Extended abstract No. 124

HOLOCENE VEGETATION CHANGE IN SARUFUTSU RIVER MIRE, NORTHERN HOKKAIDO, JAPAN

Hiroko Fujita[1], Yaeko Igarashi[2], Yukie Kato[1], Takashi Inoue[3] and Masayuki Takada[4]

[1]Botanic Garden, Field Science Center for Northern Biosphere, Hokkaido University; Noth3 West8 Chuo-ku, 060-0003, Sapporo, Japan, +81(11)-221-0066, e-mail: hiro@fsc.hokudai.ac.jp
[2]Institute for Paleoenvironment of Northern Regions
[3]Laboratory of Land Improvement and Management Research Faculty of Agriculture Hokkaido University
[4] Institute of Environmental Sciences, Hokkaido Research Organization

SUMMARY

The Sarufutsu River basin is located in the northernmost region of Hokkaido Island, Japan. This small, 40 km-long river basin consists of several mire systems on the flat plain of its lower and middle stream reaches. In contrast to most other Japanese lowland mires that began to form after the so-called Jomon marine transgression (approximately 5,000- 6,000 years ago), the upper and middle reaches of the basin seem not to have suffered sea water intrusion during the early stages of mire formation. We conducted hand boring of peat and the base layer and high resolution pollen analysis on one of the largest mires in this area. Results of the analyses demonstrate that the peat formation started under freshwater lake conditions about 7000 years ago. The mire vegetation can be divided into 3 stages: shallow lake stage; flood plain stage with alder swamp forest; and bog vegetation stage, which started about 2000 years ago.

KEY WORDS: pollen analysis, *Carex livida*, mire vegetation change, mire formation

INTRODUCTION

Japan has numerous wetlands because of its warm climate with abundant precipitation under the influence of a temperate monsoon. The largest of these have developed on alluvial plains, but numerous smaller ones are found in mountainous regions. Mire formation started at various points during the postglacial period; a few mountain mires date back to the late glacial, but most appear to have been formed during postglacial warming along with increase in precipitation, and none are older than 12000 years BP (Fujita et al., 2009). Most lowland mires developed at altitudes below 20 m and were influenced by the Jomon transgression that peaked ca. 6000 years BP (Fujita et al., 2009).

On the other hand, it is highly probable that the Sarufutsu River mire, located in the northernmost region of Hokkaido Island, has a different history of formation: the upper and middle reaches of the Sarufutsu River basin seem not to have suffered sea water intrusion related to the Jomon transgression during the early stages of mire formation. This region is located in the transitional

zone between the cool temperate and boreal zones.

Another unique feature of this mire is the existence of a Japanese relict plant of glacial age, *Carex livida*, which survives in several mires in the middle reach of this river basin. *C. livida* is mainly distributed in the mires of North America and North Europe. In the Far East, its distribution extends to Kamchatka, the Kurils, north Sakhalin, southeastern Siberia, Ussuri, north of the Korean Peninsula, and Hokkaido (Barkalov, 2004; Barkalov and Taran, 2004; Hulten, 1968; USSR Academy of Science, 1988; Volotovskyi et al., 1966). In Hokkaido, this sedge has been observed in only three regions: the Taisetsu Mountains (1700–1800 m alt.), the Shiretoko Peninsula (700–750 m alt.), and the Sarufutsu River mire (10–15 m alt.) (Kato and Fujita, 2011).
The objective of the current investigation is to discuss the mire's formation history and vegetation change using pollen analysis.

MATERIALS AND METHOD

The Sarufutsu River basin is located in the northernmost region of Hokkaido Island (Fig. 1). This 40 km-long small river basin consists of several mire systems on the flat plain of its lower and middle reaches. The total area of mires is 1,295 ha and the altitude is 2–20 m (Fujita et al., 1997, 2009). From the middle to lower reaches of the basin, there are several continuous small terraces and each terrace has a mire (Takada, 2007). Fen vegetation such as reed or sedge is the most common type, and *Sphagnum*-dominated bog/fen is found at several mires in the middle reach. In the lower reach, *Picea glehnii* is often found growing in the mire.

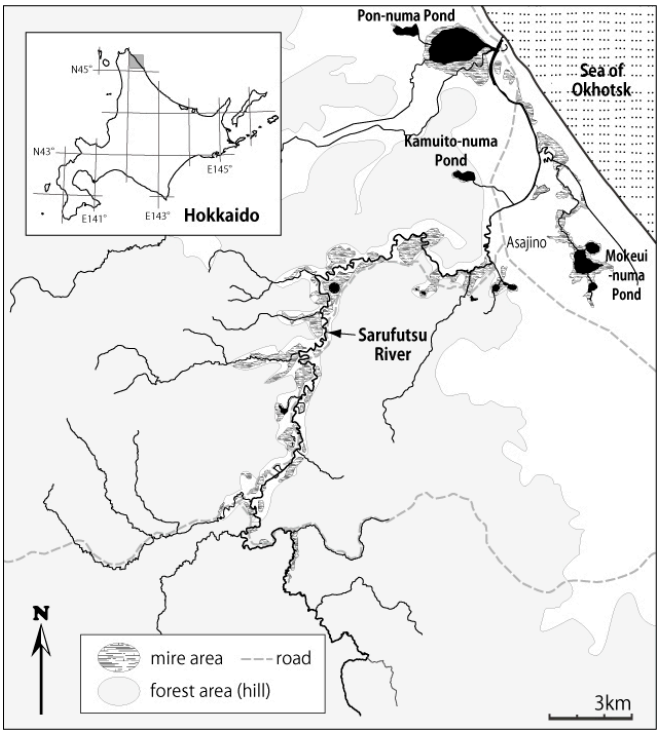

Fig. 1. Map of the study area. Black dot shows the borehole sampling point.

This investigation is carried out at the largest mire in the middle reach of the basin. We conducted vegetation surveys (phytosociological method) and microtopographic measurements using a laser altimeter and GPS surveying instrument. Peat and peaty clay from a total depth of 10.5 m were obtained using a Russian peat borer (5 cm inner diameter) in the center reach of the mire in 2005. Furthermore, 204 samples were analyzed, and the average sampling resolution was 34 y/sample. All the samples were treated according to the method of Moore et al. (1991). At least 200 arboreal pollen (AP) grains were counted from each sample. The percentage of each AP taxon was calculated based on the AP sum excluding mire taxa such as *Alnus*, *Myrica*, and *Ilex*, and non-arboreal pollen and spores were calculated based on total sum of pollen and spores.

RESULTS

The results of the vegetation survey indicate that this mire is an intermediate (bog/fen) mire, and can be classified into a hollow community (*Rhynchospora alba-Carex limosa* community) and a hummock community (*Moliniopsis japonica-Sphagnum papillosum* community); the circumference of the mire is covered with alder swamp forest (Kato et al., 2011).

The microtopographical pattern wherein the kermis and strings are arranged alternately and parallel to the contour lines of the sloping mire (known as a Kermi-Schlenke complex) was observed in the area where *C. livida* grows.

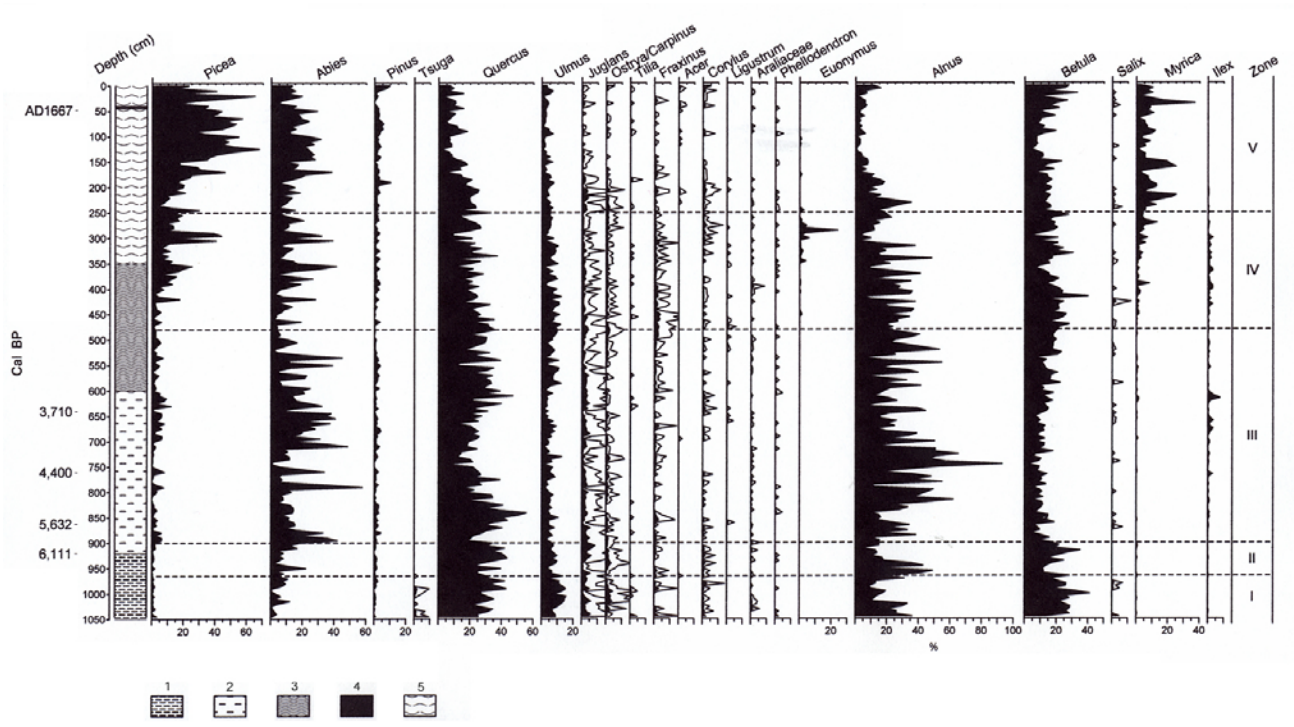

Fig. 2. Arboreal pollen diagram from the Sarufutsu River mire. 1: peat and clay; 2: woody peat; 3: clayey peat; 4: tephra; and 5: peat. Solid white line shows 5 times values.

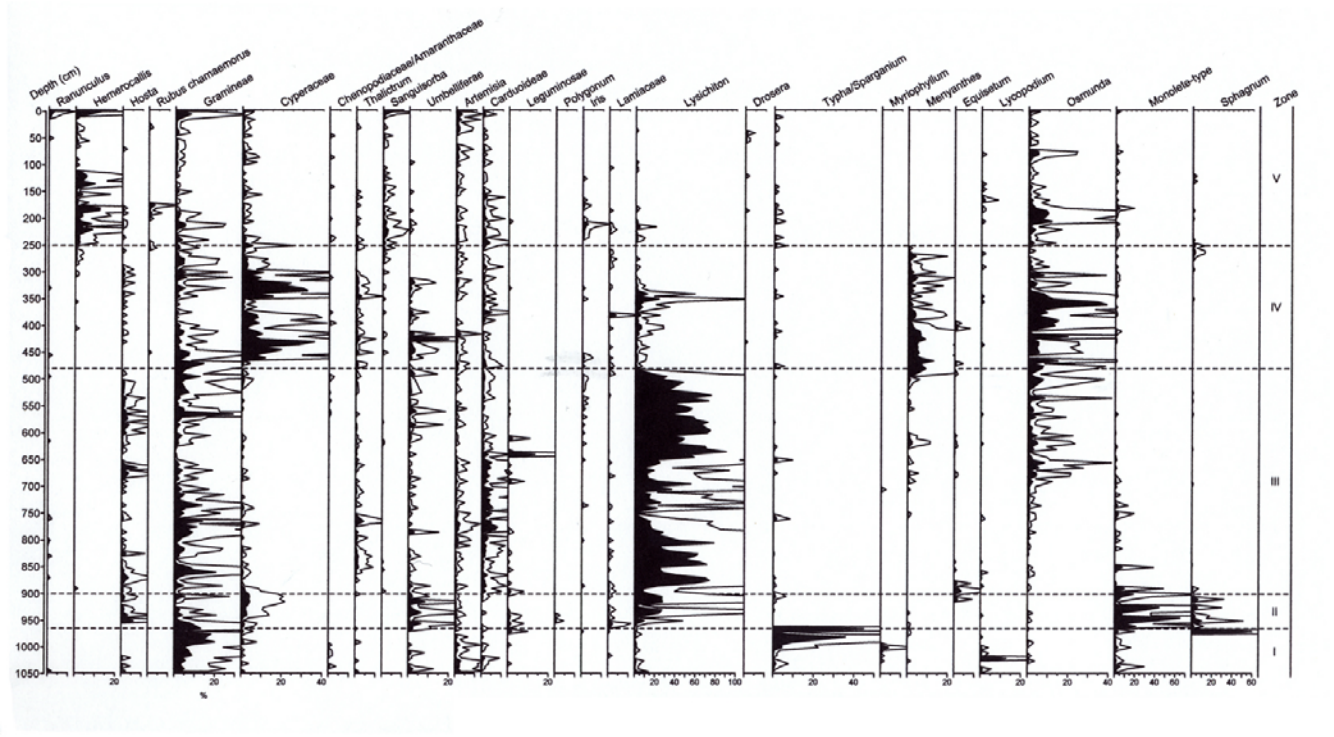

Fig. 3. Non-arboreal pollen and spores from the Sarufutsu River mire.

The sediments obtained from the mire include peat (0–350 cm deep), clayey peat (350–600 cm deep), peat containing rich wood fragments (600–920 cm deep), and alternating peat and clay (920–1050 cm deep). Below 1,050 cm depth, the lake sediments consist of blue colored clay.
Five pollen zones, labeled I–V in ascending order, were discerned based on the characteristics of the AP assemblages (Fig. 2). Zones I and II (approximately 7000–6000 years BP) are characterized by dominant *Quercus*, *Betura*, *Ulmus*, and *Alnus*, coexisting with *Abies*. Though the present forest vegetation around the Sarufutsu River mire is coniferous forest with deciduous tree species, it is considered that the period represented by Zones I and II was warmer than that at present. In Zone III (6000–2700 years BP), *Abies* increased with *Quercus* in the forest under a cool climate. In Zone IV (2700–1300 years BP), *Picea* increased in the forest under a cooler climate than that of Zone III. In Zone V, from 1300 years BP to present, *Picea* increased and a *Picea/Abies* forest came into existence.

On the other hand, Figs. 2 and 3 illustrate other changes in mire vegetation. In Zone I, high abundances of grass and herbs are represented by *Typha* and Gramineae. It is suggested that this zone represents a period of shallow lake environment. In Zone II, an increase in ferns with monolete-type spores occurred. An abundance of *Lysichiton* and *Sphagnum* characterizes this period and indicates the initiation of mire formation. Zone III is thought to represent the flood plain period because of the abundance of *Alnus* and *Lysichiton*. In Zone IV, *Cyperaceae*, *Menyanthes*, and *Osmunda* characterizes this period. In Zone V the vegetation of mire is similar to that of the present day.

CONCLUSION/DISCUSSION

The results of pollen analysis indicate that the forest vegetation transition shows a change of temperature. In this region, it was warmer ca. 7000–6000 years BP; following this (6000–2700 years BP), the forest changed with increases in *Abies* and *Quercus* under a cool climate. *Picea* increased in the forest under a cooling climate during 2700–1300 years BP. From 1300 years BP to present, a *Picea*/*Abies* forest with deciduous tree species came into existence. The above results indicate that, from 7000–1300 years BP, the moderate temperate climate conditions were gradually cooling.

On the other hand, at the surveyed mire, peat began to form under freshwater lake conditions about 7000 years ago. The mire vegetation changed as follows: first, a shallow lake stage with some emergent plant species; then, a floodplain stage with alder swamp forest; and finally, a bog/fen vegetation stage, which started about 2000 years ago. We did not analyze diatom composition of the lake sediment; therefore, we are unable to depict whether sea water flooded the middle reaches of the Sarufutsu River mire.

There are various vegetation types in the Sarufutsu River mire, and processes or stages of formation of mire and hydrologic conditions also differ. Since the last glacial age, it is presumed that the upper and middle reaches of the Sarufutsu River basin have had large and small lakes and that the mire has formed separately.

ACKNOWLEDGEMENTS

Most reaches of Sarufutsu River mire are on company-owned land. We thank the Oji Paper Co. Ltd. for the permission to carry out our survey. This study was partly supported by the research project “A new cultural and historical exploration into human-nature relationships in the Japanese archipelago” of the Research Institute for Humanity and Nature. We thank the research group and Professor Takakazu Yumoto for their support.

REFERENCE

Barkalov, V.Yu. (2004) . Floristic findings in Sakhalin Island. In Storozhenko, S.Y., Boamov, V.V., Barkalov, V.Yu., Lelej, A.S. and Makarchenko, Je.A. (eds.), *Flora and fauna of Sakhalin Island (Materials of International Sakhalin Island Project) Part 1*, pp. 23-38. Vladivostok, Dalnauka.

Barkalov, V.Yu. and Taran, A.A. (2004). A checklist of vascular plants of Sakhalin Island. In Storozhenko, S.Y., Boamov, V.V., Barkalov, V.Yu., Lelej, A.S. and Makarchenko, Je.A. (eds.), *Flora and fauna of Sakhalin Island (Materials of International Sakhalin Island Project) Part 1*, pp.39-66. Vladivostok, Dalnauka.

Fujita, H., Igarashi, Y., Hotes, S., Takada, M., Inoue, T. and Kaneko, M. (2009). An inventory of the mires of Hokkaido, Japan—their development, classification, decline, and conservation. *Plant Ecology* 2009: 9-36.

Fujita, H., Takada, M., Kaneko, M. (1997). Inventory of the present wetlands in Hokkaido, Japan. In: Hokkaido Mire Investigation Group (ed.) *Vegetation and recent changes of mire areas in Hokkaido -For the conservation of mires in Hokkaido-*, The Pro Natura Foundation (Japan), Tokyo, Japan, pp1-12 (In Japanese)

Hultén, E. (ed.) (1968). *Flora of Alaska and neighboring territories - A manual of the vascular plants-, 271.* Stanford University Press, Stanford (California).

Kato, Y., Fujita, H. and Inoue, T. (2011). Vegetation and microtopography of the patterned fen growing the relict species *Carex livida* in Sarufutsu River Mire, northern Hokkaido, Japan. *Vegetation Science* 28: 19-37 (in Japanese and English summary)

Moor, P. D., Webb, J. A. and Collinson, M. E. (1991). Pollen analysis. Blackwell Scientific Publications. 216pp

USSR Academy of Science (ed.). *Red Book (Plant).* Rosagropromiedat, Moscow (in Russian).

Volotovskyi, K., Takahashi, H. and Sato, T. (1966). Characteristics of the alpine flora of the Tokinskyi Stanovik Mountains, southeastern Siberia in relation to the Japanese alpine and eastern Siberian arctic floras. *Acta Phytotaxonomica et Geobotanica*, 47: 141-151.