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Reconstruction of Vegetation During 9th Century in Southern Korea: Anatomical and Dendrochronological Analysis of Waterlogged Woods Excavated at Cheonghea-jin Fort*

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ABSTRACT

This study is conducted to examine the woods that were excavated at Jangdo Island. The Jangdo site is located in a small island some 180 meters away from the main island of Wando, Jeollanam-do in southern Korea. This site is known as Cheong-Hea Jin fort for the marine King Jang Bogo during the early 9th century. Total of 101 specimens were collected in three groups; small-size piles, log fences (Mok-check) and logs from a well. The species of the group of piles consisted of *Quercus spp.* (43%), *Pinus densiflora* (29%), *Pinus koraiensis* (5%), *Alnus japonica* (3%), *Fraxinus spp.* (3%), *Styrax obassia* (3%), *Juglans spp.* (2%), *Zelkova serrata* (2%), *Platycarya strobilacea* (2%), *Celtis spp.* (2%), *Torreya nucifera* (2%), *Quercus myrsinaefolia* (2%), and *Cinnamomum spp.* (2%). The species of Mok-check and logs from the well were identified as all *Pinus densiflora*. The species composition indicated that the climate around A. D. 9th-10th century in southern Korea was similar to the present.. The wooden fences were also examined for tree-ring analysis. The ages of woods were 50~60 years. We made two site chronologies. The chronologies indicated that southeastern and southwestern fences were repaired frequently. The results could not give the absolute dates due to lack of reference chronologies in this period.

Keywords : archaeological woods, waterlogged woods, Silla Kingdom, dendrochronology, Quercus spp., Pinus densiflora, Mok-check, tree ring

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Introduction

The Jangdo site is known as Cheong-Hea Jin, the fort of the well-known Admiral Jang Bogo in the Unified Silla Kingdom era. This site has been excavated ten times since 1991. Radiocarbon dates of the samples from wooden fences, so-called Mok-check, indicated that built in the early and middle 9th

century. The date is well compatible with the reign of Jang Bogo's Cheonghaejin.

Many waterlogged woods were excavated from this site. This study identified total of 101 specimens; 66 specimens from Janmok-yeol(the group of small-size piles), 9 specimens from the remain of a well, 26 specimens from the wooden fences(Fig. 1). Through the identification of these woods, we can compare forest composition of the present with the 9th-century one.

We analyzed also the fence logs for tree rings. Annual rings of many species can be used to date old buildings and archeological sites by using dendrochronological methods (Stokes & Smiley 1968, Baillie 1984). Some species, which were reported to have been growing for several centuries in Korea forests, provide unique opportunities to develop long tree-ring chronologies for dating buildings in this region(Park 1994, Park et al. 2001). We may not be able to date the logs of Jangdo site because tree-ring patterns existing in Korea are not long enough to cover that period in Korea. However, we may assign relative dates to southwestern and southeastern fences. We also intended to build floating chronologies that will be useful for extending tree-ring chronologies of South Korea in future.

Materials and Methods

1. Species identification

All of 101 specimens were waterlogged woods. There were 66 specimens from small-size pile group, 9 specimens from the well, 26 specimens from the fences. We conserved them in the water to prevent from drying out. Wood blocks were subdivided into small cubes of ca. 1x1x1 ㎤ size in the laboratory with hand cutter. Transverse, radial, and tangential sections of 20 to 30 ㎛ thickness were cut with a sliding microtome after embedding in PEG-2000.

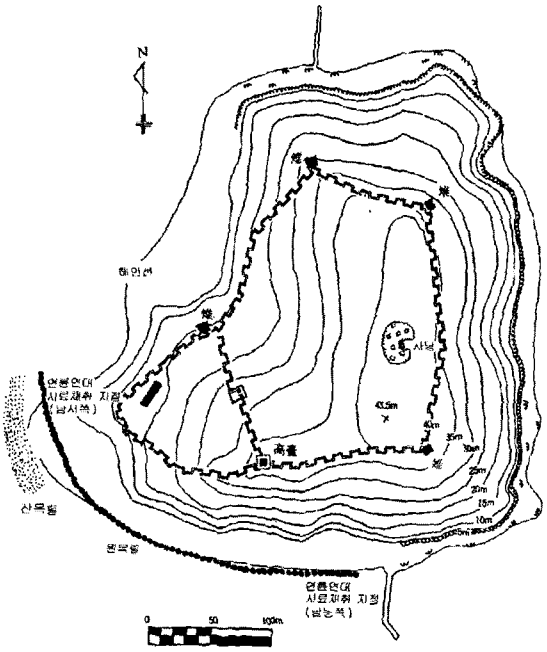

Fig. 1. Location of the small-size piles (Janmok yeol: light dots on the far left side) and the wooden fences (Mok-check yeol: heavy dot lines extending from lower left to the lower center)

Fig. 2. Southeastern fences (mok-check)

Fig. 3. Fence logs: only underground parts intact.

Fig. 4. Fence logs digged out(wedge-shaped lower side)

Table 1. Species analyzed from the group of small-size piles.

	Species	Number of samples	Percentage
Softwoods	*Pinus densiflora* Sieb. et Zucc. *or Pinus thunbergii* Parl.	19	28%
	Pinus koraiensis Sieb. et Zucc.	4	5%
	Torreya nucifera Sieb. et Zucc.	1	2%
Hardwoods	*Quercus spp.* Linn.	28	41%
	Alnus japonica Steud.	2	3%
	Fraxinus spp. Linn.	2	3%
	Styrax obassia Sieb. et Zucc.	2	3%
	Quercus myrsinaefolia Bl.	1	2%
	Juglans mandshurica Max.	1	2%
	Platycarya strobilacea Sieb. et Zucc.	1	2%
	Zelkova serrata Makino.	1	2%
	Celtis spp. Linn.	1	2%
	Cinnamomum spp. Bl.	1	2%
Unable to identify		2	3%
Total		66	100%

2. Tree-ring analysis

A total of 26 specimens (cores) were sampled from wooden fences for tree-ring analysis; ten from the southwestern side and 16 from the south eastern one. Ring widths were measured to the nearest 0.01mm by using the LINTAB measuring device. Ringwidth plots of individual samples were produced by using the TSAP program (Rinn 1996). These plots were used for visual comparison on a light table to crossdate each other by synchronizing the patterns. Correlation analysis was also used to compare each plot.

Results

1. Wood species

The species of 99 samples among 101 were identified. Two specimens from the group of small-size piles could not be identified since their condition wasn't good enough. The group of small-size piles consisted of *Quercus spp.*(43%), *Pinus densiflora*(29%), *Pinus koraiensis*(5%), *Alnus japonica*(3%), *Fraxinus spp.*(3%), *Styrax obassia*(3%), *Juglans spp.*(2%), *Zelkova serrata* (2%), *Platycarya strobilacea*(2%), *Celtis spp.*(2%), *Torreya nucifera*(2%), *Quercus myrsinaefolia*(2%), and *Cinnamomum spp.*(2%)(Table 1). All Mokcheck(fence) logs and the well logs were identified as woods of *Pinus densiflora* or *Pinus thunbergii*. These two species could not be separated by wood anatomy.

2. Dendrochronological analysis

Ring-width patterns of the fence logs were not so well matched with each other. Using a few well-matched samples, we could make two patterns so-called 'submaster' chronologies. One pattern was made from three logs of southwestern fence; CHJS007A, CHJS008A, CHJS009A(Fig. 5 and Fig. 6).

The submaster II samples consisted of one southwestern wooden fence(CHJS004A) and two southeastern ones(CHJN022A, CHJN080B)(Fig. 7 and Fig. 8). Ring-width patterns of other 20 fence logs were not matched each other.

Discussions

Identified species in the Jang-do site are not so different from the present native plants grown in southern coast regions in Korea. The results indicate that the geographical distribution of plants ca. 1,200 years ago is similar to that of the present.

The numbers of tree rings were small, mostly 50-60 years. We made two submaster chronologies from the Jangdo site. Each submaster consisted of three timbers. Particularly, submaster II consisted of one log of southwestern fence and two logs of southeastern fences. It indicates that the felling years of these three logs are the same. We concluded that the wooden fences were constructed simultaneously at southwestern and southeastern sides of the Jangdo island.

From the results of tree-ring analysis, we found that most of logs used for wooden fences possessed different ring-width patterns. From this fact, we can suppose two situations. One is that the most of logs had different felling years. The other is that the logs had different origins (growing places). The latter does not seem to be realistic because there are no significant differences among the pine chronologies in Korea. We think that most logs of wooden fence were fallen in difference years. In other words, the fence's logs had been repaired frequently.

We could not find any evidence that some logs used for the fences were made from the same tree. If they were cut from the same tree, they will show nearly identical ring-width patterns. No tree-ring patterns in the Jangdo site were identically matched.

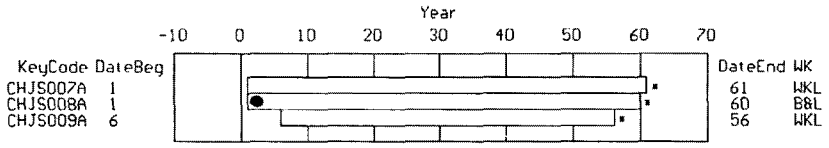

Fig. 5. Samples included in the submaster I chronology.

● : with pith, *: with bark
WKL : with bark and outmost ring with the complete latewoods.
B&L : with bark and outmost ring with the incomplete late woods.

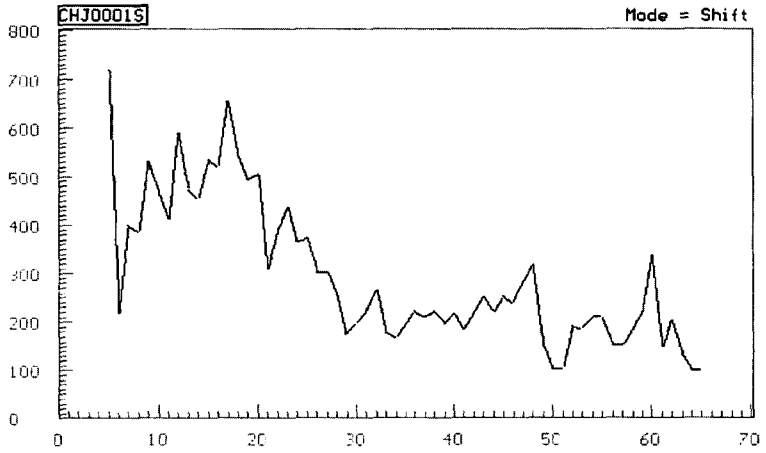

Fig. 6. The submaster I chronology(CHJ1S).

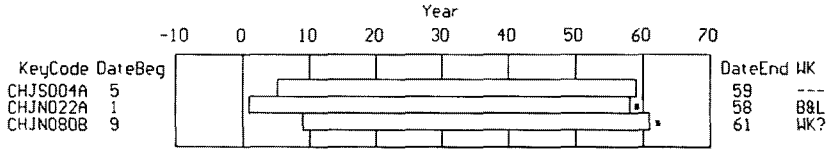

Fig. 7. Samples included in the submaster II chronology.

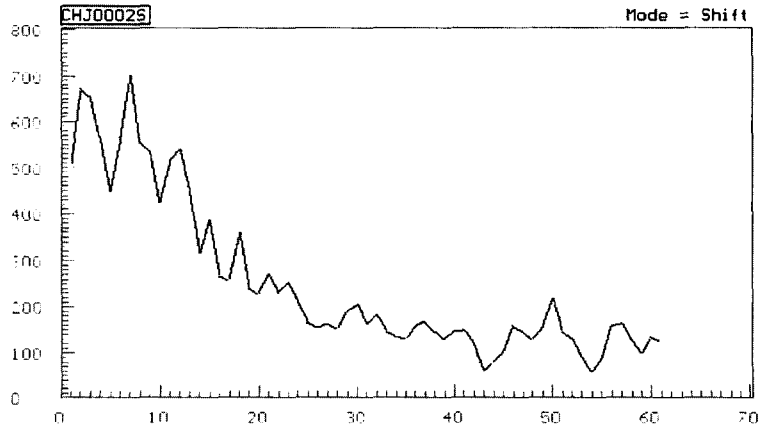

Fig. 8. The submaster II chronology(CHJ2S).

We concluded that only one log was made from one tree. In consequence, the heights of fences would be 3-4m at least if they did not discard too much portion of a log cut from a tree. At present, only ca. 60cm-logs are preserved under the ground (Fig. 3 and Fig. 4).

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