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Pollen-inferred late Holocene agricultural developments in the vicinity of Woljeong-ri, southwestern Korea

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ABSTRACT

The pollen record from Woljeong-ri in southwestern Korea reveals a vegetation history with high temporal resolution over the period from ca. 1950 BC to AD 310. The pollen profile is divided into four phases: zone 1 (ca. 1950–1220 BC), zone 2a (ca. 1220 BC–AD 200), zone 2b (ca. AD 200–290) and zone 2c (ca. AD 290–310). The abundance of *Quercus* (*Lepidobalanus*) and *Carpinus*, and the paucity of *Artemisia*, Cyperaceae and Poaceae in the initial stage suggest the dominance of deciduous broadleaved forest with little evidence of human interference. The reduction of deciduous broadleaved trees, particularly of *Quercus* and *Alnus*, and the abundance of herbaceous plants and cultivated Poaceae indicate increasing anthropogenic disturbance in the surrounding vegetation after ca. 1220 BC, which is probably attributable to agricultural expansion and the construction of rice paddy fields. This change temporally corresponds to the transition from the Neolithic to the Bronze Age across the region. The dominance of cultivated Poaceae continues in the subsequent period, and its amount increases markedly after ca. AD 200, along with the increase of *Pinus*. This implies that rice agriculture and anthropogenic disturbance on vegetation may have intensified at least a century earlier than the presumed emergence of state-level societies. The decline in rice agriculture, which is possibly related to the advent of drier climatic conditions, is suggested in the current pollen record after ca. AD 290.

1. Introduction

This paper presents palynological research from Woljeong-ri, an archaeological site located in the southwestern part of the Korean Peninsula (Fig. 1), and discusses its implications for revealing human-induced vegetation changes, ancient agricultural practices, and the development of complex societies in the late Holocene. In South Korea, considerable efforts have been made over the past few decades to understand long-term changes in vegetation, particularly for the last 12,000 years, and pollen research has contributed considerably to this realm of studies (Yasuda et al., 1980; Chang and Kim, 1982; Fujiki and Yasuda, 2004; Choi et al., 2005; Lim et al., 2007; Park and Yi, 2008; Yi et al., 2008; Chung, 2011; Park et al., 2012; Yi et al., 2012). The previous research has highlighted that vegetation over the Korean Peninsula was regionally variable, that vegetation went through significant temporal changes during the Holocene, and that these changes were induced both by environmental factors such as climatic changes, and by social factors such as agricultural activities. Because regional pollen databases are inevitably influenced by a multitude of factors, an interdisciplinary effort is necessary to better understand the observed temporal changes. The current research applies relevant archaeological information in an attempt to contextualize the pollen data sets with ancient socio-economic developments in the region, while acknowledging the possibility of climatically induced vegetation changes.

The pollen record from Woljeong-ri provides an interesting opportunity to examine the regional vegetation dynamics as it presents a continuous vegetation profile over the period from ca. 1950 BC to AD 310. Archaeological investigation across the study region indicates that over this time span the local population changed from sparsely populated hunter-gatherers to full-grown agriculturalists, and then to the constituents of emergent state-level societies with advanced agricultural tools. The southwestern region has traditionally been the granary in Korea, particularly of rice, with its vast tracts of flat and fertile land. It is therefore likely that the transition over these millennia, from a subsistence

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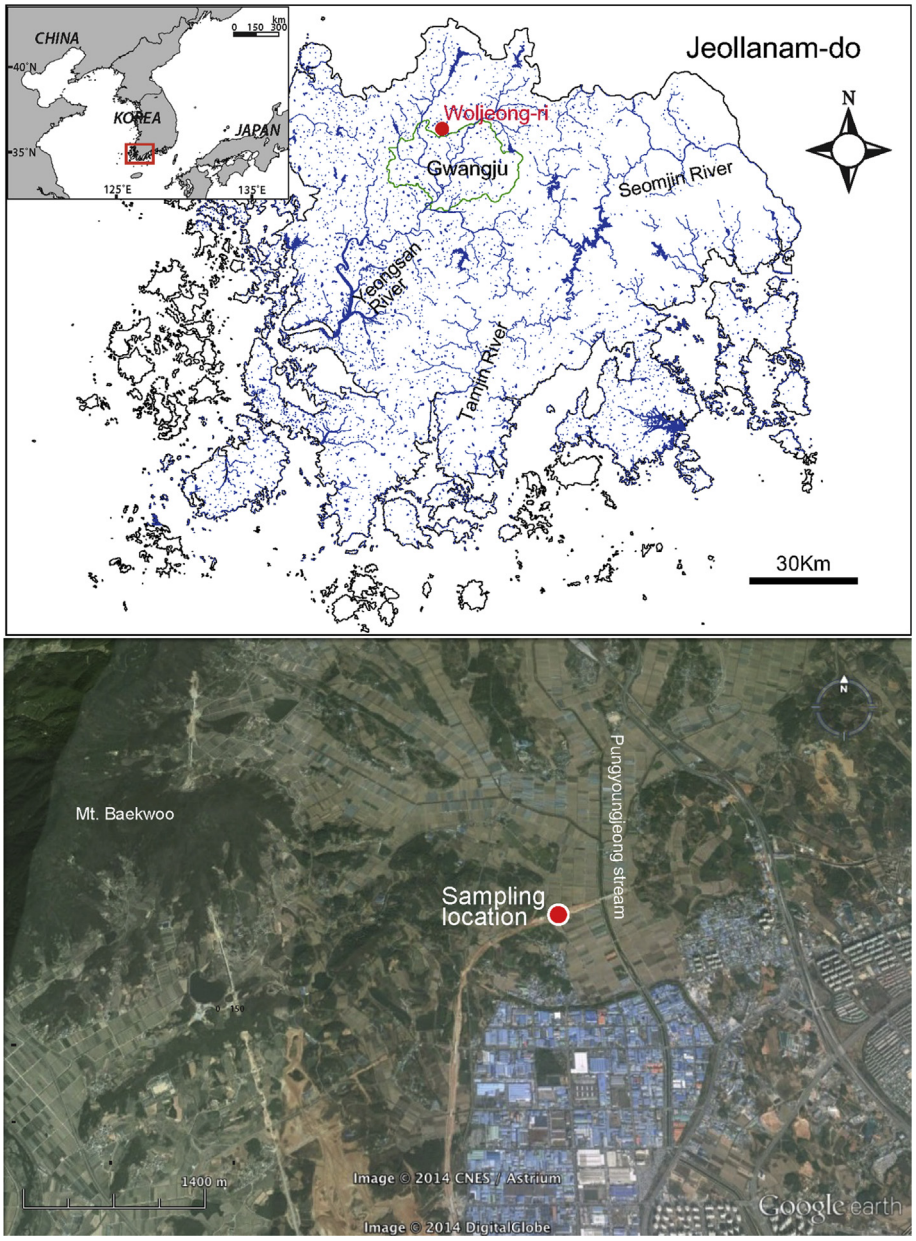

Fig. 1. Map and satellite image of the study site (source: Google Earth).

economy based on hunting, gathering, and fishing to farming, and then to an intensified form of agriculture, exerted different influences on local vegetation that are reflected in the pollen record. The current study presents a vegetation history based on pollen analysis and sheds light on the temporal dimensions in ancient human–environment relationships.

2. Regional settings

2.1. Climates and vegetation

The climate of the Korean Peninsula is characterized by four distinct seasons, with a large difference between mean monthly temperatures in summer and winter and relatively high precipitation concentrated mainly in the summer. The region experiences both continental and oceanic climates due to its peninsular location on the northeastern edge of Eurasia. The southeast summer monsoon brings hot and humid weather to the whole peninsula whereas the northwest winter monsoon brings cold and dry weather. The study area, Woljeong-ri, is adjacent to Gwangju metropolitan city in southwestern Korea and its annual mean temperature and rainfall (1981–2010) are 13.8 °C and 1390 mm, respectively. The present climate of the study site is highly seasonal. Seventy percent of the precipitation falls between July and October because of the East Asian summer monsoon. The mean monthly temperature ranges from 0.5 °C in January to 26 °C in August (Korea Meteorological Administration, 2014).

The Korean vegetation map proposed by Yim (1977) assigned the potential natural vegetation around the study area to the southern cool temperate forest, mainly consisting of *Carpinus tschonoskii* and *Acer formosum*. Pollen studies showed that *Quercus* was the dominant taxon in the study area, contributing an average of over 60% of all arboreal pollen during the Holocene Climate Optimum, and that *Alnus* was temporarily important until the