Humans, Animals and Societies of Andean Civilization

Rise of the Andean civilization: bioarchaeological approaches to health and death during the Formative Period in Peru

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Abstract The Andean civilization emerged in South America during the Formative Period (3000–50 BCE) and developed through renovation activities of ceremonial architecture. A collaborative team of Japanese and Peruvian archaeologists has been excavating an archaeological site with ceremonial architectures at Pacopampa since 2005. Pacopampa is one of the largest Formative Period sites in the Northern Highlands of Peru. This paper reviewed the previous studies of Pacopampa and reconstructed situations of health and death during an initial stage of the Andean civilization from a bioarchaeological perspective. Findings from several previous studies were summarized as follows: (1) bioarchaeological evidence supported the emergence of social stratification in the Formative Period; (2) social stratification promoted the difference in the proportion of dental diseases and stress markers between burial types; and (3) violence-related trauma was first observed at Pacopampa, which was highly likely to be caused by ritual practices. These findings will contribute to an elucidation of the impacts of social stratification on the inhabitants’ health.

Key words: Andes, bioarchaeology, Pacopampa, social stratification, trauma

Introduction

Bioarchaeologists have tried to clarify living conditions and health in former times using archaeological human remains from various regions and eras. These studies encompass the reconstruction of health, diets, demographics, and physique. Bioarchaeology has developed a foundation in the last two decades, based on an accumulation of skeletal collections in laboratories and museums, and the development of diagnostic methodologies for diseases and demographics, and population comparisons across different types of subsistence and social status (Larsen, 1997).

As the accumulation of skeletal collections permits us to compare populations in different subsistence (i.e. hunter-gatherers versus agriculturists) and social classes (i.e. higher and lower classes), recent advances in the bioarchaeology of Peru provide us with new perspectives to detect the impacts of subsistence and socioeconomic changes on diseases and death during an initial stage of social stratification.

Rise of civilization in the Central Andes

The Andean civilization was founded in South America in the Formative Period (3000–50 BCE). Public architecture was first constructed at Caral in about 3000 BCE, the beginning of the Formative Period (Shady et al., 2001). Japanese archaeologists performed the first expedition to Peru in 1958 and excavated the Kotosh site in the Central Highlands in the 1960s. This pioneering excavation revealed that the construction of ceremonial architecture in the Kotosh site preceded the manufacture of pottery, and renovation activities were the basis of the Andean civilization (Izumi and Terada, 1972). Moreover, the excavation of ceremonial architecture at Huacaclama and Layzón in the Northern Highlands showed that renovation activities of ceremonial architecture were important for social integration through collaborative labor; however, there was no evidence for social stratification. Meanwhile, evidence of social stratification was first demonstrated at Kuntur Wasi in the Northern Highlands: more than seven tombs with a boot-shaped structure were found to contain gold objects, Ecuadorian shell ornaments, and Bolivian sodalite beads, which suggests that social differentiation was based on the long-distance trade of precious goods (Inokuchi, 2001). An impressive array of ceremonial architecture was repeatedly rebuilt and renovated through collaborative labor without political control over surplus agricultural products in the Middle and Late Formative Periods (1200–250 BCE), at least in the Northern Highlands (Seki, 2014).

Pacopampa Archaeological Project

A collaborative team of Japanese and Peruvian archaeolo-
gists (directed by Yuji Seki, National Museum of Ethnology) has been excavating an archaeological site with ceremonial architectures at Pacopampa since 2005. Pacopampa is one of the largest Formative Period sites in the Northern Highlands at an altitude of 2500 m (Figure 1, Figure 2). Rafael Larco Hoyle conducted the first excavation in 1939. The Pacopampa site consists of three platforms associated with sunken courts and subterranean plazas (Figure 3) (Seki et al., 2008). The variety of foreign artifacts (i.e. shellfish objects, obsidian, and cinnabar) suggests that wide-ranging connections and patterns of exchange were essential to maintain the prestige of Pacopampa elites (Seki et al., 2008). However, the sunken court was sealed with thick layers of clay and stones, abandoned by the people of the Early Cajamarca Period (200–450 CE) (Nagaoka et al., 2019).
According to archaeological artifacts, architecture styles, and stratigraphy, the Pacopampa site is composed of two different cultural phases: (1) the Middle Formative Period (Pacopampa I phase, 1200–700 BCE), and (2) the earlier half of the Late Formative Period (Pacopampa II phase, 700–400 BCE).

Emergence of social stratification at Pacopampa

The Pacopampa Archaeological Project has excavated the remains of more than 100 individuals. One of the most interesting findings is the discovery of an elite tomb with a boot-shaped structure in cross-section (Nagaoka et al., 2012). This tomb contained a pair of gold earplugs, a pair of gold earrings, and shell objects that were brought from long-distance trades and belonged to the beginning of the Pacopampa II phase. The buried individual is a middle-aged female (nicknamed the ‘Lady of Pacopampa’) who exhibited a fronto-occipital type of artificial cranial deformation. The central position of the tomb and associated precious offerings indicated that the buried individual represented symbolic importance and belonged to a high-status group (Seki, 2008). As artificial cranial deformation was customarily performed during the first month of life (Ricci et al., 2008), this individual was presumed to have had a high status.

Subsequent excavation further yielded two individuals from an elite tomb at the center of the site (Nagaoka et al., 2020). This tomb had a boot-shaped structure with a broad bottom in cross-section. The remains of a 15-year-old male individual were found wearing a gold necklace made of ovoid gold beads and an oval pendant; mineral pigments (i.e., red cinnabar, dark red hematite, blue azurite, green malachite, dark silver magnetite, and white barite) were spread on the cranium. A middle-aged female was laid over the remains of the male. An associated ceramic stirrup bottle in the shape of a jaguar’s head and a serpent’s body gave rise to the nickname, ‘Serpent-Jaguar Priests.’ The occipital bone was vertically flattened, which possibly represented a fronto-occipital type of artificial cranial deformation. The presence of artificial cranial deformation, as well as a rich repertoire of grave goods in the tomb of the ‘Serpent-Jaguar Priests,’ is in accord with the emergence of social differentiation suggested by the ‘Lady of Pacopampa’ tomb.

Prevalence of dental caries reflecting subsistence and social stratification

Dental caries is a disease caused by focal decalcification that results from carbohydrate fermentation (Larsen, 1997). Carious prevalence exhibited wide variation according to subsistence (1.7% in hunter-gatherers, 8.6% in agriculturists, and 4.4% in mixed subsistence; Turner, 1979) and social classes (White, 1994; Klaus et al., 2010) because the use of carbohydrates in diets increased the prevalence of carious teeth.

The author obtained the pathological data of 738 permanent teeth at the Pacopampa II phase, 18.8% were carious teeth (Nagaoka and Morita, 2017), which exceeds that of the agriculturists (8.6%) reported by Turner (1979). It is safe to say that the Pacopampa people used domesticated plants and animals in their diets.

Nagaoka and Morita (2017) further compared the carious teeth ratio between Pacopampa and Kuntur Wasi. Kuntur Wasi is a ceremonial site located in the Northern Highlands at the western slope of the Andes. The chronology of the site is divided into Idolo phase (950–800 BCE), Kuntur Wasi phase (800–550 BCE), Copa phase (550–250 BCE), and Sotera phase (250–50 BCE) from the Formative Period, as well as the Early Cajamarca (200–450 CE) and Middle Cajamarca (450–900 CE) Periods. Its excavation was performed by a Japanese archaeological team from 1988 to 2002. The percentage of carious teeth found in Kuntur Wasi is 16.8% (139/826) in the Formative Period, which increased up to 32.3% (183/566) in the Cajamarca Period (Nagaoka and Morita, 2017). There is no significant difference between Pacopampa and Kuntur Wasi (Formative Period) \( (P > 0.05) \), while Pacopampa showed a lower prevalence of carious teeth than Kuntur Wasi (Cajamarca Period) \( (P < 0.01) \) (Nagaoka and Morita, 2017). Therefore, the ratio of carious teeth exceeds that of agriculturists (8.6%) both in Pacopampa and Kuntur Wasi (Formative Period) (Turner, 1979), and the reliance on domesticated plants increased from the Formative Period to the Cajamarca Period.

The emergence of public architecture in the Andean civilization led not only to social stratification but also to an increase in variation in carious prevalence according to social class. There is almost no dental caries in the three individuals from the ‘Lady of Pacopampa’ and the ‘Serpent-Jaguar Priests’ tombs, whereas individuals from less elaborate burials exhibited a higher prevalence of dental caries (Nagaoka et al., 2020). This is consistent with the previous studies (White, 1994; Klaus et al., 2010) showing less frequent carious prevalence in people with higher status than those with lower status in the Andes in the Middle Sicán Period (900–1100 CE) and Maya in the Classic Period (250–900 CE) due to less consumption of maize in diets.

Stable isotope analysis showed that individuals from elite tombs consumed less \( C_4 \) foods (e.g., maize) than those from other tombs in Kuntur Wasi during the Formative Period (Seki and Yoneda, 2005). If the social difference in consumption of \( C_4 \) foods could be applied to Pacopampa, it is reasonable to consider that the social difference in carious prevalence could be attributed to the exposure to cariogenic diets. However, the influence of \( C_4 \) foods on carious prevalence does have a limitation, because the use of such foods in the Formative Period was less compared to later years (Seki and Yoneda, 2005). Although the construction and renovation of ceremonial architecture led to social development, there was no immediate impact of social complexity on the decline in overall health at Pacopampa in terms of the prevalence of dental caries.

Cribra orbitalia as an indicator of physiological stress

This paper reviewed an earlier study of cribra orbitalia at Pacopampa (Nagaoka et al., 2018) and tried to reconstruct the living conditions surrounding Formative Period societies. In the context of bioarchaeology, stress is defined as a
physiological disruption caused by nutritional deprivation, and cribra orbitalia, enamel hypoplasia, and the Harris line represent stress indicators (Larsen, 1997). Cribra orbitalia is a pathological change with a cribriform aperture on the upper roof of the orbit, which is caused by marrow proliferation (Larsen, 1997). The etiology of cribra orbitalia includes thalassemia and sickle cell anemia, congenital anemia, and iron deficiency anemia (Aufderheide and Rodriguez-Martin, 1998). The cause of cribra orbitalia detected in Formative Period Peru is restricted to iron deficiency anemia induced by increased demands of iron at growth spurts, malnutrition, increased iron loss, disruption of iron intake, infectious disease, and chronic gastrointestinal blood loss. This is because genetic and congenital anemia did not occur in South America until contact with the Europeans (Blom et al., 2005).

The frequency of cribra orbitalia at Pacopampa is 11.1% out of 27 adult individuals (Nagaoka et al., 2018), which is lower than that of populations from the coastal regions in Peru (23.1%) (Blom et al., 2005). When the severity of cribra orbitalia was classified according to Stuart-Macadam (1985), all Pacopampa individuals showed light (66%) to medium (33%) degrees of severity (Nagaoka et al., 2018), whereas the coastal individuals were classified into light (62%), medium (26%), and severe (12%) degrees of severity (Blom et al., 2005). In terms of both frequencies and severity, Pacopampa individuals exhibited a milder degree of cribra orbitalia when compared with coastal individuals.

These observations are consistent with those of Hrdlička (1914) who showed that the prevalence of cribra orbitalia is higher in coastal regions than in mountains in the pre-contact era. Generally, the prevalence of cribra orbitalia increased with sedentism, high population density, increased use of maritime resources, and maize farming (Larsen, 1997). Consumption of raw or undercooked fish increases the risk of infectious diseases and promotes inhibited iron intake (Larsen, 1997). The difference in the prevalence of cribra orbitalia between Pacopampa and coastal individuals could be attributed to fewer parasite infections in the former than in the latter. On the assumption that auditory tori indicate cold-water stimulation in the ears (Kennedy, 1986), their absence in Pacopampa inhabitants demonstrated that these individuals were less engaged in maritime activities than coastal individuals.

**Early evidence of violence at Pacopampa**

Archaeological evidence of warfare and interpersonal violence consists of fortification, defensive architecture, settlement patterns, weapons, and iconography, whereas osteological evidence, such as decapitation, severing, modification, scalping, and depressed skull fracture, is the only and direct evidence of violent behavior in the past (Larsen, 1997). In bioarchaeology, the prevalence of fractures varies with age, sex, subsistence, and social class in North America: (1) males had a higher rate of fractures than females because they were more involved in warfare and violence; (2) elderly females had more fractures than elderly males because of decreased bone mass after menopause; (3) femoral neck fractures in the present day are frequently caused by an urban lifestyle, such as car accidents and falls; (4) the transition from hunting-gathering to farming decreased fractures because the incidence of accident-related fractures is less with a sedentary lifestyle than with a nomadic one (Larsen, 1997).

In the Central Andes, trophy heads were a favorite motif drawn on vessels in the Moche culture (100–800 CE) on the northern coast (Benson, 2001). Moreover, in the Formative Period, figures of warriors, weapons, and trophy heads were drawn in iconographies, e.g. warriors drawn on carvings at Cerro Sechin and trophy heads portrayed on a monolith at Kuntur Wasi (Benson, 2001). However, there is almost no bioarchaeological evidence of violence in the Formative Period.

Nagaoka et al. (2017) examined trauma and explored early violent behaviors that occurred at ceremonial centers at Pacopampa. Their results showed that 6 out of 103 individuals (5.8%) exhibited trauma in the Pacopampa I and II phases (Nagaoka et al., 2017). Depressed skull fracture was detected in one individual in Pacopampa I phase, whereas depressed skull fractures and facial fractures in two individuals, lower-limb fractures in two individuals, and elbow dislocation in one individual were detected in Pacopampa II phase (Figure 4) (Nagaoka et al., 2017). All observed trauma showed signs of healing (new bone formation and smooth rim) around the affected regions, which suggests the possibility that they were ante-mortem and the individuals survived after being wounded (Nagaoka et al., 2017). Although accidents and violence could cause limb-bone fractures and elbow dislocation, round depression fractures on skulls were highly likely to be caused by close-proximity assaults with sling stones or thrown rocks, and broken noses may have resulted from armed combat or fistfights (Arkush and Tung, 2013).

No trauma was evident in individuals from elite tombs; these fractures were concentrated in individuals from other
tombs. Although the relationship between social stratification and violence has not been fully interpreted, Nagaoka et al. (2017) concluded that ritual activities caused most of the exhibited trauma, because of the archaeological context (human remains with trauma were recovered from the site of ceremonial practices), as well as a lack of defensive architecture.

As for secular trends in trauma, the depth of depressed skull fracture was limited to the outer table of the cranium in the Pacopampa I phase, whereas it reached the cranial cavity in the Pacopampa II phase. When the frequencies of depressed skull fractures were compared between Pacopampa and subsequent eras, the former exhibited a lower prevalence of trauma than Conchopata (25.9%; P < 0.01), Beringa (33.3%; P < 0.01), and La Real (31.4%; P < 0.01) in the Wari culture (650–800 CE) (Tung, 2007).

Offering trophy heads in post-Formative Period activities

Nagaoka et al. (2019) provided early evidence of ritualistic offerings of trophy heads. The Pacopampa Archaeological Project excavated a sunken court and detected a post-Formative Period occupation in the Early Cajamarca Period (200–450 CE). The radiocarbon date of four isolated crania is from the latter half of the Late–Final Formative Periods (500–50 BCE), when the sunken court that functioned as a part of a ceremonial center was abandoned (Nagaoka et al., 2019). The offerings were composed of isolated human crania, miniature vessels, small gold accessories and sheets, copper needles, stone beads, an awl made of quartz and bone, and stone points. The sunken court was immediately sealed with layers of stones and clay after the rituals. The remains of six victims preserving the cranium, mandible, and cervical vertebra were excavated. All individuals showed that crania, mandibles, and cervical vertebrae were articulated when excavated. Cut marks were aggregated on the cervical vertebrae and mandibles for detaching heads from the posterior direction. The cuts to the vertebral arteries and spinal cords would be lethal if the victims were alive when sacrificed. The victims were all estimated to be young and middle-aged males, intentionally selected for decapitation. These cut marks showed similarities in location, direction, and shape, which implies that trophy heads were carefully prepared using a fixed method possibly by a professional decapitator. Based on osteological evidence, as well as archaeological settings and settlement patterns, Nagaoka et al. (2019) concluded that these individuals were highly likely to have been related to ritual practices, not organized warfare. The fact that the Formative Period heads were discovered in the Cajamarca layer might be explained by assuming that bodies that were already deceased were repeatedly used in the rituals (Nagaoka et al., 2019). The observed cut marks were early evidence of trophy heads and extends the chronology of this practice back to the past in the Northern Highlands of Peru (Nagaoka et al., 2019).

Future direction

This paper has reviewed previous bioarchaeological stud-ies of Pacopampa during the Formative Period in Peru to reconstruct patterns of human disease and death during the rise of the Andean civilization. The following tentative conclusions were obtained: (1) the emergence of social stratification was first demonstrated; (2) social stratification promoted the difference in the ratios of caries and cribra orbitalia between social classes; (3) violence-related trauma was first observed at Pacopampa, which was related to ritual practices rather than organized warfare. The construction and renovation of public architecture was the basis for social development in the Andean civilization and had a great impact on the overall health of the people during the initial stage of social stratification. The future direction of this study needs to contain perspectives of ancient proteomics, molecular paleopathology, stable isotope analysis, and zooarchaeology, which would contribute to the reconstruction of subsistence, disease structure, and the origins of organized warfare.

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Ethical considerations

The materials and methods used in this study did not include anything that required approval by the ethical committee of our institute.

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Declaration of interest

None.

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