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# Wheat in ancient Korea: a size comparison of carbonized kernels

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ABSTRACT

Archaeobotanical research over the past decades has revealed that bread wheat of a compact form, called "Ezo wheat" in Japan, was present in the Far East Asian region (Primorye in the Russian Far East, the Korean peninsula, and the Japanese archipelago) during the early stage of wheat cultivation. In response to the previous observations, carbonized wheat grains from the sites in the southern part of the Korean peninsula were measured and their sizes were compared across these sites and with other sites in East Asia. The examination indicates that grains dated over the period of AD 100–600 were considerably smaller than the modern specimens but were plumper than the previously reported Ezo wheat. The new data sets suggest that wheat with plumper kernels was introduced to the region no later than the Three-Kingdoms period (ca. AD 300–668) and continued to be cultivated until the Joseon period (1392–1910).
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## 1. Introduction

*Triticum aestivum* L., known as bread wheat or common wheat, originated from the Fertile Crescent of Southwest Asia and was widely cultivated in East Asia no later than the second millennium BC. Wheat remains from Xishanping are dated to ca. 2700 cal BC (Li et al., 2007) and samples from Donghuishan produced various AMS dates of the early second millennium BC (Flad et al., 2010). Wheat seeds from a dozen sites along the Yellow River are associated with radiocarbon dates of the second millennium BC or earlier (Flad et al., 2010). Wheat cultivation spread further eastward to reach the Korean peninsula by the Mumun period (ca. 1500–300 BC) and the Japanese archipelago by the Yayoi period (ca. 800 BC–AD 300) (Crawford, 2011; Crawford and Lee, 2003). Archaeological specimens from East Asia have been identified as bread wheat (*T. aestivum*), although the possibility cannot be ruled out that some of them were free-threshing durum wheat (*Triticum turgidum* ssp. *durum*) (Flad et al., 2010).

Bread wheat is the most variable aggregate of cultivated wheat with a long history of cultivation (Zohary and Hopf, 2000), which raises the likelihood that multiple subspecies (or varieties) differing in grain size and morphology were present in East Asian history. Carbonized wheat seeds of three Chinese sites (Fengtai, Wangchenggang, and Wangjiazui) range in size from 2.28 to 5.40 mm long and consist of both compact and plump types (Zhao, 2010). The average dimension of the pre-Zhou-period (1250–1050 cal BC) wheat grains from Wangjiazui is 3.41 (length) × 2.54 (width) × 2.17 (thickness) mm, while grains from Fengtai (1650–650 cal BC) are larger, averaging 4.50 ($l$) × 3.09 ($w$) × 2.56 ($t$) mm. Both large-seeded and small-seeded wheat were present in ancient China and it has been suggested that the small variety taxonomically belongs to *T. aestivum* ssp. *compactum* (Zhao, 2010: 152). Previous research in China has revealed variation in wheat grain size even from the early stage of wheat cultivation.

Archaeobotanical research in the Far East Asian region, i.e., Primorye in the Russian Far East, the Korean peninsula, and the Japanese archipelago, has revealed that wheat with extremely small kernels was cultivated in the region between 1500 BC and AD 1000. A detailed account of this type of wheat was first made by Crawford and Yoshizaki (1987) through their examination of carbonized cultigens from the Sakushu-Kotoni site (AD 800–850), Hokkaido, Japan. They reported that carbonized wheat seeds from the site were an unusually compact type with mean dimensions of 3.4 ($l$) × 2.2 ($w$) × 1.9 ($t$) mm, and noted that the grains bore a morphological resemblance to Indian dwarf wheat (*T. aestivum* ssp. *sphaerococcum*), although the subspecies-level identification remained unresolved. The compact-type wheat, called "Ezo wheat" in Japan after an archaeological culture in Hokkaido, was reported from a number of Iron-age sites in the Russian Far East (Sergusheva, 2005); from Oun, Okbang and Pyeonggeo-dong in Korea (Crawford and Lee, 2003; Lee, 2011); and from Harunotsuji in Japan (Takamiya, 2004) (Fig. 1).

This paper adds to these earlier observations by providing more data assembled from recent excavations in Korea. In total, these previous studies suggest that only a subset among variable wheat

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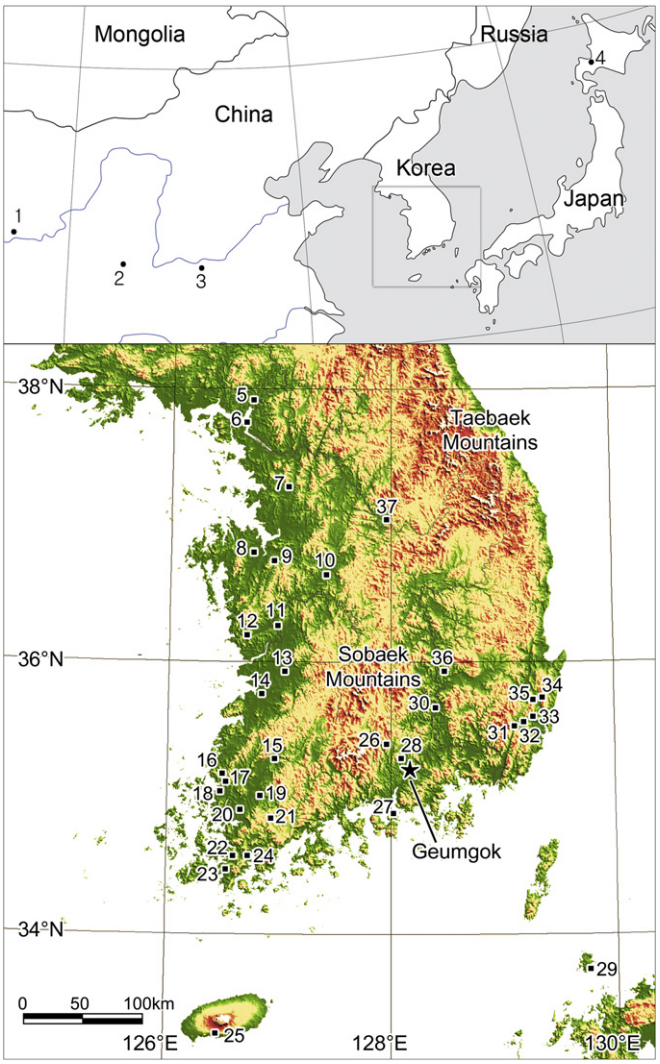


**Fig. 1.** Location of the sites mentioned in the text and/or reported to have carbonized wheat seeds (1. Fengtai; 2. Wangjiazui; 3. Wangchenggang; 4. Sakushu-Kotoni; 5. Janghyeon-ri; 6. Pungnap toeseong; 7. Gugal-ri; 8. Jagae-ri; 9. Sijeon-ri; 10. Yeonjae-ri; 11. Buso sanseong; 12. Pyeongra-ri; 13. Yongheung-ri; 14. Baeksan-seong; 15. Sinchang-dong; 16. Somyeong; 17. Jungrang; 18. Pyeonglim; 19. Podu; 20. Yangjang-ri; 21. Sangbang-chon; 22. Singeum; 23. Gungok-ri; 24. Yangyu-dong; 25. Yerye-dong; 26. Okbang; 27. Neugdo; 28. Pyeonggeo-dong; 29. Harunotsuji; 30. Dodong-ri; 31. Cheonsang-ri; 32. Gulhwa-ri; 33. Daun-dong; 34. Maegok-dong; 35. Cheongok-dong; 36. Chilgok Area 3; 37. Jodong-ri).

varieties spread from China eastward to the regions along the Pacific Ocean. Owing to a surge of rescue excavations and associated efforts to retrieve botanical remains, the finding of carbonized wheat has become increasingly common and more than thirty sites across the Korean peninsula have been reported to yield wheat seeds (Kim, 2008b; National Museum of Korea, 2006). Some of them have a large number of intact grains accompanied by reliable identification and radiocarbon dates, allowing a systematic inter-site comparison of grain size. In this study, grain dimensions are compared across the sites and the size variations are discussed in relation to the issue of compact-type wheat in ancient East Asia.

## 2. Materials and methods

### 2.1. Data collection

A review of the previous reports on archaeological wheat, which was carried out in the preliminary stage of this research, revealed that the reports were not necessarily free of identification problems. The most common mistake was to confuse bread wheat (*T. aestivum* L.) and barley (*Hordeum vulgare* L.). Both of these crops originated from the Fertile Crescent of Southwest Asia and started to be cultivated in the Korean peninsula almost simultaneously around the beginning of the Mumun period (ca. 1500 BC). As winter crops, they are usually sown and harvested in the same seasons of mid fall and early summer, respectively, and in many cases are found together in archaeological contexts. Seeds of these crops share some morphological similarities, including a furrow on the ventral size and an embryo sunken into a cavity. Although morphological similarities and co-occurrence in archaeological features often result in misidentification, the seeds are clearly distinguishable from each other based on a number of criteria (Jacomet, 2006; Kim, 2008b; Konishi, 2005b). Some wheat measurements were available prior to this study but not all of them were considered reliable because of this identification problem. The current study takes a rather conservative stance regarding this matter and only the measurements from Baeksan-seong (Ahn, 2011), Jungrang (Ahn, 2003), Neugdo (Heu et al., 2001), Sangbang-chon (Ahn, 2006; Kim, 2008b), and Yongheung-ri (Ahn and Ahn, 2008), which were presented with recognizable photographs and/or double checked by multiple researchers, were taken into consideration (Fig. 1). Assemblages containing less than thirty intact grains were also not included in the statistical comparisons.

In order to complement the existing data sets, wheat seeds from Pyeonglim, Singeum, Somyeong, Yangjang-ri, Yangyu-dong, and Yerye-dong were newly measured in this study (Fig. 1). These sites represent agricultural villages occupied between the first and seventh centuries AD (Table 1). Soil samples for the recovery of plant materials were collected from the floor of burnt dwellings and storage pits, and floated with a series of sieves ranging in aperture size from 0.5 to 4 mm. Wheat caryopses were sorted out from other charred crop remains and gently rubbed with a wet paintbrush to remove alien substance on the seed surface. If necessary, the retrieved seeds were washed with an ultrasonic cleaner for five to ten seconds before microscopic observation and measuring.

In addition to the early historical period sites of ca. AD 1–600, measurements were obtained from grains discovered from Podu, a site dated to the Joseon period (1392–1910) (Fig. 1). The site is situated on a riverbank and contains traces of furrowed agricultural fields. Flotation of the dry-field deposits was largely unproductive and only a handful of charcoal was retrieved across the site. The collected charcoal nonetheless contained crop remains, which were presumably carbonized during prescribed burning of agricultural fields or food preparation near the site. The AMS dates and associated ceramic fragments conform that the furrowed dry fields date to the Joseon period (Table 1).

As a reference material, fresh wheat was collected at Geumgok, Jinju, Korea, and carbonized using a muffle furnace. The collected specimen belongs to the short wheat variety of Korea (*Anjeun baengyi mil* in Korean), which is known to be the original donor of the "reduced height gene" (Rht8) to the modern Japanese and European bread wheat varieties (Borojevic and Borojevic, 2005). This traditional Korean landrace is now mostly replaced by the imported wheat varieties. Yet it is still grown on a handful of farms in the southern part of the peninsula, including Geumgok (Ahn, 2009) (Fig. 1). The wheat was cultivated, harvested, and generously donated for this project by Byeonghan Cheon. Measured by thousand-kernel weight, this landrace produces considerably small grains compared to other modern wheat varieties in Korea. The current samples were grown in a dry field on a riverbank and its production has benefited from the modern irrigation systems.

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