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Palynological Study of Akindonuma Moor in the Central Oh-u Backbone Range, Northeastern Japan

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ABSTRACT : Pollen analyses and ^{14}C dating of the sediments of the Akindonuma moor, which is situated in a closed depression of an old landslide, were performed in order to study the vegetation history of the montane zone of the Miyagi Prefecture, Northeast Japan. The main results are as follows: Two forest zones have been distinguished: 1) the A-I zone, or the *Fagus-Quercus-Betula* forest (R I stage, before about 11,700 yrs. B.P.), and 2) the A-II zone, or the *Fagus-Quercus forest* (R II stage, after about 11,700 yrs. B.P.). By comparing the geological section with the pollen diagram of the moor, it is assumed that the deposit environment of the Middle Part, which mostly consists of peat layers, is very stable. During the period, the *Ulmus / Zelkova* pollen ratio was very low and small peak was not recognized. According to the preceding research, there is a close relationship between the fluctuation of the *Ulmus / Zelkova* pollen ratio and the general trend of hillslope instability in the changing balance of temperature and precipitation. Actually, *Zelkova serrata* tends to cover the footslope and the lower sideslope. *Ulmus davidiana* covers the footslope and the alluvial cone. Therefore, the fact that the *Ulmus / Zelkova* pollen ratio was very low and small peak was not recognized, is believed to reflect the stability of the earth' s surface environment, which was estimated from the geological section.

Key words: Earth' s surface environment, Pollen analysis, *Ulmus/Zelkova*, Vegetation history

INTRODUCTION

Palynologists have carried out many pollen analyses in the Miyagi Prefecture, Northeast Japan(e.g. Hibino *et al.* 1991). The vegetational history and climate changes of this region have been well documented. However, relatively few pollen analytical studies have been carried out in the montane zone, which corresponds to the central Oh-u Backbone Range(e.g. Park and Tamura 2001).

The author performed pollen analysis with radiocarbon dating, and attempted to figure out the relationship between the *Ulmus/Zelkova* pollen and the earth' s surface environment at the Akindonuma moor.

STUDY AREA AND METHOD

Study area

The Akindonuma moor(38° 34′ N, 140° 31′ E) is located in a closed depression about 500m a.s.l. in the Onoda-machi, near the boundary of the Yamagata Prefecture(Fig. 1). Although the moor was formed by a depression from a massive landslide, the micro-landform of the landslide is not found in the region. The geology of the area consists primarily of Miocene Yudorinuma formation.

The moor is a closed depression with a drainage area of 6.4ha; the moor area is 2.1ha; the lowest-altitude area is about 500m high; and the highest-altitude area, which is in the northeastern hillside, is 550m high. The moor surrounding the pond has an extension of 200m in its longest width and of 100m in its shortest. A few landslides have been reported in the southeastern hillside of the moor(Fig. 2). The moor is primarily covered by *Sphagnum, Carex rhynchophysa* and *Nuphar japonicum*. Its hillslope is covered with *Fagus crenata* forests.

Method

To draw a geological section, a measure line from the western to eastern part of the depression was made(Fig. 2) . Secondly, a boring at 5 different points between A-1 and A-5 had been carried out. Next, radiocarbon dating to the peat sample from the two layers(-120cm and -355cm) at A-5 point was applied(Fig. 4).

Pollen analysis was then applied to the peat sample from A-5 point. The sample was collected by 1g at every 10cm from the boring core. The sample collected by the Hiller-type hand borer was treated with the KOH-Acetolysis and then treated with saturated solution $ZnCl_2$. More than 250 arboreal pollen as accounted for each sample : the basal number to obtain percentage. The pollen frequencies were expressed as percentages of arboreal

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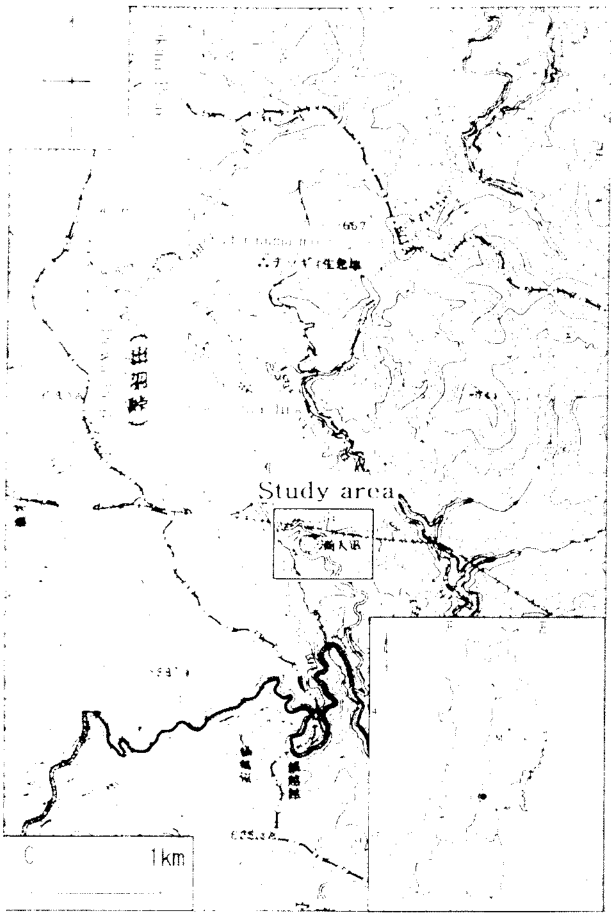

Fig. 1. Location of the study area.

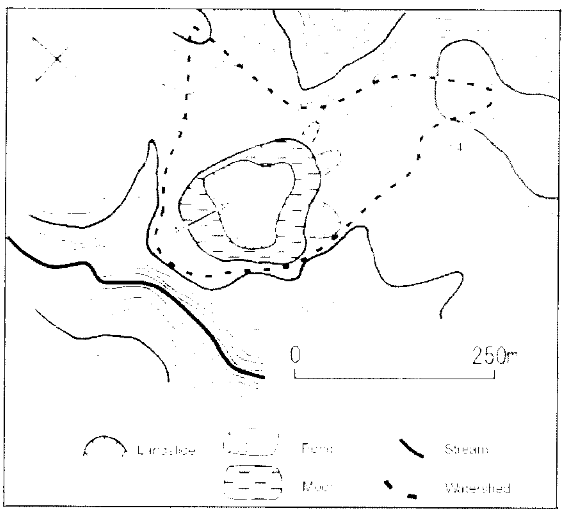

Fig. 2. Geomorphological setting of the study area.
A1~A5 : Location of geological profile

pollen (AP), except *Alnus*.

RESULTS

The pollen determined from the materials amounted to 1 family 31 genera of AP, 5 family 11 genera of non-arboreal pollen (NAP) and spore. The sequence of the main pollen, which is given in the standard pollen diagram, shows two pollen zones, as follows(Fig. 3):

AP : *Pinus, Picea, Tsuga, Abies, Cryptomeria, Fagus, Quercus, Corylus, Castanea, Acer, Alnus, Fraxinus, Betula, Pterocarya, Juglans, Ulmus/Zelkova, Tilia, Carpinus, Salix, Ilex, Cornus, Araliaceae, Ericaceae, Aesculus, Weigela, Myrica, Celtis, Sapium, Symplocos*

NAP : Gramineae, Cyperaceae, Compositae, *Liliaceae, Lysichiton, Typha, Fagopyrum, Persicaria, Rumex, Chenopodiaceae, Drosera, Sanguisorba, Haloragis, Umbelliferae, Menyanthes, Utricularia, Artemisia, Impatiens*

Spore : 1-lete type spore, 3-lete type spore, *Sphagnum*

Pollen zone

A-I : *Fagus-Quercus-Betula zone* (-445~-430cm)

Although there are only two samples from this zone, it can be clearly distinguished from the A-II zone. The A-I zone is characterized by the predominance of deciduous broad-leaved tree pollen such as *Fagus, Quercus* and *Betula.* A small amount of *Pinus* and *Abies*, both of which are conifer tree pollen, was also detected.

A- II : *Fagus-Quercus zone* (-420~-0cm)

The A-II zone is characterized by the predominance of *Fagus* and *Quercus. Betula*, however, scarcely appears in this zone. Gramineae and Cyperaceae showed high pollen ratios. Fern spore increased remarkably between -440 and -390cm, and between -320 and -190cm.

DISCUSSION

Change in past forest vegetation

A- I zone

The mother plant of the main pollen that was found in the A-I zone can be understood as follows: As far as *Quercus* is concerned, there are *Cyclobanopsis* sp. and *Quercus* sp. *Cyclobanopsis* sp. is evergreen, while *Quercus* sp. is deciduous. The quantity of *Cyclobanopsis* sp. in Miyagi prefecture is small, even though its pollen has been detected in the entire horizon for the past 7,000 years. Currently raised close to the Sendai city, it consists of *Q. salicina, Q. myrsinaefolia, Q. acuta* and *Q. glauca.*

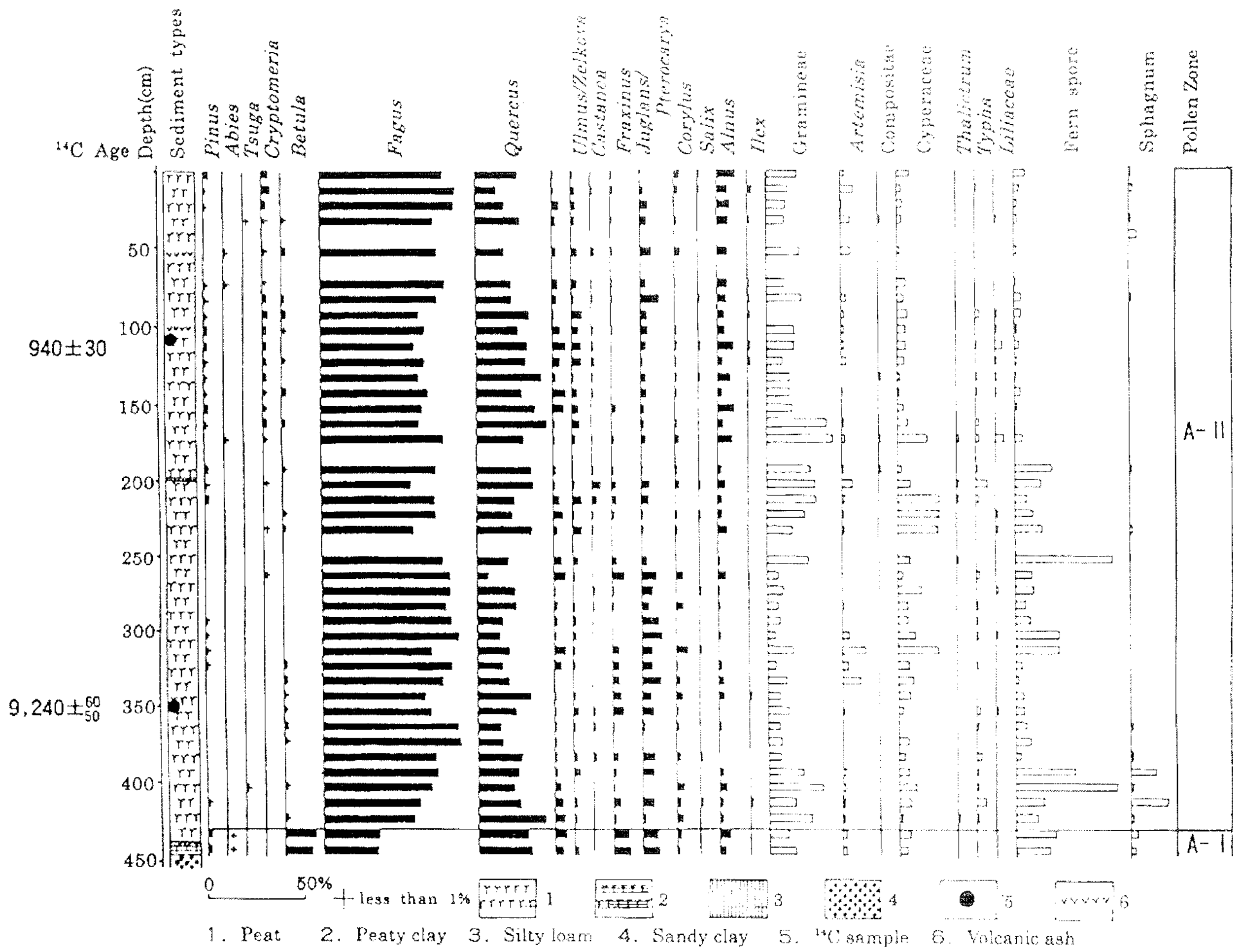

Fig. 3. Pollen diagram from Akindonuma moor.

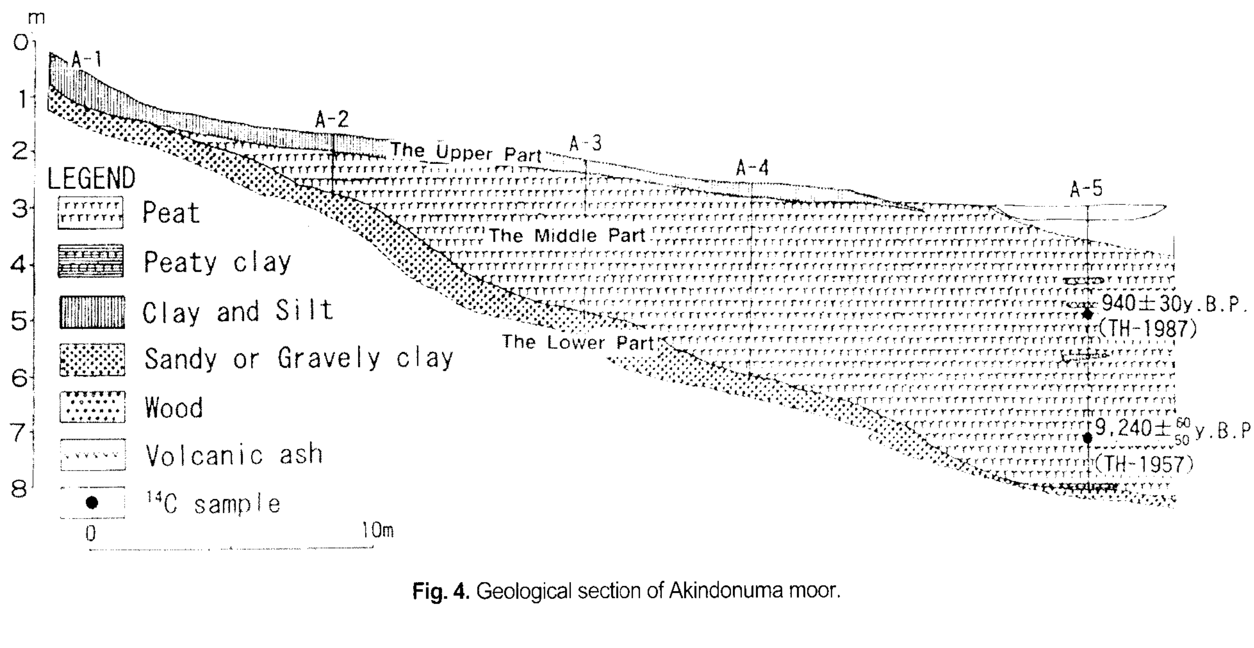

Fig. 4. Geological section of Akindonuma moor.

It is not evident, however, that it has been spreading for the past 7,000 years. If its distribution has continued, all or most of the *Quercus* pollen detected from the Akindonuma moor comes from *Quercus* sp. rather than *Cyclobanopsis* sp., considering vegetation distribution at present.

There are *Q. serrata* and *Q. grosseserrata* in *Quercus* sp., which cannot be distinguished in the form of pollen. In the present vegetation, however, *Q. grosseserrata* prevails in the high-altitude area, while *Q. serrata* is remarkably distributed in the low-altitude area, where the altitude of approximately 300m is the dividing line. Therefore, considering the vegetative features and the altitude of the Akindonuma moor (500m), it is believed that most of the *Quercus* pollen detected in the A-I zone originated from *Q. grosseserrata.*

There are two species in *Fagus: F. crenata* and *F. japonica*. In the present vegetation of the Miyagi prefecture, the high-altitude area and the low-altitude area are separated by the altitude of 300-400m as a boundary line. In the high-altitude area, *F. japonica* prevails. In the low-altitude area, *F. crenata* is widely distributed. Therefore, taking the ecological distribution features and the altitude of the Akindonuma moor into consideration, it is assumed that most of the *Fagus* pollen detected in the A-I zone originated from *F. crenata.*

There are *B. ermanii* and *B. platyphylla* in *Betula*. *B. ermanii*, a tree that constitutes the subalpine forest, is distributed more than 1,000m in the Iwate Prefecture. Like the landslide area, it is grown under special soil conditions(Yamanaka,1972). On the other hand, *B. platyphylla* grows well in the northern part of the Kitagawa Mountains and appears partly in the Ohu Backbone Range. It is assumed that the mother tree of the *Betula* pollen detected in the A-I zone is mostly *B. ermanii* (partly *B. platyphylla*).

The forests that consist of these trees do not belong to the family of typical deciduous broad-leaved forests. They are, however, forests of transition vegetation. Therefore, the A-I zone corresponds to the upper montane forest (or the lower subalpine forest). The closing period of sedimentation is roughly 11,700 yrs. B.P. After taking everything into consideration, it is estimated that the Akindonuma moor area was covered with forests that consisted of *F. crenata, Q. grosseserrata* and *B. ermanii* (partly *B. platyphylla*). The pollen record discussed above corresponds to the R I stage of Nakamura(1952). In the previous research, it corresponds to the *Quercus-Betula-Ulmus / Zelkovea* zone of the Yugawanuma moor(Park *et al.* 2001), the *Quercus-Betula* zone of the Hosoziri moor, and the *Betula* zone of the Kawadori Basin(Nakamura and Miyagi, 1984).

Meanwhile, there are almost no data indicating the pollen record of the R I stage, this study report of the Miyagi prefecture montane zone. Therefore, the A-I zone of the Akindonuma moor will play an important role in revealing the vegetation environment of the Miyagi prefecture montane zone.

A-II zone

As explained about the A-I zone, it is believed that the mother plant of the *Fagus* and *Quercus* pollen detected in the A-II zone originated from *F. crenata* and *Q. grosseserrata*. The forests that are made up of these trees are similar to the cool or temperate deciduous broad-leaved forests in central Japan at present.

In this research, there is no chronological data on the uppermost horizon in the A-II zone. In addition, the closing period of the A-II zone cannot be determined because the data on the pollen zone corresponding to the R II stage cannot be acquired. It is assumed that the Akindonuma moor was covered with *F. crenata* forests after around 11,700 yrs. B.P. Judging from these features, the A-II zone corresponds to the R II stage of Nakamura (1952). In the preceding reports(Miyagi *et al.* 1979, Miyagi *et al.* 1981), the *Quercus-Fagus* stage of the Moniwa-Takada moor, the *Fagus-Quercus-Carpinus* stage, *Fagus-Quercus-Zelkova* stage and *Quercus-Fagus-Zelkova* stage of the Nenoshiroishi moor, and *Quercus-Fagus* stage of the Isuponuma moor are correlated.

A comparison of geological section and the pollen diagram

Through a comparison of the geological section (Fig. 4) and the pollen diagram (Fig. 3) of the moor, a relationship can be seen between the influx of inorganic matter supply from the back slopes and the change in the pollen record (Miyagi *et al.* 1981). The depression deposits consisted of three parts: a basal sandy (or gravelly) clay part, a middle peaty part, and an upper clay (or silt) part from the bottom. These are called the Lower Part, the Middle Part and the Upper Part, respectively.

The Lower Part consists of sandy (or gravelly) clay layers, but the peat layer is not intercalated in it. Moreover, it shows a steep deposit slope. This feature is similar to that of the basal inorganic part (I) of the Sakunami depression and the Lower Part of the Yugawanuma moor(Park 2000). The peat obtained at -355cm of the A-5 point had been dated 9,240+60/-50 yrs. B.P., and the peat obtained at -120cm of the A-5 point had been dated 940± 30 yrs. B.P. (TH-1987). It can be estimated that the mean sedimentation rate of the peaty layers at the A-5 point is 0.28mm/yr. between -355cm and -120cm, and 1.28mm/yr. underneath -120cm. In consideration of these data, the Lower Part seems to have been deposited up to about 12,500 yrs. B.P. It may be concluded from these facts that there is a possibility that the glacial climate was involved in the deposit process of the Lower Part.

The Middle Part consists mainly of peaty layers. Therefore, there has been no influx of inorganic layers from the back slope in the west part of the Akindonuma moor, which became a closed depression after the deposit period of the Lower Part. This means that a very stable environment has been maintained continuously. The deposit period of this part is approximately between 12,500 yrs. B.P. and the latest. According to the pollen analysis, the part must have been formed in the A-I zone to the A-II zone. During this period, the pollen ratio of *Ulmus / Zelkova* was very low and small peak was not recognized.

If the instability of the hillslope around the closed depression was induced by a change in climate and other factors, it should have been recorded with the changes in both the pollen assemblage and the lithofacies of the depression fills(Miyagi *et al.* 1979). There is a close relationship between the fluctuation of *Ulmus / Zelkova* pollen ratio and the general trend of hillslope instability in the changing balance of temperature and precipitation(Park and Hibino 1999, Park 2000a, Park 2000c). It is observed in present mountains and hills that *Zelkova serrata* tends to cover the footslope and the lower sideslope(Park 2000c) and *Ulmus davidiana* covers the footslope and the alluvial cone(e.g., Makita *et al.* 1976.). The footslope is the youngest slope-unit in the watershed and is composed of colluvial deposits at the foot of the landslide scar. The lower sideslope was formed by continuing landslides during the Holocene and occupies large areas of the watershed(Park 2000c, Park *et al.* 2001). Taking everything mentioned above into consideration, the fact that the *Ulmus / Zelkova* pollen ratio was very low during the deposit period of the Akindonuma moor and small peak was not recognized, is believed to reflect the stability of the earth' s surface environment, which was estimated from the geological section.

The Upper Part consists of clay (or silt) layers. Although its deposit period is questionable, it must be the most recent formation of the layer.

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