

# Refining plant impressions using Replica-SEM method: Millet cultivation in Central highland Japan

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## Introduction

This poster presents a refined techniques for replicating and observing macrobotanical remains. Impressions left on the surface of pottery and daub were popular archaeobotanical materials to detect plant remains, before flotation became widely adopted for macrobotanical recovery. However, impression is considered as unreliable today, except for some research (Klee *et al* 2004 *etc.*) Hence the author introduces Replica-SEM Method, which is more innovated than the conventional method, and shows how effective this method is to resolve two serious problems ; i.e. deformation and contamination. Macroremains are movable, but impressions are immovable. While charred grains were often deformed, but impressions are keeping fresh condition observable for the taxonomically identifiable surface texture before charring.

In addition, as a case study, the author reports the research about dispersal of millet cultivation in Central highland Japan during The Final Jomon period (roughly estimated around 2500BP), She also hopes to show the diversity of subsistence system in Japanese archipelago.

## 1. Method: Replica-SEM Method

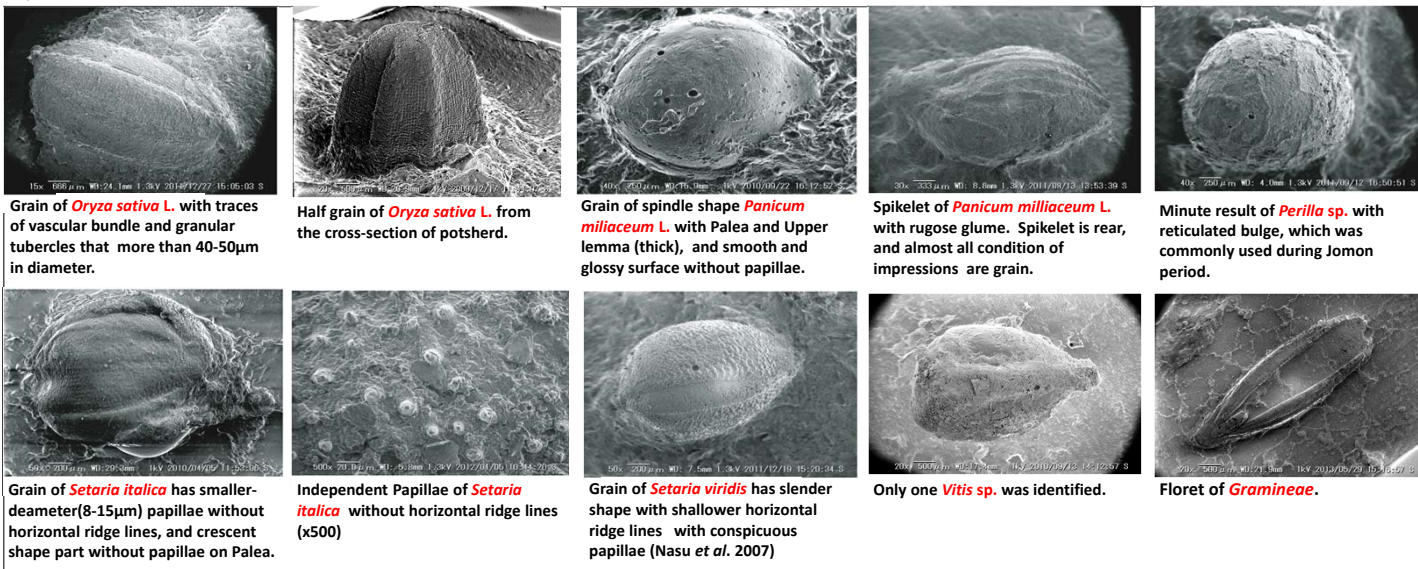
Positive replicas are made with silicone rubber resin from plant impressions on pottery surface, and we observe those replicas, using scanning electron microscopy (SEM). Owing to the high transcription of pottery's clay, it is possible to obtain 500 time magnified images of the replicas. Therefore the identification depends on not only the seed size and the shape but also the surface texture of seed, which is much more reliable. This method is especially effective to small seed like millet which size is almost half of barley or rice. Another merit of this method comes from chronological control of pottery. Using pottery typology, we can discuss the chronological position of the identified seed in archaeological context. Furthermore, this method is applicable to artifacts previously excavated and stored for a long time, and even for a lot of unidentified impressions already have been reported.



## 2. Formation process of impression

Plant impressions mainly are interpreted as intentional temper from dominant chaff remains. However, based on the condition of almost all replicas with the upper lemma and the palea, the author suggests that grains after early processing were dropped into clay coincidentally during daily food preparation in the houses or around the houses where the pottery were produced. It's difficult to regard a whole vessel with only one grain impression as a pottery temper. The author also interprets some rice impressions on vessel bottoms as intentional marking. Such impressions are observed on coetaneous Korean pottery, too.

## 3. Identification



## 4. Millet cultivation in Central Highland Japan

Site / sea level	<i>Setaria italica</i>	<i>Setaria virid</i>	<i>Panicum miliaceum</i>	<i>Oryza sativa</i>	<i>Perilla sp.</i>	<sup>14</sup> CBP	Reference
Ishigyo/440~455m	34		26	1	1	2460±20	Endo,Takase2011
Yazaki/410m	41	2	2			2535±25	Endo,Takase2011
Gongendomae/540~543m	9		16				Endo,Takase2011
Kitakatakitanohara/556m	4	1	19				Endo2012
Miyamada/530m	5		9				Endo2012
Oosyuku/570m	13		2			2440±30	Endo2012
Ishigo/675~680m	4		1				Nakazawa <i>et al.</i> 2010
Misyagui/780~783m			1				Nakazawa2012
Koujinsawa/658m	1		4				Nakazawa2012
Nakamichi/	6		28				Nakayama,Uruma2012
Yashikidaira/560m	7	1	2				Nakayama,Sano2012

Formally, fundamental change in societies of Japanese archipelago occurred with the emergence of paddy rice agriculture with the irrigation system in western region under the influence from Korean peninsula, however, in Central highland, archaeological evidence indicates that agriculture in this region started almost several hundred years later than western part of Japan. Some archaeologists used to speculate millet cultivation took place in this region, but it was difficult to present secure archaeobotanical proof for a long time.

Using Replica-SEM method, however, we have been successful in identification of numerous millets like *Panicum miliaceum* L. and *Setaria italica* (L.) P. Beauv., and the dispersal and the period of appearance were comprehended. Not only geographical and climatic condition but also unnecessary of drastic social change must be reason for selective acceptance of millet cultivation.

## Conclusion

Of course, systematic and stratigraphic flotation is at the top of the list of priorities for archaeobotanical recovery and quantitative analysis. With the high resolution of plant surfaces, the author argues that Replica-SEM Method are powerful means, especially when searching the early signs of cultivation, and discussing wild/domesticated or crop/weed status of plant.