

Mummies and dental health in the ancient Ilo valley, southern Peru

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In the very arid climate of southern Peru, archaeological remains, including many human burials, are extremely well preserved. Study of the teeth of mummified people from different cultural groups and time periods is beginning to provide evidence of diet and disease among the ancient inhabitants of the Ilo valley between the foot-hills of the Andes and the desert coast.

The small town of Ilo lies on the coast of southern Peru, some 130 km north of the border with Chile (Fig. 1). There is a large copper-smelting plant just outside the town, but Ilo is also a fishing port, with a large fishmeal industry. This part of Peru is at the northern edge of the Atacama Desert, famous for its extreme aridity. The desert coastline (Fig. 2) is magnificent, with long lonely beaches and crashing breakers, backed by an area of dry rocky hills known as the lomas. For much of the year, the coast and hills are blanketed in mist and fog, which allows a specialized type of lomas vegetation to appear during winter on the hilltops. The coastal waters teem with life, supporting huge densities of fish, shellfish and colonies of sea lions. These resources have long been the basis of human existence. On the coast at Kilometro 4, the highway cuts through a large ancient midden, packed with discarded shells and bones. The road inland from Ilo climbs a steep slope to a flat plain known as the pampa, where new areas of housing are being established, and then down into the Ilo (Osmore) valley, a strikingly green strip, cutting through the beige colours of the steep dry coastal hills (Fig. 3). The valley receives its water from the high Andes, near Lake Titicaca, and during the highland wet season (October to May) it experiences raging torrents. For the rest of

the year, the valley is watered by a more modest stream that is part of an irrigation system. The valley floor is intensively cultivated and has the longest history of olive cultivation in South America, including some of the oldest living trees, as well as much evidence for ancient irrigation agriculture in the form of channels and

systems of terraces. The valleys and hills of the lomas have long provided a range of gathered foods, and they also support a system of transhumance (the seasonal herding of livestock, particularly llamas).

On the low slopes on either side of the Ilo valley there are many archaeological sites, including cemeteries, settlements, and sometimes combinations of both. The whole coastal region is highly active tectonically and, in 2001, there was a major earthquake (8 on the Richter scale), with its epicentre just off the coast of southern Peru. Ancient graves are often revealed by earth tremors, which crack their covering of soil. Some local inhabitants (known as huaqueros) augment their living by recovering the beautiful pottery and textiles that the graves often contain as offerings. The huaqueros keep a sharp watch on the ground, and newly exposed graves may be disturbed overnight. This threat of looting



Figure 2 View northwest of the coast at Wawakiki, just south of Ilo. There is a multi-period settlement site on the promontory.



Figure 3 The Ilo valley, looking towards the highlands from the site of Chiribaya Alta. Down in the valley, the nearest farm on the right is Chiribaya, and beyond it in the distance is the village of El Algarrobal.



Figure 1 Location of Ilo and the Ilo (Osmore) valley in southern Peru.

is one of the reasons that Roxie Walker and Sonia Guillén established the Centro Mallqui–Bioanthropology Foundation Peru project in the village of El Algarrobal, in the valley near Ilo; “mallqui” is the word for mummy in the local Quechua language. The Centro Mallqui has a large secure store for the excavated mummies and for offerings from the graves. It also has facilities for study and for conservation, including an excellent x-ray laboratory, which is essential for studies of mummies. Next door is the Museo El Algarrobal which has fine displays of artefacts, mummies, palaeopathological specimens and particularly textiles. Dr Guillén has brought together a team of local people, South American students, visiting anthropologists, pathologists and radiographers, to excavate and study the large collection of material. In 2001 she invited me to join the team to work on the dental remains, and since then I have visited each year to work there.¹ The 2001 earthquake, which happened just a week after I left, has been one of the greatest challenges to the project in recent years. Fortunately, no-one was badly hurt, but the Centro Mallqui was severely damaged (with the exception of the store), and had to be rebuilt. However, it is now in full working order once again.

The archaeological context

The oldest sites in the area are from the Archaic Period (c. 6000–1000 BC, perhaps dating back as early as 8000 BC), and are characterized by large coastal middens of shell and bone such as the one at Kilometro 4. The Archaic is interpreted as a time when people were mainly coastal hunters,

gatherers and fishers, but increasingly incorporated agriculture into their way of life. So far, relatively few Archaic sites are known in the Ilo region, but the area just to the south at Arica in Chile, which is considered to be part of the same cultural area as southern Peru, is famous for the Archaic Chinchorro culture (c. 6000–2000 BC). The Chinchorro people were primarily hunters, fishers and gatherers, but they are distinguished as the makers of the earliest deliberately prepared mummies in the world, which can be seen in the excellent Museo Arqueológico San Miguel de Azapa, just outside Arica.

Sites of the succeeding Formative Period (1000 BC to AD 500) are more common near Ilo, including those of Chorrillos Playa and Roca Verde on the coast, and a scattering of sites in the Ilo valley. The Formative is marked by the first appearance of pottery, and by the establishment in the valleys of agriculture based on maize and beans, although it is clear that marine resources remained important. However, most of the sites in the Ilo valley are of much later date. Between about AD 300 and 1200, a state grew up in southern Peru, northern Bolivia and Chile, centred on the city of Tiwanaku on the southeastern shore of Lake Titicaca in Bolivia (Fig. 1). The basis of the Tiwanaku economy was both pastoral and agricultural, including a system of raised fields that allowed them to cultivate the Titicaca wetlands and protect their crops against frost. The Tiwanaku state reached its maximum extent about AD 700. By then, Tiwanaku settlements were established in the coastal valleys, but their relationship with the previous occupants

is not clear. It is possible that the valley settlements provided crops that need to be grown at lower altitudes, such as maize, beans and chili peppers, as well as resources from the coast such as dried fish and shellfish. In the Ilo valley, there are many Tiwanaku settlements and cemeteries. The burials are characterized by small deep pits, circular or square in plan, which usually incorporate a seated mummy, by distinctive and attractive decorated pottery, and by a unique form of four-pointed knotted wool hat, apparently worn by members of the elite.

The influence of the Tiwanaku state collapsed about AD 1000, and many of the villages in the Ilo valley seem to have been destroyed. The pottery and textiles in the settlements and cemeteries were replaced by quite different forms of what is known as the Chiribaya culture, named after a farm near El Algarrobal, which is the oldest surviving farmhouse in the area. Chiribaya pottery has a very characteristic motif of curved lines of white dots, outlined on either side in black. The burial pits are usually larger and have a more elongated rectangular plan than the Tiwanaku pits. They often contain offerings of fishing and hunting equipment, emphasizing the role of the sea in the lives of the people. Mummies of high-status Chiribaya men have long hair, braided into very complex styles. Chiribaya sites continue until AD 1400, when the region came under the domination of the Inca state.

Excavation of the cemeteries takes place

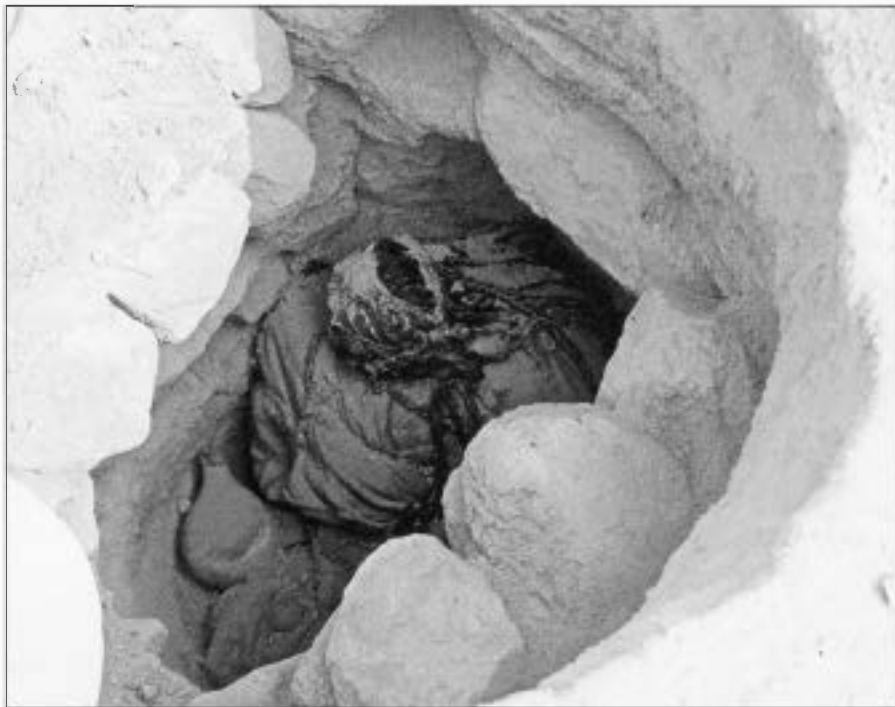


Figure 4 A Chiribaya burial at Loreto Viejo in the Ilo valley. The mummy bundle is in a stone-lined chamber, and an offering of a pottery vessel can be seen lower left. The large stones that covered the chamber have been partially removed.



Figure 5 The same Chiribaya mummy bundle shown in Figure 4, removed from the pit. It is wrapped in a blanket-like textile, bound with cord, and the elaborate braided hair shows it to be a man.

during the winter season, when it is cooler. Burial pits are located by variations in texture and colour of the soil, but it is often possible to smell a mummy before you see the top of its pit. The smell is usually not unpleasant, but it is very strongly penetrating. Burials vary, but many are in narrow and deep stone-lined pits, under a covering of large stones. Often, the mummy bundles and offerings remain intact inside the pit (Fig. 4). They have to be lifted out, usually by the person excavating hanging upside down in the pit while someone holds their feet. Once the mummy bundle is out, the astonishing preservation is apparent (Fig. 5). The climate is so dry that, even without any artificial mummification, skin, tendon, organs, nails and hair all survive. Similarly, many kinds of organic objects are preserved: textiles of plant and animal fibres, wooden bows and harpoons, food offerings and leather. Stone points are still attached to arrows with binding and resin. The colours in the textiles are extraordinarily vivid after they have been cleaned. Even a feather head-dress has survived. Paradoxically, this preservation can make study of the teeth difficult because they are covered by preserved soft tissues; but good x-rays help, as does endoscopy (the use of a fibre-optic instrument to look inside body cavities), and the mouth is often open enough for the teeth to be seen.

The dental research project

The lower Ilo valley has yielded hundreds of Tiwanaku and Chiribaya mummy bundles, and the human remains (skeletons only) of Formative burials from the coast are also stored at Centro Mallqui. The evidence of offerings in the burials, and from excavation of settlements and field survey of cultivation terraces, suggests a varying degree of dietary reliance on maize-bean agriculture, llama pastoralism, and marine mammals, fish and shellfish from the coast. My role has been to design a project to see if these contrasts can be demonstrated in the remains of teeth and jaws from these different periods and cultures.

Dental disease is strongly affected by the amount and type of carbohydrate in the diet. In the twentieth century, rates of dental caries (tooth decay) were directly related to the annual sugar consumption of different populations. Starch is also involved, although its role is less clear. In prehistoric North America, dental caries increased markedly as maize agriculture was gradually adopted, a process that has been monitored very closely by analysis of stable carbon isotopes in human bones and teeth.² In the Peruvian project I therefore start with the hypothesis that variation in the consumption of maize will be reflected by variation in rates of caries.

Another factor to take into account is wear of the teeth. In different cultural contexts and parts of the world there is considerable variation, not just in the rate of wear but also in its pattern. The teeth of

ancient agriculturalists may show heavy wear, by comparison with modern people, but the teeth of hunters, gatherers and fishers typically display even more striking wear. In addition, tooth wear often shows irregularities that are thought to represent the use of teeth for a variety of purposes other than eating. I have, for example, previously seen evidence of extreme and highly distinctive wear on the teeth of the remains of coastal foragers of the Californian Channel Islands, off the coast near Santa Barbara. My second hypothesis for the Peruvian project is therefore that the role of coastal hunting and fishing will be reflected in the tooth wear of individuals from the burials around Ilo. I hope also to investigate the role of marine foods by using stable-isotope analysis.

My third working hypothesis is that variation in food resources, whether people lived in settled or migratory communities, and other aspects of the environment in which children grew up, would have had

an effect on their growth and development. Rates and patterns of growth in body size are frequently used today to monitor the health of children. It is difficult to do this directly from archaeological remains, because of the lack of a method for estimating age that is itself independent of growth. Instead, however, it is possible to show the effects of growth being disrupted in childhood by studying tiny defects in the enamel of the tooth crowns. Diseases and dietary deficiencies during the first six years of life leave their mark as clear defects, and the layered growth of the enamel can be used to determine the age at which these defects were caused.

Dental diseases are strongly related to age, and vary greatly between different parts of the mouth, so it is necessary to record a great deal of information for each individual to account for these effects. I have devised a recording system and have been teaching South American students how to use it. Some of the recording I have



Figure 6 A lower jaw from the Formative Period site of Roca Verde on the coast. The molar teeth are heavily worn, with strongly sloping wear facets. Exposure of the pulp and root canals in the first molar (third tooth from the right) has caused inflammation of the bone around the tips of the roots.



Figure 7 Another jaw from the Roca Verde site, showing very irregular wear.

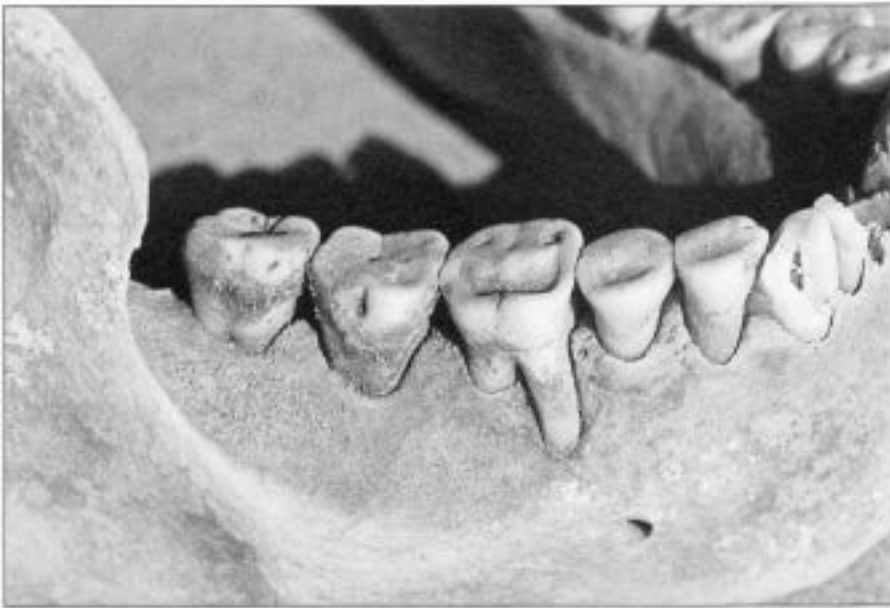


Figure 8 A lower jaw from *el Descanso*, a Tiwanaku site in the Ilo valley. The wear is still heavy, but much more regular than in Figures 6 and 7. The second molar (second tooth from the left) has a small lesion of dental caries – the dark stained pit in the side of the crown. Some bone has been lost around the roots, and there are moderately heavy deposits of calculus, suggesting the pattern of periodontal inflammation that is possibly associated with coca chewing.



Figure 9 A Chiribaya lower jaw from *Chiribaya Baja* in the Ilo valley. The rest of the skeleton shows this to be a middle-age man, but the teeth are already substantially worn. The black, stained deposits of calculus on the molars and premolars also suggest the periodontal inflammation possibly associated with coca chewing.

already done, and some is being completed as part of a student project. It is a process that will take years, because there is a great deal of material to record, and the observations recorded are very detailed. We have already recorded the Formative material from the sites of Roca Verde and Chorillos Playa, and are progressing through the much larger group of Tiwanaku and Chiribaya remains. In general, the Formative Period teeth do show the expected very heavy wear (Figs 6, 7). It seems that strong forces were applied

between the teeth, causing very sloping facets of wear and fracturing, which exposed the tooth pulp to infection. Dental caries is uncommon in the Formative material. Tiwanaku and Chiribaya material (Figs 8, 9) also shows heavy but more regular wear, the wear facets are less strongly tilted and there is also more evidence of dental caries. However, it is too early in the project to determine the extent of the differences between the two periods. A distinctive feature, particularly of Chiribaya dentitions, is a kind of periodontal

disease that causes loss of the supporting bone around the molar and premolar teeth (Fig. 9). The teeth are often coated in a darkly stained calculus or tartar, and one side is more affected than the other. This may be the result of the chewing of coca leaves. Many Chiribaya burials have woven bags, containing coca leaves, as offerings. Today, the leaves are mixed with ash or lime, chewed into a wad and then held in the cheek. During a lifetime, this might well have an irritant effect, although the exact mechanism is not understood. Coca is grown in the highlands, so some contact would have been needed to maintain a supply. Eventually, this periodontal condition leads to loss of teeth.

As our database of dental records grows, we are looking for other comparisons to make elsewhere in Peru. Another major collection of mummies is in the other base of Centro Mallqui, at Leymebamba near Chachapoyas in the cloud forest of the northern highlands of Peru.³ The Chachapoya culture dominated the area from AD 800 until it was conquered by the Inca in the 1470s. Chachapoya territory is marked by circular stone settlements, and tombs high on cliffs. Two hundred mummies from tombs built on a cliff ledge above the remote Laguna de los Cóndores are now in the Museo Leymebamba. The highland plants they cultivated and the lack of marine resources contrast strongly with the Chiribaya, so they will make a good comparison for our continuing study of dental pathology in southern Peru.

Notes

1. This is a collaborative project with the Centro Mallqui–Bioanthropology Foundation Peru. I am very grateful to them for their support. Many people associated with the project have given their time to advise me, show me the sites and the region, give me experience of excavating the mummies, and help me work on the material. I wish especially to thank Sonia Guillén herself, Marvin Allison, Elsa Tomasto and María Concepción Godoy Allende, all of whom are deeply involved in the study of the human remains.
2. See, for example, C. S. Larsen, R. Shavit, M. C. Griffin, “Dental caries evidence for dietary change: an archaeological context”, in *Advances in dental anthropology*, M. A. Kelly & C. S. Larsen (eds), 179–202 (New York: Wiley-Liss, 1991) and C. S. Larsen, D. L. Hutchinson, M. J. Schoeninger, L. Norr, 2001. “Food and stable isotopes in La Florida: diet and nutrition before and after contact”, in *Bioarchaeology of Spanish Florida: the impact of colonialism*, C. S. Larsen (ed.), 52–81 (Gainesville: University Press of Florida, 2001).
3. For information about the Centro Mallqui at Leymebamba, visit its website at http://centromallqui.org.pe/ley_index_en.htm.