Characteristics of Ecological System

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Chapter 1

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The island of Hokkaido is the northernmost in the Japanese archipelago. It faces the Sea of Okhotsk and is separated from Honshu by the Tsugaru Strait and from Sakhalin by the Soya Strait. The lowlands of Hokkaido represent a transitional zone between cool temperate forests in the south and sub-arctic forests in the north. The mostly upland eco-region of Hokkaido is situated in the cold-temperate and sub-arctic/sub-alpine climate zones. This chapter introduces the importance and uniqueness of wildlife and ecosystem of Hokkaido.

1. What is Hokkaido Island?

(1) Where and how big is this?

The map (Fig. 1-1) shows that Hokkaido is located between 41°21'N and 45°33'N latitude, and 139°20'E and 148°53'E longitude. It is in the same latitude as Portland, Oregon (USA), Toronto (Canada) and Rome (Italy). The area of Hokkaido is 83,451 km^2, which is 22% of the total land area of Japan. The population of Hokkaido is 5.69 million (cf. 11.77 million in Tokyo) and 32% (1.856 million) of people live in Sapporo city, which is the capital of Hokkaido. The population density of Hokkaido is roughly 68 people/km^2 compared to 5384 people/km^2 of Tokyo.

(2) Geography

Hokkaido is a biogeographically important region. The central Hokkaido has mainly mountains and highlands. It includes the Taisetsu mountain range (Fig. 1-2), which has the highest summit Mt. Asahidake (2291 m ASL), the Tokachi mountains and east Taisetsu mountains. The Taisetsu mountain range is also called the "The Roof of Hokkaido". In the north of the central highlands is the Kitami mountain range. Towards the Sea of Japan runs the Teshio mountain range from north to south. In the south of the central highlands stretch the sharp

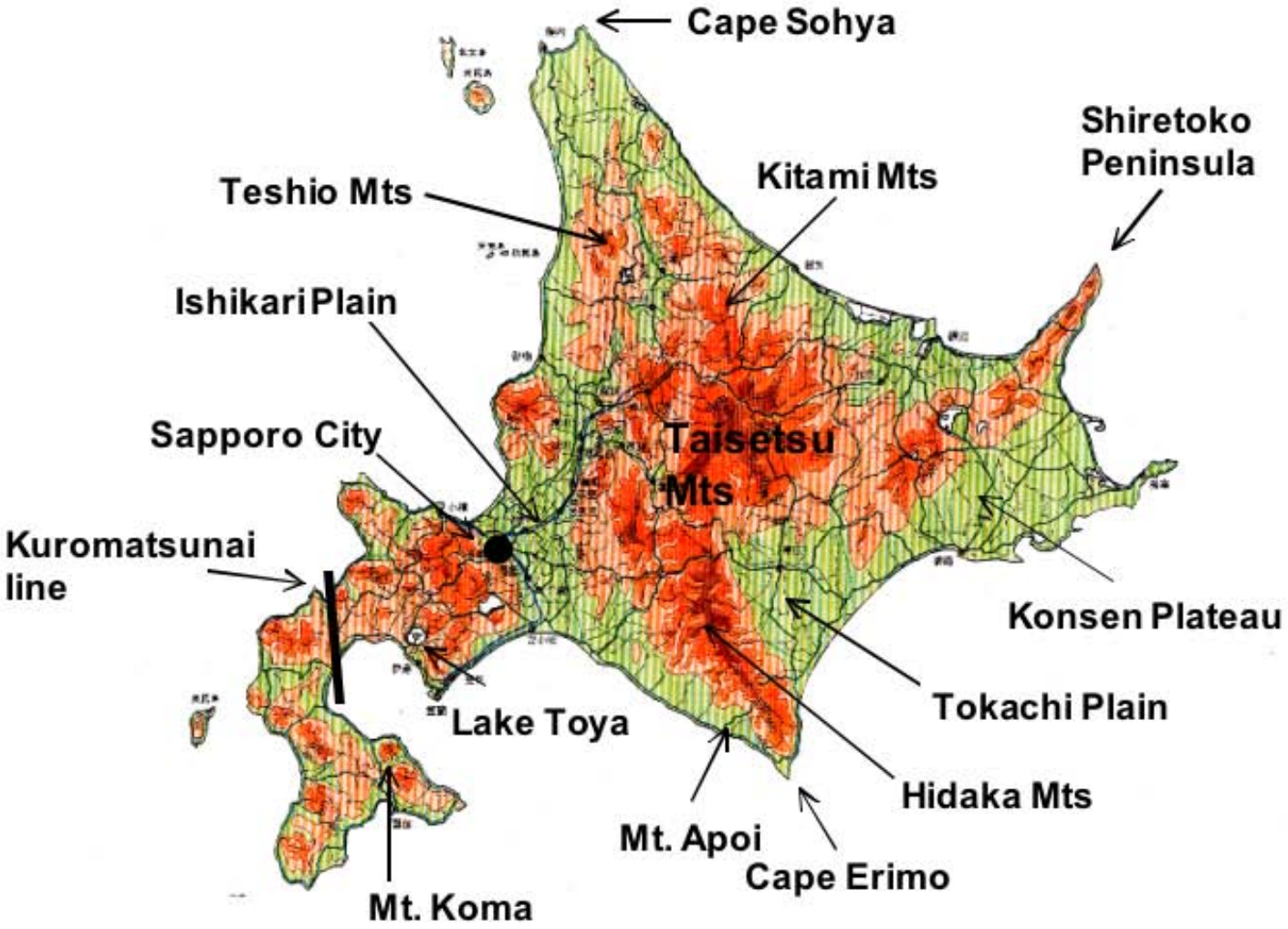

Fig. 1-1. Geographical map of Hokkaido

ridges of the Hidaka mountain range,140 km toward cape Erimo. The Yubari mountain range lies parallel to the west of the Hidaka mountain range. These spinal mountains that run from cape Sohya to cape Erimo, are truly the backbone of Hokkaido, and undoubtedly influence the climate and vegetation of Hokkaido.

In eastern Hokkaido, there is Shiretoko peninsula, which has been designated as a world heritage site. The Akan volcanoes are in the southernmost part of the Chishima volcanic zone. In the southwest area of the Ishikari lowland zone, there is a chain of active volcanoes such as Mts. Tarumae, Usu, Koma (Fig. 1-3), Yohtei and the Niseko ranges. Because of volcanic activities in Hokkaido, there are many crater lakes, namely Shikotsu, Toya (Fig. 1-3), Kussharo, Akan and Mashuu.

(3) Climate

Hokkaido has four distinct seasons like the rest of Japan. As it lies in far north, it generally has cooler summers, and cold, snowy and blustery winters (Fig. 1-4). The average temperature in August is around 22°C (72°F), while in January it ranges from -12°C to -4°C (10°F to 25°F) depending on elevation and latitude. Unlike the other major islands of Japan, Hokkaido is normally not affected by “Tsuyu” and typhoons in the rainy season. During winter, passage through the Sea of Okhotsk is often disturbed by large ice floes broken loose from the Kamchatka peninsula. Due to high winds that occur during winter, air travel and maritime activity almost come to a halt in the northern coast of Hokkaido.

2. Vegetation

Since the geographical structure of Hokkaido is complex with mosaic distributions of volcanic, sedimentary and metamorphic rocks, this island has been historically providing a variety of habitats for wildlife. It has interesting Japanese Islands, Sakhalin and Kurile, and its flora and fauna are a mixture of species from southeastern Asia, Siberia and North America. The southern sea barrier, Tsugaru Strait, is the bio-geographical boundary, “Blakiston Line”, which has interrupted the migration of many animals between Hokkaido and Honshu,

Fig. 1-2. A view of Taisetsu Mountains (Photo by Dr. Akira S. Hirao)

the main island of Japan. On the other hand, in the northern barrier, Sohya Strait, a land bridge was frequently formed in the glacial epoch. Hokkaido is located in a zone of high snowfall and this has facilitated a mixture of summer-green deciduous trees and evergreen coniferous trees. Actually, the mixed forest of this island is considered to be the richest in species among all temperate and boreal vegetations of the world.

(1) Boreal coniferous forests

This forest cover is dominated by Asian spruce (*Picea jezoensis*) and Sachalin fir (*Abies sachalinensis*). These are distributed at high altitudes of Taisetsu and Hidaka mountain ranges as well as at comparatively lower elevations of Sohya, Kushiro and Nemuro districts. Dominance of *Picea jezoensis* increases at higher altitudes with increasing levels of stability.

Conifer forests are found up to an elevation of approximately 1,500 m in Hokkaido; above this point alpine conditions predominate. Stone pine (*Pinus pumila*) forms low (1-2 m) and dense growth in alpine areas, with poorly developed undergrowth, but vigorous mosses on the ground. The abrupt change of the landscape from high forests to low lying *Pinus pumila* shrubs is impressive and can be easily recognized. In the alpine zone, the coniferous species are sometimes accompanied by deciduous broad-leaved shrub communities. The main associations found are of birch-alder (*Betula ermanii-Alnus maximowiczii*) and mountain ash (*Sorbus sambucifolia*). Alpine heaths composed conspicuously of *Empetrum nigrum* and dwarf shrubs (*Arcterica nana-Loiseleuria procumbens* association) are found at some of the highest altitudes (Kudo 1993).

The sub-alpine coniferous forests that used to extend up to the northeastern hills and plains in coastal areas, for the most part, have been cut down. However, compared to the rest of the country there still remain relatively intact large tracts of forests in Hokkaido. Mt. Daisetsu National Park is the largest national park in Japan covering several volcanic mountains with extensive spruce and fir forests on its slopes.

(2) Deciduous forests

Fig. 1-3. A volcanic mountain, Mt. Koma (top) and a crater lake, Lake Toya (bottom)

The lowlands of Hokkaido represent a transitional zone between cool temperate forests in the south and sub-arctic forests in the north with the exception of the Oshima peninsula. This eco-region covers low hills and plains of Hokkaido. The lowland deciduous forests of the island are dominated by oaks (*Quercus* – especially Mongolian oak *Quercus mongolica* var. *crispula*), basswoods (*Tilia japonica*), elm (*Ulmus davidiana*) and ash (*Fraxinus mandshurica*), typically with undergrowth of dwarf bamboo (*Sasa* species). The base of the peninsula forms a boundary known as the Kuromatsunai line (Tatewaki 1958; cf. Fig. 1-1). The beech (*Fagus crenata*) forest, representative forest type in the cool-temperate zone of Japan, is the only forest present throughout the Oshima peninsula, which is situated south of Kuromatsunai lowland. This is a striking northern limit for the distribution of this species.

The campus of the Hokkaido University is located in the center of Sapporo city developed on the drainage basin of two big rivers, Ishikari and Toyohira, in Ishikari plain. In the campus, there are many large elm (*Ulmus davidiana*), maple (*Acer mono*) and ash (*Fraxinus mandshurica*) trees, which prefer mesic and rich soil (Fig. 1-5).

In spring as days become longer and temperature rises, brown deciduous forests and fields of Hokkaido start to turn green. The forest floor in particular, brightens as scores of wild flowers, “the spring ephemerals”, bloom in April and May. These flowers open, and leaves unfurl for a few days only. During this short period, the spring ephemerals show many unique and different ecological features (cf. Fig. 1-5). Although most of the species of Araceae are common in tropical regions, *Lysichiton camtschatcense* (Fig. 1-5a) of this family is adapted to cool temperate regions, having unique life forms. *Erythronium japonicum* is one of the representative spring woodland perennials of Japan (Fig. 1-6b). The large showy pinkish flowers of this species have been attracting many flower lovers. *Corydalis fumariifolia* (Fig. 1-6c) has deep blue palate, arranged in racemose inflorescence of 1 to 15 flowers. Each flower has a spur in which nectar collects. Nectar attracts bumblebees, which is an important pollinator. A representative wild flower of Hokkaido worth mentioning is *Trillium camschatcense* (Fig. 1-6d). This flower can be seen on the main campus and in the Botanical garden of Hokkaido University. This flower figures in the emblem of

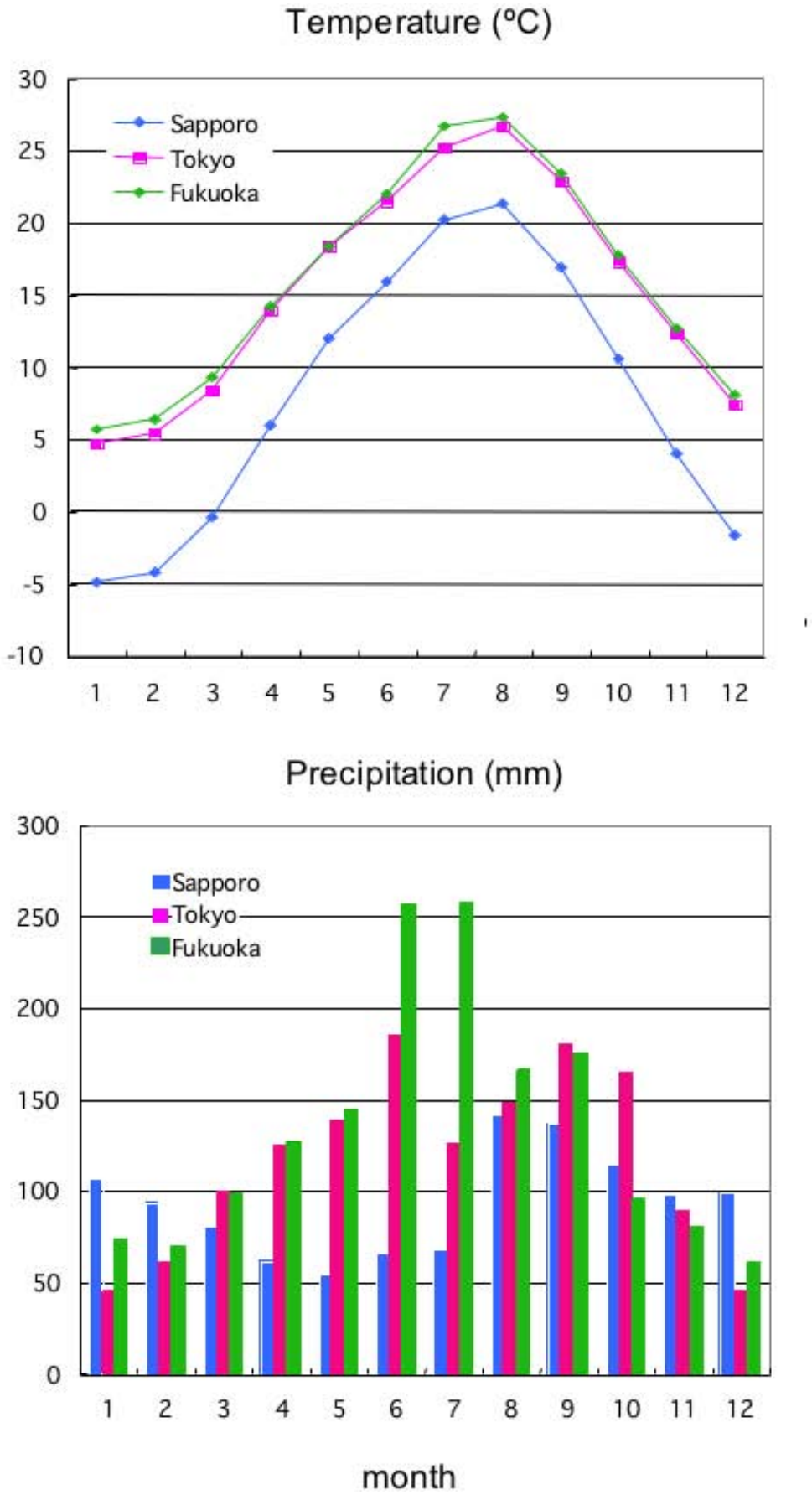

Fig. 1-4. Average temperature and precipitation of Sapporo, Tokyo and Fukuoka

Hokkaido University. In May, one finds *Trillium camschatcense* in bloom everywhere in Hokkaido (Fig. 1-5). In late spring (early June), lily-of-the-valley, *Convallaria keiskei* with aromatic white flowers starts to flower (Fig. 1-6e). In summer (during July) in deciduous forests, one finds tall plants (1.5–2.0 m high) of *Cardiocrinum cordatum* (Fig. 1-6f) with large conspicuous flowers.

(3) Mixed conifer-hardwood forests

The conifer-hardwood forest is a mixture of boreal evergreen conifers and temperate deciduous hardwoods that differ in life forms but grow in the same place (Fig. 1-7). However, in some cases, the mosaic-like areas of pure stands of different species growing adjacent to one another are also called mixed forests. The mixed forests can be seen not only in the Far East including Hokkaido, but also in southern Scandinavia and northern parts of Eastern Europe, and those between the Great Lakes regions and the northernmost of the Appalachian mountains of North America. Tatewaki (1958) named this type of forest zone the “pan-mixed forest zone”, which is more commonly known as the “hemi-boreal zone” (Hamet-Ahti et al. 1974) or the “boreo-nemoral forest ecotone” emphasizing the transitional aspects (Uemura 1993).

3. Biodiversity Features

(1) Flora

There are 2,250 species of higher plants (including ferns, gymnosperms and angiosperms), and it is important to note that the central mountain ranges in Hokkaido harbor many rare and endemic flora particularly in areas with serpentine rocks. For example, *Salix paludicola*, chickweed (*Stellaria pterosperma*), aconite (*Aconitum yamazakii*), and *Draba nakaiana* are endemic to Mt. Daisetsu. The flora of Mt. Apoi also contains by far the greatest number of endemics of Hokkaido, and is one of the most distinct among the serpentine communities of Japan. Some of the remarkable serpentine relics are *Hypochoeris crepidioides*, *Callianthemum miyabeanum*, *Crepis gymnopus*, *Rhamnus ishidae*, *Betula apoiensis*, *Viola hidakana*, and *Primula hidakana*.

(2) Mammals

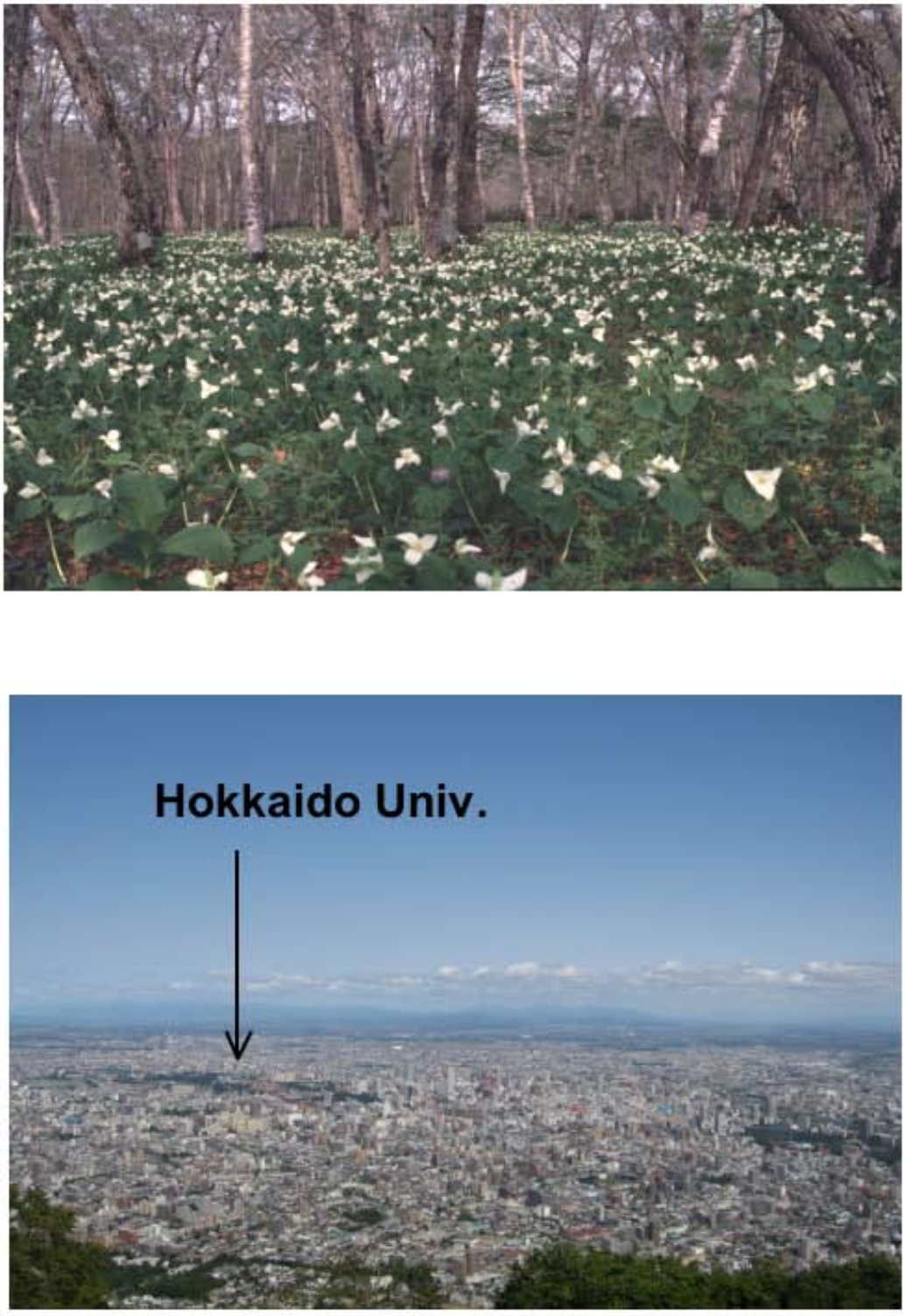

Fig. 1-5. Lowland deciduous forest. A view in early spring (top: leaves of canopy trees are just opening), and a view of Sapporo City (bottom: the city is expanding by developing lowland deciduous forest established on the Ishikari depression)

There are approximately 62 species of mammals in this eco-region. These are mostly small mammals such as microbats, rodents, rabbits, and small mustelids. Red foxes (*Vulpes vulpes*) are also present. There is also an endemic subspecies of a more widespread Sika deer (*Cervus nippon yesoensis*) (Kamamichi 1996; Hilton-Taylor 2000). Japan's largest mammal species the Yezo brown bear (*Ursos arctos yesoensis*) is found only in this eco-region. The Yezo brown bear is considered a subspecies and is also found in the neighboring Russian controlled islands. The brown bear is an area-sensitive focal species for conservation planning as its population has restricted distribution in the lowland eco-region where they tend to overlap with human areas.

There is also an endemic sub-species of Pika (*Ochotona hyperborea yesoensis*) and Sable (*Martes zibellina brachyura*). Pika is a remnant of the glacial age and has a very narrow habitat range in the central mountains around Mt. Daisetsu. The Japanese sable is threatened by breeding with the Japanese marten (*Martes melampus*) introduced in Hokkaido.

(3) Birds

In Hokkaido, more than 400 species of birds are thought to habit and/or breed (Brazil 1991; Birdlife International 2000). A number of species found in Hokkaido is associated with northern latitudes and are not seen in the rest of Japan. These include vulnerable Stellar’s sea eagle (*Haliaeetus pelagicus*), white-tailed sea eagle (*Haliaeetus albicilla*), common merganser (*Mergus merganser*), tufted puffin (*Lunda cirrhata*), hazel grouse (*Tetrastes bonasia*), three-toed woodpecker (*Picoides tridactylus*), and willow tit (*Parus palustris*) (Higuchi et al 1995; Hilton-Tayler 2000). An endemic sub-species of hazel grouse (*Tetraste bonasia vicinitas*) is also found in Hokkaido (Higuchi et al. 1997).

Blakiston's fish owl (*Keputa blakistoni*) is a rare, endangered bird found in this eco-region. Its habitat-range is believed to be limited to the Hidaka mountain to Nemuro and the Shiretoko peninsula.

The endangered red-crowned Japanese crane (*Grus japonensis*) is considered a natural national bird and a symbol of happiness and longevity.

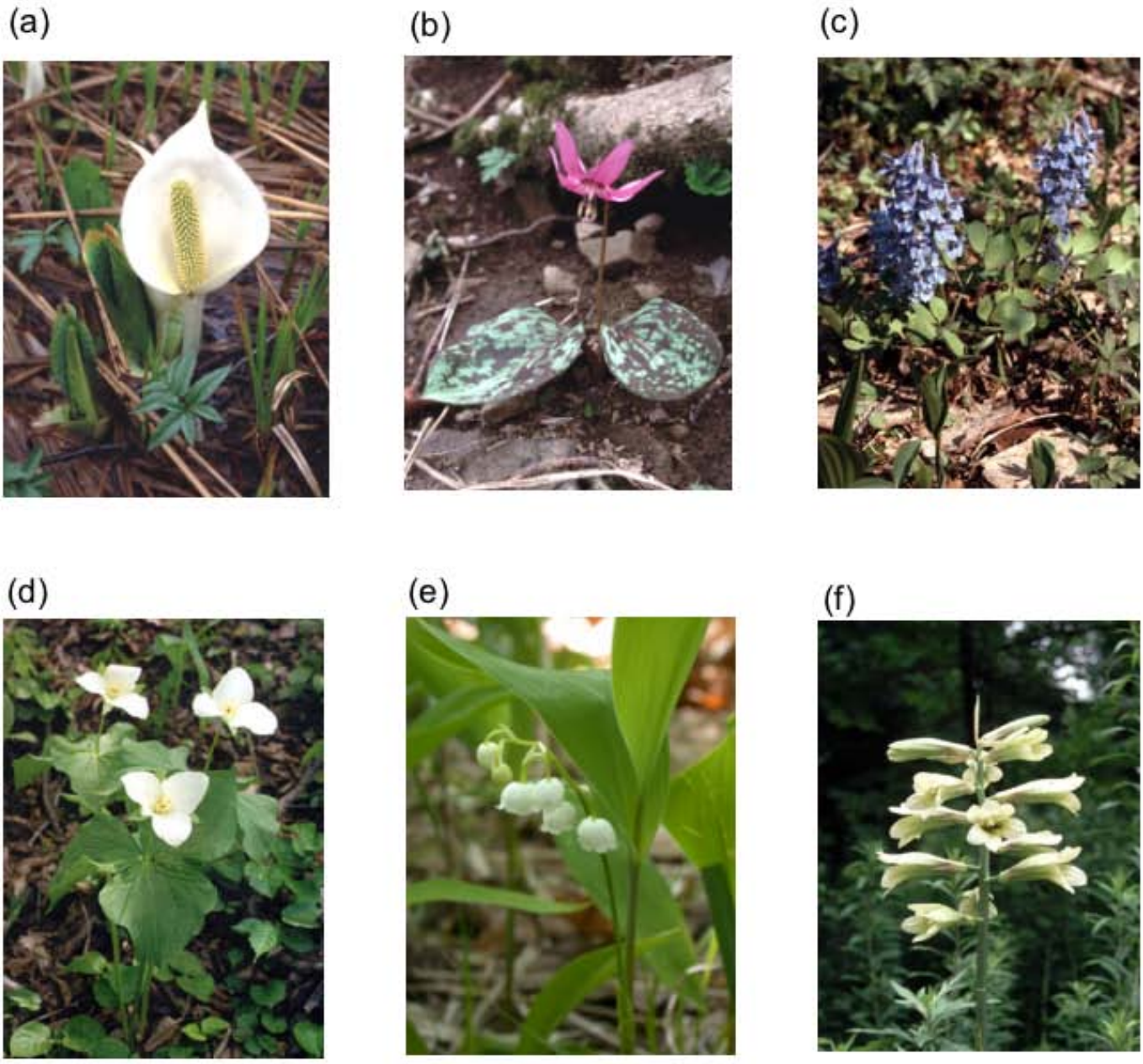

Fig.1- 6. Herbaceous plants in deciduous forests: *Lysichiton camtschatcense* (a), *Erythronium japonicum* (b), *Corydalis fumariifoia* (c), *Trillium camschatcense* (d), *Convallaria keiskei* (e), *Cardiocrinum cordatum* (f)

Hokkaido's red-crowned crane is a permanent resident of the lowland east coast of the island, whereas the mainland population of red-crowned cranes is migratory.

4. Importance of Conservation

(1) Factors responsible for extinction of wildlife

A variety of causes, independently or in concert, are responsible for extinction of wildlife. Historically, overexploitation was the major cause of extinction; although overexploitation is still a factor. Habitat loss is another major problem of today. Many other factors can contribute to species extinctions as well, including disruption of ecosystem interactions, pollution, loss of genetic variations, and catastrophic disturbances, either natural or man-made. The action of one factor predisposes a species to be more severely affected by another factor. For example, habitat destruction may lead to decreased birthrates and increased mortality rates. As a result, populations become smaller, and more fragmented and isolated making them more vulnerable to disasters such as floods or forest fires, and also to inbreeding. The loss of genetic variation through genetic drift, further decreases the population fitness. So, which factor causes the final *coup de grace* may be irrelevant as many factors and interactions between them may have contributed to a species' eventual extinction.

(2) What is happening in Hokkaido?

As mentioned above, Hokkaido is geographically, geologically and biologically interesting and unique island, and there is much precious wildlife including endemic species. However, after the rapid settlement of the Japanese in the Meiji era (1868-1912), natural forests were quickly replaced by farmlands and plantations, and some animal species such as the gray wolf and European river otter are now extinct. Tokachi plain in eastern Hokkaido, is a very active area for agriculture (adzuki bean, soybean, sugar beet and so on) and dairy farming. Anthropogenic land conversion (e.g. road construction and agricultural development) has resulted in highly fragmented landscape with a large number of forest remnants, many of which are smaller than 1 ha (Tan 1994)(Fig. 1-8).

Fig. 1-7. Mixed conifer-hardwood forest

Loss of habitat by a species frequently results not only in decrease in population, but also in fragmentation of the population into unconnected patches. A habitat may become fragmented in non-obvious ways, when roads and human habitation intrude the forest. This often results in disastrous consequences for wild life. The conservation status in Hokkaido is not satisfactory, and fragmentation of wildlife habitat is thought to be very substantial.

Habitat loss and degradation in the form of continued agricultural and industrial development constitute the principal threats to red-crowned cranes in Hokkaido. However, adoption of two active habitat management measures i.e. winter feeding stations and the installation of conspicuous markers on utility lines have allowed the Japanese red-crowned crane population to increase. These actions have reduced the rate of mortality from near extinction to approximately 60% (Swengel 1996).

Only 30% of the Blakiston's fish-owl nesting sites are protected within national parks or wildlife protected areas, and there is no regulation for general protection of the owl habitats. Well developed mixed forests have often been exploited for human establishments. Wild life has also been heavily affected by grazing by horses and cattle. Rapid decline in the population of endemic hazel grouse subspecies has been observed and it is probably due to the replacement of natural deciduous mixed forest with pine (*Larix leptrepis*) plantations for several decades.

Population of brown bears has been affected by hunting for sport and vehicular disturbances, but the greatest threat is the conversion of hardwood habitats into conifer plantations. Efforts directed at public education regarding human-bear interactions and the need to conserve and plan around bears' habitats have been identified as priorities.

(3) Harmony in agriculture and conservation

Development of agricultural fields and conservation of forests is antagonist to each other. However, we need to combine the both. Species populations in isolated patches may go extinct unless efforts are made to re-colonize these. It has become clear that isolated patches of habitat lose species far more rapidly than large preserves do. Corridors may assist dispersal between patches, and

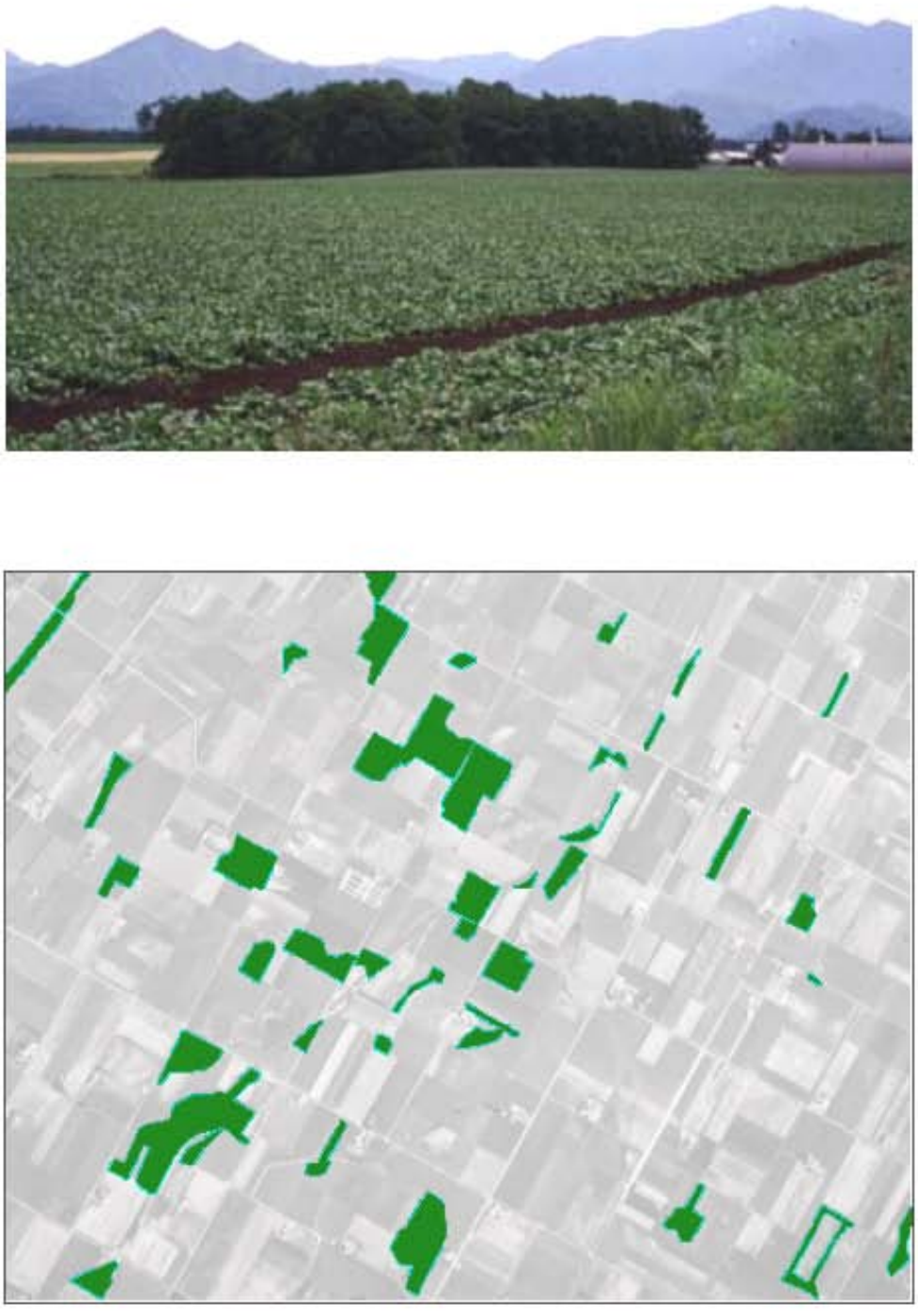

Fig. 1-8. A fragmented forest in sugar beet field (top) and various shapes of fragmented forests in agricultural area (bottom) in Tokachi Plain

maintaining connectivity among habitats has become one of the important features of conservation biology. Conservation biologists recently have promoted the criterion of so-called “mega-reserves”, large areas of land containing a core of one or more undisturbed habitats. The key to devoting such large tracts of land for long periods is that the operation of reserve should be compatible with local land use. Thus, while no economic activity is allowed in the core regions of the mega-reserve, the rest of the reserve may be used for nondestructive harvesting of resources i.e. sustainable resource harvesting. Linking reserved areas to carefully managed land zones creates a much larger total patch of habitat than would otherwise be economically practical, and thus addresses the key problem created by habitat fragmentation. Accordingly, joint management of biodiversity and economic activity is essential. The ecological challenge of conservation biology is to develop adequate management plans for individual species and ecosystem, whereas the challenge for the government is to broaden the movement so as to harmonize agricultural land use with conservation of natural habitats for wildlife in Hokkaido.

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