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

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ABSTRACT: Pollen analyses and 14C dating of the sediments of the Akidonuma 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 Akidonuma moor.

STUDY AREA AND METHOD

Study area

The Akidonuma 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 Yudonuma 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 rhynchoephysa 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 Heller-type hand borer was treated with the KOH-Acetalysis and then treated with saturated solution ZnCl2. 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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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).


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-1 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 (420~80cm)**

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 *Cyclobalanopsis* sp. and *Quercus* sp. *Cyclobalanopsis* sp. is evergreen, while *Quercus* sp. is deciduous. The quantity of *Cyclobalanopsis* 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. myrsinæfoliæ*, *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 Akidonuma moor comes from Quercus sp. rather than Cyclobalanopsis 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 Akidonuma 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 Akidonuma 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 Otoh 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 Akidonuma 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-Ulms / Zeikova 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 Akidonuma 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 Akidonuma 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 Morisawa-Takada stage, the Fagus-Quercus-Carpinus stage, Fagus-Quercus-Zelkova stage and Quercus-Fagus-Zelkova stage of the Nenoshuarioishi 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+690/50 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. underneather -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 Akidonuma 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 / Zeikova was very low and small peck 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 / Zeikova 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 Zeikova 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-units 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 / Zeikova pollen ratio was very low during the deposit period of the Akindonuma moor and small peck 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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LITERATURE CITED


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