Study on the comparative morphology of pollens between Chinese Mt. Tiantai and Korean Mt. Jiri tea plants.

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Summary
The earliest Korean historic record indicates that some tea plant seeds from China was planted at Mt. Jiri in Korea in 828 (A.D.).

This study was aimed to compare between five types of tea plants from Mt. Tiantai (China) and Mt. Jiri (Korea) using the pollen comparative morphological method.

The results showed that all the pollen grain sizes of five samples were middle, prolate (P/E=1.68-1.79) from the equatorial view, and trioblate-obtuse triangle from the polar view. The sprouted aperture was all 3-corporate with thin and long colpus, which belongs to the relatively evolved shape. The ora was elliptic. The exine ornamentation was the cloud-shaped and reticulate. Most of the lumina showed the irregular aperture shape, and the shape of the muri was undulate and distinct, which belongs to the evolved shaped.

There were no significant differences between the five samples in the size and shape of the pollen grain. Also there were extreme similarities between the five samples in the characteristic of the sprouted aperture and the exine ornamentation. The results suggest that tea plants from some tea gardens at Mt. Jiri (Korea) were propagated from Mt. Tiantai (China).

Key words
Comparative Morphology, Pollen, Mt. Tiantai, Mt. Jiri

Introduction
The earliest Korean historic record indicates that the diplomat of Shilla dynasty in 828 (A.D), brought some seeds of the tea plant from Tang dynasty in China, in obedience to Huengduk's command and the seeds were planted at Mt. Jiri in Korea. Jaesaeng Kim (1982) reported that the tea plants in Mt. Jiri of Korea originate from Chinese Mt. Tiantai and were planted near the Ssanggye Temple in 828 (A.D.). While Tangheng Zhang et al. (1994) reported that the seeds of a tea plant propagated from China in 828 (A.D.) were planted around the Hwaum temple. A common point of above-mentioned accounts is that some seeds of a tea plant in Mt. Jiri of Korea were propagated from China in 828 (A.D.). However, neither the origin of propagation in China nor the place of cultivation in Mt. Jiri have been accurately identified. Based on an account of Jingyo priest of Hwaum temple, the tea plants of its garden were propagated from India in 544 (A.D.). This account is inconsistent with Zhang Tangheng et al.'s report. Therefore the origin of the tea plants at Mt. Jiri (Korea) is not accurately defined, whether they're from China or India. There are also many views to this. For these reasons, the present writer formerly selected the experiment materials from both the Mt. Tiantai (China) and Mt. Jiri (Korea) and researched the comparative morphology of its leaves and flowers. The result showed that all of the five samples belong to the Camellia sinensis (L.) Kuntze var. bohea below Camellia sinensis (L.) Kuntze ssp. bohea. After measurement of the comparative 34 parameters, they showed that there was no significant differences between Guiyundong and near the Ssanggye temple of the tea plants in their natural growths. This indicates that near the Ssanggye temple is the origin of propagation for the Tiantai variety of China. The results of the comparison of the two tea gardens pickled tea leaves showed that the Ssanggye tea garden could also be the origin of propagation for...
the Tiantai variety of China. But it is difficult to determine the Hwaum temple’s tea garden as the origin of propagation for the Tiantai variety. Mainly because the morphology of leaves and flowers can be affected with many factors such as geographical conditions, variety, pickling and fertilization management, and produce variations. So it is very difficult to verify the relation between the varieties. According to no less research reports, we can use the morphological observation of pollens to prove a plant’s origin, classification, system development and the affinity of it. We can obtain dependable evidence from it. According to this, by using the method of comparative morphological of pollens, this article researched deeper into whether the Mt. Jiri (Korea) was the propagated place of Mt. Tiantai (China) or not and could scientific evidence be given for it.

Materials and Methods

This study was aimed to compare the tea plants of the Mt. Tiantai (China) with the tea plants of the Mt. Jiri (Korea). Two tea plant varieties were collected from Mt. Tiantai in China. The first variety was harvested at Ximaopeng tea garden in the western part of the Hwuading temple, and the second at Guiyundong the northern part of the same temple. In Korea, three varieties were collected; one at the Ssanggye Temple tea garden, another at the northern part of the Ssanggye temple tea garden, and the third at the Hwaum Temple tea garden. Through the end of October to the beginning of November of 1998, a random sampling of a flower bud was done between 8 and 10 a.m. It was then spread in a shade and cooled indoors for 10 to 12 hours. Wrapped in weighing papers it was put in a desiccator. Kept and reserved. First, using a double-sided adhesive tape on the copper stand the naturally dried pollen was directly scattered on it and plated by a Japan IB-5 type ion-plating machine. It was observed and taken pictures by SEM (scanning electron microscope). For measuring the size of the pollens, every material was observed under a 200 times magnification and taken pictures. After copying the film onto the computer, normally grown pollen were randomly chosen and measured.

Observed items: pole axis (P), equator axis (E), size and shape of the pollen, shape of the ora, shape of the colpus, exine ornamentation, the polar and equatorial view of the pollen and the calculated value of P/E.

Results and Discussion

The size and shape of the pollen

The size of the pollen is indicated with the longest axis. According to Jilin Shu et al. (1996), if the length of the longest axis is between 25 μm and 50 μm, it is classified with a middle size pollen: if between 50 μm and 100 μm, this is included in the large size pollen. The results showed that the polar axis of the samples is larger than the equatorial axis. Therefore, it was compared with the length of the polar axis. The result is as follows: the mean value is between 45.23 μm and 47.36 μm. This is included in the middle size pollen (refer to Figure 1).

A,B,C,D,E (45.23 μm~47.36 μm)

![Figure 1. Sizes of pollens](image)
The mean values of P/E in the five samples are between 1.68 and 1.79. According to the division standard of the shape of the pollen by G. Erdman (1969), all of them are included in prolate (refer to Figure 2). The result showed that the size and shape of the pollen of the five samples have no significant differences.

The polar view of the pollen from the tea plants are different according to the varieties of the tea plants. There are trioblate-globular, trioblate close-globular, trioblate-obtuse triangle, tetraoblate-obtuse square and pentaoblate-obtuse pentagon. A large of number of them are trioblate close-globular and trioblate-obtuse triangle. The shape of the polar view of five samples is all of the trioblate-obtuse triangle shape.

The comparison of aperture
The aperture is the position of the pollen germination. According to the dry and damp condition, it is able to change and controll volumes. Generally, it is described with colpus and porus. Colpus is long aperture. The length of the long apex is double the length of a short apex and over. Porus is called short aperture. The length of a long apex is double the length of a short apex or smaller. When we determined in which type and variety of plant the pollen is included, the number, position and character of colpus and porus have an important meaning. As to tea plants, varieties can be differentiated by the shape of colpus and porus. The results showed that the shapes of the five samples’ sprouted aperture were tri – corporate with thin and long colpus. The ora is the center of a colpus. The shapes of the five samples’ ora were elliptic. According to Van Campo (1976), the aperture shape of the plant which belongs to angiosperm tends to be circular along with the changed evolved shape. Walker put forward a course which is as follows: a primitive aperture is mono - trough shape far from pole, and then evolved to a fortibranche trough, ring trough, mono – aperture, trough shape close to pole, trough without aperture: again evolved to ditrough – diporus, all around aperture, ring trough close to pole, possessed colpus, possessed porus etc. Except to lily magnolia subclass in angiosperm, the main evolved tendency of sprouted aperture which belongs to subclass is tricolpus→ tri-obscurcly colporate→ triporus→ tricolporate→ scattered aperture. According to this, trough without aperture and obscurely colporate belong to a relatively primitive shape. Tricolporate belongs to a relatively evolved shape. Tetra or pentacolporate belong to the evolved type. All of five samples are tricolporate aperture which belongs to the relatively evolved shape.
The comparison of exine ornamentation

The main components of exine ornamentation consist of cellulose and pectine et al. The exine ornamentation consists of muri and lumina. The results showed that the exine ornamentation of the five samples was cloud-shaped and reticulate. Most of lumina showed the irregular aperture shape, and the shape of the muri was undulate and distinct, which belongs to the evolved shape. Different varieties of tea plants have the diversity of the exine ornamentation. There are reticulate, obscurely ornate, obscurely ornate – granular and granular ornate in it; there are circular, close to circular, small rill shape and irregular or indistinct shape of lumina; there are curved, long–narrow, granular, tumor and undulate shape of muri. According to Walker’s (1976) thesis, Liubaoxiang (1981) put forward his opinion as follows: smooth shape which belongs to the primitive type evolved to granular and reticulated shape. Generally, the exine ornamentation of pollens which belongs to primitive types of tea plants are smooth in shape. The undulation of the muri is indistinct. The length, roughness and size of lumina is regular; on the contrary, the evolved shape assumes roughness. The undulation of the muri is distinct. That forms irregular roughness and reticulate shape. The results show that all of five samples belonged to the evolved shape.

The morphology of tea leaves and flowers in the same varieties is closely related to the environmental conditions. Because except for temperatual conditions, there was somewhat of a difference to the geographical conditions between Mt. Tiantai(China) and Mt. Jir(Korea). Therefore the results of the comparative morphology of leaves and flowers in this study showed significant or extremely significant differences in 10 of the 34 parameters. But owing to the pollen belonging to a part of the sexual organ which is not easily influenced to the environmental factors. It is relatively stable, and it is also the genotype of the external part. It could accurately differentiate the characters of the varieties. The results showed that all the pollen grain sizes of the five samples were middle, prolate (P/E=1.68 - 1.79) from the equatorial view, and trioblate –obtuse triangle from the polar view. The sprouted apeture was 3-corporate with thin and long colpus. The ora was elliptic. The exine ornamentation was cloud-shaped and reticulate. Most of the lumina showed the irregular aperture shape, and the shape of the muri was undulate and distinct.

There were similarities between Mt. Tiantai and Mt. Jiri in the pollen morphology. This result suggests that tea plants from some tea gardens at Mt. Jiri(Korea) were propagated from Mt. Tiantai (China). According to Heliqing(1989), the pollen of Camellia sinensis var. assamica which belongs to a large leaves type, was mostly of middle size and globular shape. A few were close to oblate shape. The sprouted aperture was tricolporate. The ora was rectangle. The exine ornamentation was obscurely reticulate ornamentation. The shape of the muri which was especially undulate, formed a small chunk and crowded together in arrangement. There were small rills between the undulations. Granule and tumor were distributed on the surface. On this basis, there were distinct differences between the five samples and Camellia sinensis var. assamica in the ora shape and exine ornamentation. These results suggested that the tea plants from Hwaum Temple tea garden at Mt. Jiri (Korea) were not propagated from India.