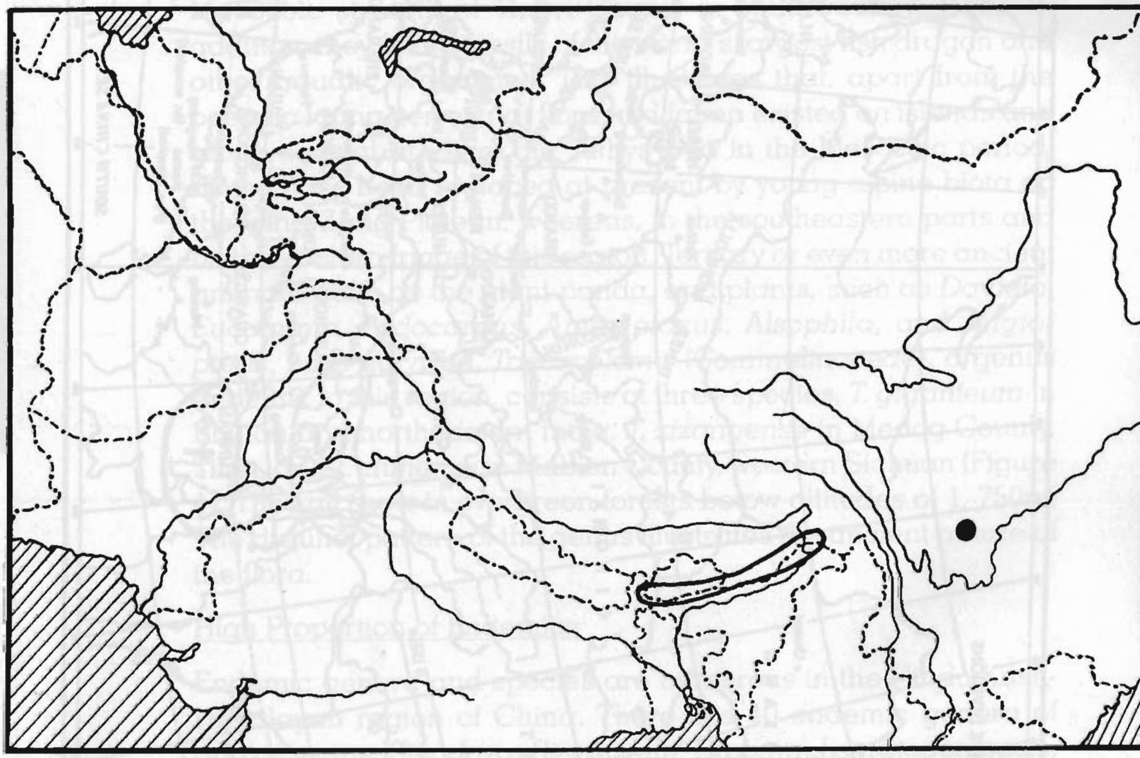


Figure 1:
The two distribution centres of the Ophiopogon-Liriope complex. Thirty species in circle 1 are all diploid with x=18 and more symmetric karyotypes, mostly primitive as can be seen from the external morphology, whereas 27 species in circle 2 are diploid, tetraploid, and hexaploid with x=18 or 17 and less symmetric karyotypes, and mostly advanced as can be seen from the external morphology. It is reasonable to infer that circle 2 is the secondary differentiation centre, while circle 1 is the primary one.

endemic to the HKH region (Figure 2); of the *Campanulaceae*, two genera, *Cyananthus* and *Leptocodon*, are endemic to this region (Figure 3), and there are seven endemic genera of *Scrophulariaceae* (Figure 4). Therefore, we can say with some confidence that hundreds of plant genera, thousands of plant species, and many more animal genera and species endemic to this natural region exist.

Figure 2: Disjunct distribution of the genus *Tricarpelema* (*Commelinaceae*) which is endemic to the HKH Region



Since this region is large, with extremely complex natural conditions and very poor transportation, some areas are not easily accessible to biologists. Many species and genera with narrow distribution areas have still not been found. A new, large mammal, *Muntiacus gongshanensis*, was discovered in 1988 by Kunming Institute of Zoology, CAS, in northwestern Yunnan. "Species", a journal of IUCN, expressed great concern about this event and considered it as a newly discovered but already endangered species. The genus, *Acanthochlamys*, was recorded as new in 1980 in Daofu County of western Sichuan and placed in the family *Amaryllidaceae* (Kao 1980). It was raised to the sub-family, *Acanthochlamydoideae* in 1981, still in the *Amaryllidaceae* family (Chen 1981). Accepting C.Y. Wu's suggestion, Kao (1987) treated this as a new species from the latter family and raised it to an

Figure 3: Genera of *Campanulaceae* endemic to the HKH Region

—— *Leptocodon* — — — *Cyananthus*

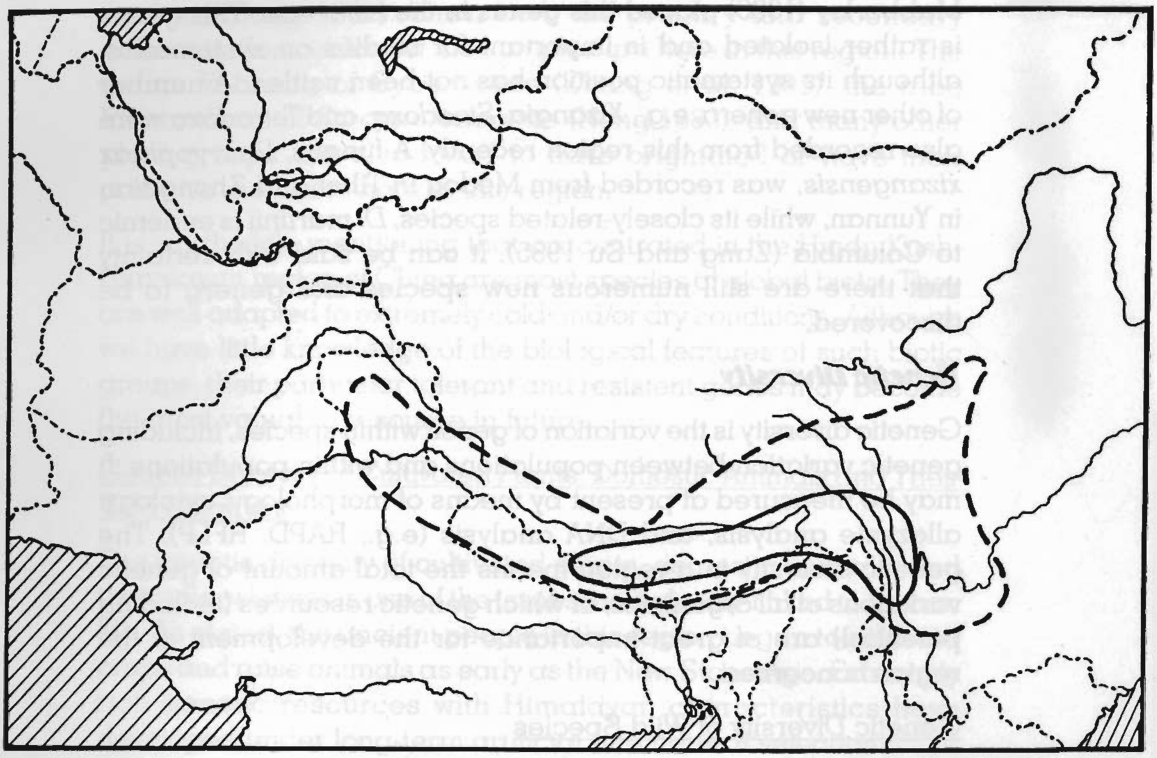
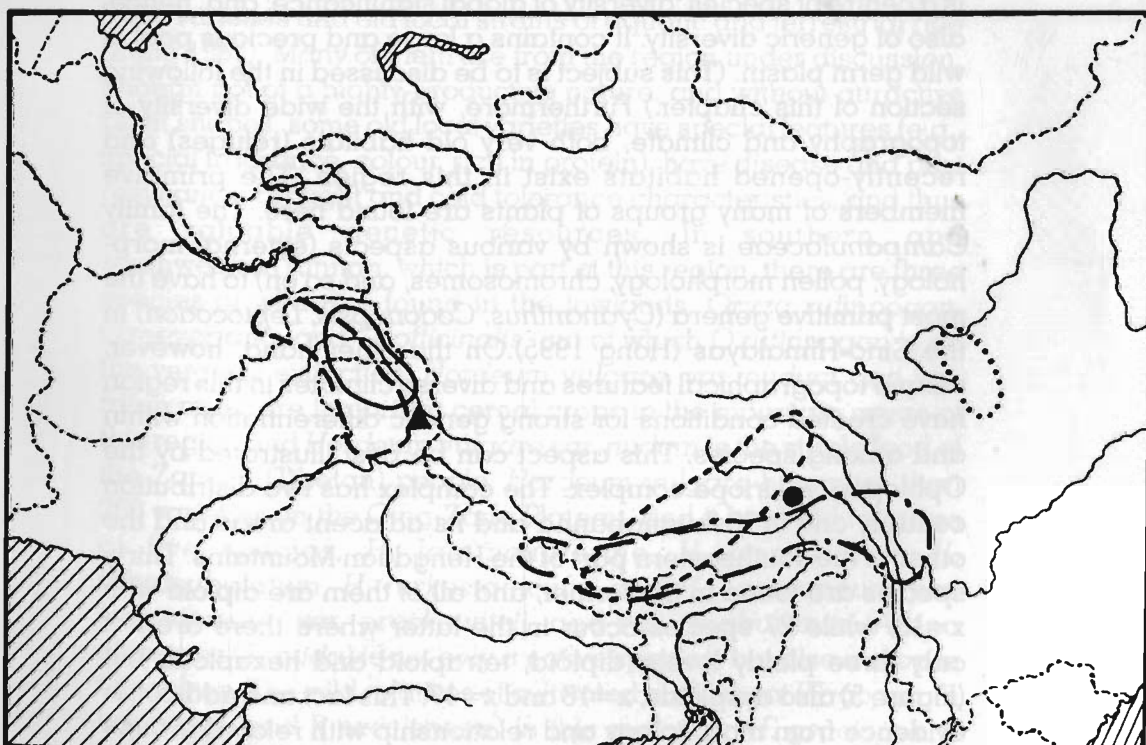


Figure 4: Genera of *Scrophulariaceae* endemic to the HKH Region



▲ *Kashmiria* — — *Neopicrorhiza* - - - - - - *Oreosolen*

—— *Picrorhiza* • • • • *Scrofella* — — — — *Wulfeniopsis*

● *Xizangia*

independent family, *Acanthochlamydaceae* (Kao 1989). However, Mabberley (1990) placed this genus in the *Liliaceae*. This genus is rather isolated and is important for studies on systematics, although its systematic position has not been settled. A number of other new genera, e.g., *Xizangia*, *Sinodoxa*, and *Tetradoxa* were also recorded from this region recently. A fungus, *Dacryopinax xizangensis*, was recorded from Medog in Tibet and Zhongdian in Yunnan, while its closely-related species, *D. martinii* is endemic to Columbia (Zang and Su 1985). It can be said with certainty that there are still numerous new species and genera to be discovered.

Genetic Diversity

Genetic diversity is the variation of genes within species, including genetic variation between populations and within populations. It may be measured at present by means of morphology, cytology, allozyme analysis, and DNA analysis (e.g., RAPD, RFLP). The genetic diversity in a region means the total amount of genetic variations of all organisms, of which genetic resources (including potential) are of great importance for the development of the region concerned.

Genetic Diversity of Wild Species

As mentioned above, the Hindu Kush-Himalayan region of China is a centre of species' diversity of global significance; and, hence, also of generic diversity. It contains a large and precious pool of wild germ plasm. (This subject is to be discussed in the following section of this chapter.) Furthermore, with the wide diversity of topography and climate, both very old habitats (refuges) and recently-opened habitats exist in this region. The primitive members of many groups of plants are found here. The family *Campanulaceae* is shown by various aspects (external morphology, pollen morphology, chromosomes, and so on) to have the most primitive genera (*Cyananthus*, *Codonopsis*, *Leptocodon*) in the Sino-Himalayas (Hong 1995).On the other hand, however, unique topographical features and diverse climates in this region have created conditions for strong genetic differentiation within and among species. This aspect can be best illustrated by the Ophiopogon-Liriope complex. The complex has two distribution centres, one in Xishuangbanna and its adjacent areas and the other in the southeastern part of the Hengduan Mountains. Thirty species are found in the former, and all of them are diploid with x=18, while 27 species occur in the latter where there are not only three ploidy levels, diploid, tetraploid and hexaploid, but (Figure 5) also dysploids, x=18 and x=17. This fact and additional evidence from morphology and relationship with related groups support the inference that the complex originated in the first centre, i.e., Xishuangbanna and its adjacent areas, while the

Hengduan Mountains constitute the secondary differentiation centre (Zhang 1991). Thus, both the primary and secondary differentiation centres of the complex are here in this region. The genus *Kobresia* of *Cyperaceae* (Zhang et al. 1995), the tribe *Rhinantheae* of *Scrophulariaceae* (Hong 1983), and many other plant groups are also found to have originated or have their primitive members here in this region.

It is worthwhile mentioning that concentrated in the Hindu Kush-Himalayan region of China are most species of global biota. They are well adapted to extremely cold and/or dry conditions. Although we have little knowledge of the biological features of such biotic groups, their particular tolerant and resistent genes may become the most valuable resource in future.

<u>Genetic Diversity of Cultivated Plants, Domestic Animals and Their Wild Relatives</u>

The genetic diversity of cultivated plants, domestic animals, and their wild relatives is one of the issues most closely-linked to human life. As stated, the ancient people in this region began to cultivate crops and raise animals as early as the New Stone Age. Extremely rich genetic resources with Himalayan characteristics have developed under long-term artificial and natural selection.

Yunnan is one of the 'origin sites' of rice (*Oryza sativa*), with over 5,000 varieties and old local strains of aquatic and terrestrial rice (Zeng 1987). Many of them are from the region under discussion. Though not of a highly-productive nature, and without attractive plant shapes, some old local varieties have special features (e.g., special fragrance, colour, rich in protein), have disease and pest resistance, drought and cold tolerance characteristics, and thus are valuable genetic resources. In southern and southwesternYunnan, which is part of this region, there are three species of wild rice found in the lowlands, *Oryza rufinpogon*, *O.meyeriana*, and *O. officinalis*, out of which *O.rufinpogon* is on the verge of extinction. *Hordeum vulgare*, var. *nudum* and var. *trifurcatum* are important cereal crops in the mountain areas of this region and *Hordeum vulgare* var. *nudum* is the staple food of the Zangzu (Tibetan) people. *Hordeum vulgare* has more than 260 varieties on the Qing-Zang Plateau, and it has wild relatives of five species, *H. lagunculiforme*, *H. agriorithon*, *H. brevisubulatum*, *H. turkestanicum*, and *H. spontaneum* var. *ischnaterum*, var. *proskowitzii*, and var. *ithaburense*. Avena chinensis (*A. nuda*) is not only a native species, but also a crop in this region. The wild relatives of cultivated buckwheat (*Fagopyrum tataricum*, and *F. exculentum*) in this region are *F. gracilipes*, *F. gilesii*, *F. leptopodum*, *F. dibotrys*, and *F. urophyllum*. The wild relative (*Glycine soja*) of soyabean (*Glycine max*) extends

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westwards to Medog in Tibet. The original tea plant, *Camellia sinensis*, and all its varieties are native to southern and southwestern China, covering a part of this region. The largest tree of *Camellia sinensis* var. *assamica* in a natural forest is found in *Xishuangbanna* and is up to 32.11m tall, with a DBH of 1.03m, and is 1, 700-years-old; the oldest known tea tree in the world. This is evidence that here is one of the original sites for tea.

The yak (*Bos grunniens*) is the only working stock species adapted to the environment of the Qing- Zang Plateau. It has differentiated into many varieties in different areas, e.g., the Jiali yak and Yadong yak, in Xizang, and the Yushu yak and Menyuan yak, in Qinghai Province. They are adapted to coarse fodder, have high fat contents in their milk (6% on an average), and their meat and hair are both usable. The yak is an important animal for the *Zangzu* (Tibetan) people. The wild yak (*Bos mutus*) is the ancestor of the domestic yak, occasionally seen on the periphery of the plateau, but frequently found in Qiangtang District, Tibet, often in groups of several hundreds. Hybrids of the male wild yak and female domestic yak are very large and tough, with great tolerance to extreme conditions. Outside the plateau, the yak is replaced by cattle species (*Bos taurus, B. indicus*), which have rare wild relatives in the southeastern mountains, i.e., *B. gaurus, B. frontalis*, and *B. javanicus*. Whereas *B. frontalis* is large in size, well-adapted to steep mountain areas, and tolerant to extreme climates. It is more docile than other wild oxen and can survive on a variety of forage. It has tender meat, so that it has considerable potential for exploitation.There are wild relatives of many other kinds of livestock and poultry in this region, e.g., the wild pig, *Sus scrofa*, the ancestor of the chicken, *Gallus gallus*, and ancestors of the duck, *Anas platyrhynchos* and *A. poecilorhyncha*.

Importance of Biodiversity with Special Reference to Mountain Development

The importance of the conservation of biodiversity can be summarised as follows.

- The maintenance of diverse and unique ecosystems is critical, not only for development in the HKH region but also for adjacent regions. Six large water systems, on which the most dense population in the world depends, originate in this region.
- The region is very rich in economic plants, fungi, and animals, including for medicines, fragrance, essential oils, timber, fibre, tanin, resin, rubber, starch, pigment, wild vegetables, wild fruits, ornamental plants, fur, economic insects, edible fungi, medicinal fungi, and so on. For example, there are a 1,000

species of wild ornamental plants, over 1,500 species of medicinal plants, and more than 90 species of medicinal animals. Some famous flowers have many species here in this region and other famous flowers even have their distribution centres here. The genus *Primula* has 242 species (c. 500 in total) in this region. More than 300 species of rhododendron (total:c. 800) occur in this region, which is apparently the distribution centre of the genus. *Gentiana* (200/400), *Meconopsis* (ca. 40/50), *Aconitum* (150/350), and *Pedicularis* (250/500) are also concentrated in this region. *Camellia*, a very famous genus for both its ornamental flowers and tea, has 35 species in this region. *Paeonia suffruticosa* (peony) is called the 'king of flowers' in China and, actually, all the woody *Paeonia* species are native to China. Two or three species of this genus occur in the Hindu Kush-Himalayan region. The Chinese caterpillar fungus (a fungus parasitic on the larva of an insect) (*Cordyceps sinensis [Berk] Sacc.*) is one of the most famous Chinese medicines and is mainly found in this region. Musk, perhaps the most famous Chinese medicine, is taken from the musk deer, which is mainly distributed in this region. Many medicinal plants, such as *Aconitum* spp *Neopicrorhiza scrophulariiflora*, *Panax pseudo-ginseng*, and *Paris* spp and many others found here play a very important role in Chinese medicine. In addition, there are tree species, e.g., *Parashorea chinensis*, *Cupressus gigantea*, and *Taiwania flousiana* which provide very good timber and can be used for afforestation. The useful fish species found are *Racoma labiata* and *Schizothorax plagiostomus*. *Hucho bleekeri* are found here with body weights of over four kilogrammes (Wu and Wu 1992).

- A wide variety of crops and livestock and their wild relatives, in addition to precious and abundant wild biotic resources are found. There are over 230 species of wild relatives of crops and more than 20 species of wild relatives of livestock.

- The region is also home to diverse ethnic groups and their valuable experiences. Thirty ethnic groups live in the HKH region of China, and they have accumulated rich experiences in sustainable use of biodiversity.They are also adept in the use of natural medicines. This knowledge is valuable in the search for new medicines, particularly those against cancer and cardiovascular disease.

Factors Causing Loss of Biodiversity

The maintenance of biodiversity is a prerequisite for the existence of human beings. However, the loss of biodiversity is accelerating due to human activities. The extinction of species is now taking place 1,000-10,000 times faster than before the ascent of mankind (Wilson 1988). The problem in the Hindu Kush-Himalayan region of China is even more severe than the general situation, because China is a developing country, and the rapid growth in population, deforestation, and overexploitation of natural resources have combined to make a strong impact on biodiversity. The population of this region is now over 35 million, more than double that of 30 years ago. The region is already overpopulated in proportion to the limited cultivable land. The destruction of forests through slashing and burning has accelerated with the growing population. Southwestern China, mostly in the HKH, is one of the two prime forest areas in China. Economic development means that the demand for timber has growing, and thus the negative impact on forests, particularly those in southern and south-westernYunnan and western Sichuan, has also increased. In the past 30 years, most of the virgin forests have disappeared from this region, particularly in southern, southwestern, and northwesternYunnan and western Sichuan.

According to the IUCN (1986), 61 per cent of the habitats of wild plants and animals have been lost in the tropics of China, including in southern and southwestern Yunnan. The forest cover in these areas decreased from ca. 60 per cent in the 1950s to 20 to 30 per cent. It is estimated that, in rubber plantations and artificial forests, the species' diversity of birds has decreased by 70 per cent, and that of mammals by not less than 80 per cent.

We can learn much from the fact that the giant panda (*Ailuropoda melanoleuca*) has been on the verge of extinction. This precious animal lives in conifer forests in the mountain areas, and it eats mainly bamboo, e.g., *Fargesia* spp, which is the principal element in conifer forests. Due to denudation of the forests, much of the habitat of the giant panda has been lost, with the remaining habitats isolated on high mountain peaks. Moreover, with the loss of forests, the bamboo has almost disappeared. Following these events the population of giant panda has decreased in number and is becoming smaller in stature. The isolation of the animal means that inbreeding is becoming more frequent. Unless corridors connecting the existing populations are built through afforestation, the giant panda is doomed to become extinct, at least in the wild.

In addition, owing to serious deforestation, water in the Yangtze River and its tributaries in the upper reaches has turned yellow, and floods take place more frequently.

Over-hunting animals and over-collecting plants for commercial purposes are other factors causing the loss of biodiversity. Two to three thousand black bears (*Selenarctos thibetanus*) and

Malaysian bears (*Helarctos malayanus*) have been caught from Yunnan or smuggled via Yunnan from other countries each year since 1986, and most of them were used to extract gall bladder bile. Seven hundred kilogrammes of musk were smuggled into Japan in 1987, which means that more than 100,000 musk deers (*Moschus moschiferus*) were killed. Yunnan produced 200kg of musk each year during the 1950s and1960s, while only 30kg of musk could be produced per year by the end of the 1980s. Leopard (*Panthera pardul*) fur is an important traditional export of Yunnan, which exported 5,000 to 10,000 per year during the 1960 and 1970s. Eighty thousand skins appeared on the market in 1988, and since then the number has quickly decreased. The EEC stopped importing this fur from China in 1988, and all other countries in1993. Due to the destruction of ecosystems and over-hunting, a large number of animal species, such as *Rhinoceros* spp, the south China tiger (*Panthera tigris amoyensis Hilzheimer*), red-necked crane (*Grus antigone*), and black gibbon (*Hylobates concolor*) have disappeared in Yunnan, and many others, e.g., peacock, white-handed gibbon, have become highly endangered or are on the verge of extinction (Wang 1993). A rare butterfly, *Sinolitis thaidina*, is concentrated on Gongga mountain, in western Sichuan. During summer and autumn, many people catch it and dig out the host plant of its larva, *Aristolochia moupiensis*, and sell it as medicine in large quantities. This will surely lead to the extinction of these two species(Wu 1990). Many rare or already endangered plants, e.g., *Rheum forrestii, Polygala lijiangensis, Eranthis lobulata, Dysosma auranticalis* are still being gathered for medicine. More than 100 plant species have not been found for 50 to 100 years, and we can say with some certainty that many of them, if not all, are already extinct.

CONSERVATION OF BIODIVERSITY

In Situ Conservation

In situ consevation is the most effective measure for conserving biodiversity. China's first nature reserve was set up in 1956 on Dinghu mountain in Guangdong Province, and, to date, there are over 700 nature reserves in the country, covering 5.54 per cent of the total land. There are also over 480 scenic areas and over 510 forest parks, many of which play an important role in the conservation of biodiversity. Of the 56 nature reserves in the HKH region of China, six are national and 50 provincial (Annexes 1). The Wolong Nature Reserve in Sichuan Province is included in the Man and Biosphere (MAB) Reserves, the Jiuzhaigou and Huanglongsi Nature Reserves, also in Sichuan Province, belong to International Nature Relics.

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Ex Situ Conservation

Ex situ conservation measures are primarily suitable for emergency rescue of highly endangered species that will otherwise become extinct, and captive collections could have some value for public education.

Ex Situ Conservation of Wild Plants

Botanical gardens or arboretums can play an important role in conserving plant diversity. The number of botanical gardens in China increased rapidly during the 1980s, and now there are about 110. Among these, comprehensive botanical gardens or medicinal botanical gardens are used mainly for scientific research (Table 3) . Some gardens are used primarily for tree seed collection, others for ornamental plants or educational and training purposes.

Table 3: Principal Botanical Gardens in China

Name of botanical gardens	Area (ha)	Protected species variety
Beijing Botanical Garden	66	5000
Guizhou Botanical Garden	213	2000
Hangzhou Botanical Garden	232	3400
Heilongjiang Foreatry Botanical Garden	136	2190
Kunming Botanical Garden*	43	4000
Lushan Botanical Garden	293	3400
Shanghai Botanical Garden	66	3000
South China Botanical Garden	300	5000
Sunyatsen (Zhongshan)Botanical Garden (Nanjing)	186	3000
West China Subalpine Botanical Gardent*	3000	2500
Wuhan Botanical Garden	66	3000
Xi'an Botanical Garden	20	2000
Iishuangbanna Botanical Gatdent*	660	2700

*These gardens are situated in the HKH region of China

Ex Situ Conservation of Wild Animals

<u>*Ex Situ* Conservation in Zoos</u>

By 1991, 41 zoos had been built across the country (Table 4). If animal exhibition areas in large parks were included, the number would reach 175. These zoos and exhibition areas altogether raise more than 600 species of vertebrate animals, totalling 100,000 individuals. In past decades, zoos in the country carried out extensive research in preservation and reproduction techniques for rare animals and have achieved some progress, protecting and, in some cases, reproducing individuals or small groups of endangered and endemic animal species. The zoos in Beijing, Shanghai, Chengdu, Chongqin, Fuzhou, Xi'an, and Xining succeeded in breeding a few giant pandas (*Ailuropoda melanoleuca*), Manchurian tigers (*Panthera tigris altaica*), snow leopards (*Panthera uncia*), black-necked cranes (*Grus nigricalis*), golden monkeys (*Rhinopithecus* spp), *Alligator sinensis*, *Budorcas taxicolor*, and *Presbytis francoisi*.

Table 4: The Main Zoos in China (Han and Wang 1990)

Name of Zoos	Area (ha)	Protected species	Number of individuals
Beijing Zoo	90	600	5000
Chengdu Zoo	25	232	2756
Guangzhou Zoo	44	326	2332
Harbin Zoo	40	125	1000
Shanghai Zoo	74	320	3800
Tiangjin Zoo	50	180	1000
Xi'an Zoo	27	132	783

Ex Situ Conservation Bases and Reproduction Centres

To date, 26 reproduction farms of endangered and endemic animals have been built for conservation. If those built for commercial purposes, such as deer (*Cervus unicolor Kerr*), mink (*Mustela vison Schreber*) and pheasant (*Lophera nyctomera*) farms were included, the count would be 230. There has been some success in breeding some 10 species of animal, such as the *Ailuropoda melanoleuca*, which is on the verge of extinction. In addition, cell banks have been recently established in Shanghai Institute of Cytology and Kunming Institute of Zoology, CAS, and a gene bank is being established in Shanghai Institute of Biochemistry and the Base of Bioengineering, at the CAS. Preserved in the cell bank of the Kunming Institute of Zoology are 198 cell samples, including 92 species of animals (one species of insect, 12 of fishes, 5 of reptiles, 11 of birds, and 63 of mammals), among which 26 species are national protected animals, e.g., *Rhinopithecus bieti*, *Hybates hoolock*, *Varanus salvator*, *Nycticebus coucang*, *Muntiacus crinifrons*, *M.gongshanensis*, *Naemorhedus cranbrooki*, *Elaphodus cephalophus*, and *Panthera pardus* (Han and Wang 1990). All the endangered animals mentioned are native to the region.

Collection, Assessment and Conservation of Varieties and Wild Relatives of Crops and Livestock

Collection and Conservation of Crop Varieties and Wild Relatives

In the late 1950s, the state carried out a nationwide collection of field crops, with about 200,000 specimens of some 50 species of field crop germ plasm collected. But, during the 1960s and 1970s, some of the preserved crop varieties were damaged or lost. Since the 1980s, work on crop genetic resources has again received attention, and the number of accessions now totals 350,000 one of the largest collections in the world. In 1987, the Chinese

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Academy of Agricultural Sciences set up the national germ plasm bank for crop genetic resources. By 1992, this national germ plasm bank had 230,000 accessions. In addition, some provinces and municipalities have established local, mid-term germ plasm banks and nurseries.

Collection and Preservation of Domestic Breeds of Livestock and Poultry

According to the preliminary statistics, China has preserved 398 fine breeds of livestock and poultry. Rapid progress has also been made in establishing gene banks for livestock breeds. Several modern animal cell, sperm, gamete, and embryo banks have been completed or are being built (National Environmental Protection Agency et al. 1994).

INVENTORIES

Biological expeditions to the HKH region of China began in the early nineteenth century. The first expedition was carried out by Britishers W. Moorcroft, H. Hearsey, and Trebeck in 1812. They collected plant specimens around the Mapam Yumco Lake in Tibet. Moorcroft's travel account was published in summary in 'Asiatick Researches' (Vol. 12). Subsequent expeditions to this region were by the Frenchman, V. Jacquemon, in southwestern Tibet in 1830; Britishers, R. Strachey and J.E. Winterbottom, in the southwest and Mapam Yumco District of Tibet in 1848; Britisher, J.D. Hooker in an area of Tibet near Sikkim in 1848; Britisher, E. Faber, to the Emei Mountain in western Sichuan in 1865; Britisher, J. Anderson, to Tengcong (then Momein), Yunnan, and the upper reaches of the Irrawaddy River in Myanmar, from India in 1868; French missionary, A.David, to Baoxin (Mupin) in Sichuan in 1868; Austrian, F. Stoliczka, to Tibet from Kashmir and then to western Xinjiang across the Kunlun Range in 1873; Britisher, W.J.Gill, to the interior parts of the Hengduan Mountains in Sichuan and Yunnan in 1877; Hungarians, B.C. Szechenyi and L. Loczy, to western Sichuan and northwesternYunnan in 1879; the Russian, N.M. Przewalski, twice to the southern slopes of the Tanggula Range from Qinghai in 1879 and 1885; Britisher, E.C. Baber, to Sichuan three times from 1876 to 1888, westwards to Kangtien; Frenchman, J.M. Delavay, procured an extensive collection in northwestern Yunnan from 1883 to 1890; Britisher, A.E.Pratt, to western Sichuan twice in 1885 and 1890; Britisher, F.S.A. Bourne, to Yongning and Kunming in Yunnan in 1885; and Russians, N. Potanin and others, to Nanping, Songpan, and Pingwu in Sichuan in 1885 . More biologists and amateurs made expeditions to this region and collected specimens here from the 90s in the nineteenth century to the 30s in the twentieth century, so that a large amount of new taxa were recorded in this period. The first comprehensive report on the flora of Tibet was published in 1902 by W.B.Hemsley and H.H.W.Pearson(Hemsley and Pearson 1902). In 1916, F.K. Ward proposed the concept of Sino-Himalayan Flora for the first time. K. K. Tsoong was the first Chinese biologist to make an expedition to this region. He made a trip in 1919 to the Cangshan Mountain in Dali and the Jizu Mountain in Binchuan and Yongbi, Yunnan Province. W.P. Fang started exploring and collecting in western Sichuan from 1929. During the 1930s and 1940s, W.C. Cheng,.F.T. Wang, W.C. Wu, T.T. Yu, X.T. Tsai, K.L. Chu, C.W. Wang, and K.J. Fu collected specimens from western Yunnan and western Sichuan. C.W. Wang travelled further westwards to Zayu in Tibet and T.N. Liou went even further westwards, reaching Kashmir and India across Tibet from the Kunlun Range. Most of the activities during this period and previous ones were carried out by individuals. From the 1950s, however, a number of integrated scientific expeditions to this region have been carried out by China. The first one was the exploration of natural resources in Xizang from 1951 to 1954 carried out by the Agricultural Science Group in the Working Team to Xizang, sponsored by the Commission of Culture and Education of the State Council of China. Important comprehensive explorations of biodiversity in the HKH region of China have so far been carried out 13 times (Annex 2) and 5, 900 persons have been involved. All these expeditions were organised by the Chinese Academy of Science (CAS). The completeness of disciplines involved, the number of scientists engaged, the extent of exploration and the depth and extensiveness of investigation broke all records. The results of the explorations are reflected in more than 70 monographs and over 1, 000 articles (such as The Proceedings of Integrated Scientific Expeditions to Xizang, The Forests of Xizang, Insects of Xizang Vols. 1 and 2, Aquatic Invertebrates of Xizang, Birds of Xizang, Mammals of Xizang, Amphibians and Reptiles of Xizang, Fungi of Xizang, Lichens of Xizang, Bryophytes of Xizang, Flora Xizangica Vols. 1 to 5, Vascular Plants of the Hengduan Mountains Vols. 1 and 2, Studies on the Qing-Zang Plateau, Special Volume of the Expeditions to the Hengduan Mountains 1 and 2, Wild Barley of Xizang and the series of Reports on the Scientific Expeditions to the Qomolangma Area, compiled by the Integrated Scientific Expedition of the CAS to the Qing-Zang Plateau, Insects In Mt. Namjagbarwa Region, and The Flora of Vascular Plants in Mt. Namjagbarwa Region of Xizang [Tibet], both compiled by the Mountain-climbing Scientific Expedition of the CAS, Forests in W. Sichuan and N. Yunnan, Agricultural Geography in W. Sichuan and N. Yunnan, Reports on Exploration of Forests in Garze, Aba and the Xiaoliangshan Area, compiled by the Integrated Expedition of the CAS to [the] West Region for Transferring Water from the South to the North, Plant Resources and Their Evaluation in Qinghai and Gansu, and Reports on Exploration of Mammals in Qinghai and Gansu, compiled by the Integrated Expedition of the CAS to Qinghai and Gansu). The above-mentioned monographs and articles comprehensively reflect the long-term efforts by both Chinese and foreign scientists in studies on the HKH region and provide fundamental data and scientific bases for conservation, management, and sustainable use of biodiversity in this region.

In addition, 'Fauna of China', 'Flora of China', and 'Cryptogamic of China', are the basis for the national inventory of species' diversity for China. Altogether, a total of 374 volumes are planned. To date, 57 volumes of 'Fauna of China' have been published, about 30.2 per cent of planned publications and 91 books of 'Flora of China' have been published, or 70.2 per cent of those planned. Four volumes of cryptogams have been published, or 13 per cent of the total volumes planned. In 1984, the Environmental Protection Committee of the State Council issued the 'List of Plants under the State's Key Protection'. In 1988, the State Council approved the 'List of Wild Animals under the State's Key Protection'. In 1991, the Chinese and English editions of the 'China Plant Red Data Book' (Vol. 1) was published. The 'China Animal Red Data Book' is currently being compiled by the CAS. An inventory is also included in a Biodiversity Research Information Management (BRIM) Project that the CAS is conducting (National Environmental Protection Agency et al. 1994).

Gaps in Research and Information Database on Biodiversity

Biological research in China began early this century, over 100 years later than in the countries of Europe and North America. Although some outstanding contributions have been made to biological studies on the Hindu Kush-Himalayan region of China, obvious gaps still exist, and we are facing serious problems—mainly as follow.

- Fundamental exploration of biodiversity is far from complete. Taking Tibet as an example, only several years after the publication of 'Flora Xizangica' (Wu 1983-1987), new records of six families, *Bambacaceae*, *Burseraceae*, *Connaraceae*, *Icacinaceae*, *Lecythidaceae*, and *Pandanaceae* and 46 genera have been added to the angiosperm flora of Tibet, and two new genera of flowering plants (*Xizangia and Sinoleontopodium*) have been described by the expedition to the Namjagbarwa Mountain. Two new genera of *Adoxaceae*, *Sinadoxa* and *Tetradoxa*, were recorded from this region (Ni and Chen 1992). A large mammal species, *Muntiacus gongshanensis*, was only recently recorded as new to science from N.W. Yunnan (Shi 1990).

One can see that we are still far from completing an inventory of biodiversity in our region. We know that some large mammals, such as *Rhinoceros* sp, *Pygatrix nemaeus*, and a rare fish, *Cyprinus yilongensis* (Chen 1990), have become extinct in this region. We know that more than 100 plant species in this region have only type specimens but have had no second records for over 50 years. However, no survey on rare and endangered species of plants or animals has been carried out, and thus we do not know how many of them have become extinct. No studies of the demography and biological features of important economic species have been carried out, and studies on genetic diversity are just beginning.

- There is a great shortage of funds. There are no reliable funds for the study of the conservation of biodiversity in China. Funds from the state for such research are very limited, and most government departments for management of biodiversity give no financial support for studies on conservation. The equipment for research into biodiversity is usually old and out of date.
- There is a great shortage of personnel. This problem is particularly reflected in the shortage of taxonomists. There are 400 insect taxonomists in China, but over 2,000 in the United States (Han and Wang 1990). Furthermore, most taxonomists now in China are approaching retirement, and, thus, there are not enough taxonomists to conduct research. The shortage of funds is mainly responsible for the decrease of personnel.
- There is a lack of integrated regionalisation of biota. Regionalisation of the flora and fauna of China has taken place separately, but there has been no integrated regionalisation of biota, which is of great importance for planning the conservation of biodiversity.
- Data and materials are scattered. Scientists and amateurs from about ten countries collected specimens in this region at the beginning of the early nineteenth century. The specimens, including types, preserved in museums, herbaria, or systematic collections in the U.K., France, the United States, Germany, Austria, Russia, Sweden, Switzerland, Italy, and elsewhere, left no duplicates in native countries, creating difficulties for taxonomies and inventories. Recently, the U.K., U.S.A. and Sweden began sending duplicates (including isotypes) of specimens collected by G. Forrest, E.H. Wilson, and H. Smith back to the Herbarium of the Institute of Botany of the CAS (PE), and this will make a considerable contribution to studies on biodiversity in the HKH region of China.

INSTITUTIONS WORKING IN BIODIVERSITY CONSERVATION AND MANAGEMENT

Role of Public Agencies

The public plays a crucial role in the conservation and sustainable use of biodiversity. China is one of the very few countries with rich biodiversity. However, China has the largest population in the world, with 1.2 billion at present, and it is a developing country. The population in China is still growing and will reach its peak in the early twenty-first century. The impact on biodiversity in China is great and will be greater with continuous growth of the population and rapid development of the economy. The population in the HKH region of China is over 35 million, with ca. 20/km^2. Since most of this region is alpine or subalpine, and thus uninhabitable, the population is actually concentrated in the valleys of the eastern and southeastern areas and along the Yarlung Tsangpo River Valley. The population in this region is growing more rapidly than in other parts of China, and the demand for natural resources is also growing. Conservation and sustainable use of biodiversity will depend on the public to a great extent.

Thirty ethnic groups, or minority nationalities, in this region, such as the *Zangzu, Miaozu, Yizu, Daizu, Lisu, Tuzu, Derung, Wazu*, and *Naxi*, have accumulated rich experiences in rational use of biotic resources through long-term practice.In Xishuangbanna, for example, the *Dai* plant a fast-growing tree, *Cassia siamea*, as an important fuelwood source for rural energy, and this has effectively preserved indigenous tropical forests (Pei 1983). The *Zangzu* (Tibetan) people use dried animal dung as fuel, and this has conserved a number of indigenous slow-growing shrub species.Traditionally preserved 'Fengshui Forests', 'Holy Hills, ' or 'Dragon Hills' are present around most villages and temples in this region, and this has also effectively preserved some ecosystems and species. Certain rare and precious species have been protected as totems. On the other hand, slashing and burning in some areas, over-hunting of animals, and over-collecting of medicinal plants are the serious threats to biodiversity. Since 1956, the Chinese and provincial governments have issued a series of laws, codes, and regulations for conserving natural environments and biological resources. This has provided conservation and management with a legal base.

Role of Research Institutions

In China, institutions involved in study and conservation of biodiversity are mainly in the Chinese Academy of Science (CAS), Ministry of Forestry, Ministry of Agriculture, Ministry of Construction, and in the universities (or colleges). The CAS is the centre for research on natural sciences and technology in China. The Committee of Biodiversity of the CAS was set up in 1989 and is responsible for long-term planning of study and conservation of biodiversity and for coordinating basic research on biodiversity, in cooperation with other ministries in China and other countries. Among a total of 123 institutes in the CAS, 32 institutes and about 1, 000 scientists and technicians are involved in studies of biodiversity (Table 5). The CAS has now more than 50 field stations, more than half of which are engaged in the study and monitoring of biodiversity.

Table 5: The Personnel Involved in Studies of Biodiversity in CAS

Name of Institutes	Location	No. of Scientists and Technicians involved	No. of Specimens Preserved
Institute of Zoology	Beijing	200	3, 220, 00
Institute of Botany	Beijing	150	1, 900, 00
Institute of Microbiology	Beijing	120	140, 00
Institute of Hydrobiology	Wuhan	80	350, 00
Wuhan Institute of Botany	Wuhan	20	170, 00
Wuhan Institute of Vitologg	Wuhan	35	400 (strains
South China Institute of Botany	Guangzhou	30	600, 00
South China Sea Institute of Oceanography	Guangzhou	60	10, 00
Kunming Institute of Botany	Kunming	45	750, 00
Kunming Institute of Zoology	Kunming	80	500, 00
Northwest Plateau Institute of Biology	Xining	80	210, 00
Chengdu Institute of Biology	Chengdu	80	280, 00
Shanghai Institute of Entomology	Shanghai	35	680, 00
Commission of Comprehensive Exploration of Natural Resources	Beijing	20	53, 00

There are about 400 herbaria or systematic collections in China at present, distributed throughout research institutes, universities, museums, and nature reserves, accommodating a total of 24.7 million biotic specimens.

Role of Provincial and Local Governments

Corresponding comprehensive management departments, specialised management departments, public security and law enforcement departments, and scientific research and educational departments have been set up in provincial (autonomous region and municipalities) governments similar to those established at the national level. All these departments assume responsibility for biodiversity conservation under the guidance of the corresponding institution at national level. Their functions and responsibilities are similar to those at the national level. However, China is decentralised, and, thus, local institutions function administratively under their local governments which, in fact, exert the primary control over them, though they receive technical guidance from their national equivalents.

The main weakness regarding the effectiveness of reserve management is the lack of cooperation among local agencies with authority over resources within or around nature reserves. The reserve management should have some authority to coordinate use of resources within their boundaries. It would be desirable for each reserve to have some sort of coordinating council run with the participation of relevant local agencies and the support of local government, so that integrated management of ecosystems is possible.

The same issues of local institutions and coordination are very important for biodiversity conservation outside nature reserves. The local governments below the provincial level have established relevant specialised and non-specialised departments to assume responsibilities for biodiversity conservation, depending on the scale and scope of work they have in their domain.

Role of NGOs and Indigenous Communities

Non-government organisations for biodiversity conservation in China refer mainly to academic or professional bodies such as the China Ecology Society, China Environment Society, China Forestry Society, China Agronomy Society, China Oceanographic Society, China Botany Society, China Zoology Society, China Wildlife Protection Society, China Gardening Society, China Botanical Garden Society, and China Zoological Park Society. Non-government bodies in China play a somewhat different role from more autonomous activist ones in other countries, and their contribution to biodiversity conservation in China is primarily through research, monitoring, and public information. They probably have a substantial potential role in raising public awareness on the importance and threats to China's biodiversity wealth (National Environmental Protection Agency et al. 1994).

ONGOING PROJECTS AND PLANNED PROGRAMMES ON BIODIVERISTY OF THE HKH REGION OF CHINA

National Programmes

The general goal of China's Biodiversity Conservation Action Plan (1994) is to take effective measures to conserve biodiversity as quickly as possible. Among nature reserves of this region, 20 for forest ecosystems, two for grassland-desert ecosystems, and three for wetland or aquatic ecosystems have been listed as priority for conserving ecosystems in China. More than 140 species of animals and 46 species of plants have been included in the list of priority protected species in China, and varieties of five livestock and poultry, and relief sites of wild relatives of three crops have also been listed as priority protected objects.

Ongoing projects and planned programmes on biodiversity relevant to this region of China.

- Studies on Conservation Biology of Main Endangered Plants in China (the CAS et al., 1993-1997)
- The Biological Basis of the Conservation and Sustainable Use of Biodiversity in China (the CAS, 1991-1995)
- Studies on the Conservation of Biodiversity in China (The State Science and Technology Commission, for 5 years)
- Research on Conservation of Biodiversity and Fellowship Training Programme (National Environmental Protection Agency et al. for 10 years)
- Developing Manpower for Biodiversity Conservation (Ministry of Forestry for 5 years)
- Testing of Models for Integration of Conservation with Development in Buffer Zones of Nature Reserves (Ministry of Forestry et al., for 4- 6 years)
- Survey on the Trade in Wildlife in China (Ministry of Forestry et al., for 2 years)
- Full Utilisation of Existing *Ex Situ* Facilities for Conservation (Ministry of Construction et al., for 5 years)
- Development of Health Centre to Serve Chinese Zoos and Captive Breeding Units (Ministry of Construction, Ministry of Forestry, for 3 years)
- Integration of Sustainable Selective Logging with Construction of Biodiversity (Ministry of Forestry et al., for 4 years)

Mountain Specific Programmes

- Planning and Establishment of the Longmenshan Reserve, Sichuan Province (Ministry of Forestry Sichuan Forestry Bureau,

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for 2-3 years) to establish a nature reserve in the mountains of northwestern Sichuan to protect the giant panda, the Sichuan snub-nosed monkey *(Rhinopithecus roxellanae)*, and the takin *(Budorcas taxicolor)* and other priority species.

- Protection of the Sichuan Hill Partridge *(Arborophila rufipectus)* (Ministry of Forestry and Institute of Zoology, the CAS, 3 years); to save the Sichuan hill partridge, which is one of the most threatened birds *in* China, from extinction.

OVERALL CONCLUSIONS AND RECOMMENDATIONS

The Hindu Kush-Himalayan region of China is a critical area in terms of biodiversity The region is among those with the richest biodiversity in the world, with all the types of terrestrial and aquatic ecosystems in the Northern Hemisphere, with hundreds of endemic animal and plant genera, thousands of endemic animal and plant species, with a large number of economic plants, fungi, and animals, and numerous wild relatives of cultivated plants and domestic animals, which are of great importance for the development of this region. However, due to the rapid growth of the human population, denudation of forests and irrational use of natural resources, the loss of biodiversity in this region is much more severe than in most parts of the world, and, therefore, effective measures should be taken as quickly as possible to preserve extant forests, to prevent over-hunting and over-collecting, and to conduct conservation studies in this region. The HKH region of China has unique topographical features and extremely diverse habitats, with the so-called third pole on one side, and with tropical climate and tropical rain forests on the other, and, therefore, this region is an ideal site for studies on the formation and function of ecosystems and on species' differentiation and evolution.

The HKH region is an integrated natural region. Although it is across eight countries, the region is facing the same problems with respect to biodiversity and, therefore, regional collaboration is essential for a better understanding and for conserving biodiversity in this region.

For this purpose we propose the following measures.

- Set up several regional academic groups on biodiversity to coordinate an integrated study on conservation biology.
- Undertake integrated regionalisation of biota; re-plan nature reserves on the basis of the regionalisation and overall regional considerations.
- Introduce integrated inventories of all biotic groups; compile two series of books on endemic genera and rare, endangered and endemic species for the whole region.

- Conduct demographical analyses of selected economic and rare animals and plants for sustainable use (e.g., musk deer, snow leopard, Chinese caterpillar fungus *(Neopicrorhiza scrophulariiflora)*
- Conduct studies on genetic diversity of selected species, particularly domestic animals and cultivated plants, and their wild relatives, important for the economic development of this region (e.g., local varieties and wild relatires of rice, yak, and so on)
- Create models of rational use of biodiversity to promote development of the mountain economy.
- Work out an overall plan of *ex situ* conservation based on the inventory, using existing botanical gardens, zoos, cell banks, gene banks, and other available facilities.

Since all the countries in the HKH region are cooperating, reliable funds will be essential.

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Annex 1

Nature reserves in the Hindu Kush-Himalayan Region of China mainly for preserving integrated natural ecosystems

(N=national; P=provincial)

Province (Regional)	Name of nature reserves	Location (county or city)	Area (ha)	Main conserved objects	Time of Founding
Yunnan	Ailao Mountsin Nature Reserse	Chgxiong, Shaangbai, Xinping, Zhenyuan, Jingdon	50,660	Subtropical evergreen broad-leaved ecosystems and rare and precious animals such as *Pavo muticus*, *Presbytis phyrei*, *Hylobates* spp *Anthreacoceros* spp	1986N
	Wulian Mountain Nature Reserve	Jingdong	23,355	South-subtropical mountain forest ecosystems and rare and precious animals	1958P
	Laiyang River Natute Reserve	Simao	7,035	Tropical and subtropical forest ecosystems and rare and precious animals	1986P
	Tongbiguan Natule Re-serve	Yingjiang, Longchuan, Ruili	34,158	South-subtropical monsoon rain forest ecosystems and rare and precious animals, gibbon, wild cattle etc	1958P
	Yongde Daxue Mountain Nature Reserve	Yongde	15,786	South-subtropical evergreen broad- leaved forest ecosystems and rare and precious animals, e.g., leopard	1959P
	Lincang Daxue Mountain Nature Reserve	Cangyuan	17,887	ditto	1993P
	Lugu Lake Nature Reserve	Ningland	8,133	Alpine conifer forest ecosystem, plateau lake and habitats for aquatic birds	1986P
	Dianchi Nature Reserve	Kunming	292,000	Water ecosystems	1981P

China

Province (Regional)	Name of nature reserves	Location (county or city)	Area (ha)	Main conserved objects	Time of Founding
	Lujiang Nature Reserve	Gongshan, Beijing	375,433	Subtropical alpine mixed conifer and broad-leaved forest ecosystem and precious plants like *Taiwania flousiana Davidia involucrate*, and animals like golden monkey, lesser panda.	1986P
	Nangunhe Nature Reserve	Cangyuan	6,983	Tropical monsoon rain forest ecosystems and rare and precious animals, e.g., elephant, tiger.	1958P
	Xishuangbanna Nabanhe Nature Reserve	Jinghong	26,067	ditto	1991P
	Xishuangbanna Nature Serve	Jinghong, Menghai, Mengla	41,776	Tropical forest ecosystems and precious wild animals such as elephant, wild cattle, hornbill	1959P
	Tianchi Nature Reserve	Yunlong	6,667	*Pinus yunnanensis* virgin forest ecosystems, plateau lake and rare and precious animals	1983P
	Weiyuanjian nature Re-serve	Jingu	7,653	*Pinus kesiya* var. *langbianensis virgin* forest ecosys-tems; precious animals such as *Nyeticebus coucany*	1983P
	Huanglian Mountain Natute Reserve	Luchun	13,835	Evergreen broad-leaved forest ecosystems and rare and precious animals such as gibbon	1983P
	Baima Snow Mountain Nature Reserve	Deqin	90,144	Alpine conifer forest ecosystems and rare and precious animals such as Yunnan golden monkey	1983N

Province (Regional)	Name of nature reserves	Location (county or city)	Area (ha)	Main conserved objects	Time of Founding
	Gaoligong Mountains Nature Reserve	Baoshan, Tengcong, Lushui	123,900	Subtropical alpine forest ecosystems and rare and precious animals	1958P
	Bitahai Nature Reserve	Zhongdian	14,181	Alpine conifer forest ecosystems and aquatic birds	1984P
	Yulong Snow Mountain Nature Reserve	Lijiang	5,966	Alpine forest ecosystems; Yunnan golden monkey and other rare and precious animals	1958P
	Haba Snow Mountain Natute Reserve	Zhongdian	21,908	Alpine forest ecosystets and rare and precious animals, e.g, Yunnan golden monkey	1958P
	Jizushan Nature Reserve	Binchuan	10,760	Forest ecosystems	1981P
	Canshan Ehai Nature Reserve	Dali	9,700	Water ecosystems and *Schizothorax taliensis*	1981N
Xizang (Tibet)	Gangxiang Nature Re-serve	Bomi	4,600	Virgin *Picea* forests and forest ecosystems and precious wild animals and plants	1985P
	Medog Nature Reserve	Medog	62,620	Mountain forest ecosystem with a complete vertical profile and precious animals and plants	1985P
	Qomolangma Nature Reserve	Dinggye, Tingri Gyirong Nyalam	3,391,000	Himalayan mountain ecosystems and wild animals like snow leopard	1989N

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Province (Regional)	Name of nature reserves	Location (county or city)	Area (ha)	Main conserved objects	Time of Founding
	Qiangtang Nature Reserve	Shuanghu, Wennan, Gerze	24,712,000	Plateau ecosystems and rare and precious animals	1995P
Sichuan	Sigulian Mountain Nature Reserve	Xiaojin	48,500	Mountain forest ecosystems and precious wild animals and plants	1995P
	Juzhaiou Nature Reserve	Nanping	60,000	Giant panda and other rare and precious animals, natural landscape and forest ecosystems	1978P
	Huanglongsi nature Reserve	Songpan	40,000	Giant panda and other rare and precious animals and natural landscape	1983P
	Longqi Hongkou Nature Reserve	Dujiangyan (Guanxian)	34,000	Subtropical mountain forest ecosystems	1981P

Annex 2

Nature reserves in the Hindu Kush-Himalayan Region of China mainly for preserving rare and precious animals

(N=national; P=provincial)

Province (Regional)	Name of nature reserves	Location (county or city)	Area (ha)	Main conserved objects	Time of Founding
Sichuan	Wolong Nature Reserve	Wenchuan	200,000	Giant pandas and other rare and precious animals and natural forest ecosystems	1975N
	Wanglang Nature Reserve	Pingwu	32,279	ditto	1963P
	Mabian Dafengdien Nature Reserve	Mabian	30,000	ditto	1978P
	Meigu Dafengdien Nature Reserve	Meigu	21,864	ditto	1978P
	Fongtongzhai Nature Reserve	Baoxing	39,079	ditto	1978P
	Baihe Nature Reserve	Nanping	20,000	Golden monkey and other rare and precious animals	1963P
	Tiebu Nature Resere	Ruoegai	20,000	*Carvus nippon* and other rare and precious animals	1983P
	Labahe Nature Reserve	Tianquan	23,872	*Budorcas taxicolor* and other rare and precious animals	1963P
Yunnan	Anzhihe Nature Resere	Chonqing	11,000	Giant pandas and other rare and precious animals	1993P
	Nepahai Nature Reserve	Zhgongdian	2,400	*Guru nigricollis* and other rare and precious birds and their habitats	1984P

Province (Regional)	Name of nature reserves	Location (county or city)	Area (ha)	Main conserved objects	Time of Founding
Xizang (Tibet)	Zham Port Nature Reserve	Nyalam	6,852	Subtropical precious wild animals and natural landscape	1985P
	Xinza Nature Reserve	Xianza	4,000,000	*Grus nigricollis* and other rare and precious animals	1993P
	Markam Nature Reserve	Markam	185,300	Yunnan golden monkeys and their habitats	1993P
	Riwoqe Nature Reserve	Riwoqe	63,700	Cervus elaphus wallichi et al.	1993P
	Dongjug Nature Reserve	Nyingchi	22,600	*Naemorhedus cranbrooki* et al.	1993P
	Painbo Blacknecked Crane Nature Reserve	Lhunzhub	9,680	*Grus nigricollis* and their habitats	1993P
Qinghai	Longbao Nature Reserve	Yushu	10,000	*Grus nigricollis* and other rare and precious birds, and their habitats	1984N

Annex 3

Nature reserves in the Hindu Kush-Himalayan Region of China mainly for preserving rare and precious relict plants and endemic ecosystems

(N=nationa; P=provincial)

Province (Regional)	Name of nature reserves	Location (county or city)	Area (ha)	Main conserved objects	Time of Founding
Sichuan	Panzihua Cycas Nature Reserve	Panzihua (Dukuo)	651	Precious plant *Cycas panzihuaensis*	1983P
Yunnan	Yaoshan Nature Resetve	Qiojao	10,215	Chinese traditional medicinal plants and alpine natural forest ecosystems	1984P
	Diaoling Mountain Nature Reserve	Lufeng	613	Subtropical evergreen broad-leaved forest ecosystems	1984P
	Puduhe Nature Resetse	Luqien	11	Natural *Cycas* forest	1984P
	Jiache Nature Reserve	Huize	8,287	Natural *Pinus armandi* forests	1984P
	Longshan Nature Reserve	Menglian	54	Dragontree, a precious species of plant	1986
Xizang (Tibet)	Bajie Nature Reserve	Nyingchi	8.7	Old trees of *Cupressus gigantes*, a precious tree species and its habitat	1985P
	Jiangcun Nature Reserve	Gyirong	34,060	*Pinus roxburghii* and *Picea smithiana*, Precious tree species, and forest ecosystems	1985P
	Zayu Nature Reserve	Zayu	101,412	Subtropical evergreen broad-leaved forests and *Cinnamomur glanduliferum*, *Machilus* spp, *Michellia* spp etc	1985P

Annex 4

Major expeditions on biotic resources of the Hindu Kush-Himalayan Region of China

(mainly from H. Chen and al. 1990)

Name of expeditions	Area involved	Main purposes	Disciplines involved	No. of scientists engaged	No. of Inst. engaged	Time
Comprehensive Expedition of Biotic Resources to the Tropics of Yunnan	Yunnan	Exploitation and utilisation of tropical and subtropical biotic resources such as shellac	8	>500	>40	1953-1962
Integrated Expedition to West China for Transferring of Water from the South to the North	NW. Yunnan W. Sichuan	Route for water transferring and exploitation and utilisation of natural resources in W. China	38	>800	114	1959-1961
Integrated Expedition to Xizang	Xizang (Tibet)	Natural resources and their exploitation and utilisation	25	>200	>20	1960-1962
Integrated Expedition to SW. China	Sichuan, Yunnan (and Guizhou)	Exploitation and utilisation of natural resources and rational distribution of production	43	>90	>50	1963-1966
Integrated Scientific Expedition to Xizang	The Qomolangma Mountain area	Scientific Exploration	>20	>90	>10	1966-1968
Grassland Expedition to Yushu, Qinghai	Yushu Automous Prefecture, Qinghai	Condition of grasslands for livestock migration to the west	5	>20	4	1970

Name of expeditions	Area involved	Main purpose	Disciplines involved	No. of scientists engaged	No. of Inst. engaged	Time
Integrated Scientific Expedition to the Qing-Zang Plateau	Xizang, Hengduan Mountains of Sichuan and Yunnan, the Karakoram and Kunlun Ranges	Causes for lifting of the plateau and its effect on nature and human beings, exploitation and utilisation of natural resources	>50	>1,500	>7	1973-1979 (1st stage) 1981-1986 (2nd stage) 1987-1991 (3rd stage)
Scientific Expedition to the Qomolangma Peak	The Qomolangma area, Xizang	Cause for formation of the peak and its effect on natural conditions and human beings	11	40	11	1974-1975
Mountain-climbing Scientific Expedition to the Namjagbarwa Mountain	The Namjagbarwa Mountain area	Formation and evolution of the Namjagbarwa and its effect on natural environments	10	110	24	1982-1985
Integrated Scientific Expedition to SW. China	Sichuan, Yunnan (also Guizhou, Guangxi)	Exploitation of natural resources and economic development	>25	200	20	1986-1990
Integrated Scientific Expedition to the Qomolangma Nature Reserve	The Qomolangma Peak, Xizang	Assessment of the nature reserve	3	25	3	1989-1991
Integrated Scientific Expedition to the Kekexili range	The Kekexili Range, Qinghai	Geological, geographical and biological exploration of the range	27	>100	68	1990
Integrated Land Resources' Expedition to Xizang Autonomous Region	Xizang	Grassland resources, etc	>10	>100	812	1984-1991

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