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THE UTILIZATION AND CONSERVATION OF MIRES IN JAPAN

Japanin suot ja niiden hyväksikäyttö sekä suojelu

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Japan has approximately 200 000 ha of mires (0.5% of the total land area), and peat reserves of ca. 625 million tons. Because of the great diversity in both climatic and topographic conditions various types of mire and wetlands are found. These range from the large coastal mires in Hokkaido to the mangrove forests with surrounding limnogenic mires in subtropical regions of the Ryukyu Archipelago. The majority of Japanese mires are, however, located in regions of recent volcanic activity and on the alluvial plains of Central Honshu and northwards. Most of the lowland mires have long since been reclaimed for rice culture or have partly been buried under built-up areas. In this paper, different forms of mire utilization are outlined and 30 legally (or otherwise) protected mires in Hokkaido are briefly described.

Keywords: Hokkaido, Japan, peatlands, preservation, utilization

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INTRODUCTION

The total area of mires in Japan is some 200 000 ha and the reserve of peat is estimated to be ca. 625 million tons (Moore & Bellamy 1974, Sakaguchi 1980, 1983). The peat deposits can reach a thickness of 8 to 9 m, but average 3 to 5 m, and the average peat accumulation rate is 1.0 mm/year (Sakaguchi 1961). In response to a wide range of climatic and geographic conditions, a variety of regional types of mire and wetlands have developed. These range from the extensive coastal mires in Hokkaido and the mountain mires in Honshu, to the mangrove forests (*Kandelia candel, Bruguiera conjugata, Sonneratia alba, Rhizophora mucronata, Avicennia officinalis, Lumnitzera racemosa*) with surrounding limnogenic mires in subtropical regions of the Ryukyu Archipelago (Shin 1970, Environment Agency 1981).

Most of the mires in Japan are located in regions of recent volcanic activity and on the alluvial plains of Central Honshu and northwards. Peat bogs have developed in basins dammed by lava flows or mud flows, in shallow depressions on lava flows and mud flows, on gentle slopes of volcanoes composed of impermeable weathered volcanic ash, and around springs on the slopes or at the foot of volcanoes. Peat

deposits often contain layers of volcanic ash, the ash being capable of travelling great distances from the eruption source (Sakaguchi 1961).

The 25°C isotherm for July, which runs across the middle of Honshu, has been regarded as the southern limit of the peat bogs in Japan (Sakaguchi 1961), and the 20°C isotherm for July to coincide with the southern limit of intensive peat formation in lowlands. Hokkaido, which is situated within these limits, is the most intensive peat forming area in Japan (Fig. 1). *Sphagnum* peat bogs are found further south, for example, on the islands of Yakushima and Kyushu, but only in the mountains (Arakane 1960, Suzuki 1972). Most of the lowland mires have developed from so-called back swamps that have formed in the interfluves between river channels and valley-sides. Mires which have developed in small valleys in the uplands often have characteristics of spring-water mires (Sakaguchi 1961).

There have been four periods of mire formation during the Holocene epoch (Sakaguchi 1961). The first mire forming period began at the beginning of the Holocene epoch. The second was 6 000 to 5 000 B.P., and was the period when the basin mires were intensively formed in the lowlands of northern Japan. The third period occurred when the climate became cooler and moister, about 3 000 B.P. It is believed that most of the sloping mires or watershed mires were formed then. The fourth period coincided with the Christian era.

Most lowland mires have been reclaimed for agricultural use or have partly been buried under urban and industrial development, and have so lost their original features. Even in protected areas, many mires are under heavy pressure from increasing numbers of visitors and are suffering considerable disturbance as a result. Urgent measures are required to protect the remaining mires.

MIRE CLASSIFICATION

According to traditional mire classification, three mire types are recognized: oligotrophic, mesotrophic and eutrophic mires. The main components of the oligotrophic mires in Japan are: *Sphagnum papillosum, S. magellanicum, S. rubellum, S. fuscum, S. compactum, S. tenellum, Moliniopsis japonica, Carex middendorffii, Andromeda polifolia, Oxycoccus quadripetalus, Drosera rotundifolia, Eriophorum vaginatum, Rubus chamaemorus, Ledum palustre* var. *diversipilosum, Chamaedaphne calyculata* and *Empetrum nigrum* var. *japonicum* as hummock vegetation, *Rhynchospora alba, Scheuchzeria palustris, Moliniopsis japonica, Carex limosa, Drosera rotundifolia, D. anglica* and *Lycopodium inundatum* as hollow vegetation. The following plant species are commonly encountered on Japanese mesotrophic mires: *Moliniopsis japonica, Drosera rotundifolia, Carex omiana, Hosta* spp., *Sanguisorba officinalis, Rhynchospora fauriae, Lobelia sessilifolia* and *Pogonia japonica*. The main components of Japanese eutrophic mires are: *Phragmites australis*, various species of *Carex* (*C. augustinowiczii, C. schmidtii, C. caespitosa, C. thunbergii* var. *thunbergii, C. vesicaria*), *Lastrea thelypteris, Lycopus* spp., *Polygonum thunbergii, Viola verecunda, Lysichiton camtschatcense, Lysimachia vulgaris, Lythrum salicaria, Equisetum fluviatile, Menyanthes trifoliata, Comarum palustre, Cicuta virosa* and *Angelica genuflexa* (Suzuki 1975).

Forested mires are relatively uncommon in Japan. The most important types are: alder (*Alnus japonica*) swamps, the *Picea glehnii* dominant fens in eastern Hokkaido, the *Larix kaempferi* dominant swamps in Central Honshu and *Larix gmelinii* var. *japonica* dominant swamps in the southern Kuril Islands (Horikawa & Ando 1954, Tatewaki 1958, Shinsho 1983, Tsujii 1987).

From the climatic and topographic conditions, Japanese mires would belong to L. von Post's topogeneous and soligeneous types of peatland (Sakaguchi 1980). Sakaguchi (1979) has presented a classification of mires based on mire forming processes and on the topography of the original ground. The combination of *Sphagnum* mosses has been used in another classification of Japanese mires (Suzuki 1972).

Damman (1988) compared Japanese raised bogs with those in other parts of the world and pointed out their unique

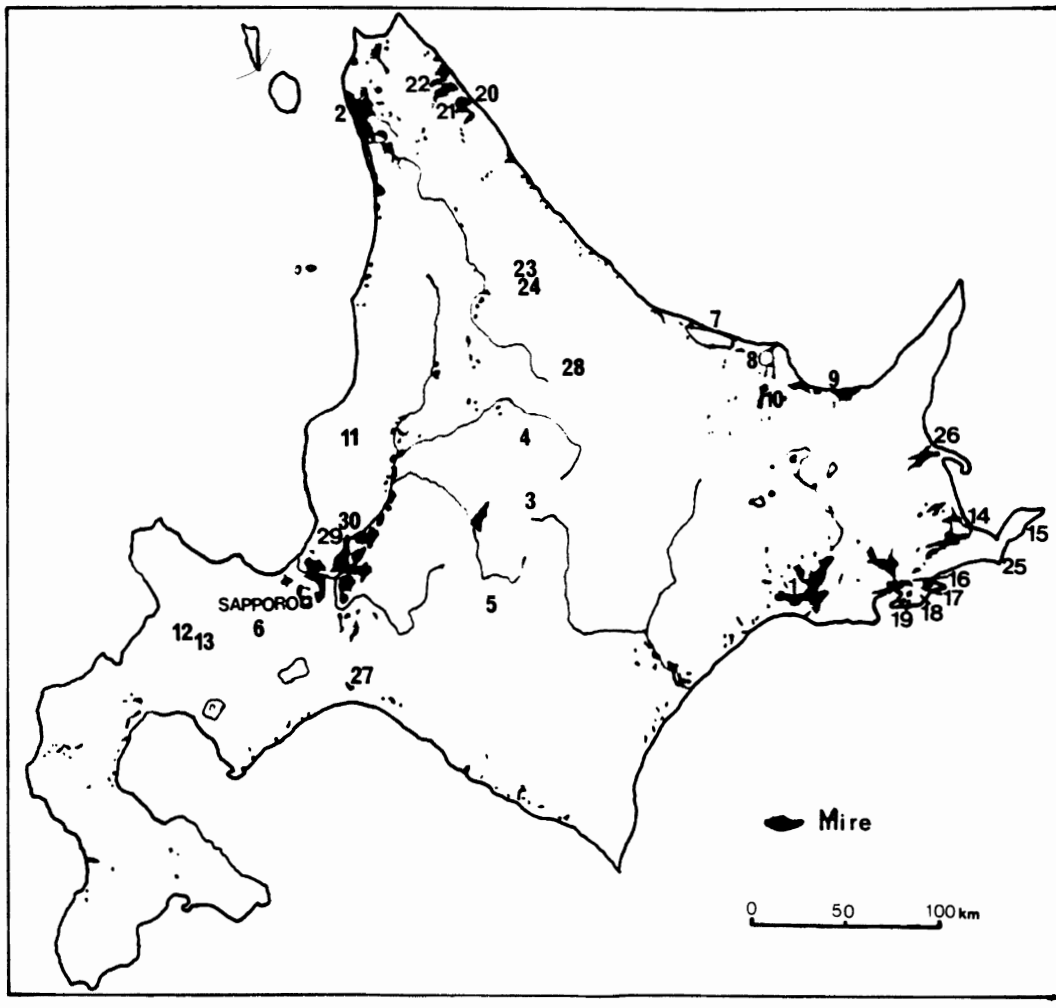

Fig. 1. The location of mires in Hokkaido as well as legally or otherwise protected mires. Modified from Tsujii (1987). Legend: 1. Kushiro, 2. Sarobetsu, 3. Numanohara, 4. Numanotaira, 5. Genshigahara, 6. Orochigahara, 7. Saromako, 8. Notoroko, 9. Tofutsuko, 10. Memanbetsu, 11. Uryunuma, 12. Shinsennuma, 13. Kagaminuma, 14. Furenko, 15. Onnenuma, 16. Akkeshiko, 17. Kiritappu, 18. Hichiripputo, 19. Mochiripputo, 20, Kutcharoko, 21. Mokeunito, 22. Hyotannuma, 23. Matsuyama, 24. Piyashiri, 25. Ochiishimisaki, 26. Shibetsu, 27. Utonaiko, 28. Ukishima, 29. Bibai, 30. Tsukigaumi. The numbers correspond to those of Appendix 1.

Kuva 1. Soiden pääasialliset esiintymisalueet sekä lain nojalla tai muutoin suojellut suot Hokkaidolla. Muunneltu Thujiin kuvasta (1987). Numerot viittaavat liitteeseen 1.

features. These features were: 1) the abundance of grasses and herbs, and the subordinate role of ericaceous dwarf-shrubs, 2) the presence of many species not found in ombrotrophic bogs elsewhere, such as *Parnassia palustris, Carex michauxiana*, or *Sphagnum flexuosum*, 3) the predominance of Ca ions and the large spatial variation in SO_4 concentrations in the bog pools, 4) the more highly humified peat, the higher ash percentage (3x), and the larger amounts of Al (100x), Fe (>16x) and Mg (>12x) than those in the surface peat of ombrotrophic bogs elsewhere, and 5) the rapid increase in N and decrease in C/N with peat depth, indicating that N immobilization is not limited by a nutrient deficiency. This enrichment of the chemistry of the peat and of the vegetation is caused by the presence of volcanic ash. The effect of the ash on the surface vegetation can remain evident for over 200 years.

The influence of volcanic ash on the development and successional changes in wetland vegetation is, however, controversial. Sakaguchi (1980) stated that ash, when mixed with peat, promotes eutrophication and improves aeration in mires, and that oligotrophic mires change into eutrophic mires. Wolejko and Ito (1986) proposed a new term, "a tephratrophic mire", and defined it as a mire that has formed and developed under the influence of tephra (volcanic ash). They distinguished four mire types in Hokkaido as follows: (1) mixed bog and fen tephratrophic mires, (2) mountain tephratrophic fens, (3) several types of lowland fens, and (4) fen swamps (alder swamps). Furthermore, they identified five mire zones in Japan using mire and peat types: (1) the mountain mire zone of Hokkaido, (2) the lowland raised bog zone of Hokkaido, (3) the mountain mire and upland raised bog zone of northern Honshu, (4) the transitional zone, and (5) the peatless or peat-poor wetland zone of southern Japan (Fig. 2). These zones reflect the properties of climate for potential development of a particular mire type.

MIRE UTILIZATION

Agricultural utilization

Most Japanese lowland mires have been reclaimed for use as rice paddy fields. Rice is grown on 70 000 ha of mire in Japan (Moore & Bellamy 1976), although this constitutes only a small proportion (ca. 2.5%) of the country's total of rice paddy fields. The general characteristics of these lowland mires can be recognized from the remnants that remain and abandoned paddy fields (Yoshioka 1974).

Of ca. 200 000 ha of mires in Hokkaido, 62% are being used for agricultural lands and urbanization areas (Sakaguchi 1979). Agricultural utilization of mires must be preceded by land improvement procedures involving drainage, liming and dressing with mineral soil. Experimental fields on mires were established as early as 1919 and investigations on the choice of suitable crops and fertilizer were initiated (Yano et al. 1980)

In 1953, the Ishikari (Hokkaido) Basin Development plan was proposed upon the initiative of the central government. This plan included the systematic development of 55 000 ha of mires into farmlands by land amelioration. Since 1955, research into high yield paddy rice farming has advanced remarkably. The necessary technology was successfully developed and firmly established by 1965 and the plan was completed in 1970 (Saito 1983).

The mires at Sarobetsu and Kushiro in Hokkaido are not used for paddy rice farming because of unsuitable climatic conditions. However, they can be made suitable for dairy farming areas. So far, about 9 600 ha of previous mires have been reclaimed for use as grasslands. This is made possible by a successive procedure of till-

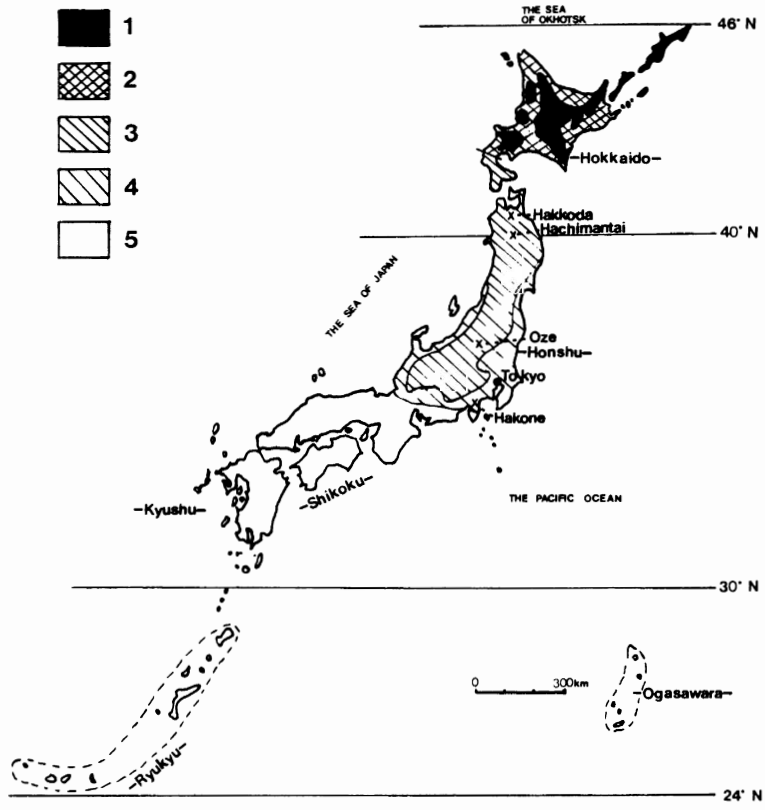

Fig. 2. Climatic mire zones in Japan. Explanation of symbols: 1 = mountain mire zone of Hokkaido, 2 = lowland mire zone of Hokkaido, 3 = mountain and upland mire zone of northern Honshu, 4 = transitional zone, 5 = peatless or peat-poor wetland zone of southern Japan. Modified from Wolejko and Ito (1986). Location of four mire areas (Hakkoda, Hachimantai, Oze and Hakone) is also marked on the map.

Kuva 2. Ilmastollisesti luokitellut suoyhdistymätyypit Japanissa. Muunneltu Wolejkon ja Iton kuvasta (1986). 1. vuoristosuovyöhyke Hokkaidolla, 2. alangon suovyöhyke Hokkaidolla, 3. vuoristo- ja ylängon suovyöhyke Pohjois-Honshussa, 4. siirtymävyöhyke, 5. veden vaivaama vyöhyke. Lisäksi karttaan on merkittu tekstissa mainittuja suoalueita (Hakkoda, Hachimantai, Oze ja Hakone).

ing, cultivating the surface peat layer with rotary tilling machines, applying lime and fertilizer, and seeding with proper grass (Yano et al. 1980, Tsujii & Umeda 1983).

Forestry amelioration

The area of mires drained for peatland forestry is negligible in Japan. The forest drainage that has been carried out is confined to small-scale experiments (Takatoi et al. 1956, Kawana 1966).

Horticultural utilization

Peat is used as a growth and soil improvement medium in greenhouses, for gardening and on golf-courses to a limited extent

in Japan. According to the Hokkaido Peat Moss Association, the total amount of annual domestic peat harvesting is 35 000–40 000 tons (50% moisture content). The total amount of imported peat in 1989 was 60 347 tons:

Country	Tons	Million yens
Canada	55 363	2 818
Germany	2 377	106
Formosa	542	15
U.S.S.R.	492	11
Finland	397	22
Others	1 176	59

Recreation utilization

Because of improved accessibility, awakening of public interest, their scarcity value and better circulation of information, more and more people have begun to visit mires. However, mire vegetation is very susceptible to repeated trampling and the number of visitors is now posing a serious threat to mires. Two mires of special recreation interest will be shortly presented below.

Ozegahara Mire

The Ozegahara mire (36°56´N, 139°15´E) lies at an altitude of 1 400 m a.s.l. in northeast Honshu and is part of the Nikko National Park (Fig. 3). It is 6 km long (NE to SW) by 1–2 km wide (NW to SE), with a total mire area of 800 ha. It occupies a valley bottom that was formerly a lake known as the "Old Ozegahara Lake". It is the largest unit of mountain mire in Japan and has several raised parts and extensive fen areas. The mire is surrounded by mountains covered by *Fagus crenata* forest at 1 400 to 1 600 m, and by *Abies mariesii* forest at 1 600 to 1 900 m. Mire formation is estimated to have begun about 8 000–10 000 years ago. Many boreal species that migrated south during the Ice Age are still preserved. Plants, such as *Drosera anglica, Scheuchzeria palustris* and *Nuphar pumilum* var. *ozeana*, exhibit their southernmost occurrence on the Ozegahara Mire (Hara & Mizushima 1954).

Fig. 3. The Ozegahara mire, the largest individual mountain mire complex in Japan, with an area of 800 ha at 1 400 m altitude in northeast Honshu. Mt. Shibutsu (2 228 m) commands a fine view of the whole Ozegahara mire. The mire is also famous for its abundance of mire flora, dozens of which are glacial relicts and show striking discontinuous distribution. (Photo: T. Miyazawa).

Kuva 3. Ozegaharan suo, Japanin suurin yksittäinen vuoristosuoyhdistelmä (800 ha), 1 400 m:n korkeudella Honshun koillisosassa. Shibutsu-vuorelta avautuu koko suoalueen kattava maisema. Tämä suoalue tunnetaan myös runsaslukuisesta kasvistosta. Lajistossa on kymmeniä jääkauden relikteja, joiden muut esiintymisalueet ovat kaukana pohjoisessa. (Kuva: T. Miyazawa).

The Ozegahara mire is nowadays within easy access of the metropolitan area of Tokyo and the number of visitors has increased remarkably. At the height of the season, as many as 20 000 visitors per day can be expected. Under this kind of

trampling pressure, a vast expanse of mire surface vegetation has been seriously damaged. Various kinds of rehabilitation measures have been tried since 1966. Nevertheless, natural revegetation has proved to be a slow process, even when access was not allowed and has not always produced satisfactory results. The more spongy and moist the site, the more effective was artificial rehabilitation. This was achieved by sowing pioneer sedge species and transplanting carefully selected partial vegetation from elsewhere, either alone or in combination, using the litter-bed method (Tachibana 1983).

Hakone Mire Botanical Garden

The Hakone Mire Botanical Garden was established by the town of Hakone in 1972. The aim was to introduce to the public the Sengokubara mire, which had been designated as a national natural monument, and to increase public awareness of nature conservation. This unique mire model park is located at an altitude of 650 m a.s.l. in Central Japan near the Fuji-Hakone-Izu National Park. The total area of the park is about 3 ha with a 1 km long trail. The park was opened to the public in 1976, when the number of visitors was 90 000. By 1983, the numbers had reached 190 000. The park, which was artificially created on the site of previous paddy fields and has been maintained by constantly regulating the water supply, is divided into eight sections. Each section represents a different plant community, six being mire communities. Most of the plants growing in the garden were transplanted to their present location from elsewhere (Inoue 1983).

The main plant composition of each section related to mire sites is as follows (Inoue 1983):

- Eutrophic mire section: *Primula sieboldii, Amsonia elliptica, Typha angustata, Lythrum anceps, Lysimachia davurica.*
- Mesotrophic mire section (Fig. 4): *Moliniopsis japonica, Hemerocallis dumortieri, Veratrum stamineum, Iris setosa.*
- Oligotrophic mire section: *Sphagnum* spp., such as *S. papillosum, S. magellanicum,* and *Andromeda polifolia, Pogonia japonica, Calla palustris.*
- The Sengokubara mire model section: *Phragmites australis, Carex thunbergii, Iris ensata, Utricularia japonica, Utricularia yakusimensis.*
- Alder swamp section: *Alnus japonica, Acer rubrum, Callicarpa dichotoma, Lysichiton camtschatcense, Ligularia japonica, Swertia bimaculata.*

MIRE CONSERVATION (WITH SPECIAL REFERENCE TO HOKKAIDO)

The Second National Survey on the Natural Environment (Environment Agency

Fig. 4. The Hakone Mire Botanical Garden at 650 m altitude in Central Japan. This section represents a mesotrophic mire type which comprises *Moliniopsis japonica, Hemerocallis dumortieri, Veratrum stamineum, Iris setosa* and *Nuphar japonicum.* (Photo: T. Miyazawa).

Kuva 4. Hakonen suokasvitieteellinen puutarha 650 m:n korkeudella Keski-Japanissa. Kuvan lohko edustaa mesotrofista suota, jossa kasvavat mm. japaninsiniheinä, pärskäjuuri, sinikurjenmiekka ja japaninulpukka. (Kuva: T. Miyazawa).

1981), identified 3 833 sites of high scientific value or in need of special care and protection. These sites covered a total of 935 000 ha or 2.5% of the land area of Japan. Of the specific plant communities, nearly 10% (233 cases with the total area of 36 315 ha) were categorized as mire. More than 90% of these mires (in terms of area) were located in Central Japan and northwards (Figs. 5–8), and include the comparatively large-scale mires in the far north of Hokkaido (Fig. 1, Appendix 1).

National and quasi-national parks as well as prefectural nature parks have been established under the Natural Park Law on land belonging to the State, to local governments and to private owners. Nature conservation areas, wildlife special protection areas, and national natural monuments have been designated by the Nature Conservation Law, the Law Concerning Protection of Wildlife and Hunting, and the Cultural Properties Protection Law, respectively. Furthermore, in Hokkaido, prefectural natural monuments have been declared by the Hokkaido Prefectural Government Cultural Properties Protection Ordinance. According to the Hokkaido Prefectural Government Ordinance Concerning Protection of Natural Environment, scientific nature conservation areas are preserved in their entirety. Ramsar sites are designated wetlands under the Ramsar Convention of 1971.

An inventory is presently under preparation by the Nature Conservation Division of the Hokkaido Government, which will cover almost all the protected and unprotected mires situated in Hokkaido. Under an inquiry commission set up by the Environment Agency, a multidisciplinary five year project, "A study for the conservation of wetland ecosystems", has been underway since 1988. This project, which is being carried out in the Kushiro and Sarobetsu mires, aims at developing methods for monitoring mire ecosystems and at finding appropriate measures to counter

Fig. 5. *Phragmites australis* v. *longivalvis* fen at 1 200 m altitude in the Towada-Hachimantai National Park, North Honshu. This mire is bordered by stunted *Abies mariesii* firs and mixed forests of *A. mariesii* and *Betula ermani* are seen in the far background. (Photo: T. Miyazawa).

Kuva 5. Järvikorteneva 1 200 m:n korkeudella Hachimantain alueella Pohjois-Honshussa. Suota reunustavat kitukasvuiset honshunpihdat. Taustalla honshunpihdan ja kivikoivun muodostamat sekametsät. (Kuva: T. Miyazawa).

Fig. 6. *Menyanthes trifoliata* vegetation growing in a small pond at 1 600 m altitude close to the summit of Mt. Hachimantai, North Honshu. This mire is bordered by *Sasa kurilensis* bushes and stunted *Abies mariesii* firs. The Hachimantai mire area covers 170 ha. (Photo: T. Miyazawa).

Kuva 6. Vesiallikossa tavataan raatetta 1 600 m:n korkeudella Hachimantai-vuoren huipun tuntumassa Pohjois-Honshussa. Suota reunustavat vaivaisbambun pensaikko ja kitukasvuiset honshunpihdat. Tämän alueen suot peittävät yhteensä 170 ha. (Kuva: T. Miyazawa).

Fig. 7. Widely distributed sloping mires intermingled with slow-growing *Abies mariesii* firs and *Sasa kurilensis* thickets at 1 200 m altitude on the slope of Mt. Hakkoda, part of the Towada-Hachimantai National Park, North Honshu. (Photo: T. Miyazawa).

Kuva 7. Rinnesoiden, kitukasvuisten honshunpihtojen ja vaivaisbambun pensaikon muodostama mosaiikkimainen maisema 1 200 m:n korkeudella Hakkoda-vuoren rinteilla Pohjois-Honshussa. Tämä alue kuuluu Towada-Hachimantain kansallispuistoon. (Kuva: T. Miyazawa).

Fig. 8. Sloping mires of different sizes at 1 400 m altitude in the vicinity of the timberline of Mt. Hakkoda. Heavy snowfall and stagnant thawed water are considered to contribute to the mire formation. The Hakkoda mire area covers 1 500 ha. (Photo: T. Miyazawa).

Kuva 8. Erikokoisia rinnesoita 1 400 m:n korkeudella Hakkoda-vuoren puurajan tuntumassa. Paksu lumipeite ja seisova lumen sulamisvesi mahdollistavat suon muodostumisen. Tämän alueen suot peittävät yhteensä 1 500 ha. (Kuva: T. Miyazawa).

the influences from the surrounding agricultural lands.

CONCLUSIONS

Japan is a densely populated country and mires with a potential for agriculture have been brought into effective use as rice paddy fields and grasslands. A conflict between mire utilization and its conservation persists to this day.

A variety of human activities, including river improvement works, land reclamation, construction of passage roads and embankments, drainage works, deforestation, peat harvesting and damming up for storage reservoirs, have damaged mire vegetation drastically. Eutrophication and increased sedimentation from the surrounding agricultural and built-up areas are recent threats. Recreation is the greatest threat to the more accessible mires.

In spite of accounting for little of the country, the mires of Japan are an essential part of the country's natural heritage and deserve more protection. Not only should the protection of existing protected areas be enforced, but there is an urgent need for a national comprehensive mire conservation and utilization plan to save Japanese mires for future generations.

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TIIVISTELMÄ:

JAPANIN SUOT JA NIIDEN HYVÄKSIKÄYTTÖ SEKÄ SUOJELU

Japanin saarivaltio sijaitsee 24. ja 46. pohjoisen leveyspiirin välissä ja on koillis–lounaissuunnassa yli 3 000 km pitkä. Japani on suurimmaksi osaksi vuoristoa ja siellä on yli 150 kvartäärikaudella syntynyttä tulivuorta. Vuotuinen sademäärä on keskimäärin n. 1 700 mm. Näin ollen suokasvillisuus vaihtelee Hokkaidon saaren laaja-alaisten oligotrofisten soiden ja Riukyun saariston mangrove-metsien välillä.

Japanissa on soita n. 200 000 ha, joka on 0,5% maan pinta-alasta. Turvekerrostumia on arvioitu olevan n. 625 milj. tonnia. Soiden turvekerroksen keskimääräinen paksuus on 3–5 m, enimmillään 8–9 m. Tulivuorten toiminnan johdosta Japanin turpeet ovat hyvin tuhkapitoisia. Suurin osa Japanin soista sijaitsee Keski- ja Pohjois-Honshun sekä Hokkaidon nuorilla tuliperäisillä alueilla sekä alluviaalisilla tasangoilla. Ilmastollisesti ja topografisesti Japanin suot kuuluvat L. von Postin luokittelun mukaan topogeenisiin ja soligeenisiin soihin.

Oligotrofisilla soilla tavataan pääasiassa *Sphagnum*-lajeja, *Carex middendorffii, C. limosa, Scheuchzeria palustris, Eriophorum vaginatum, Rubus chamaemorus, Empetrum nigrum* var. *japonicum, Rhynchospora alba* ja *Ledum palustre* var. *diversipilosum*. Mesotrofisten soiden lajistoon kuuluvat *Moliniopsis japonica, Carex omiana, Sanguisorba officinalis, Lobelia sessilifolia, Pogonia japonica, Hosta rectifolia* ja *Myrica gale* var. *tomentosa*. Eutrofisilla soilla kasvavat mm. *Phragmites australis, Carex*-lajeja, *Zizania latifolia, Equisetum fluviatile, Menyanthes trifoliata* ja *Lastrea thelypteris*. Japanissa ovat leppää, glehninkuusta ja lehtikuusta lukuun ottamatta muut puulajit soilla harvinaisia.

Väkirikkaassa ja teollistuneessa Japanissa kaupunkien laajeneminen, teiden ja teollisuusalueiden rakentaminen ja raivaustoiminnat riisiviljelyn ja laidunnan hyväksi ovat supistaneet jatkuvasti alavilla mailla olleiden soiden pinta-alaa. Viljelykelvottomuuden ja vaikeapääsyisyyden johdosta lähes koskemattomina säilyneistä soista on jäljellä rippeitä Etelä-Japanissa. Niitä on säilynyt enemmän Pohjois- ja Keski-Japanin vuoristoseuduilla sekä eräillä alankomailla Hokkaidolla.

Turvetta nostetaan nykyään Hokkaidon Sarobetsun ja Ishikarin suoalueilta. Vuotuinen kotimainen tuotanto arvioidaan 35 000–40 000 tonniksi (vesipitoisuus n. 50%). Turvetta tuodaan mm. Kanadasta, Saksasta, Taiwanista, Venäjältä ja Suomesta. Tuontiturpeen määrä oli v. 1989 60 347 tonnia. Turvetta käytetään pääasiassa puutarhoissa kasvualustana, maataloudessa ja golf-kentillä maanparannusaineena. Muita turpeen käyttömuotoja ovat öljyvahinkojen ja kalanviljelylaitosten päästöjen torjuminen, Jiffy-pottien valmistaminen, veden puhdistus- ja hajunpoistamisaineiden valmistaminen.

Japanissa suurimman uhan vuoristojen suoluonnolle muodostavat turismin lieveilmiöt. Etenkin tallaaminen rasittaa kasvillisuutta yli sen sietorajan. Alankojen soihin kohdistuu jatkuvasti erilaisia ihmisen toiminnan aiheuttamia paineita, esim. kiintoaineksen kulkeutuminen soita ympäröiviltä asutuskeskuksilta ja viljelymailta ja myös soiden rehevöityminen on paheneva riesa.

Hokkaidolla on yhteensä 30 suoaluetta (Kuva 1, Liite 1), jotka on lain nojalla tai muutoin suojeltu. Niistä mainittakoon Itä-Hokkaidon Kushiro Shitsugenin suoalue (21 440 ha), joka on Japanin ensimmäinen yksinomaan suoluonnolle omistettu kansallispuisto (per. v. 1987). Tämä pääosiltaan eutrofinen suoalue on myös tärkeä manchuriankurjen ja muiden vesilintujen pesimä- ja levähdyspaikkana.

APPENDIX 1

Legally (or otherwise) protected mires in Hokkaido. The information in the following sections is given in order of: location, commune in which it is located, area and altitude, brief description, year of protection and designation, and important flora and fauna.

The following list of protected mires in Hokkaido is not complete (Samejima & Misumi 1955, Tachibana & Ito 1980, Anzai 1983, Miura 1983, Satsuki 1983, Damman 1988, Environment Agency 1989, IWRB Japan Committee 1989, Takada 1991). Some small patches of scattered mires located in National and quasi-National parks and Hokkaido's prefectural nature parks remain outside the scope of this article. Other mires have not yet been fully investigated. Some of the statistics are tentative estimates as no accurate data are available on the status of several mires.

LIITE 1

Lain nojalla tai muutoin suojellut suot Hokkaidolla. Jokaisen suon tietoa esitetään seuraavassa järjestyksessä: sijainti, esiintymispaikkakunta, pinta-ala ja korkeus merenpinnasta, lyhyt kuvaus, suojelualueen perustamisaika sekä tärkeä kasvisto ja eläimistö. Luettelo ei ole täydellinen, koska muutamat pienet suojelualueet puuttuvat.

(1) **Kushiro** (Fig. 9)

Eastern Hokkaido (42°59′N, 144°24′E), Kushiro City, Kushiro Town, Shibetsu City, Tsurui Village; 21 440 ha, <10 m a.s.l. An extensive fen area including very oligotrophic parts. This is the nesting site of the Japanese crane (*Grus japonensis*). 1967: National Natural Monument & Wildlife Protection Area, 1980: Ramsar Site, 1987: Kushiro Mire National Park. Flora & fauna: *Phragmites australis, Alnus japonica, Polemonium acutiflorum* v. *lakiflorum, Hosta rectifolia, Grus japonensis, Ardea cinerea, Anser fabalis, Hucho perryi, Salamandrella keyserlingii, Aeshna subarctica, Leucorrhinia intermedia ijimai.*

(2) **Sarobetsu**

Northern Hokkaido (45°05′N, 141°41′E), Toyotomi Town, Horonobe Town; 14 600 ha, <10 m a.s.l. A large coastal mire with several low raised domes covered with a poor fen vegetation. 1974: Rishiri-Rebun-Sarobetsu National Park. Flora & fauna: *Eriophorum vaginatum, Hemerocallis esculenta, Carex middendorffii, Moliniopsis japonica, Sphagnum* spp., *Rhynchospora alba, Utricularia intermedia, Drosera anglica, Lacerta vivipara.*

Fig. 9. Kushiro Shitsugen (21 440 ha) in Eastern Hokkaido, is part of the first national park of Japan dedicated exclusively to mire conservation (est. in 1987). This extensive fen area was formed on the alluvial plain. The overgrowing of Japanese alder (*Alnus japonica*) along meandering river courses is in rapid progress. (Photo: M. Takada).

Kuva 9. Kushiro Shitsugen (21 440 ha), Japanin ensimmäinen yksinomaan suoluonnolle omistettu kansallispuisto (per. v. 1987), Itä-Hokkaidolla. Pääosaltaan eutrofinen suoalue on muodostunut tulvamaan tasangolle. Mutkittelevien jokien varsilla japaninlepän voimakkaasta levittäytymisestä on tullut riesa. (Kuva: M. Takada).

(3) Numanohara

Central Hokkaido, Kamikawa Town; 60 ha, 1 400 m a.s.l. A mountain mire with several raised parts on the slope of a volcano. 1934: Daisetsuzan National Park, 1971: National Natural Monument. Flora: *Sphagnum* spp., *Andromeda polifolia, Vaccinium oxycoccus, Scheuchzeria palustris, Drosera anglica, Carex limosa, C. curta, Rhynchospora alba.*

(4) Numanotaira

Central Hokkaido, Kamikawa Town; 50 ha. 1 400 m a.s.l. A mountain patterned mire on the slope of a volcano. 1934: Daisetsuzan National Park, 1971: National Natural Monument. Flora: *Sphagnum* spp., *Andromeda polifolia, Vaccinium oxycoccus, Scheuchzeria palustris, Rhynchospora alba.*

(5) Genshigahara

Central Hokkaido, Furano Town, Minami–Furano Town; 150–200 ha, 1 000–1 100 m a.s.l. A mountain mire with several raised parts on the slope of a volcano. 1934: Daisetsuzan National Park. Flora: *Picea glehnii, Ledum palustre* v. *diversipilosum, Sasa kurilensis, Coptis trifolia.*

(6) Orochigahara

Western Hokkaido, Sapporo City; 10 ha, 1 000 m a.s.l. A mountain mire with some oligotrophic parts on the slope of a volcano. 1949: Shikotsu-Toya National Park. Flora: *Drosera rotundifolia, Rhynchospora alba, Sphagnum* spp., *Geum pentapetalum, Vaccinium oxycoccus, Eriophorum vaginatum, Fauria crista-galli.*

(7) Saromako

Northeastern Hokkaido, Tokoro Town, Saroma Town, Yubetsu Town; 15 000 ha, <10 m a.s.l. An extensive fen. 1957: partly Prefectural Natural Monument, 1958: Abashiri Quasi-National Park. Flora: *Salicornia europaea, Phragmites australis, Zostera marina, Aster tripolium, Glaux maritima* v. *obtusifolia.*

(8) Notoroko

Northeastern Hokkaido, Abashiri City, 5 850 ha, <10 m a.s.l. An extensive fen. 1958: Abashiri Quasi-National Park. Flora: *Salicornia europaea, Phragmites australis, Zostera marina, Aster tripolium, Glaux maritima* v. *obtusifolia.*

(9) Tofutsuko

Northeastern Hokkaido (43°56′N, 144°25′E), Abashiri city, Koshimizu Town, 900 ha, <10 m a.s.l. An extensive fen. 1958: Abashiri Quasi-National Park. Flora: *Phragmites australis, Typha latifolia, Scirpus tabernaemontani, Juncus gracillimus, Zostera marina, Triglochin maritimum.*

(10) Memanbetsu

Northeastern Hokkaido, Memanbetsu Town, 25 ha, ca. 10 m a.s.l. An extensive fen with alder swamps. 1958: Abashiri Quasi-National Park,

1972: National Natural Monument. Flora & fauna: *Fraxinus mandshurica* v. *japonica, Alnus japonica, Lysichiton camtschatcense, Polygonum thunbergii, Ardea cinerea.*

(11) Uryunuma

Northwestern Hokkaido, Uryu Town, 100 ha, 850 m a.s.l. A plateau bog with irregular pools. 1964: Prefectural Natural Monument, 1990: Shokanbetsu-Teuri-Yagishiri Quasi-National Park. Flora: *Nymphaea tetragona* v. *tetragona, Menyanthes trifoliata, Fauria crista-galli, Lysichiton camtschatcense, Sphagnum* spp., *Vaccinium oxycoccus, Veratrum stamineum, Carex limosa.*

(12) Shinsennuma

Western Hokkaido, Kyowa Town, 10 ha, 760 m a.s.l. A mountain raised bog. 1963: Niseko-Shakotan-Otaru Seaside Quasi-National Park. Flora: *Geum pentapetalum, Fauria crista-galli, Menyanthes trifoliata, Nuphar japonicum, Ledum palustre* v. *diversipilosum, Moliniopsis japonica, Sphagnum* spp., *Drosera rotundifolia, Empetrum nigrum* v. *japonicum, Eriophorum vaginatum.*

(13) Kagaminuma

Western Hokkaido, Kutchan Town, 5 ha, 560 m a.s.l. A mountain raised bog. 1963: Niseko-Shakotan-Otaru Seaside Quasi-National Park. Flora: *Sphagnum* spp., *Drosera rotundifolia, Rubus chamaemorus, Parnassia palustris, Vaccinium oxycoccus, Ledum palustre* v. *diversipilosum, Hosta rectifolia.*

(14) Furenko (Fig. 10)

Eastern Hokkaido (43°15′–43°21′N, 145°14′E), Nemuro City, Bekkai Town, 2 650 ha, <10 m a.s.l. A large coastal mire with several low raised domes covered with a poor fen vegetation with high hummocks up to over 50 cm. 1962: Notsuke-Furen Prefectural Nature Park. Flora & fauna: *Picea glehnii, Alnus japonica, Phragmites australis, Scirpus tabernaemontani, Triglochin maritimum, Glaux maritima* v. *obtusifolia, Myrica gale* v. *tomentosa, Grus japonensis, Anser fabalis, Cygnus* spp., ducks.

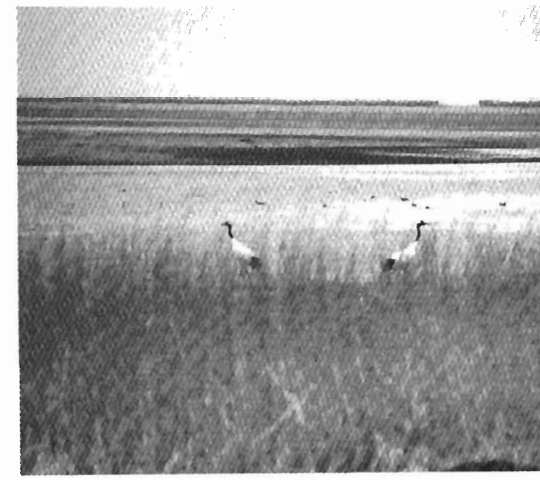

Fig. 10. Lake Furen with its surrounding mire area in Eastern Hokkaido is a paradise for various kinds of water fowl and birds. In spring and autumn, migratory water fowl such as swans (*Cygnus cygnus*), geese and ducks find their resting place here. It is also one of the most important nesting places for the red-crowned crane (*Grus japonensis*) and the white-tailed eagle (*Haliaeetus albicilla*). (Photo: M. Takada).

Kuva 10. Itä-Hokkaidon rannikolla sijaitseva Furenin järvi ympäröivineen suoalueineen on monien vesi- ja muiden lintujen paratiisi. Keväällä ja syksyllä muuttolinnut pistäytyvät täällä lepäämään. Tämä alue on yksi manchuriankurjen ja merikotkan tärkeimmistä pesimäpaikoista. (Kuva: M. Takada).

(15) Onnenuma

Eastern Hokkaido, Nemuro City, 550 ha, <10 m a.s.l. An extensive coastal mire. 1962: Notsuke-Furen Prefectural Nature Park. Flora: *Picea glehnii, Phragmites australis, Lysichiton camtschatcense, Triglochin maritimum, Carex subspathacea.*

(16) Akkeshiko

Eastern Hokkaido, Akkeshi Town, 3 200 ha, <10 m a.s.l. An extensive fen. 1955: Akkeshi Prefectural Nature Park. Flora: *Salicornia europaea, Glaux maritima* v. *obtusifolia, Triglochin mari-*

timum, Carex subspathacea, Phragmites australis.

(17) Kiritappu

Eastern Hokkaido (43°05´N, 145°06´E), Hamanaka Town, 4 000 ha, <10 m a.s.l. A large coastal mire with several low raised domes covered with a poor fen vegetation. 1922: National Natural Monument, 1955: Akkeshi Prefectural Nature Park. Flora: *Sphagnum* spp., *Vaccinium oxycoccus, Eriophorum vaginatum, Moliniopsis japonica, Polemonium acutiflorum* v. *lakiflorum, Cornus suecica.*

(18) Hichiripputo

Eastern Hokkaido, Hamanaka Town, 350 ha, <10 m a.s.l. An extensive coastal mire. 1955: Akkeshi Prefectural Nature Park. Flora: *Phragmites australis, Calamagrostis langsdorffii, Zostera marina.*

(19) Mochiripputo

Eastern Hokkaido, Hamanaka Town, 60 ha, <10 m a.s.l. A coastal mire. 1955: Akkeshi Prefectural Nature Park. Flora: *Phragmites australis, Calamagrostis langsdorffii, Zostera marina, Alnus japonica.*

(20) Kutcharoko

Northern Hokkaido (45°09´N, 142°20´E), Hamatonbetsu Town, 1 600 ha, <10 m a.s.l. An extensive coastal mire which surrounds Lake Kutcharo. 1968: North Okhotsk Prefectural Nature Park, 1989: Ramsar Site. Flora & fauna: *Phragmites australis, Scirpus tabernaemontani, Typha latifolia, Zizania latifolia, Zostera nana, Potamogeton perfoliatus, Cygnus columbianus*, ducks.

(21) Mokeunito

Northern Hokkaido, Sarufutsu Village, 50 ha, <10 m a.s.l. A coastal mire. 1968: North Okhotsk Prefectural Nature Park. Flora: *Phragmites australis, Menyanthes trifoliata, Nuphar japonicum, Trapa japonica, Nymphaea tetragona, Potamogeton distinctus, Eriophorum vaginatum, Hemerocallis esculenta, Myrica gale* v. *tomentosa.*

(22) Hyotannuma

Northern Hokkaido, Sarufutsu Village, 10 ha, <10 m a.s.l. A coastal mire. 1968: North Okhotsk Prefectural Nature Park. Flora: *Nuphar japonicum, Trapa japonica.*

(23) Matsuyama

Northern Hokkaido, Bifuka Town, 20 ha, 800 m a.s.l. A mountain raised bog with irregular pools. 1976: Matsuyama-Piyashiri Nature Conservation Area. Flora: *Sphagnum* spp., *Drosera anglica, Rhynchospora alba, Eriophorum vaginatum, Carex middendorffii, C. pauciflora, Empetrum nigrum* v. *japonicum.*

(24) Piyashiri

Northern Hokkaido, Oomu Town, 5 ha, 920 m a.s.l. A mountain raised bog with irregular pools. 1976: Matsuyama-Piyashiri Nature Conservation Area. Flora: *Sphagnum* spp., *Drosera anglica, Rhynchospora alba, Eriophorum vaginatum, Scheuchzeria palustris, Vaccinium oxycoccus, Cornus suecica.*

(25) Ochiishimisaki (Fig. 11)

Eastern Hokkaido (43°04´N, 145°30´E), Nemuro City, 130 ha, 50 m a.s.l. An extremely poor fen with locally well-developed hummocks. 1940: National Natural Monument, 1976: Ochiishimisaki Nature Conservation Area. Flora: *Picea glehnii, Rhododendron albrechtii, Eriophorum vaginatum, Carex middendorffii, Ledum palustre* v. *diversipilosum, Empetrum nigrum* v. *japonicum, Vaccinium oxycoccus.*

(26) Shibetsu

Eastern Hokkaido, Shibetsu Town, 150 ha, <10 m a.s.l. A coastal mire with several oligotrophic parts. 1979: National Natural Monument. Flora: *Sphagnum* spp., *Ledum palustre* v. *diversipilosum, Andromeda polifolia, Vaccinium oxycoccus, Cornus suecica, Orchis aristata.*

Fig. 11. The Ochiishimisaki mire at 50 m altitude in Eastern Hokkaido. Cottongrass spruce fen where slow-growing spruce trees (*Picea glehnii*) are predominant with cottongrass (*Eriophorum vaginatum*) in the field layer. Also *Carex middendorffii, Empetrum nigrum* v. *japonicum, Ledum palustre* v. *diversipilosum, Vaccinium oxycoccus* and *Myrica gale* v. *tomentosa* are very common. (Photo: M. Takada).

*Kuva 11. Ochiishimisakin suo 50 m:n korkeudella Itä-Hokkaidolla. Tupasvillakorpia (TK) vastaava suotyyppi, jolle on ominaista harva ja kituva glehninkuusi ja kenttäkerroksen valtalajina kasvava tupasvilla. Lisäksi eräs sara (*Carex middendorffii*), variksenmarja, suopursu, isokarpalo ja suomyrtti ovat melko yleisiä. (Kuva: M. Takada).*

(27) Utonaiko

Southwestern Hokkaido (42°42´N, 141°43´E), 230 ha, <10 m a.s.l. An extensive coastal mire. 1981: Wildlife Special Protection Area, 1991: Ramsar Site. Flora & fauna: *Phragmites australis, Alnus japonica, Zizania latifolia, Scirpus tabernaemontani, Calamagrostis langsdorffii, Anser albifrons, Anser fabalis, Ardea cinerea, Cygnus* spp., ducks, *Emberiza aureola.*

(28) Ukishima

Central Hokkaido (43°56´N, 143°13´E), 15 ha, 870 m a.s.l. A plateau bog with irregular pools, the plateau is raised over 4 m above the lagg. 1984: Wildlife Special Protection Area. Flora: *Nymphaea tetragona* v. *tetragona, Potamogeton fryeri, Scheuchzeria palustris, Rhynchospora alba, Carex limosa, Pogonia japonica, Geum pentapetalum.*

(29) Bibai

Central Hokkaido, Bibai City, 6 ha, ca. 10 m a.s.l. A riverine poor fen. 1975: Kamibibai Scientific Nature Conservation Area. Flora: *Sphagnum* spp., *Scheuchzeria palustris, Vaccinium oxycoccus, Myrica gale* v. *tomentosa, Chamaedaphne calyculata, Rhus trichocarpa, Haloragis micrantha.*

(30) Tsukigaumi

Central Hokkaido, Tsukigata Town, 40 ha, ca. 10 m a.s.l. A riverine poor fen. 1975: Tsukigaumi Scientific Nature Conservation Area. Flora: *Sphagnum* spp., *Carex middendorffii, Moliniopsis japonica, Myrica gale* v. *tomentosa, Lobelia chinensis, Aster rugulosus, Alnus japonica, Miscanthus sinensis.*

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