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A Conservational Review of Sarobetsu Mire, Northern Hokkaido

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Abstract

From the point of view of conservation, the authors explained the present status of Sarobetsu Mire in relation to land use and landscape change, plant association change, and species rarity. In the land use and landscape change from 1923 to 1976 it is pointed out as follows : (1) a drastic decrease of mire, (2) an increase of cultivated land, (3) an extension of canals and road networks, and (4) short cutting of the Teshio River from which the enlargement of cultivated area has resulted. In the change of plant association, it is most remarkable that *Sasa* community has been encouraged by a decrease of soil humidity resulted from drainage. In species rarity channel digging has caused an increase of endangered species. Recently Sarobetsu Mire has been realized as a precious asset by tourists as well as inhabitants, and the authors predict that its conservational trend will be strengthened increasingly in future.

Key words : Bog, Coservation, Conservational species, Fen, Mire, Plant association, Sarobetsu, Species rarity.

1. Introduction

On his concluding remarks on the future of mires Goodall (1983) stated that although the existence of mires as an ecosystem is not endangered, there are areas, where the destruction of these wetlands has been almost completed. The most vulnerable are mires in areas of high civilization development, and also those formed on the border of their geographically, climatically controlled distribution (Terasmae, 1977)

In Japan, the two reasons mentioned above are combined, resulting in deterioration of mires almost everywhere in the main island of Honshu, Shikoku and Kyushu. In the lowland of Hokkaido, where conditions for extensive peat formation are the best in Japan, transformation and destruction of mires are relatively new phenomena, dating back to the beginning of this century but achieving considerable scope in the sixties. In that time large wetland-conversion scheme commenced, performed by the Hokkaido Development Agency as a national policy. Until now, more than 50% of lowland mires (of original 200,642 ha [Yano *et al.*, 1980]) have been transformed, mostly into agricultural and urban areas (Fig. 1). There are still a considerable number of small mountain mires, both in Hokkaido and

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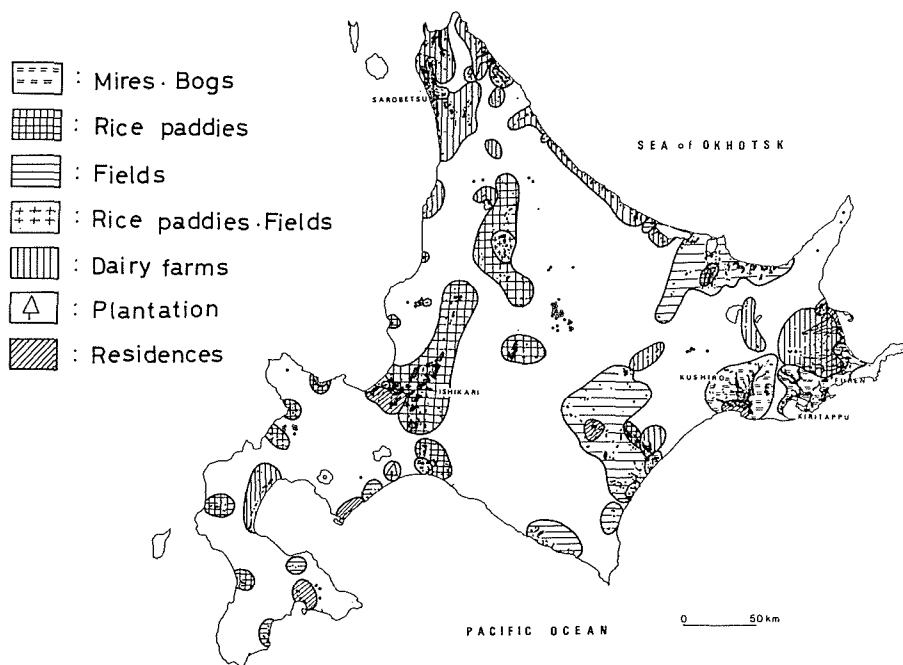


Fig. 1. Transformation of mires in Hokkaido

Northern Honshu, which are relatively safe from total destruction. In many cases, however, the interesting and rare flora and vegetation cover are affected by treading by numerous hikers and "nature loving" visitors (Kashimura and Tachibana, 1982 ; Ito, 1983 ; Ito and Tachibana, 1987 ; Tachibana, 1969, 1976, & 1977 ; Tachibana *et al.* 1988).

The mire transformation processes are best studied in Hokkaido, where they are now in progress. Within the area, the degree of changes varies considerably, which can be attributed to the local differentiation of climatic conditions, accessibility and distance from development centres. While the natural mire vegetation in the southern, western and northwestern parts of the island has already almost disappeared, there are still some extensive and unchanged mires in the the eastern region, namely Kushiro, Furen, and Kiritappu mires (Fig. 2). Such an inequality is well understood when the cold climate of the eastern coast, influenced by the cold Kuril Current, is compared with the milder climate of the southwestern Hokkaido. The latter, improved by the warm Tsushima Current, allows the rice cultivation on the developed surfaces of the former mires. An example of this is the case of Ishikari Plain, where about 55,00 ha of peatlands were transformed into paddy fields (Figs. 1 and 2A).

An evaluation of the relative importance of different impact types on mires in Hokkaido is given in Table 1. The biggest threat is posed by agriculture, and different forms of infrastructure development in the lowland mires.

In the present paper we deal with Sarobetsu Mire or Sarobetsu Genya as an example

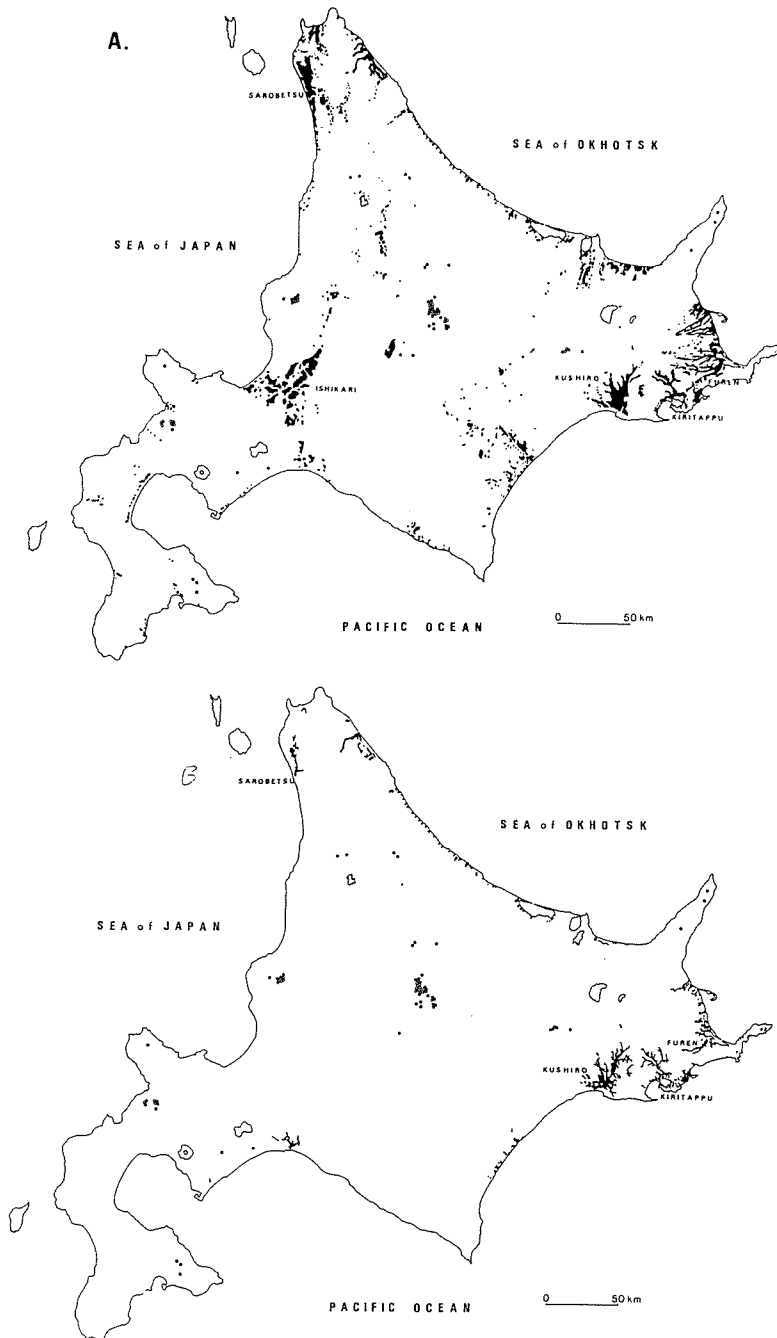


Fig. 2. Past and present distribution of mire vegetation in Hokkaido.
 A. original distribution (based on the map by Hokkaido Agr. Exp. Sta. 1936)
 B. present distribution (based on by the Map Ito *et al.*, 1982)
 Black pieces : lowland mires and wetlands. Open circles : small mountain mires

Table 1. Relative importance of different human impact types on mire ecosystem in Hokkaido.

Type of impact	Description	Relative importance in Hokkaido
A. Direct		
1. Change of function		
a. urban development	Occupation of mire space for construction, housing, dump storage, sports facilities, etc.	XX
b. agricultural development	Agricultural crop production after drainage, soil dressing, etc. Utilization for hay and pasture.	XXXX
2. Peat cutting	Excavation and removal of peat.	X
3. Burning	Intentional or incidental fire of mire surface.	XX
4. Direct human impact	Trampling by visitors, ; plant collection.	XXX
B. Indirect		
5. Disturbances in hydrological regime	Change in quantity of water, fluctuations of water level, ect., induced by e.g. river shortcutting and embankment, ; construction of roads and railways.	XXX
6. Change of water quality and nutrient supply	Eutrophication (leaching from agriculture, industrial and urban pollution). Acidification.	XX

XXXX—very strong ; XXX—strong ; XX—moderate ; X—negligible

of the transformation of bog vegetation from the points of land use and landscape, plant association, and species rarity.

2. Sarobetsu Mire or Sarobetsu Gennya

Sarobetsu Mire lies on 45°05' NL and 141°40' EL in the centre, NW Hokkaido, and its dimension is about 14,600 ha, 27 km long in N-S direction by 5-8 km wide in E-W direction. This mire belongs to a flood plain peatlands category (Sakaguchi, 1979). Mires of this type mostly originate from backmarshes of alluvial plains. Two types of the Holocene flood plain peatlands are distinguished according to the time of formation. Peat formed initially, during the major Holocene transgression, well known in Europe in the areas adjacent to sea coast, is called a basal part peat. According to Sakaguchi (*op. cit*) in Sarobetsu Mire the peat layer at 26 m below sea level is considered basal peat accumulated during the Lateglacial or the early Postglacial. Japanese basal peats are dated 8,000 to 14,000 years BP. The second type of peatlands formed in time of sea regression and these peats are younger than 6,000 years.

The large scale alluvial plains in Japan continued to subside during the Quaternary. In the profile of Sarobetsu Mire (N-S) the floor of the peat layers becomes lower towards S, lying below the sea level in Shimosarobetsu south of Lake Penke. In this area, *Carex-Sphagnum* peats, which are 2-3 m thick in the lower half of the peat profile, lie directly on the basement of the peat layers, consisting of clay+peat, clay, and sand (Hokkaido

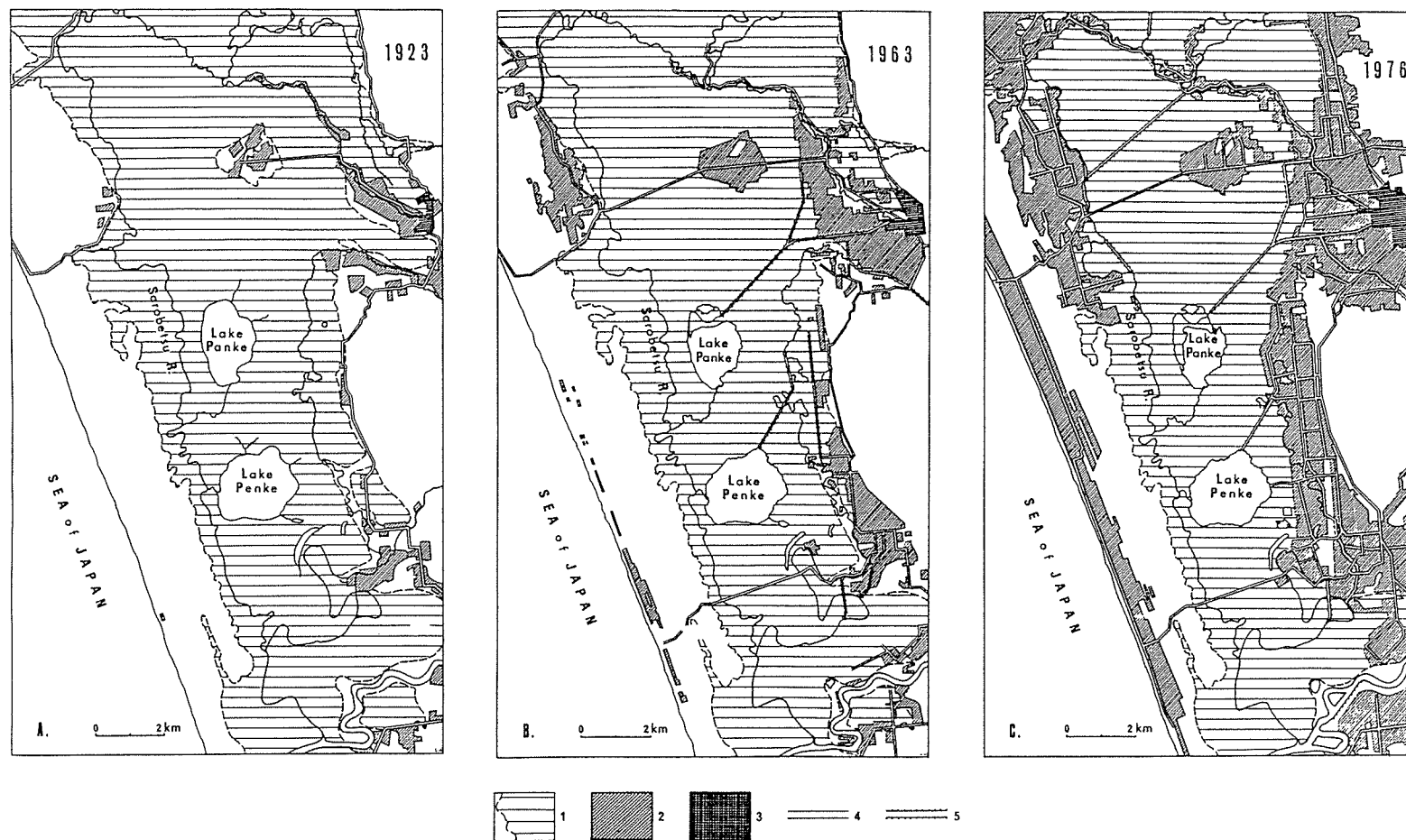


Fig. 3. Transformation of Sarobetsu Mire during 53 years
 A : situation in 1923 B : in 1963 C : in 1976
 1 : mire 2 : cultivated land 3 : urban area 4 : road
 5 : channel

Table 2. Area changes of mire, cultivated lands, residences and open water on Sarobetsu Mire from 1923 to 1976.

	A 1923		B 1963		C 1976	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
Mire	12,152.70	(89.1)	11,411.05	(81.6)	9,296.69	(58.0)
Cultivated lands	806.71	(5.9)	1,929.24	(13.8)	6,041.22	(37.7)
Residences	41.64	(0.3)	86.40	(0.6)	158.74	(1.0)
Open water	637.56	(4.7)	566.00	(4.0)	541.02	(3.3)
TOTAL	13,638.61	(100.0)	13,992.69	(100.0)	16,037.67	(100.0)

Development Agency, 1963). Consequently, the basement is considered to have already become land before the occurrence of peat. The date of the emergence is considered to be 5,000-6,000 years BP. In Kamisarobetsu there are signs of the sea influence (a sand layer containing shells of *Corbicula japonica* has been found 1 m below the surface) suggesting that Sarobetsu Mire was surely affected by the subsidence centering in the southern part of the plain.

3. Land use and landscape change

Fig. 3 shows that during a course of (time) agricultural development, channel digging, road construction, and river regulation have progressed in Kamisarobetsu Mire. Table 2 shows area changes of mire, cultivated lands, residences, and open water on Sarobetsu Mire from 1923 to 1976. From both Fig. 3 and Table 2 it is very clear : (1) a drastic decrease of mire during 13 years from 1963 to 1976 in comparison with that of the preceding forty years from 1923 to 1963, and the total area of mire is about 58% of the original of 1923, (2) a similar tendency can be seen in an increase of cultivated lands ; the total areas of cultivated lands in 1976 has reached six times as large as that in 1923, (3) an extension of canals and road networks along a small creek in north part of the Mire. The latter is particularly remarkable along the sea coast and eastern border of the Mire. In 1976 the northwestern part of cultivated area connects completely to the northeastern part of it and the village of Toyotomi, and (4) shortcutting of the Teshio River as seen on the right-hand bottom corner in Fig. 3. It may serve the enlargement of cultivated land in an area around this area after short-cutting construction.

Transformation of landscape is the most conspicuous feature, when large areas of diversified fen, moss and swamp forests are substituted by human-made fields and pastures. As seen in Fig. 4, vegetational landscape has diversified ; once an extensive cover of fen on the margin and moss in the centre of Sarobetsu Mire has pieced into several types of vegetation, but it is the most prominent change of landscape to be from fen to *Sasa* vegetation, particularly its invasion and extension along the channel for drainage. This means the progress of drying of peat lands. Moss vegetation has been shrinking its scope and is affected considerably on disappearance of Moss landscape by *Sphagnum* digging for soil amelioration, horticultural usage, and feed for cattle.

Table 3. Comparative list of plant communities on Sarobetsu mire.

Sarobetsu Mire		
	Tachibana, H. and K. Ito (1980)	Miyawaki, A. <i>et al.</i> (1976)
A. Hydrophyte Communities A-I. Floating-leaf Communities	Nymphaeteum tetragonae Nymphaea-Nuphar soc. Nu. pumilum soc. Nu.-Eleocharis soc. Trapaetum japonicae	
A-II. Emerged Plant Communities	Nu. japonicum comm. Nu. japonicum soc. Nu.-Sparganium soc. Zizano-Phragmitetum Zizania japonica soc. Z.-Phragmites soc. Typha-Phragmites soc.	
B. Marsh and Fen Vegetation	Callo-Menyanthetum trifloratae Calla palustris soc. Cal.-Sph. riparium soc. Menyanthes-Sph. riparium soc. Iris-Sph. riparium soc. Rubus-Sph. riparium soc. Myrica-Sph. riparium soc. Phr. communis soc. Phr.-Carex soc. Phr.-Sasa soc. Phr.-Moliniopsis soc. Phr.-Moliniopsis-Sphagnum soc. soc. Carex rhynchosphysa comm. C. lyngbyei comm. C. koidzumi-Eriophorum gracile soc. Calamagrostis langsdorffii comm. Calam. soc. Calam.-Sasa soc. Osmundastrum cinnamomeum var. fokiense comm. Sasa palmata comm. S.-Phragmites soc. S.-Moliniopsis soc. S.-Malus soc.	Scirpus-Calla palustris comm. Potentilla palustris-Sph. riparium comm. Calam. langsdorffii-Phr. communis Ass. Caricetum rhynchosphysae S. senanensis comm.
C. Moss Vegetation C-I. Pool and Hool-low	Caricetum limosae C. limosa soc. C.-Sph. apiculatum soc. C.-Eriophorum gracile soc. Scheuchzeria-Rhynchosporium albae boreale Rhynchospora alba-Drosera anglica soc. Scheuchzeria-Rhynchospora soc. Rhy.-Sph. cuspidatum soc. Rhy.-Sph. pulchrum soc. Rhy.-Sph. apiculatum soc.	Lycopodium inundatum-Drosera anglica comm. Sph. pulchrum comm.

Table 3. Comparative list of plant communities on Sarobetsu mire. (Continued)

Sarobetsu Mire.		
	Tachibana, H. and K. Ito (1980)	Miyawaki, A. <i>et al.</i> (1976)
C-II. Hummock	Sphagnetum papillosoi Rhy. alba-Sphagnum papillosum soc. Eleocharis margaritacea-Sph. papillosum soc. C. middendorffii-Sph. papillosum soc. C. middendorffii-Sph. magellanicum soc. Sphagnetum fuscum Ledum-Sph. fuscum soc. Empetrum-Sph. fuscum soc. Polytrichum-Cladonia comm. Emp.-Polytrichum soc. Emp.-Cladonia soc. Oxycocco-Caricetum middendorffii Vaccinium oxycoccus-Carex middendorffii soc. Vacc. oxycoccus-C. middendorffii-Sph. magellanicum soc. Sph. capillaceum soc.	Rubus chamaemorus-Sph. papillosum Ass.
C-III. Intermediate (Transition)	Moliniopsidetum japonicae Moliniopsis japonica-C. middendorffii soc. Mol. japonica-Myrica gale var. tomentosa soc. Mol. japonica-C. koidzumii soc. Mol. japonica-S. palmata soc.	Carici-Moliniopsidetum japonicae C. lasiocarpa var. occultans-Mol. japonica comm. S. senanensis-Mol. japonica comm.

In the table Phragmites communis is an old name of Ph. australis.

4. Plant association change

Phytosociologically or syntaxonomically Sarobetsu Mire is characterized by the prevalence of the Moliniopsidetum japonicae, of several elements of the Oxycocco-Caricetum middendorffii, and richness of orchidaceous plants in comparison to other mires in Hokkaido (Tachibana and Ito, 1980). Phytosociological works on Sarobetsu Mire based on the Relevé method (Ellenberg, 1955 ; Mueller-Dombois and Ellenberg, 1974) were carried out by Ito and Tohyama (1968), Ito *et al.* (1969), Miyawaki *et al.* (1976), and Tachibana and Ito (1980). Miyawaki *et al.* distinguished 12 vegetational units (associations and communities) under such categories as Hochmoor, Zwischenmoor, Sasa meadow, Niedermoor, swamp, marsh, and forest, and made a vegetation map (cf. Fig. 4) in their work in 1976. Tachibana and Ito described 25 associations and communities ; it was the completion of preworks by Ito *et al.* in 1969. Their major categories are hydrophyte communities or deep marsh, fen, moss, tall herb communities, and swamp. The comparison of the two works mentioned above is shown in Table 3.

In fact, the changes of plant associations have never followed on Sarobetsu Mire. In spite of it, it is possible to detect the changes at the community level as seen in Tsujii's work, although it is partial.

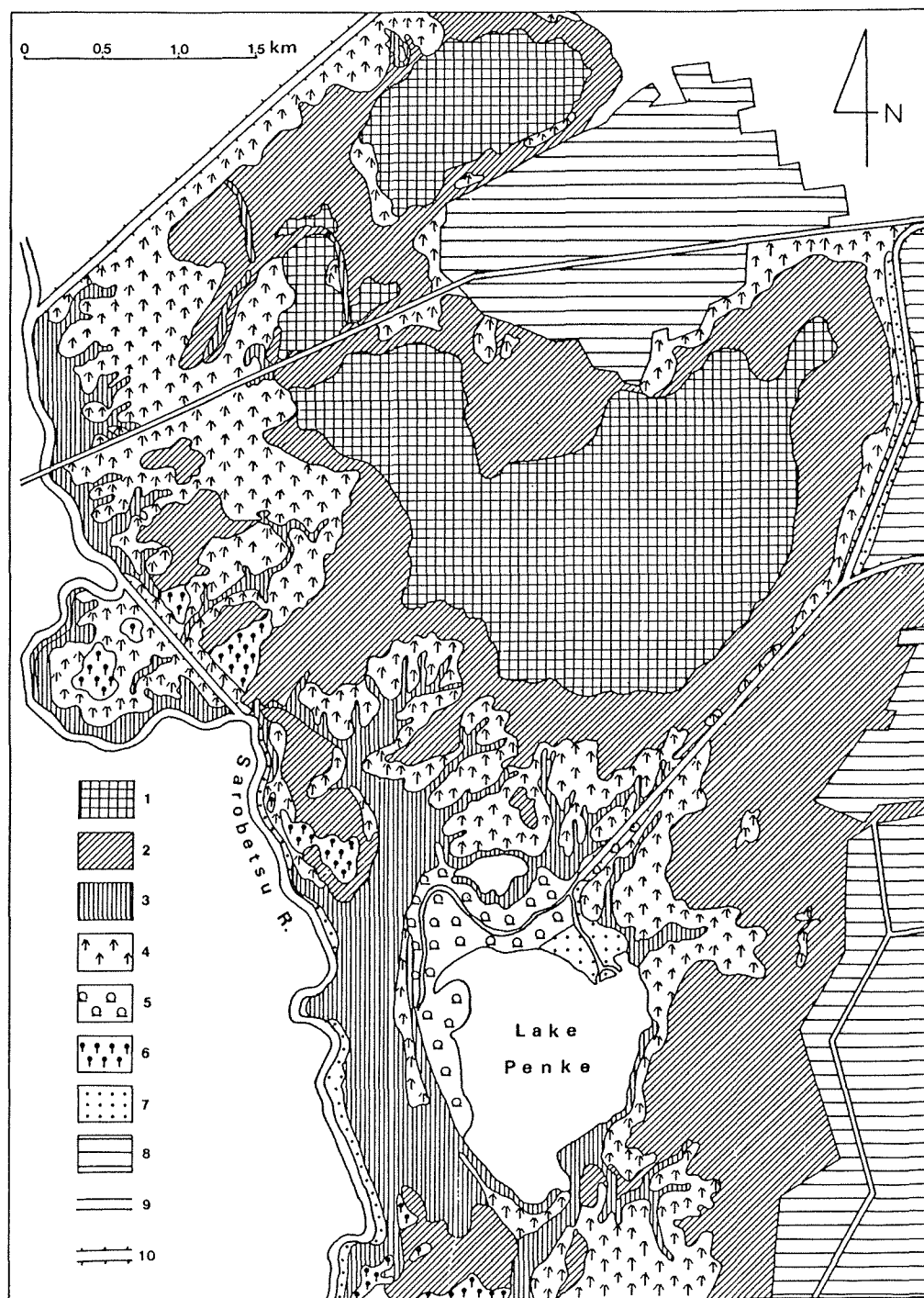


Fig. 4. vegetation map of (Kami) Sarobetsu Genya (based on the map by Miyawaki *et al.*, 1976)

1: moss 2: poor fen 3: fen 4: *Sasa* thickets 5: willow bushes 6: alder forests 7: tall herbs 8: pasture 9: roads 10: channels

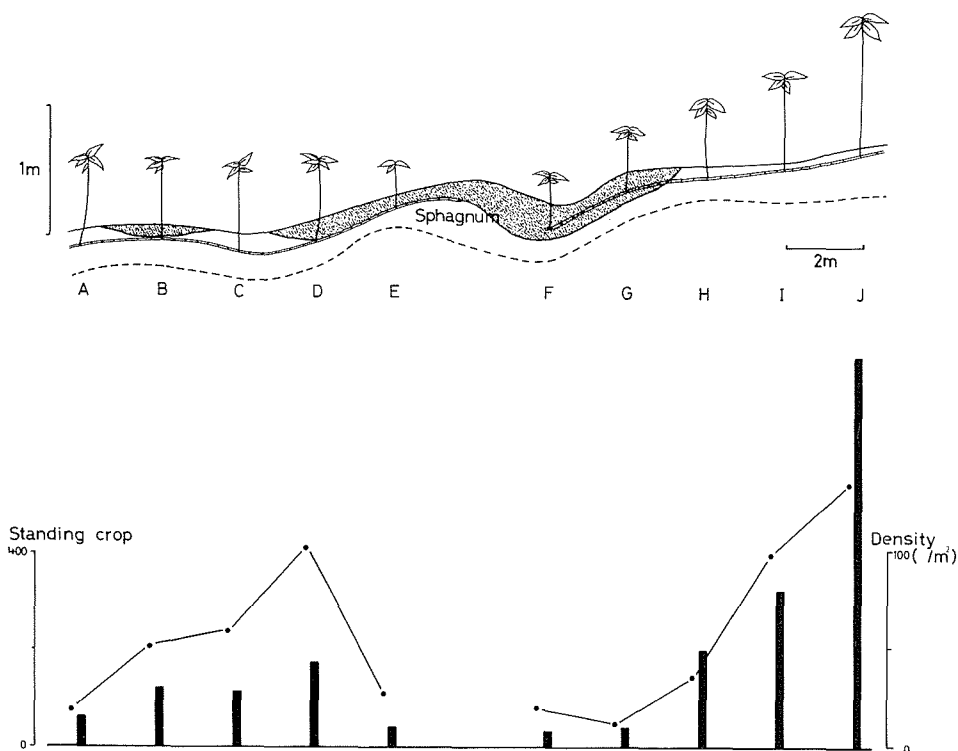


Fig. 5. A relationship between substrate humidity and *Sasa* growth in Tsukigako mire, Ishikari. Note that the standing crop (g/m^2) (solid lines), culm heights (top figure) and culm density (solid columns) decrease drastically at points E, F and G which are covered with a thick *Sphagnum* layer (stippled areas) (Takakuwa, 1981 ; Ito, 1983 ; Takakuwa and Ito, 1986)

Beside the work mentioned already, Tsujii (1963) distinguished 7 dominant species types, although they were not based on phytosociological Relevé method, but his phenotypical dominant species types are available to detect remarked changes of vegetation in a site affected by drainage or drying up of a bog. His types are as follows : (1) E type ; *Empetrum nigrum* var. *japonicum* (dominant), (2) C type ; *Calamagrostis langsdorffii* (d.), (3) H type ; *Hemerocallis esculenta* (d.), (4) M type ; *Myrica gale* var. *tomentosa* (d.), (5) O Type ; *Vaccinium oxycoccus* (d.), (6) R type ; *Rhynchospora alba* (d.), and (7) S type ; *Sasa palmata* or *S. senanensis* (d.). He set 117 meshes over Sarobetsu Mire in 1960, and checked them in 1970, ten years later. The change patterns are as follows :

1960	1970
C type	S type
H type	S, C, and E type
M type	S type
O type	E type
R type	E type

Here, the change to *Sasa* type is predominant, and it is essential to identify the true modification resulted from drainage or drying up, because it shows the lowering of ground water level, the change of physical features of soil, etc. The change to E type is sometimes superfluous, because the dominant *Empetrum* can elongate its prostrate stems and branches radiately from the centre of the stock into all direction indifferent from micro-habitual features. However, the change from R type to E type is resulted from the effect of drainage on the alteration of vegetation, and means a disappearance of "Schlenke" and remarked deterioration of the vitality of *R. alba*. In addition, the area of the wettest communities with *Scheuchzeria palustris* has reduced its area to 50% during ten years from 1960 to 1970 (Tsujii, 1963).

Specific communities which are prosperous along ditches and channels on Sarobetsu Mire are as follows : (1) *Calamagrostis langsдорffii* community predominated by *C. langsдорffii*, and followed by *Phragmites australis*, *Sanguisorba tenuifolia* var. *alba*, *Iris laevigata*, *Lycopus uniflorus*, etc. ; (2) *Osmundastrum cinnamomeum* var. *fokiense* community predominated by *Osm. cinn.* var. *fokiense*, and followed by *Moliniopsis japonica*, *Myrica gale* var. *tomentosa*, *Hemerocallis esculenta*, *Phr. australis*, *Lastrea nipponica*, *Sasa palmata*, etc. ; and (3) *Sasa palmata* community dominated by *S. palmata*, and followed by *Pteridium aquilinum* var. *latiusculum*, *Hem. esculenta*, *Mol. japonica*, *Polygonum perfoliatum*, etc. Working agents of transformation are drainage and burning in all communities mentioned above. A close relationship between *Sasa* growth and ground water content is shown in Fig. 5. (cf. Ito, 1983).

5. Species rarity

The indigenous flora of Sarobetsu Mire is characterized by numerous rare bog plants, and by relative richness of orchids. From the 71 species of the Orchidaceae native to Hokkaido (Tatewaki, 1954), several were reported from the mire. Their survival, as well as that of other bog plants, is highly endangered by progress in drainage and disappearance of native communities. This applies to such species of bog orchids as *Amitostigma kinoshitae*, *Habenaria yezoensis* var. *longicalcarata*, *Platanthera tipuloides* var. *nipponica*, *Pogonia japonica*, and *Eleorchis japonica*, among which the latter two species are on Sarobetsu Mire at their northern distributional border. The list of other endangered bog species contains *Drosera anglica*, *Scheuchzeria palustris*, and *Lycopodium inundatum*.

Channel digging is the most influential disturbances, allowing the advancement of *Sasa* community along newly-built watercourses. The replacement of a poor fen community, that is, the *Moliniopsidetum japonicae*, by the *S. palmata* facies is the most remarkable. The decrease in species number and almost complete disappearance of character species of the *Oxycocco-Caricetum middendorffii* and the *Sphagnetum papillosum*, and such elements of bog vegetation as *Vaccinium oxycoccus*, *Chamaedaphne calyculata*, *Drosera rotundifolia*, *Sphagnum papillosum*, *Eriocaulon* sp., etc. have also been reported (Tachibana and Ito, 1980).

About 20 years ago, when Ito engaged in the phytosociological work on Sarobetsu

Mire, it was possible to recognize *Picea glehnii* stands in some places. This species is nearly almost endemic of Hokkaido, and prefers to establish their stands in wetlands. However, as its growth rate is very slow, and also it can tolerate severe—particularly watersaturated and wind blown— conditions, the dwarf type of this tree is the best for “Bonsai”. At the present time, *P. glehnii* stands have vanished and *P. glehnii* is going to disappear from Sarobetsu Mire by drying of the bog and digging out the dwarf *Picea* by Bonsai-lovers.

According to the Red-data Book (Numata *et al.*, 1989) it should be noticed : most of extinct species are in wetlands or bogs, and their extinction is resulted from the development of wetlands or bogs, that is, lowering the water table or lack of soil humidity ; on Orchidaceous species the extinction is mainly due to the habitat deterioration and too much collection of them for the appreciation and ornament commercially or personally. Orchidaceous species on Sarobetsu Mire have been endangered : one is the habitat deterioration due to the canal or channel construction, and the other is the disappearance of conifer forests, because some of them are clearly forest-dependent species.

Anyway, the development of Mire must, if unwisely, despoil all things of value in wild-life which have not been substituted.

6. Concluding remarks

In central and western Europe the most endangered are species of both extremely oligotrophic and highly calcareous sites (Jasnowski, 1972 ; Wolejko, 1983 ; Sheail and Wells, 1983, etc.). In Hokkaido, where the ecological gradient is not so pronounced, the oligotrophic flora is still sufficiently preserved in the mountainous areas. However, rare elements of the mesotrophic fens and bogs in lowlands are on the verge of extermination. Thus, the necessary efforts in nature protection as well as nature conservation should be oriented towards these particular types of mire systems.

The transformation of natural vegetation to cultivated fields has been rather limited, because the climatic condition is not favourable to cultivation of various kinds of crops in comparison to warmer region. The agricultural activities are not so high, but the dairy activities are high. According to the Ecosystem Map of Hokkaido (Ito *et al.*, 1982) Sarobetsu area is one of major dairy fields in Hokkaido, and is considered to be the northern-extreme dairy farm area in Japan. However, the trend of depopulation has never stagnated, and people have been looking for a new industry.

Now, Sarobetsu Mire is included in the Rishiri-Rebun-Sarobetsu Quasi-National Park, and most of them are strictly protected by Government. Thus, Sarobetsu Mire is noticed an important resource of a sight-seeing and environmental education, and an invaluable specimen of lowland bog in Japan.

Although it is very natural that increasing development of this Mire should be stopped to prevent it from drying up, it is essential to watch closely the acceleration of eutrophication of water and pools by increase of visitors, etc. Unfortunately, we have not any data on the water chemistry of this Mire, but it is urgent to begin the water-chemical studies on the Mire as we pointed out already (Wolejko and Ito, 1986).

There is one problem of landscape transformation. We can see a lodgehouse built for bird watching and environmental education to visitors by Environmental Agency. This building serves unfortunately a role which disturbs the eyesight. This is a wrong case in a sense of deterioration of natural landscape, because the lodge cuts endless sight—the sky line and extremely extensive landscape of plain bog vegetation. It should have been built on either end of the Mire.

The conservation of plant association is responsible for that of rare species. The conservation of *Sasa* community, however, is sometimes problematic. *Sasa* prefers dry or mesic condition to wet condition, and indicates the drying up of soils in bog vegetation. The establishment of *Sasa* community prevents the development of herbaceous bog communities, and reduces the diversity of species richness. In addition, the invasion of *Sasa* into the bog may lead to the eutrophication of oligotrophic Moss by the supply of a large amount of leaves. Thus, we are coming face to face with conservational resolution of the eutrophication of waters, drying of soils, and the reduction of the species diversity on Sarobetsu Mire.

The vast extension of bog vegetation on Sarobetsu Mire is the greatest of the lowland bog vegetations in Japan. Occurrence of *D. anglica* and *Nup. pumilum* var. *ozense* is another interesting issue of phytogeography in relation to geological-climatic changes of Japan in the past. The drainage and cultivation of the surrounding area and controlled canalization of the systems have been affecting on this Mire. Agricultural utilizations of the *Sphagnum* peats for land amelioration have been bringing forth the damages of the natural Sphagnetea as well. The abovementioned is a conclusion stated by Ito *et al.* in 1969, thirty years ago. However, Sarobetsu Mire has been realized as a precious asset by tourists as well as inhabitants, and conservational status of this Mire seems to be strengthened more and more than that 30 years ago.

(A part of the preprint paper was presented at the 2nd International Wetlands Conference, 13–23 June, 1984, Trebone, Czechoslovakia.)

Appendix I

A list of conservational species* on Sarobetsu Mire

I. Bryophyta

A. Musci

1. Sphagnaceae

<i>Sphagnum cuspidatum</i> Hoffm.	Harimizugoke
<i>Sph. fallax</i> (Klinggr.) Klinggr. (= <i>Sph. apiculatum</i> H. Lindb.)	Sankakumizugoke
<i>Sph. fuscum</i> (Schimp.) Klinggr.	Chamizugoke
<i>Sph. magellanicum</i> Brid.	Murasakimizugoke
<i>Sph. nemoreum</i> Scop. (= <i>Sph. capillaceum</i> (Weiss.) Schrank)	Sugibamizugoke
<i>Sph. palustre</i> L.	Ōmizugoke
<i>Sph. papillosum</i> Lidb.	Ibomizugoke

Sph. pulchrum (Braithw.) Warnst.	Utsukushimizugoke
Sph. riparium Aongstr.	
II. Pteridophyta	
2. Lycopodiaceae	
Lycopodium inundatum L.	Yachisygiran
III. Spermatophyta	
B. Gymnospermae	
3. Pinaceae	
Picea glehnii (Fr. Schm.) Masters	Akaezomatsu
C. Angiospermae	
a. Dicotyledoneae	
i. Choripetalae	
4. Nymphaeaceae	
Nuphar pumilum var. ozense (Miki) Hara	Ozekōhone
5. Droseraceae	
Drosera anglica Hudson	Nagabamosengoke
D. rotundifolia L.	Mōsengoke
6. Rosaceae	
Rubus chamaemorus L.	Horomuiichigo
7. Empetraceae	
Empetrum nigrum var. japonicum K. Koch	Gankōran
8. Violaceae	
Viola kamtschadalorum W. Becker et Hulten	Ōbatachitsubosumire
ii. Sympetalae	
9. Ericaceae	
Andromeda polifolia L.	Himeshakunage
Chamaedaphne calyculata (L.) Moench.	Yachitsutsuji
Vaccinium oxycoccus L.	Tsurukokemomo
10. Primulaceae	
Trientalis europaea L.	Tsumatoriso
11. Gentianaceae	
Gentiana triflora var. horomuiensis (Kudo) Hara	Horomuirindo
Menyanthes trifoliata L.	Mitsugashiwa
12. Lentibulariaceae	
Utricularia intermedia Hayne	Kotanukimo
Utr. vulgaris var. japonica Makino	Tanukimo
b. Monocotyledoneae	
13. Scheuchzeriaceae	
Scheuchzeria palustris L.	Horomuisō
14. Poaceae	
Moliniopsis japonica (Hack.) Hayata	Numagaya
15. Cyperaceae	

<i>Eleocharis margaritacea</i> (Hult.) Miyabe et Kudo	
<i>Rhynchospora fauriei</i> Franch.	Shirominoharii Ōinunohanahige
16. Araceae	
<i>Calla palustris</i> L.	Himekaiu
17. Eriocaulaceae	
<i>Eriocaulon monococon</i> var. <i>confusum</i> Ko. Ito	Sarobetsuhoshikusa
18. Liliaceae	
<i>Heloniopsis orientalis</i> (Thunb.) C. Tanaka	Shōjyōbakama
<i>Hemerocallis esculenta</i> Koidz.	Zenteika
<i>Veratrum stamineum</i> Maxim.	Kobaikeiso
19. Iridaceae	
<i>Iris laevigata</i> Fisch.	Kakitsubata
20. Orchidaceae	
<i>Amitostigma kinoshitae</i> (Makino) Schltr.	Koanichidori
<i>Dactyloctenium aegyptium</i> L.	Ichōran
<i>Eleorchis japonica</i> (A. Gray) F. Maekawa	Sawaran
<i>Ephippianthus schmidtii</i> Reich. fil.	Koichoran
<i>Epipactis papillosa</i> Fr. et Sav.	Ezosuzuran
<i>Ep. thunbergii</i> A. Gray	Kakiran
<i>Goodyera foliosa</i> var. <i>laevis</i> Finet	Akebonoshusuran
<i>Gymnadenia conopsea</i> (L.) Cham. Miyae et Kudo	Nobinechidori
<i>Habenaria linearifolia</i> Maxim.	Ōmizutonbo
<i>Hab. yezoensis</i> var. <i>longicalcarata</i> Miyabe et Tatewaki	Ozenosawatonbo
<i>Liparis kumokiri</i> F. Maekawa	Kumokirisō
<i>Listera cordata</i> (L.) R. Br.	Futabaran
<i>Myrmechis japonica</i> (Reich. Fil.) Rolfe	Aridōshiran
<i>Oreorchis patens</i> (Lindl.) Lindl.	Kokeiran
<i>Platanthera hologlottis</i> Maxim.	Mizuchidori
<i>Plath. tipuloides</i> var. <i>nippoica</i> (Makino) Ohwi	Kobanotonbosō
<i>Pogonia japonica</i> Reich. fil.	Tokisō
<i>Spiranthes sinensis</i> (Pers.) Ames	Nejibana

* Here, conservational species mean the species which are considered to be protected from the threat of extinction and to be designed their preservation and maintenance in fields.

Nomenclature : Iwatsuki and Mizutani (1974), Nakaike (1982), Ohwi and Kitagawa (1983), Smith (1978), Suzuki (1972), and Watson (1981).

Appendix II

Terminology

It has been offered to define a Japanese word “Shitsugen” that it now occurs in northern Japan, especially in Hokkaido, where the climate is too cold for forests to be formed in wetlands ·····, and that it usually accompanies peat and is equivalent to German “Moor” (Kushiro Shitsugen National Park Office, Nature Conservation Bureau, Environmental Agency, 1989). This concept of Shitsugen may be available to conveniently an explanation about the so-called wetland, because there are various kinds of vegetation types in combination with genesis, species composition, gomorphology, landscape, etc. and it is very difficult for people to understand properly what is a bog, what is a marsh, etc.

In the present paper, we use several words or terms about wetland vegetation, so that we would like to show our concept of those terms.

The term *wetland* is used here in a broad sense, covering several types of ecosystems characterized by permanent or prolonged waterlogging, namely bogs, fens, marshes, swamp forests, and mangrove forests. The definition of bog, fen, swamp forests and marsh follows principally that given by Gore (1983), and Zoltai and Pollet (1983).

Bogs are peat-covered areas or peat-filled depressions with a high water table and a surface carpet of mosses, chiefly *Sphagnum* spp. The mosses often form raised hummocks, separated below wet interstices. The bog surface is often raised, or, if flat or level with the surrounding wetlands, it is virtually isolated from mineral soil waters. Trees may or may not be present in bogs, and they are frequently characterized by a layer of ericaceous shrubs. It is very often to use the term “Moss”. Moss is used here synonymously for bog, which is the wet acid peat vegetation, but is used somewhat strictly in a sense of syntaxonomy. Tansley (1965) stated that “Moss” has the additional advantage of linguistic correspondence with the Scandinavian words Mosse (Swedish), Mose (Danish and Norwegian) and the German Moos, which are applied to just the same vegetation, although it has the drawback—not perhaps very serious— of possible confusion with taxonomic group of *Musci*. There is a disadvantage of the term “bog” as Tansley (*op. cit.*) pointed out that it is sometimes loosely used in common language for *any* wet soil into the foot sinks, (but not a very serious drawback).

Fens are peatlands characterized by surface layers of poorly to moderately decomposed peat, often with well-decomposed peat near the base. They are developed in a poorly drained areas under the influence of waters derived from outside, and, in the course of transport, enriched with dissolved compounds. In comparison with European fens, it may be emphasized the alkaline character, but it is not necessarily to be alkaline. “Fen is somewhat or decidedly alkaline, nearly neutral or somewhat, but not extremely acid” (Tansley, *op. cit.*). For all types of bogs and fens a collective name “mires” is applied (Moore and Bellamy, 1974 ; Gore, *op. cit.*), and it has been used by Ito since 1969 (Ito *et al.*, 1969) in Japan.

Swamps are wooded wetlands (peatlands and mineral wetlands) where standing to gently flowing waters occur seasonally or persist for long period on the surface. Frequently there is an abundance of pools and channels indicating surface water flow. The substrate

is usually continually waterlogged, and it consists of mixtures of transported mineral and organic sediments, or peat deposited *in situ*.

Marshes are grassy, wet mineral soil areas, periodically inundated to a depth of 2 m or less, with standing or slowly moving water (Zoltai and Pollet, 1983). Surface water levels may fluctuate seasonally, with declining levels exposing drawdown zones of matted vegetation or mudflats. Marshes are subject to a gravitational water table, but water remains within the rooting zone of plants during at least part of the growing season. The substratum usually consists of mineral and organic soils with a high mineral content, but there is a little peat accumulation. Marshes characteristically show zonal or mosaic surface pattern of vegetation, consisting of unconsolidated grass and sedge sods, frequently interspersed with channels or pools of open water.

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* in Japanese ** in Japanese with English summary or with English translation of Figures and Tables *** in Japanese with German summary