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

Figure 2 View northwest of the coast at Wawakiki, just south of Ilo. There is a multiperiod 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.
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 valley near Ilo; "mallqui" is the word for the Quechua language.

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.
been monitored very closely by analysis of 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.

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. The Chachapoya culture dominated the area from AD 800 until it was conquered by the Incas 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.