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Research paper

Pollen and sediment evidence for late-Holocene human impact at the Seonam-dong archeological site, Gwangju, Korea

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ABSTRACT

We present pollen and sediment evidence for late-Holocene human impact from the Seonam-dong archeological site in Gwangju in southwest Korea. Due to the lack of undisturbed profiles with high sedimentation rates, the relationship between the environment and agricultural activities has not been properly investigated in Korea using a paleoenvironmental approach. This study shows possible climate-induced changes in chestnut production, which was contemporaneously recognized by the Chinese as an important and unique local food source in southwestern Korea. Our results also show that human adaptation to climate change may have resulted in both the degradation and recovery of the local forest ecosystem in the study area. The data from the Seonam-dong archeological site provided evidence supporting the following hypotheses. 1) Chestnut cultivation declined from 400 BC to AD 200 (2350–1750 cal BP), as herbaceous crop production may have sufficiently expanded to sustain the population, possibly due to agricultural improvements and/or climatic amelioration. 2) Chestnut cultivation was enhanced from AD 200 to AD 800 (1750–1150 cal BP), probably to compensate for decreased herbaceous crop yields due to climatic deterioration. 3) The increase in chestnut cultivation led to forest disturbance and increased flooding, with intermittent forest recovery during periods of decreased cultivation.

1. Introduction

Scientists are increasingly interested in the impact of past climate change on human due to heightened concern over the recent global warming and its results. Various proxy data suggest that past climate changes have been powerful enough to cause the rise and fall of ancient dynasties (Weiss and Bradley, 2001; Haug et al., 2003; Zhang et al., 2008; Buckley et al., 2010; Patterson et al., 2010). Chinese cave records indicate that the stability of the Chinese dynasties over the last 1800 yr was highly dependent on the Asian monsoon (Zhang et al., 2008).

The effect of climate change on past human societies should also be detectable on the Korean peninsula, where civilizations began as long ago as ca. 4000 BP (Yoon, 2002). It is important to investigate the impact of past climate change on human lives to accurately predict how future climate change will affect us. It is also important to study the past environmental change induced by human activities to ensure the sustainability of our future generations. The aim of this study is to infer the impact of past climate change on human lives and anthropogenic impact on the environment in response to climate change in the southwestern part of the Korean peninsula during the late Holocene.

Prehistoric and historic agriculture on the Korean peninsula remains poorly understood, mainly due to a lack of reliable historical documents, archeological evidence, and proxy data. For example, the starting time and diffusion routes of rice agriculture have been hotly debated among Korean archeologists and geographers (Park, 2007). Low sedimentation rates and subsequent agricultural disturbance of the upper layers of sediment profiles make it difficult to obtain proxy data showing the mutual interaction between humans and the environment during the late Holocene. In Korea, the few related archeological studies have only used proxy data to infer agricultural history.

Fifty four ancient statelets collectively called Mahan occupied the study area during ca. AD 1–660. There is no extant Korean historical document on the lifestyle of the Mahan people, but the Mahan statelets are briefly mentioned in the Houhanshu, a Chinese historical document of the 5th century AD. The Houhanshu notes that chestnut fruits as large as Chinese pears were produced in great quantity (Lee and Lee, 2005). The production of chestnut must have been significant for the Chinese to comment on it in this short description of the Mahan statelets. However, chestnut cultivation in the study area has not attracted research attention from archeologists or palynologists due to the absence of any relevant proxy data. Recently, Kim (2011) reported an interesting shift in the arboreal composition around villages in his examination of carbonized and waterlogged wood. He concluded that chestnut trees became important at the expense of pine and oak

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trees because the Mahan people set a high value on chestnut trees as fuel, construction material, and food. In neighboring Japan, many palynologists are currently interested in a primitive form of chestnut cultivation, which is argued to have already begun in the Early Jomon Period (7000–5500 BP) (Kitagawa and Yasuda, 2004, 2008).

To reconstruct changes in the importance of chestnut trees that have been undetected in previous pollen records, we analyzed backswamp sediments from the Seonam-dong archeological excavation site in the Gwangju Metropolitan City in the south-western part of the Korean peninsula, where many waterlogged chestnut trees were found in the sediment. The study aims are 1) to investigate the alterations in land-use patterns and anthropogenic environmental changes in the Gwangju area through pollen and sediment analyses, 2) to infer hypotheses for the alterations and their relationship to the paleoclimate and historical events, and 3) to infer the meaning of the cultivation of chestnut trees in the study area.

2. The study area

The study site, the Seonam-dong archeological site (35°09′02″E, 126°46′28″N), lies within a backswamp of the Hwangryoung River, between the river to the south and Mt. Eodeung (340 m) to the north (Fig. 1).

2.1. Climate and vegetation

The climate of Korea is characterized by four distinct seasons, with a large temperature difference of about 25 °C between mean monthly temperatures in summer and winter and relatively high rainfall (1000–1700 mm per yr) concentrated mostly in the summer. Korea experiences both continental and oceanic climates due to its peninsular location on the eastern edge of Eurasia. The southeast summer monsoon brings hot and humid weather to the whole peninsula while the northwest winter monsoon brings cold and dry weather.

The study area, Gwangju Metropolitan City, is located in the southwestern part of Korea and its annual mean temperature and precipitation (1981–2010) are 13.8 °C and 1391 mm, respectively. The present climate of the area is strongly seasonal (Fig. 2). Seventy percent of the precipitation falls between July and October due to the summer monsoon. The mean monthly temperature ranges from 0.5 °C in January to 26 °C in August (Domestic Climate Data).

The Korean vegetation map proposed by Yim (1977) assigned the natural vegetation around the study area to the southern cool temperate forest zone consisting of *Pinus thunbergii*, *Carpinus tschonoskii*, and *Acer formosum*. Palynological studies showed that *Quercus* was the most important taxa in the study area, with an average of over 60% of the arboreal pollen sum during the Holocene Climate Optimum, and that *Alnus* was temporarily dominant until the frequencies of *Pinus* pollen began to increase 3000–4000 yr ago, which was indicative of agricultural disturbance (Choi et al., 2005; Park and Kim, 2011). Currently, *Pinus densiflora*, *Alnus firma*, *Castanea crenata*, *Quercus serrata*, *Quercus variabilis*, and *Quercus acutissima* are dominant tree species in Mt. Eodeung (Lee and Cho, 2011). The urban forest in Gwangju Metropolitan City mainly consists of *Quercus acutissima*, *Quercus xmccormickii*, and *Pinus densiflora* (Lee and Oh, 1995). The natural vegetation of the Gwangju area has been heavily disturbed by a long tradition of agriculture and by recent urbanization.

2.2. Human occupation of the area

Archeological investigations over the last two decades have revealed that human occupation in the Jeolla region, the southwestern province of Korea, started no later than circa 80,000 BP, as suggested by lithic tools and optically stimulated luminescence dating from Dangga, Chipyeong-dong, and Dosan (Lee and Lee, 2006). Starting from this early date, the archeological chronology of the region is divided into the Paleolithic period (ca. 80,000–10,000 BP), the Neolithic period (ca. 7000–3450 cal BP), the Mumun period (or Bronze Age) (ca. 3450–2250 cal yr BP), the Early-Iron Age (ca. 2250–1950 cal BP), and the Mahan and Baekje period (or the Three-Kingdoms period) (ca. 1950–1300 cal BP).

Despite the long history of human occupation in the region, there are few archeological sites predating the late phase of the Mumun period (ca. 2750–2250 cal BP). Trace evidence of human presence in the Neolithic and early Mumun periods is found mostly in the form of a few shell middens and rectangular pit-dwellings along the coastlines and large rivers. The number of sites soars during and after the latter half of the Mumun period, which presumably reflects the influence of intensified agriculture. The pit dwellings of this stage are typically circular

Fig. 1. Location map and aerial view of the Seonam-dong archeological excavation site, Gwangju city, SW Korea.