MATERIALS

Identification of Common Millet from the Toyosato Site in Hokkaido by Means of a Scanning Electron Microscope

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Abstract Among the three types of millet, “awa”, “hie” and “kibi”, which were cultivated in ancient Japan, the common millet, “kibi” (*Panicum miliaceum* L.), was less popular. Hence the samples of “kibi” reported from the archaeological sites were fewer than the other two types. As noted in the previous reports (MATSUTANI 1986b, 1987) grains of these millets are so small that their identification is often difficult, especially when carbonized, unless their cell structures are observed with a scanning electron microscope (SEM). So the carbonized grains of these millets might often be identified as “awa”, which was the most popular one. The present study reports the discrimination of common millet among the carbonized grains from a site in Hokkaido belonging to the Satsumon period (9 c.–12 c.) using SEM. Formerly, these grains were considered as “awa” (*Setaria italica* (L.) Beauv.).

Keywords Millet, Identification, SEM

Introduction

In contrast to abundant evidence of rice cultivation in Japanese prehistory, that of millet cultivation is very rare. In ancient Japan three types of millet were cultivated, namely “awa”, “hie”, and “kibi”. They are matched to *Setaria italica* (L.) Beauv., *Echinochloa utilis* Ohwi et Yabuno, and *Panicum miliaceum* L. respectively. The

ancestor of “kibi” is not known unlike the other two millets and the place where cultivated “kibi” originated is not clear yet.

This crop appears to have been less widely cultivated than the other two millets and its findings are also reported fewer than the others (WATANABE, 1970). Perhaps owing to their small grains, identification of these millets is often difficult and they are confused with each other or all

identified as "awa", which was the most common of the three. The present author has been interested in the discrimination of millets using spodography and scanning electron microscopy. In the previous two reports (MATSUTANI, 1986b, 1987) it was described and shown in photomicrographs how "awa" or "hie" was distinguished from other millets based on its characteristic cell patterns of lemma and palea. In this report carbonized grains identified as "kibi" are analysed.

The characters of "kibi" (common millet) are observed from the paleas of recent materials and compared with those of the excavated ones.

Key for the Discrimination of Common Millet

As in the case of "awa" and "hie", the epidermes of paleas and lemmas of "kibi" are constituted solely of the long cells, and the identification keys must be looked for in the features of these long cells, which have sinuate contours like those of the other two millets.

Firstly, as in "hie" (MATSUTANI, 1987) long cells of "kibi" do not have any tubercles at the end of cells. In this respect the long

cells of "hie" or "kibi" are clearly distinguishable from those of "awa" which have clear tubercles (MATSUTANI 1986). However, in some varieties of "awa", such as "uruchi" (Fig. 11), tubercles are not observed in the long cells of palea and lemma (also reported in spodography by WATANABE, 1970). In such case the shape of the arms or the sinuated lateral parts of the long cells may be useful for the discrimination of "awa" from "kibi" or "hie". In "awa" the tips of the arms are club-shaped or widened (Fig. 12) while the tips of the arms in "kibi" or in "hie" are acute or narrowed and not club-shaped (Fig. 9).

Secondly, the length of the long cells of palea in "kibi" is longer than the breadth, and the standard ratio reaches to about double, which is quite different from the case in "hie" or in "awa", where the length of the long cells of palea is equal to or shorter than the breadth. In the previous report, the cell patterns under the surface of palea of "hie" were shown to be sharply dentated (MATSUTANI, 1987). In "kibi" also the cell patterns under the surface of palea are dentated (Fig. 10), but the above mentioned ratio of the long cells can be applied to the distinction between them.

Fig. 1. An isolated carbonized lump from the Toyosato Site.

Fig. 2. Magnification of Fig. 1 where the sinuate long cells were observed.

Fig. 3. Magnification of Fig. 2. Characteristic cell patterns of "kibi" were observed.

Fig. 4. An isolated grain with better outward form.

Fig. 5. Remains of cells under the surface perhaps derived from the neighboring grain.

Fig. 6. Magnification of Fig. 5 (90 degrees rotated).

Fig. 7. Ventral side view of a recent "kibi" with palea and lemma.

Fig. 8. Magnification of Fig. 7. Sinuate cell patterns of long cells are shown.

Fig. 9. Magnification under Fig. 8.

Fig. 10. Cell patterns under the surface of recent "kibi".

Fig. 11. Ventral side view of a variety of "awa" (Uruchi) in which no papillae or tubercles are found.

Fig. 12. Magnification of Fig. 11. Tip of the arm is club-shaped or widened rather than acute or narrowed.

500u

50u

50u

500u

50u

50u

500u

50u

50u

50u

500u

50u

Materials

Carbonized grains from the Toyosato Site at Toyotomi-cho in Hokkaido belonging to the Satsumon period (9–12c.), which is approximately parallel in age to the Heian period in mainland of Japan, were observed.

The site was excavated in 1958 and finds of carbonized grains of “awa” (*Setaria italica*) accompanied by “ryokuto” (*Vigna radiata* (L.) Wilczek) and “soba” (*Fagopyrum esculentum* Moench.), were reported without a detailed description or explanation of the identification (KOHNO, 1959). However, this identification was often cited as evidence of the cultivation of “awa” in the Satsumon period (HAYASHI, 1969). The present author had doubts that they were really “awa” and wanted to ascertain the kind of millet, for the author had experienced the detection of “kibi” from another Satsumon site (MATSUTANI, 1980). These grains had been preserved in Asahikawa City Museum without further examination until this study.

Method

The sample was composed of carbonized grains which were around 2mm in diameter and fused into lumps. Some grains were isolated and were observed under a binocular microscope and two specimens with floral bracts such as lemma and/or palea were selected from among them. They were rinsed with acetone and mounted on stubs with double coated Nichiban tape. After being sputter-coated with platinum they were observed with a Hitachi S-700 SEM and photographed using both TriX film and Polaroid P665 film.

As in the case of “hie” (MATSUTANI, 1987), the recent samples for comparison

were treated with the following operations. Namely, the uncarbonized kernel with palea and lemma was soaked in a dilute solution of hydrosulphate in a water bath for one hour. After being washed with distilled water three times and rinsed with acetone, they were then mounted and sputter-coated with platinum, then observed and photographed as in the case of excavated ones. Further, to see the cell structures under the surface, recent grains were incinerated with a plasma inorganizer (UMEMOTO and HOZUMI, 1971) and were treated with dilute hydrochloric acid; the same procedures as above were then followed.

Results

The first specimen looked like a grain with a binocular, but with SEM several fragments of grains were observed to fuse into a lump and among them a part of the epidermis of palea or lemma was detected (Fig. 1) and when it was enlarged it revealed the characteristic long cells of sinuate contours without tubercles and under the surface dentated zigzag patterns of the structures (Fig. 2, 3). Length of the long cells was clearly longer than the breadth, and that was matched with the characteristics of long cells of palea or lemma of “kibi”. The second specimen with a clearer outward form (Fig. 4) was also observed, but long cells of palea or lemma were not detected on the surface of this sample. Instead, the remains of cell patterns perhaps derived from the neighbouring grain were observed, and they also indicated the cell patterns characteristic of “kibi” (Figs. 5, 6). Scanning electron photomicrographs of recent “kibi” are shown in Figs. 7–10 for comparison.

Conclusions

Based on the cell patterns of characteristic long cells and also on the cell patterns under the surface, carbonized grains uncovered from the Toyosato Site more than twenty years ago could be identified as “kibi” and not as “awa” as hitherto have been considered.

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Note

Part of this study has already been reported in Japanese (MATSUTANI, 1986a).

抄 録

走査電子顕微鏡による豊里遺跡出土炭化キビの識別

松 谷 暁 子

古代から栽培されていた日本の主要雑穀三種であるアワ、ヒエ、キビのうち、遺跡からの出土報告が一番少ないのがキビである。小粒であるイネ科雑穀は、炭

化物の場合、走査型電子顕微鏡 (SEM) による微細構造の観察によらないかぎり、識別が困難なため、最も普遍的なアワとして三者が包括されている場合がある。本報告では、アワとヒエの報告例 (松谷 1986b, 1987) に続き、SEM によりキビ粒と判定された事例を示した。北海道天塩郡豊富町の豊里遺跡 (擦文期) から出土した炭化粒で従来アワと考えられていたものである。

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