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# Craniofacial variation of the Xiongnu Iron Age nomads of Mongolia reveals their possible origins and population history

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## ABSTRACT

This paper examines Iron Age Mongolia during a time when nomadic tribes created the world's first steppe empire in Inner Asia. These aggregated tribes, known as Xiongnu (3rd century BC to the 2nd century AD), came to define steppe polity construction, later used by the Mongol Empire under the reign of Genghis Khan. They moved extensively over the eastern steppe and interacted, both in trade and intermarriage, with peoples from southern Siberia to Xinjiang. However, the Xiongnu as a people are relatively unknown to scholars, as they did not possess a written language. This study assesses Xiongnu population history and biological structure by analyzing craniofacial diversity via geometric morphometrics. Twenty-four coordinate cranial landmarks were used to test relationships among groups in the region and infer potential biological origins. The Relethford–Blangero R-matrix method was used to test hypotheses of phenotypic variation resulting from microevolutionary processes. This study hypothesizes biological continuity among Xiongnu individuals extending into modern Mongolian populations. Alternatively, long-range gene flow from adjacent geographic regions might suggest a complex population structure among the Xiongnu indicative of multiple populations controlling administrative functions. Results indicate the Xiongnu were potentially composed of at least two biologically distinct groups. Individuals from the elite cemetery of Borkhan Tolgoi (Egiin Gol) share their ancestry with a Bronze Age population from western Mongolia, and possibly, to a later migration of Turks, who came to rule the eastern steppe from the 6th to 8th centuries AD. The Xiongnu also evidence biological similarity with nomads from the Mongol Empire during the medieval period and modern Mongolians, as well as modern and ancient Central Asian, Chinese, and Siberian groups. These results are similar to ancient DNA studies that suggest a mix of Eastern and Western Eurasian haplogroups in the Xiongnu while also achieving consensus with models of steppe polity formation proposed by archaeologists who suggest local ties to extra-local groups through interactive exchange networks.

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## 1. Introduction

Genghis Khan (c. AD 1162–AD 1227) founded the Mongol empire in AD 1206, in what would later become the largest contiguous land empire in known history (Morgan, 1986). Stretching from Eastern Europe to the Sea of Japan, the Mongols ruled and conquered a vast array of peoples. Though the Mongol empire was

known for rapid territorial expansion with brutal conquering efficiency, they were not the first nomadic empire to rule from horseback. The Mongols are just one in a long succession of polities that ruled over the vast Inner Asian steppe beginning in the second century BC. Chinese historical records and more recent archaeological investigation indicate these small-scale societies aggregated into novel organizational forms as large-scale, hierarchically organized, integrated polities of pastoral peoples. This study concerns the first of those steppe polities, a group of nomads that resided in what is now central and northern Mongolia, though at their height, were known to control a large territory of Inner Asia. Chinese scholars referred to these Iron Age people as Xiongnu. However, the peoples of the Xiongnu were among several nomadic cultures to

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inhabit parts of greater Northern Asia throughout the Iron Age, including the Tagar and Pazyryk of Siberia and the Xianbei of Northeast China. Although these terms represent various aggregated tribes, peoples, and possibly ethnicities, Fig. 1 uses names ascribed to archaeological cultures in order to present potential interaction spheres amongst these nomadic peoples.

As a confederation established at the end of the first millennium BC and disintegrated sometime during the 2nd or 3rd century AD, there is still much that scholars do not understand about Xiongnu origins and its people. As a non-literate society, much information comes from sources written by Chinese historians during the Qin (BC 221–BC 206) and Han Dynasties (BC 206–AD 220). Though much of what we do know archaeologically and genetically come from a mortuary and burial context, very little research has been undertaken using skeletal quantitative traits in an effort to answer anthropologically important questions about origins, migration, and interactions with peoples in the greater Northern Eurasian region.

In addition, most researchers assume archaeological samples to be composed of biologically or ethnically homogenous individuals. Xiongnu as a single homogenous tribe can be contested using methods presented here and in combination with other studies using ancient genetic data. For example, Chinese accounts of the Xiongnu were often fluid and changed depending on the political dynamic at the time (Miller, 2009). In northeast China, some of the Hu groups became known as Xianbei, who it appears were subsumed under the label Xiongnu during the steppe polity's reign, but regained the label Xianbei after the collapse of the Xiongnu Empire. This example illustrates the nature of possible multiple ethnicities within the Xiongnu Empire as political or military circumstances changed.

The Xiongnu polity is the prototypical example of regional political organization on the northeastern steppe, defined as the territories of Mongolia, South Siberia, and Chinese Inner Mongolia

(Allard and Erdenebaatar, 2005; Honeychurch and Amartuvshin, 2006; Houle, 2010). Archaeological evidence of the Xiongnu comes from Mongolia and the Zabaikal'e region located along the Selenge River valley to the shores of Lake Baikal in southern Siberia (Allard et al., 2002; Crubezy et al., 2006; Wright et al., 2009). Xiongnu material culture has been radiocarbon dated and a firm chronological framework established (Hall et al., 1999). This material culture includes evidence for a complex and large-scale polity of pastoral nomads. The burials reveal a hierarchy of scale and mortuary style and complexity. Large, royal tombs were immense constructions tens of meters square and deep (Wright, 2006). The most common grave associated with Xiongnu material culture are stone ring burials between five and ten meters in diameter with a central shaft two or more meters deep at the center, usually containing a wooden or stone coffin.

Xiongnu graves are normally found in groups, ranging in size from a few burials to hundreds of structures of various sizes. Within the core area of Xiongnu control (central Mongolia), three-level size hierarchies appear within the defined cemetery types (Honeychurch, 2003). The first are large cemeteries containing massive square tombs and hundreds of associated ring graves. The second rank cemeteries include the so-called 'hundred grave cemeteries' such as Borkhan Tolgoi in the Egiin Gol valley of northern Mongolia and Baga Gazarynn Chuluu located in the Middle Gobi. We include several individuals from Borkhan Tolgoi in this study. Surrounding these second level cemeteries are smaller, more localized cemeteries, with spatially distinct burial locales with less than a dozen graves. Wright et al. (2009) suggest a regional system of hierarchy and political organization as evidenced in the material remains of grave goods found in both smaller cemeteries and larger elite cemeteries.

These non-local connections seem to connect inhabitants of smaller settlement sites to a larger system of external decision-making. Grave goods, such as silks, jade items, bronze mirrors,



**Fig. 1.** Iron Age archaeological cultures of Mongolia, NE China, and Southern Siberia discussed throughout the article. We present these as representative of potential overlap amongst these geographically disparate Iron Age nomadic peoples.

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